Main pictures on the cover page are CEFIPRA’s 30th year logo and supported project numbers 3800-W1; 4604-4; 5103-1; 5108-1; 5204-2; 5304-1; 5307-1; 5408-1 FIRST and TILLING projects implemented under CSRP & IARDP.
Indo-French Centre for the Promotion of Advanced Research (IFCPAR)

Centre Franco-Indien pour la Promotion de la Recherche Avancée (CEFIPRA)

Annual Report 2016-17
It gives me immense pleasure to present the Annual Report of the Indo-French Centre for the Promotion of Advanced Research (IFCPAR/CEFIPRA) for the financial year 2016-17. CEFIPRA being at the nucleus of Indo-French ecosystem for promoting Science, Technology and Innovation enjoyed the unique position as an enabler and facilitator for various initiatives in Science, Technology & Innovation (S,T&I) and successfully accomplished its annual activities during 2016-17.

In this year, CEFIPRA also welcomed the new Ambassador of France to India, H.E. Mr. Alexandre Ziegler and with his valuable guidance and support, we are working closely towards strengthening the activities of CEFIPRA, based on Indo-French joint research and development.

Across the years, CEFIPRA’s role has evolved a lot from funder to catalyzer and for providing valuable visionary guidance and potential future roadmap for the Centre, a Vision Group was formulated and revised again. First & second meetings of the Revised Vision Group and meetings for reviewing the Memorandum of Association (MoA) & Byelaws of the Centre were organized during this year, as the MoA and Byelaws were dated 29 years back.

As new initiatives during the year, CEFIPRA also constituted a Standard Expert Panel (SEP) for mentoring and monitoring of Principal Investigators on Intellectual Property related issues and also prepared guidelines for Conflict of Interest (CoI) for members of Scientific Council (SC) and Industrial Research
Committee (IRC). The CEFIPRA’s new website was launched to provide new design, features and a user friendly outlook with lots of information for improving communication with the users. This year, CEFIPRA signed a LOI and initiated an Indo-French Programme between Technology Development Board (TDB) and Bpifrance to foster technological exchange and collaboration between the two countries in the identified areas of Aeronautics, Automotive and Biotechnology with special emphasis to Health Biotechnology.

Looking into the growth of S&T ecosystems and increasing emphasis of respective governments on innovation for social goods, we provided the platform to national funding agencies for different Targeted Programmes and also encouraged private sector entities to utilize this platform for strengthening the knowledge wealth transformation pathways. During the year, the Centre also supported 5 seminars/workshops in different areas of S&T like Processing and Recycling of Rare Earths, Advances in Phase-Change Thermal Systems, Pressure Effects on Strongly Correlated Materials, Epigenetic Mechanism of Male Germ Cell Maturation and Early Development and Catalysis by Design using NMR.

Fourth Annual Lecture Series of CEFIRA by the eminent Indian Scientist, Prof. D. D. Sharma, IISc., Bengaluru was also organized and three lectures were delivered by him at different institutions in France. Similarly, for various deliberations, delegation from Mission of CEA Sciences Division (DRF), Ecole Normale Superior (ENS), Institut National de la Proprieten Industrielle (INPI), Inria, ANR from France and officials from Dassault Aviation and French Company-Tereos visited CEFIPRA during this year. Through our dedicated mobility support programmes for young Doctoral/Masters students and mobility under different scientific programmes, hundreds of scientists/researchers got exposure of the S&T systems of each other’s labs & institutions for ensuring sustainability of the bilateral S&T ecosystem.

On this note, I wish to put on record our sincere thanks for the tremendous support and valuable guidance rendered by the former Ambassador of France to India, Mr. Francois Richier during his tenure and I would also like to extend my gratitude to both the Co-Chairs, Members of Governing Body, Scientific Council (SC) and Industrial Research Committee (IRC) and all those who have been associated with CEFIPRA and its activities with the hope that our commitment and their continued support will harvest more opportunities and far reaching image of the Centre in strengthening of the Indo-French cooperation through collaboration in the areas of Science, Technology & Innovation between the two countries.

Dr. Mukesh Kumar
Director, CEFIPRA
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I. Overview & Activities of the Centre
Overview & Activities of the Centre during 1st April, 2016 to 31st March, 2017

Indo-French Centre for the Promotion of Advanced Research (IFCPAR/CEFIPRA), a bi-national organization, set up by Governments of India and France commenced its activities in 1987 with the mandate to promote collaborative research between India and France in cutting edge Science and Technology through research projects, seminars/workshops and encouraging Public Private Partnerships (PPPs).

Growing from people-to-people interaction in 1987 to institutional-to-institutional linkages, CEFIPRA has redefined its role from more of a funder to a facilitator or catalyst, while strengthening its programme profile across the knowledge innovation chain. The same has also been achieved by involving more programmes in its portfolio, funded through National Funding Agencies of India and France. The Centre is now close to achieving another landmark, which is the completion of its 30 years in 2017, as a service to Indo-French S&T community. Furthermore, in the context of this land mark to be achieved soon; the Vision Group was revised by both the Governments as per the decision of the 29th Governing Body meeting.

The first meeting of the revised Vision Group was organized on 2nd September, 2016 at CEFIPRA Office with recommendations/suggestions to have assessment of CEFIPRA's programme profile for further deliberations. Subsequently, second meeting was organized on 27th January, 2017 at CEFIPRA Office wherein, its programme profile was discussed on various parameters and recommendations were presented in 30th Governing Body meeting held on 6th March, 2017 at Paris. The Centre is gearing up for celebrating its 30 Year Anniversary in 2017-18. The Centre in the span of three decades has grown its activities, from three core activities to nineteen under core and non-core programmes.

Collaborative Scientific Research Programme and Projects

The 57th & 58th Scientific Council (SC) meetings were held on 17-20th May, 2016 at Tour, France and on 23-25th November, 2016 at Varanasi, India, respectively. Under the Collaborative Scientific Research Programme (CSRP), 10 proposals were recommended by 57th SC and 6 proposals by 58th SC. These were in the domains of Pure and Applied Physics (5), Materials Science (3), Life and Health Sciences (3), Pure and Applied Chemistry (3), one each in Earth & Planetary Sciences, Mathematics and Computational Science. Besides these new projects, CEFIPRA continued supporting fifty ongoing scientific projects. Mobility of hundred and five scientists and twenty two students was supported between the two countries. Twenty two completed projects during the year have outcome in the form of development of resources like libraries, new methods, data collection etc. During the year, around one hundred forty publications in SCI journals were reflected as global scientific output. The Centre had also analyzed the scientific output of the projects completed during 2016 and 2017. These papers were published in Science Citation Indexed Journals with a high impact factor such as Nature Communications, Nucleic Acid Research, Current Opinion in Structural Biology, Physical Review Letters and Chemical Communications etc.

Industry-Academia Research and Development Programme and Projects

The 28th and 29th Industrial Research Committee (IRC) meetings were held on 20-21st May, 2016 at Tours, France and on 26-27th November, 2016 at Varanasi, India, respectively. During the year, 5 proposals were approved out of fifteen proposals with three in 28th IRC and two in 29th IRC meetings. During the 28th & 29th meetings, the Committee had a discussion on submission of the IP Management Plan and creating a favourable environment for involving Small Industries, SMEs & Start-ups for making collaboration and scouting more proposals under Industry Academia Research and Development Programme (IARDP).
Seminars/Workshops

The bilateral knowledge space had been further catalyzed through supporting five seminars/workshops/training schools in the areas of E-Waste, Phase-Change Thermal Systems, Materials Science, Epigenetics and Early Embryonic Development etc. Through five seminars, the Centre brought hundreds of scientists/students/researchers from India and France together to share the knowledge in the advanced areas for planning of future collaboration. There was overwhelming appreciation of the support and encouragement from CEFIPRA in fostering scientific exchange and collaborative research between Indian and French scientists.

Outreach Programmes

CEFIPRA also conducted Outreach Programmes with an aim to reach and create more awareness on its expanded activities in support of Indo-French Science and Technology Cooperation.

During the year, CEFIPRA conducted the 4th Lecture under its Annual Lecture Series which was delivered by Prof. D. D. Sarma, IISc, Bangalore at College de France, Paris on 27th June, 2016, at École Polytechnique, Palaiseau on 29th June, 2016 and CRISMAT, Cean on 30th June, 2016. An Outreach Programme was also organized by CEFIPRA during Annual Lecture Series in Paris & Cean in June, 2016. Further, Outreach Programmes were organized by CEFIPRA after the SC & IRC meetings held in November, 2016 at Varanasi.

Targeted Programme

The Centre has continued to offer a platform to the National Funding Agencies to come together and support collaborative scientific research in focused/targeted areas of mutual interest. The following Targeted Programmes expanded the mandate of CEFIPRA across the knowledge innovation chain.

**DST-ANR:** During the year 2012, DST-ANR targeted programme was initiated for fostering collaboration between scientific communities of two countries in specific thematic areas of Science & Technology over the period of 3 years. Currently, six projects are ongoing in the areas of Infectious Diseases, Neurosciences and Engineering Sciences. The projects were funded by DST in India and by ANR in France.

**DST-Inria-CNRS:** This targeted programme was initiated during 2013 in the areas of Big Data, Cyber-Physical Systems, High Performance Computing, Embedded Systems, Reliable and Scalable Computation, Computer Science for Biology and Life Sciences, Cyber Security and Machine Learning etc. Currently, 12 projects are ongoing. The 4th Call for Proposals-2016 in the areas of High Performance Computing, Big Data Analytics, Internet of Things (with focus on smart cities), Artificial Intelligence and Machine Learning was launched in July, 2016. A total of 24 proposals were evaluated in a meeting of the expert committee held in December, 2016 and 7 proposals (6 with CNRS and 1 with Inria) were recommended for further consideration. Further, a joint meeting of the funding agencies was held in January, 2017 at CEFIPRA Office, New Delhi and 4 proposals (3 with CNRS and 1 with Inria) were finally selected for support.

**DST-INRA:** The programme focused in the area of integrated water management in agriculture in the context of climate change. The project on “Adaptation of irrigated agriculture to climate change” was implemented under this targeted programme and reviewed finally with “Excellent” grade.
High Impact Scientific Research Network Programme

CEFIPRA has started High Impact Scientific Research Network Programme in order to harvest the strength of the network of scientists and scientific groups in all areas of interest in Science & Technology between India and France with special emphasis in the areas of Optics, Nano Sciences, Cold Atoms, Synchrotron Science, Computer Science & Bio-informatics, Energy Storage Devices, Metabolic Disorders and Infectious Diseases.

Presently, two proposals in the areas of High Energy Physics and Health Sciences are being supported. The progress of the following projects was reviewed during 58th meeting of the Scientific Council at Varanasi in November, 2016 and was found satisfactory.

- Indo-French High Energy Physics Network
- International Study on Atypical Haemolytic Uremic Syndrome

Dedicated Mobility Support Programmes

In order to strengthen the supply chain of human resource and skill enhancement across the knowledge innovation chain, under the already existing programme, the Centre has three mechanisms as mentioned below.

**Raman-Charpak Fellowship:** The programme aims at improving the doctoral skills of Indian and French students by providing them an opportunity to carry out part of their research work in a University / Research Institute based in France or India, respectively.

During the year 2016-17, the programme was renewed by 29th GB and was also opened to French Masters students. For the Call launched in April, 2016, a total of 211 applications were received. Two-tiers Selection Committee meetings (Preliminary and Final) were held in July, 2016 and August, 2016, respectively wherein 25 Indian and 6 French students (1 regretted later) were awarded the fellowship.

**CEFIPRA-European School on Nanoscience and Nanotechnology (ESONN) Fellowship** – Three weeks fellowship programme aimed for training to doctoral and junior scientists has provided an exposure to young researchers in the areas of Nanoscience and Nanotechnology.

For ESONN Session - 2016 (13th edition) which was held from 28th August to 17th September, 2016 in Grenoble, France; 110 applications were received and evaluated by Expert Committee in its meeting held in June, 2016. A total of 8 Indian doctoral students were awarded and supported under the CEFIPRA-ESONN Fellowship 2016. Call for Applications was launched in March, 2017, after consultation with ESONN.

**CEFIPRA-SOLEIL Synchrotron:** In an effort to utilize large scale scientific facilities available with India & France for the scientists/researchers of both the countries, CEFIPRA has signed a MoU in 2014 with SOLEIL Synchrotron to facilitate the use of the facility in France by Indian scientists. During the FY 2016-17, 3 proposals (1 under Call AP 17 & 2 under Call AP 18) were supported with participation of 9 scientists/researchers.

Public Private Partnership (PPP) Programme

The CEFIPRA has defined its role as a Partner (funding contributor) and as a Facilitator (providing platform for the funding agencies). The programmes under its role as “Partner” and “Facilitator” are as follows:
Overview & Activities of the Centre

CEFIPRA-SGRI Programme

CEFIPRA–Saint Gobain Research India (SGRI) PPP Programme on “Sustainable habitat for hot and/or humid climates” is the first initiative under the innovation programme launched in 2013. Currently, four projects are ongoing involving institutes like IIT Delhi, IIT Madras & IIIT Hyderabad.

BIRAC-CEFIPRA-French Embassy

BIRAC, CEFIPRA and French Embassy in India had launched in 2014 an Indo-French challenge oriented programme in the area of red biotechnology up to pre-commercialization stage in 2 + 2 model. The areas for collaboration under the first Call were molecular diagnostics for prediction of diseases like Cardiac, Alzheimer, Cerebral Palsy and Generation of New Assistive Technologies for Mobility of Physically Challenged. Two projects are ongoing both in the area of cardiovascular diseases. Second call was launched in October, 2015 with closing date as 15th July, 2016 in the areas of molecular diagnostic for prediction of Alzheimer’s and Dementia, new technologies for mobility of physically challenged and biomaterials and cell engineering for health applications. One proposal was recommended, in principle, for support by a Joint Selection Committee during its meeting held in September, 2016 at CEFIPRA Office, New Delhi.

BIRAC-CEFIPRA-Bpifrance

CEFIPRA in 2015 has expanded its activity by bringing Bpifrance (a public investment bank) as a new stakeholder and launched the Indo-French health technology programme in association with Bpifrance and BIRAC in the area of red biotechnology upto pre-commercialization stage. First Call was launched in the areas of Cancer, Cardiac and Infectious Diseases with themes such as identification of new targets or biomarkers, development of new therapeutic, affordable process development for existing therapeutics having potential implication on effective industrial scale-up for cost effective production.

One proposal was received which was not selected for support. For the call for proposal launched in November, 2015 in the areas of digital healthcare (e-health, tele-care, health IT, m-health, etc.) and individualized medicine (therapeutic solutions for individual patients, pharmacogenetics, etc.), two proposals were received, evaluated & recommended for submission as full proposals by preliminary Selection Committee in its meeting held in April, 2016. Afterwards, full proposals were received with the deadline of 31st May, 2016 and were evaluated in the meeting of the Joint Selection Committee held in December, 2016 wherein one proposal was, in principle, recommended for support while other is under process for reconsideration.

Indo-French Centre for Applied Mathematics (IFCAM)

The Indo-French Centre for Applied Mathematics (IFCAM) was jointly set up in 2012 by the Indian (DST) and French (CNRS) Governments at the Indian Institute of Science, Bangalore for 4 years as an international joint research unit UMI 3494. IFCAM provides funds for joint research projects including exchange visits of faculty and students, post-doctoral fellowships, joint research workshops, annual summer/winter school, and local visits.

The selection of proposals is made by IFCAM and the management of funds is done by CEFIPRA. On receipt of funds from DST, CEFIPRA disburses funds to IFCAM on request from Director, IFCAM for meeting the expenses related to workshop, schools etc. CEFIPRA only facilitated approved visits of Indian scientists and students to France.

CEFIPRA also receives support from CNRS as untargeted funds to facilitate work of post-docs employed on the French side & supporting visits from India to France.
During the FY 2013-14 (1st year) and 2014-15 (2nd year), 12 projects were supported by IFCAM. For FY 2015-16 (3rd year), 6 projects were supported. CEFIPRA is currently handling the visits (India to France) for 19 ongoing proposals under IFCAM programme.

A meeting for the renewal of IFCAM was held on 17th June, 2016 at the Office of CEFIPRA. Director, IFCAM along with expert committee members and officials of DST & CEFIPRA were present. It was decided that the visits under IFCAM will be supported till 31st March, 2017 (extended period) & renewal of IFCAM is under consideration by DST.

Indo-French Water Network (IFWN) Programme

Considering the strong urge of the French and Indian Governments to reinforce scientific collaboration to address prevalent and emerging challenges in water, the French Embassy in India and the Department of Science & Technology (DST), India, joined hands in 2013 for Indo-French scientific networking programme in the field of water. This networking programme has been implemented by CEFIPRA in the priority areas such as Waste Water Treatment (Industrial/ Domestic) and Natural Water Treatment Systems. The programme’s objectives are as follows:

- To form dedicated networks of Indian and French research groups & industries to address identified water issues.
- To strengthen and expand the quality and potential of water research in both countries by building greater interaction between France and India.
- To build stronger relationships between industry and academic communities in France and India coupled with better knowledge exchange, to form the basis for future collaborations, research projects, and joint endeavour related to water technology, research & innovations.

The first Call for Proposal for the IFWN programme was launched in 2015 and in a Joint Selection Committee meeting held in Oct. 2015, two proposals were supported for a period of two years which are ongoing successfully. Under these projects, Indo French workshops were organized for networking of collaborators.

Technology Development Board (TDB)-CEFIPRA-Bpifrance Programme

Based on the discussions held with Technology Development Board (TDB), a Letter of Intent (LOI) and Procedures Document were prepared and shared with TDB, India and Bpifrance for their consideration in January, 2016. Subsequently, TDB and Bpifrance have signed a MoU in April, 2016; CEFIPRA-TDB-Bpifrance has signed Loi and Procedures Document on 10th May, 2016 at New Delhi. Accordingly, under this MoU, TDB, CEFIPRA and Bpifrance launched a Joint Call for Proposal for Indian and French Companies/Industries/SMEs in August, 2016 with the extended deadline up to 31st January, 2017 in three targeted areas of Aeronautics, Automotive & Biotechnology with special emphasis to Health Biotechnology. Project shall have at least one company each from India and France as ‘Joint Applicants’ (1+1 model). Other companies may also participate as partners to make it 2+2 model. Academia can act as subcontractors of the company. The Call for Proposal was opened with two to three cut off dates. Active dissemination of information of this programme has been done by Centre, by contacting CII, IFCCI, IRC members, IamSMEofIndia and various other French (70) & Indian (30) industries. Four proposals in the domain of Aeronautics (2), Automotive (1) and Health Biotechnology (1) were received against the extended deadline of 31st January, 2017.
Overview & Activities of the Centre

As per the directive of the 27th meeting of Governing Body held on 6th March, 2014, New Delhi; the Scientific Council of CEFIPRA in its meeting held in November, 2014 recommended to find ways for forward chaining of knowledge generated through CEFIPRA’s support. The Biotech Consortium India Limited (BCIL), New Delhi was therefore, assigned the job of evaluating the projects supported by CEFIPRA with respect to Intellectual Property and Commercial Potential. The BCIL submitted a detailed assessment report which was discussed in the 56th meeting of Scientific Council held in November, 2015 in Bangalore and recommended that the report should be discussed along with the members of the Industrial Research Committee (IRC) of CEFIPRA.

The report provided some leads to the possibility of Commercial Potential. Accordingly, an Overlapping Meeting of the 57th Scientific Council and 28th Industrial Research Committee was held in Tours, France during May, 2016. Based on the directives of this meeting, a Standard Expert Panel (SEP) was constituted by CEFIPRA for mentoring and monitoring of PIs on various IP related issues for its Collaborative Scientific and Industry-Academia Programmes. The first meeting of SEP was held on 12th January, 2017, wherein it was recommended to hold half a day workshop/brainstorming/training session for new project investigators (PIs) for educating them on matters related to IP for monitoring purpose, the PIs will again attend next level mentoring session after one year, CEFIPRA also developed a training module for the workshop/brainstorming/training sessions for PIs etc.

Launch of Revamped website (www.cefipra.org) of CEFIPRA

The new and revamped website of CEIFPRA was launched on 22nd December, 2016 by Prof. Ashutosh Sharma, Indian Co-Chair, CEFIPRA and Secretary, Department of Science and Technology, GoI, other Senior Officials from Government of India, representative of French Embassy in India and Director & staff of CEFIPRA were also present.

The revamped website of CEFIPRA provides a new designed outlook with lot of information available readily to the users. The information like genesis of the Centre’s organizational structure, complete programme profile with important deadlines, list of ongoing projects, photo gallery, list of various institutions/universities of India and France
etc. are available. The website also contains various policy documents, list of members of various scientific and administrative bodies of CEFIPRA, contact information of its staff etc. Amongst the new features, the site also contains integrated social media buttons for Facebook and Twitter to foster improved communication with the users. The website can be accessed across various platforms such as Mobile, Tablet, Desktop etc. in both English and French versions for better understanding.

Memorandum of Association and Byelaws of CEFIPRA and Pension and Post-Retirement Medical Benefit Scheme for the employees

i) The Centre was established in 1987 and the Memorandum of Association was prepared almost 30 years back at the time of its establishment. The Byelaws of the Centre were approved in the 4th Meeting of the Governing Body held in 1990 at Paris. Considering the enormous changes in the functioning of the Centre over the period of time, it was decided in the 28th and 29th meetings of the Governing Body held on 13th April, 2015 at Paris and 4th March, 2016 at New Delhi, respectively; a Committee was constituted comprising of the representatives/members from both the Governments nominated by the Co-Chairs of the Governing Body.

The Committee on MoA & Byelaws met for the first time under the Chairmanship of Mr. B.S.Rawat, Joint Secretary(Admn.), DST on 30th August, 2016 and again on 21st February, 2017. The other members of the Committee were Dr. I.D. Gabba, Former Scientist G, DRDO, Dr. Philippe Arhets, Counsellor for Science and Technology, French Embassy in New Delhi and Dr. Rajiv Kumar, Scientist E, International Cooperation (Bilateral), DST. The amended draft MoA and Byelaws were placed before the 30th Governing Body meeting held on 6th March, 2017 at Paris and approved the revision of MoA and Byelaws.

(ii) On 30th August, 2016 a meeting of Sub-Committee on Pension and Post-Retirement Medical Benefit Scheme was also held under the Chairmanship of Mr. B.S.Rawat, Joint Secretary(Admn.), DST. The other members of the Sub-Committee were Dr. Philippe Arhets, Counsellor for Science and Technology, French Embassy in New Delhi, Mr. Himanshu Gandhi, Under Secretary (IFD), DST (representing JS&FA, DST) and Dr. Rajiv Kumar, Scientist E, International Cooperation (Bilateral), DST. The purpose of the meeting was to look into the existing ‘Pension Scheme’ and to make recommendations that would maximize the benefits to the employees and also proposed a scheme for employees called ‘Post-Retirement Medical Benefits Scheme’.

The recommendations of the Sub-Committee were placed before 30th Governing Body meeting held on 6th March, 2017 at Paris. The GB sought the opinion of Finance Sub-Committee on this matter.

Development of Conflict of Interest- Guidelines

During 57th Scientific Council (SC) meeting held during 17-20th May, 2016 at Tours, France, the SC had suggested that based on the existing guidelines for Conflict of Interest adopted by DST, DBT, CNRS and French Universities etc. CEFIPRA could also develop a criteria for Conflict of Interest for its members of SC and IRC, as per its requirement.

For the Scientific Council (SC)/Industrial Research Committee (IRC) meetings, the CEFIPRA obtained a written certification from all the members that they have not participated in any reviews of applications when their presence would have constituted a real or apparent Conflict of Interest and that the confidentiality of actions will be maintained. Prior to the SC/IRC meetings, members will receive a form on which they must identify applications with which they have a Conflict of Interest, if any and must certify that no Conflict of Interest exists with the remaining applications.
Revised Vision Group (VG)

The Centre is now close to achieving another landmark, which is the completion of its 30 years in 2017-18, as a service to Indo-French S&T community. Furthermore, in the context of this landmark to be achieved soon; the Vision Group was revised, as per the decision of the 29th Governing Body meeting held on 4th March, 2016, at CEFIPRA Office and six members (3 from each side) were nominated by both the Governments.

Subsequently, with the preparation of Approach Paper I, the first meeting of the revised Vision Group was organized on 2nd September, 2016 at CEFIPRA Office, New Delhi. Nominated Members, along with the Director, CEFIPRA and other officials of the Centre attended the meeting. One of the prominent suggestions was to have an impact/ SWOT analysis of the programmes currently managed, facilitated and supported by the Centre. Accordingly, the Approach Paper II was prepared comprising of Part I & II; where in Part I, reflected the evolution of CEFIPRA with the updated programme profile and Impact/SWOT analysis for each categories of the programmes. Also, on suggestion of the members of Vision Group, Part II of this document was prepared, highlighting the analysis done for various parameters of activities. It also provided the information on other activities of the Centre. The 2nd physical meeting of the revised Vision Group was held on 27th January, 2017. Afterwards, the combined recommendations of both the meetings were presented in 30th meeting of Governing Body (GB) held on 6th March, 2017 at Paris. The GB recommended the extension of revised Vision Group and suggested to involve SC & IRC members in finalizing the recommendations.

Outcome & Bibliometric Analysis of Supported Projects

As per the directive of the 27th meeting of the Governing Body of CEFIPRA held on 6th March, 2014; the technological impact of the supported projects has to be measured accurately and periodically. Therefore, the Centre developed a questionnaire with the help of the Scientific Council, which was sent to the project investigators in March, 2016 after a period of three years from the date of completion of projects. Through this questionnaire, follow up data was collected on additional publications/achievements as a result of the project in the intervening five years period. This data, combined with the information received in the final report submitted by PIs was used for analyzing the outcome of the completed projects. A total of 94 projects were completed under Collaborative Scientific Research Programme during the period from 2011 to 2015. The report entitled “Outcome Analysis of the Research Projects completed under the Collaborative Scientific Research Programme during 2011-2015” of the above mentioned analysis was released by the two Co-Chairs during the 30th GB meeting on 6th March, 2017 at Paris.

The bibliometric analysis of 797 publications emanated from the 94 projects completed during 2011 to 2015 was carried out by CSIR-National Institute of Science Communication and Information Resources (CSIR-NISCAIR). The analysis showed on an average that there are 9 papers resulted per project and these were published in scientific journals such as Nature, Nature Materials, Cell etc. The average impact factor of the papers is 4.122 and 33 papers received citations 50 and above.
2. Governance & Guidance
Guidance by the Governing Body

The 30th Governing Body (GB) meeting of CEFIPRA was organized on 6th March, 2017 at Paris, France. This meeting was Co-Chaired by Mme. Anne Grillo, Director of Cultural Cooperation, Academic and Research, Directorate General of Globalization and Partnerships, Ministry for Europe and Foreign Affairs, Government of France and Prof. Ashutosh Sharma, Secretary, Department of Science and Technology, Ministry of Science and Technology, Government of India. The meeting was attended by the members, special invitees, observers from both sides and CEFIPRA officials.

During the meeting, several issues placed in the agenda were discussed and deliberated upon. Governing Body took decisions and provided valuable guidance on CEFIPRA coordinated programmes and other policy matters. The French and Indian Co-Chairs released the Annual Report of CEFIPRA for 2015-16 along with compilation of two volumes of scientific publications emanated from CEFIPRA supported projects during the year 2016 under Collaborative Scientific Research Programme. A report on Outcome Analysis on research projects completed during 2011 to 2015 under Collaborative Scientific Research Programme was also released by the Co-Chairs.

The Co-Chairs placed on record their satisfaction for the functioning of CEFIPRA and its contribution to the dynamism of long lasting cooperation between France and India. The GB also appreciated CEFIPRA’s new initiatives and developments such as TDB-CEFIPRA, Bpifrance programme, developing guidelines for Conflict of Interest (CoI), formation of Standard Expert Panel (SEP) and launch of new website of CEFIPRA.

The Co-Chairs pointed out that the Centre needs to move towards cutting edge Science and Technology through its programmes in the fast moving scientific world. The Co-Chairs also expressed views for exploring possibility to work together in contextual to the national programmes like DST’s Visiting Advanced Joint Research (VAJRA) Faculty Scheme of DST wherein distinguished international faculty as Adjunct/Visiting Faculty in Indian institutions are envisaged with the French National Agencies which would bring new perspective in the dimension of collaborative research. The Centre would be starting its 30th anniversary year in May, 2017 and this landmark achievement would be a new benchmark for Indo-French S,T&I collaborations. The GB suggested that the 30th year celebration of CEFIPRA would be coordinated with the first Indo-French Knowledge Summit during ‘Bonjour India’ programme of the French Embassy in India scheduled in 2017-18.

The GB also recommended that the revised Vision Group should look in a focused manner with clarity and vision in depth on different programmes of the Centre based on the resources and manpower available and bring out suggestions in consultation with the members of Scientific Council (SC) and Industrial Research Committee (IRC). The GB also recommended enhancing the mobility of students and young researchers under the programmes of CEFIPRA.

30th meeting of Governing Body held on 6th March, 2017 at Paris
Meetings of the Scientific Council

The scientific activities of CEFIPRA under Collaborative Scientific Research Programme are guided by its Scientific Council (SC). The Scientific Council consists of five members each from India and France. These members are internationally recognized scientists of high caliber and standing from both countries nominated by their respective Governments. The SC evaluates proposals twice a year for joint research submitted under Collaborative Scientific Research Programme. These high quality proposals are from Indo-French research groups from advanced areas of basic and applied sciences in ten domains of S&T. The SC also closely monitors and assesses the progress of recommended collaborative research projects and other programmes of the Centre.

The 57th and 58th meetings of Scientific Council were held during 17-20th, 2016 at Tours, France and on 23-25th November, 2016 at Varanasi, India respectively.

The above two meetings of the Scientific Council reviewed one hundred and nineteen new proposals (including one deferred) in ten domains, out of which sixteen proposals were recommended for funding support. The proposals were recommended in the areas of Pure and Applied Mathematics (1), Computational Science (1), Life and Health Sciences (3), Pure and Applied Physics (5), Pure and Applied Chemistry (2), Materials Science (3) and Earth and Planetary Sciences (1).

During the financial year 2016-17, seventeen new projects were started, which were recommended by 57th and 58th SC meetings of CEFIPRA. A total of ten proposals were recommended by 57th SC and 6 proposals by 58th SC and one from previous meeting. The SC deliberated on the matter related to reallocation of budget of few projects, change of manpower, inclusion of Co-PI, change of equipment and extension of projects.

The SC also discussed change of the deadlines from April 1st and October 1st each year to January 15th and July 15th and information regarding pre-clearance from French Government.

In view of upcoming landmark thirty years of CEFIPRA, the SC had also suggested to develop comprehensive document to be prepared on the occasion of celebration of 30 years of CEFIPRA, based on the realistic picture of the achievements of the projects, instead of simple quantitative analysis, it is necessary to develop parameters for the assessment for the review of completed projects. The SC discussed on the matter and developed the parameters for emphasizing the fact that simple quantitative analysis is too limited to evaluate the impact and potential of completed projects. Qualitative analysis made by experts is necessary to provide a realistic view of the potential and long term impact of research projects. The SC also discussed the need to elaborate a short document presenting concrete S&T impacts/outcomes resulted from the support of CEFIPRA. This should also include accurate figures about the number of PhD/Post-doc trained, publications and any other highlights on relevant initiatives with major impact.

**Collaborative Scientific Research Programme (CSRP)**

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<th>57th Meeting of the Scientific Council</th>
<th>58th Meeting of the Scientific Council</th>
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<tr>
<td>17-20th May, 2016 at Tours, France</td>
<td>23-25th November 2016 at Varanasi, India</td>
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</table>
Meetings of the Industrial Research Committee

The activities under Industry Academia Research and Development Programme (IARDP) are guided by Industrial Research Committee (IRC).

During the year, 28th and 29th meetings of the Industrial Research Committee were held on 20-21st May, 2016 at Tours, France and on 26-27th November, 2016 at Varanasi, India respectively.

A total of thirteen proposals were received under the programme, out of which, five proposals (38%) were recommended in the areas of Fiber Optics, 3D Printing, Immunology etc. In addition, one seminar proposal was also recommended for funding support.

The progress review of 4 ongoing projects and final review for 2 completed projects were undertaken by IRC during these meetings.

The Committee also suggested that the submission of the IP Management Plan shall be within the period of 6 months from the starting date of the project and shall not be a condition for the 1st year release of the funds. CEFIPRA may take an undertaking from the PIs counter signed by Head of Institutions, certifying that research work will be carried out immediately on receipt of funds and the IP Management Plan/Consortium Agreement will be provided by collaborators within six months from the start of project.

Further, a Standard Expert Panel (SEP) was formed, with objectives to mentor/monitor and update new project PIs on Intellectual Property (IP) at the initial stage of projects.

To make IARDP more attractive for private players, the Committee members suggested to have discussion with industry association for evolving methodologies for collaborative industrial research projects. The Committee also discussed the template for presentation by PIs and modified it by adding new parameters such as information on state of the art development, proof of concept, IP search report, identification of potential users of proposed technology/solution/product etc.

Industry Academia Research and Development Programme (IARDP)

28th Meeting of the Industrial Research Committee  
20-21st May, 2016 at Tours, France

29th Meeting of the Industrial Research Committee  
26-27th November, 2016 at Varanasi, India
3. Seminars / Workshops & Outreach
To enhance the Indo-French ST&I system and to promote new linkages and collaborations, the CEFIPRA, under its Collaborative Scientific Research Programme & Industry-Academia Research and Development Programme has supported the following five Seminars/Workshops in cutting edge sciences.

A four day Indo-French workshop on ‘Challenges in the Processing and Recycling of Rare-Earths (CIPRE)’ was organized from 18-21st July, 2016 at Tata Research Development and Design Centre, Tata Consultancy Services, Pune, India. The workshop was jointly organized by Tata Consultancy Services (TCS), Institut de Chimie Séparative de Marcoule (ICSM), France, Indian Rare Earths Limited (IREL) and CSIR-National Metallurgical Laboratory (NML), under the aegis of Industry-Academia Research and Development Programme (IARDP) of CEFIPRA. At the inaugural function, Dr. Beena Rai and Dr. Stephane Pellet-Rostaing, Coordinators of the workshop, welcomed the participants and highlighted the key aspects of the workshop.

The overall goal of the workshop was to enable discussions on the challenges faced by the industry in India and France and the opportunities available to the researchers in both the countries to seek collaboration on topics of mutual interest.

Dr Baldev Raj, a distinguished scientist, former President, Indian National Academy of Engineering, and former Director, Indira Gandhi Centre for Atomic Research, Kalpakkam (Department of Atomic Energy) and the Director, National Institute of Advanced Studies, Bangalore inaugurated the workshop on 19th July, 2016. The workshop had three essential features namely technical lectures from invited experts, panel discussions led by eminent experts in the field for discussion to work out joint research proposals. There were 20 technical presentations by leading experts from India and France on the topics related to current scenario and roadmap, extraction and separation technologies (solvent extraction), and applications of rare-earths. Two panel discussions, led by experts from industries to deliberate about various challenges and opportunities, were also organized. The final day of the workshop was dedicated to three break-out sessions, where delegates worked towards the identification of a few challenging topics for possible joint research proposals. Around 50 delegates, including 8 from France, participated in the workshop, out of which, nearly half the participants were from industries. The significant participation from the industry (both from India and France) made the discussions more broad based and imparted greater industrial relevance to the projects discussed during the workshop.

Some of the identified proposals which should be taken up for further collaboration are as follows:

- Design and development of selective extraction reagents (media and the extractant) based on molecular modeling computations (for example, nd/pr and er/tb), ionic liquids
- Design of flexible flow sheets for processing rare earth resources (variety and variability)
- REO to metal and alloys – creation of a rare-earths industry
- Rare-earths in steels and aluminium alloys
- Molten salt electrolysis for production of rare-earth metals
- A comprehensive technology demonstration program to process secondary resources like red mud, fly ash and phospho-gypsum (zero waste technologies)
- PCB pyrolysis and then recycling through copper smelters (Tin and Tantalum is a challenge)
- Collection systems for diffuse sources of waste
- Rare earth magnets scrap recycling
One important point which emerged during the discussions was an urgent need to create an eco-system, so that there is commercial production of rare-earths and products containing rare-earths in the country. A book of abstract-cum-souvenir was also brought out on the eve of the workshop.
The two day Indo-French workshop on ‘Advances in Phase-Change Thermal Systems’ was organized by Indian Institute of Technology- Kanpur and INSA-Lyon France, during 27-30th November, 2016 at Khajuraho (MP) to bring together Indian and French experts on a common platform and shared the state-of-the-art knowledge on topics related to phase-change thermal systems with academia and industry, especially focusing on fundamentals and specific terrestrial applications in defence sector, nuclear power and space thermal management technology. The workshop was attended by fifty Indian participants, including faculty and doctoral students from IITs, NITs and other technical schools and industry catering to defence, space and nuclear sectors. There were seven participants from French universities, including teaching and research staff. The workshop led to intense networking among the peers and discussions on future possibilities of cooperation. A total of 19 invited lectures and four guest lectures were delivered. In addition, 32 posters were presented by the students in four separate sessions.

The inaugural address was delivered by Dr. Mukesh Kumar, Director, CEFIPRA encapsulating the joint R&D ecosystem which operates under the aegis of CEFIPRA/IFCPAR. The Guest of Honour at the workshop was Dr. Sandrine Maximilien, Attaché for Science and Technology at the Consulate General of France, Mumbai. She delineated on the breadth of opportunities and incentives for Indian researchers to conduct joint projects with French counterparts. Dr. Srinivasa Kaveri, Director, CNRS India, through his Skype talk gave an overview of the CNRS initiatives in India and presented a roadmap for furthering cooperation between French and Indian researchers. Prof. P. K. Panigrahi, Head, Department of Mechanical Engineering and Prof. K. Muralidhar, Dean of Faculty Affairs, were also present during the workshop.
A four day Indo-French workshop on ‘Pressure Effects on Strongly Correlated Materials’ was held at Bharathidasan University, Tiruchirappalli from 9-12\textsuperscript{th} January 2017. The joint workshop was coordinated by Prof. S. Arumugam from Indian side and Dr. Daniel Braithwaite, CEA Centre de Grenoble, Grenoble from French side. A total of seventeen speakers delivered lectures during the course of the workshop. Six French scientists were; Dr Fabrice Wilhelm, European Synchrotron Radiation Facility (ESRF) Grenoble, Dr Sebastien Burdin, Bordeaux University, Dr Gaston Garbarino and Luigi Paolasini from ESRF, Grenoble. Dr William Knofo Centre Nationnal de la Recherche Scientifique (CNRS), Toulouse and eleven eminent Indian scientists from Indian Institutes of Technology (IITs), Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Matter Physics and Material Science, Mumbai, Jawaharlal Nehru University (JNU), Delhi, Pondicherry University etc. There were eighteen scientific lectures spread over four days. The Director, CEFIPRA delivered the inaugural lecture. The workshop was also attended by 50 local students & teachers. The workshop aimed to gather specialists in materials physics and high pressure to present recent important results and discuss future paths for research and collaborations. The workshop focused on ‘High Pressure’ which is a clean way of tuning microscopic interactions in solids, therefore, opening another dimension in materials research for new materials was equally important for understanding fundamental questions for identifying new candidate materials for applications. The workshop resulted in exposing young faculties and students to importance of High Pressure Techniques, instrumentation and latest trend in pressure effect on strongly correlated systems; exchanging of new ideas and techniques among the participants and Invited speakers from both the countries. Moreover, it helped in potential collaboration with French scientists from other laboratories in France.
A three day workshop on ‘Epigenetic Mechanisms of Male Germ Cell Maturation and Early Development’ was held during 15-18th February, 2017 at Tata Institute of Fundamental Research, Mumbai. The workshop brought together leaders in the field of male germ cell maturation, epigenetics and early embryonic development. The workshop was attended by forty participants, twenty scientists made their presentations on seven sessions on diverse, yet linked mechanisms that control male germ cell development with impact on early embryonic stages via epigenetic mechanisms. Students also presented their posters. Uniquely, a session was dedicated to proteomics and genomics of theses biological processes enabling discussions on developing novel approaches to tackle the fundamental biological problem of transmission of genetics and epigenetic information across generations.

The success of a meeting was assessed by quality of science presented. In addition to high quality of science that was discussed, the meeting provided a platform for young researchers to interact with peers and leaders in the field. Moreover, all the participants unanimously voted to keep this meeting as regular event to be organized once in two years and alternate between France and India. Also continuing the scope/agenda of CEFIPRA, this meeting was also successful in terms of allowing people to come up with several collaborative projects and if the outset 3-4 projects may end up being pursued seriously. There was overwhelming appreciation of the support encouragement from CEFIPRA in fostering scientific exchange and collaborative research between Indian and French scientists.
The 3-day symposium on ‘Catalysis by Design Using NMR’ was held at the University of Lille, France during March 15-17th, 2017.

The scientific and organizing committee included: Prof. Olivier Lafon, French coordinator from Unité de Catalyse et de Chimie du Solide at the Université de Lille, Dr Vivek Polshettiwar, Indian coordinator from TIFR, Mumbai, the other eminent experts who participated were Dr Jean-Paul Amoureux, Univ. Lille, Dr Laurent Delevoye, CNRS, Villeneuve d'Ascq, Régis Gauvin, CNRS, Villeneuve d'Ascq, Dr P. K. Madhu, TIFR, Hyderabad, Dr Frédérique Pourpoint, ENSC Lille, and Dr Julien Trébosc, CNRS, Villeneuve d'Ascq. A total of 23 Indian and French experts participated from the field of catalysis and NMR spectroscopy participated. Three talks were given by organizing committee members during the symposium and eight talks were selected among the submitted abstracts by French researchers on NMR and catalysis from other laboratories. In total, thirty four talks of 30 minutes each were delivered during the 3 day symposium. The event had a total participation of fifty two scientists. French researchers from companies such as Bruker BioSpin, TOTAL, Solvay and BASF also participated in the symposium.

This interdisciplinary symposium addressed the most recent advances in the areas of catalysis and NMR, and had brought together international experts of the communities of catalysis and NMR spectroscopy. This symposium not only generated new ideas about the characterization of catalytic materials using DNP, but also disseminated about the technique which also improves the sensitivity of solid-state NMR by several orders of magnitude, open new avenues for the characterization of catalytic surfaces and active sites. Furthermore, this event contributed to accelerate the transfer of knowledge between two distinct fields of research: catalysis and NMR spectroscopy. At the end, the scientists working on catalysis gained a much better understanding of the possibilities offered by NMR spectroscopy, whereas the NMR experts identified the unsettled questions related to the development of novel catalysts.
Under the 4th Annual Lecture Series of CEFIPRA, three Lectures were organized in June, 2016 at different academic institutions of France. The Lectures were delivered by Prof. D. D. Sarma of Solid State and Structural Chemistry Unit, Indian Institute of Science, Bengaluru and member of Governing Body of CEFIPRA. The first Lecture was organized on 27th June, 2016 at the College de France, Paris and the title of the Lecture was “Layer-resolved electronic structure of oxide heterostructures using high energy photoelectron spectroscopy”. The second Lecture was organized on 29th June, 2016, at the Ecole Polytechnique, Palaiseau and the title of this Lecture was “Are chemical and physical pressures equivalent for tuning material properties?”. The third Lecture was organized on 30th June, 2016 at CRISMAT, Caen and the title of the Lecture was “Role of disorder in magnetism and colossal magnetodielectricity in complex transitional metal oxides”.

The Lecture series is a part of CEFIPRA’s outreach activities. Director, CEFIPRA also participated in this outreach event and gave presentation about various activities of CEFIPRA to the audiences at the onset of each Lecture and also utilized the opportunity for meeting scientists and collaborators of various institutes such as FondaMental Foundation & Inria etc.

The Lectures were a success and each Lecture was attended by 35-40 academicians, young researchers and former collaborators of CEFIPRA supported projects. The members of audience interacted with Dr. Sarma and Director, CEFIPRA showing keen interest in the activities of his work and the CEFIPRA.
Outreach Programmes

Lectures by Members of Scientific Council Outreach Programme

Banaras Hindu University, Varanasi
26th November, 2016

Lectures by (i) Prof. Claude Jaupart, Institute de Physique du Globe de Paris, Universite Paris was delivered on “The Generation of Continental Crust and the Fate of Mafic Cumulates’ at Banaras Hindu University, Varanasi on 26th November, 2016. He elaborated upon the evidence for removal of mafic cumulates in large igneous intrusions such as those from the Bushveld (South Africa), Rhum (Scotland) from geophysical (including fluid dynamical and experimental) and geological points of view. His talk enumerated the conditions under which the removal of cumulates can happen and showed that a fraction of the cumulates may be left behind at original emplacement level. He also pointed out that the gravity-driven removal of ultramafic cumulates does not lead to the formation of eclogites.

(ii) Prof. Stephane Noselli, CNRS-INSERM-UNSA Université Nice Sophia-Antipolis delivered a very interesting talk at Banaras Hindu University, Varanasi on 26th November, 2016 on his lab’s work on the regulation of left-right asymmetry during Drosophila development, taking examples of the genitalia rotation in males and looping of the gut. He talked about the roles of Abd-A, Myo-ID and Dachsous genes in deciding the dextral or sinistral rotation and the consequent left-right asymmetry that emerges in the two organs. He also emphasized the relevance of these studies in the fly model for human development. The lecture was attended by many faculty members and large number of research students of the Zoology Department and from other Departments like Molecular & Human Genetics and Biochemistry, as well by researchers in labs using Drosophila as model organism.

(iii) Dr. Anne Imberty, CERMAV-CNRS, Grenoble, France, delivered a talk on “Lectins from Bacteria and Fungi: Therapeutical Targets and Research Tools” at Banaras Hindu University, Varanasi on 26th November, 2016. Her talk was focused on biologically active oligosaccharides and significance of lectins as a potential therapeutic target for antimicrobial drug discovery. Dr. Ann’s laboratory has been doing interdisciplinary research from target identification to drug development. Her talk was divided into two parts: firstly by the significance of the sugar molecules in terms of various biological aspects including the blood group chemistry was presented. Secondly by the significance of lectins was discussed as a novel biological target to discover the antibiotics. The success story of various sugar molecules as anti-lectin developed in her lab was presented. In order to show the proof of concept her lab has tested simple sugar molecules in-vivo antibacterial animal model. Based on the initial results various substituted triazole containing sugar molecules were fully characterized in terms of chemistry and biology. The lead molecules were further refined to reduce the size while maintaining the desired anti-lectine activity. Anne presented various biological tools like ITC, X-ray crystallography images, computational and in-vivo data. Her seminar was consider very interesting and highly appreciated in the Department. She interacted with the students and faculty members. She also visited the laboratories in the Department for possible collaborations in future.
Ensemble: The Newsletter of CEFIPRA

The CEFIPRA publishes a periodic newsletter called Ensemble. This is one of the important communication tool to communicate and highlight the research and developmental activities funded by the Centre and disseminate the information to the research communities and other officials in India and France.

CEFIPRA has published five issues during the year 2016-17, showcasing about the Centre’s activities and programmes to patrons, policy makers, scientists, researchers and students. This is a valuable instrument which helps in increasing awareness about the India-France collaborative activities in R&D and innovation sectors.

The major topics highlighted in issues of Ensemble were on Indo-French S&T Systems such as Networking and Joint Platform of Indo-French Science, Technology and Innovation Partners; Network & Outreach for Promoting Science, Technology & Innovation; Global Commitment; Sealing the deal in line with COP21; Imaging through dense scattering media-seeing through fog and Kinetics and spectroscopy in extreme environment applications to Astrophysics and Astrochemistry and CEFIPRA’s role for Unique Linkages Platform as Catalyser, Enabler, Connector & Facilitator.
4. Dedicated Mobility Support Programmes
The “Raman–Charpak Fellowship” scheme was launched during the state visit of the President of France, H.E Monsieur François Hollande, to India during February 14–15th, 2013. The aim is to facilitate the exchange of doctoral students between the two countries. The Fellowship Programme is implemented by CEFIPRA with joint funding from the Department of Science and Technology (DST), Government of India and Service for Science & Technology, French Embassy in India, Ministry for Europe and Foreign Affairs, Government of France. The fellowship facilitates exchange of Doctoral (for India) and Doctoral/Masters (for France) students by providing them an opportunity to access to laboratories which are better equipped & suited for research work. Hence, improving their overall research skills and carry out part of their research work in a University / Research Institute based in France or India, respectively. The scheme also provides an exposure and experience about the current research methods and trends in France and India, while discovering each other’s cultural context.

From year 2013 to 2015, 57 Raman-Charpak Fellows (43 Indian and 14 French) have been supported under this programme and 3 Debriefing Sessions have been organized. The Programme was renewed for 3 years (2016-2018) by the Governing Body of CEFIPRA during its 29th meeting held on 4th March, 2016 at New Delhi with increased number of slots and is now also opened to French Master’s students.

For year 2016, the Call for Applications was launched on 1st April, 2016 and a total of 196 applications were received against the deadline of 31st May 2016 which was extended till 30th June, 2016. The meetings of preliminary and final selection committee where held on 21st July, 2016 and 24th August, 2016 at CEFIPRA Office, New Delhi, respectively. After evaluations, the Committee selected following 30 Indian and French candidates for the RCF 2016:

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<th>S. No.</th>
<th>Name</th>
<th>Area of Interest</th>
<th>Supervisor Name and Address &amp; PhD Registered University</th>
<th>Name of Host Scientist</th>
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<tbody>
<tr>
<td>1.</td>
<td>Mr. Bonam Srinivasa Reddy</td>
<td>Life and Medical Sciences</td>
<td>Dr. H.M Sampath Kumar Academy of Scientific and Innovative Research (AcSIR), Indian Institute of Chemical Technology Hyderabad</td>
<td>Prof. Sylviane Muller CNRS, Institut de biologie moléculaire et cellulaire Strasbourg</td>
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<td>2.</td>
<td>Mr. Mayank Agarwal</td>
<td>Engineering Sciences</td>
<td>Dr. Manoj Kumar Meshram Indian Institute of Technology (BHU) Varanasi</td>
<td>Prof. Vikass Moneburrurun Department of Electromagnetics, EXPOSE Research Group PIEM/GEEPS, CentraleSupelec Gif-sur-Yvette</td>
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<td>3.</td>
<td>Ms. Nisha Rani Mahato</td>
<td>Mathematical and Computational Sciences</td>
<td>Prof. Snehashish Chakraverty National Institute of Technology Rourkela Rourkela</td>
<td>Prof. Luc Jaulin École Nationale Supérieure de Techniques Avancées (ENSTA), Bretagne Brest</td>
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<td>4.</td>
<td>Mr. Sagar Satpathi</td>
<td>Chemical Sciences</td>
<td>Dr. Partha Hazra Indian Institute of Science Education &amp; Research Pune</td>
<td>Dr. Jean-Louis Mergny Institut Européen de Chimie Biologie (IECB), INSERM US01, CNRS UMS 3033 Université de Bordeaux 2 Pessac</td>
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<td>5.</td>
<td>Mr. Anila H. Ashoka</td>
<td>Chemical Sciences</td>
<td>Dr. Amitava Das Acsir-CSIR-National Chemical Laboratory Pune</td>
<td>Dr. Andrey S Klymchenko University of Strasbourg Strasbourg</td>
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<td>6.</td>
<td>Mr. Wasim Jeelani Mir</td>
<td>Materials Science</td>
<td>Dr. Angshuman Nag Indian Institute of Science Education and Research (IISER), Pune</td>
<td>Dr. Emmanuel Luillier Institut des Nanosciences de Paris (INSP) Université Pierre et Marie Curie (UPMC) Paris</td>
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<td>7.</td>
<td>Ms. Sathya Ramalingam</td>
<td>Engineering Sciences</td>
<td>Dr. J Raghava Rao CSIR-Central Leather Research Institute, Chennai / Anna University Chennai</td>
<td>Dr. Adeline Perro Institute for Molecular Sciences, University of Bordeaux, Pessac</td>
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<td>8.</td>
<td>Mr. Anant Yadav</td>
<td>Environmental Sciences</td>
<td>Dr. Srikanth Mutnuri Birla Institute of Technology &amp; Science – Pilani K K Birla Goa Campus</td>
<td>Dr. Florent Chazarenc GEPEA, UMR CNRS 6144 Department of Energy Systems and Environment Ecole des Mines de Nantes Nantes</td>
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<td>9.</td>
<td>Mr. M. Venkateswararao K</td>
<td>Mathematical and Computational Sciences</td>
<td>Dr. Veeraruna Kavitha Indian Institute of Technology Bombay Mumbai</td>
<td>Prof. Urtzi Ayesta Laboratory for Analysis and Architecture of Systems CNRS IRIT-ENSEEIHT 2 Toulouse</td>
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<td>Mr. Pawbake Amit Sharad</td>
<td>Materials Science</td>
<td>Dr. Sandesh R. Jadkar Savitribai Phule Pune University Pune</td>
<td>Prof. Abhay Shukla Pierre and Marie Curie University Paris</td>
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<td>Mr. Dinesh Motilal Dhumal</td>
<td>Life and Medical Sciences</td>
<td>Prof. K. G. Akamanchi Institute of Chemical Technology Mumbai</td>
<td>Dr. Ling PENG Interdisciplinary Centre of Nanoscience in Marseille, Aix-Marseille University &amp; CNRS, UMR 7325 Campus of Luminy Marseille</td>
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<td>Ms. Debika Chowdhury</td>
<td>Physical Sciences</td>
<td>Dr. Dawood Kothawala &amp; Prof. L. Sriramkumar Indian Institute of Technology Madras Chennai</td>
<td>Prof. Jérôme Martin Institut d’Astrophysique de Paris, UMR 7095-CNRS, Université Pierre et Marie Curie Paris</td>
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<td>13.</td>
<td>Ms. Richa Sharma</td>
<td>Environmental Sciences</td>
<td>Dr. Shilpi Sharma Indian Institute of Technology Delhi New Delhi</td>
<td>Dr. Pascal Piveteau UMR1347 Agroécologie INRA Department of Agroecology, Université de Bourgogne Dijon</td>
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<td>14.</td>
<td>Mr. Alladi. Charanraj Goud</td>
<td>Life and Medical Sciences</td>
<td>Dr. D.G. Shewade Jawaharlal Institute of Postgraduate Medical Education &amp; Research Puducherry</td>
<td>Prof. Frank Bellivier Inserm UMR-S 1144 Variabilité de Réponse aux Psychotropes Universités Paris Descartes - Paris Diderot Faculté des Sciences Pharmaceutiques et Biologiques, Paris</td>
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<td>15.</td>
<td>Mr. Parswajit Kalita</td>
<td>Physical Sciences</td>
<td>Dr. Santanu Ghosh Indian Institute of Technology Delhi New Delhi</td>
<td>Dr. Gael Sattornay CSNSM, University of Paris Sud Orsay</td>
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<td>Mr. Rahul Shukla</td>
<td>Chemical Sciences</td>
<td>Dr. Deepak Chopra Indian Institute of Science Education and Research Bhopal</td>
<td>Prof. Mohamed Souhassou CRM2, CNRS-Université de Lorraine Nancy</td>
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<td>Life and Medical Sciences</td>
<td>Dr. Suvendra Nath Bhattacharyya CSIR- Indian Institute of Chemical Biology (IICB)/University of Calcutta Kolkata</td>
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<td>Ms. Ritu Gupta</td>
<td>Physical Sciences</td>
<td>Prof. Zakir Hossain Indian Institute of Technology Kanpur Kanpur</td>
<td>Prof. Pierre Rodiere Institute NEEL/CNRS Grenoble</td>
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<td>Life and Medical Sciences</td>
<td>Dr. Sundeep Jaglan AcSIR CSIR-Indian Institute of Integrative Medicine Jammu</td>
<td>Dr. Samuel Bertrand Laboratoire Mer, Molécules Santé-EA 2160, UFR des Sciences Pharmaceutiques et Biologiques, Université de Nantes Nantes</td>
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<td>Mr. Syed Adil Mizan</td>
<td>Atmosphere and Earth Sciences</td>
<td>Dr. Shakeel Ahmed IFCGR, CSIR-NGRI Hyderabad / Osmania University Hyderabad</td>
<td>Dr. Benoit Dewande Bureau de recherches géologiques et minières (BRGM) Montpellier</td>
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<td>Ms. Madhuchhanda Brahma</td>
<td>Engineering Sciences</td>
<td>Dr. Santanu Mahapatra Indian Institute of Science Bangalore</td>
<td>Dr. Marc Bescond Institut Matériaux Microélectronique Nanosciences de Provence (IM2NP), UMR CNRS 7334 Universités d'Aix-Marseille et de Toulon Strasbourg</td>
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<td>Name of Host Scientist</td>
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<td>22.</td>
<td>Mr. Rajasekar P</td>
<td>Materials Science</td>
<td>Prof. Arun M. Umarji Indian Institute of Science Bangalore</td>
<td>Prof. Sebastian Volz Laboratoire d'Energétique Moléculaire et Macromoléculaire, Combustion, UPR CNRS 288 CentraleSupélec Châtenay Malabry</td>
</tr>
<tr>
<td>23.</td>
<td>Ms. Sukanya Pandeti</td>
<td>Chemical Sciences</td>
<td>Dr. T. Narender CSIR-Central Drug Research Institute Lucknow</td>
<td>Dr. L. Feketeová and Dr. H. Abdoul-Carime Institut de Physique Nucléaire de Lyon Université Lyon 1 Lyon</td>
</tr>
<tr>
<td>24.</td>
<td>Ms. Shweta Sharma</td>
<td>Atmosphere and Earth Sciences</td>
<td>Dr. A. Guha Indian Institute of Technology Kanpur Kanpur</td>
<td>Dr. Thierry Dauxois Laboratoire de Physique ENS de Lyon Lyon</td>
</tr>
<tr>
<td>25.</td>
<td>Mr. Deepak Mishra</td>
<td>Engineering Sciences</td>
<td>Dr. Swades De Indian Institute of Technology Delhi New Delhi</td>
<td>Dr. George C. Alexandropoulos Mathematical and Algorithmic Sciences Lab Huawei Technologies Co. Ltd. Boulogne-Billancourt</td>
</tr>
<tr>
<td>26.</td>
<td>Mr. Lucas Lestandi</td>
<td>Engineering Sciences</td>
<td>Dr. Mejdi Azaiez I2M TREFLE Université de Bordeaux Talence</td>
<td>Prof. Tapan K. Sengupta Indian Institute of Technology Kanpur Kanpur</td>
</tr>
<tr>
<td>27.</td>
<td>Mr. Minmooy Das</td>
<td>Life and Medical Sciences</td>
<td>Dr. Jagadeesh Bayry Centre de Recherche des Cordeliers – INSERM Unité 1138, Université Pierre et Marie Curie Paris 6 Paris</td>
<td>Prof. Kithigannahi Narayanaswamy Balaji Indian Institute of Science (IISc), Bangalore</td>
</tr>
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<td>S. No.</td>
<td>Name</td>
<td>Area of Interest</td>
<td>Supervisor Name and Address &amp; PhD Registered University</td>
<td>Name of Host Scientist</td>
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<tr>
<td>28.</td>
<td>Ms. Elise Vickridge</td>
<td>Life and Medical Sciences</td>
<td>Dr. Olivier Espeli Centre Interdisciplinaire de Recherche en Biologie - UMR CNRS 7241 / INSERM U1050 College de France Paris</td>
<td>Prof. Jayaraman Gowrishankar Centre of DNA fingerprinting &amp; Diagnostics, Hyderabad</td>
</tr>
<tr>
<td>29.</td>
<td>Mr. Zelaci Hacen</td>
<td>Mathematical and Computational Sciences</td>
<td>Prof. Pauly Christian Laboratoire J.A. Dieudonné, University of Nice-Sophia Antipolis UMR 7351 CNRS, Nice</td>
<td>Prof. Vikraman Balaji Chennai Mathematical Institute, Chennai</td>
</tr>
<tr>
<td>30.</td>
<td>Mr. Nicolas Gheeraert</td>
<td>Physical Sciences</td>
<td>Dr. Nicolas Roch / Dr. Serge Florens Institut Néel-CNRS 25 Universite Grenoble-Alpes Grenoble</td>
<td>Dr. Rajamani Vijayaraghavan Tata Institute of Fundamental Research Mumbai</td>
</tr>
</tbody>
</table>
CEFIPRA joined hands with Université Joseph Fourier (now Université Grenoble Alpes), Grenoble, France for supporting Indian doctoral students to participate in the ESONN session in Grenoble, France. ESONN is a three-weeks course aimed at providing training for graduate students, postdoctoral and junior scientists from universities and laboratories in the field of nano-sciences and nano-technologies in Physics, Biology and Chemistry. During the year, 110 applications were received and following eight Indian doctoral students were supported for participation in the 13\textsuperscript{th} edition of ESONN training programme held from 28\textsuperscript{th} August to 17\textsuperscript{th} September, 2016 at Grenoble, France:
CEFIPRA-SOLEIL Synchrotron

In an effort to utilize large scale scientific facilities available in India & France for the scientists/researchers of both the countries, CEFIPRA signed a MoU on 14th October, 2014 with SOLEIL Synchrotron to facilitate the use of the SOLEIL Synchrotron facility in France by Indian Scientists. Under this programme, CEFIPRA had supported visits of 26 scientists/researchers to SOLEIL till February/March, 2017. The PIs who have been allocated beam time at SOLEIL (Call AP19) were requested by CEFIPRA in January, 2017 to submit the proposal under this programme for further consideration. However, as per the suggestion made by 55th & 58th Scientific Council that the programme may be taken-up by National Funding Agencies for further continuation and expansion, CEFIPRA has approached DST accordingly. The Centre will continue to support the successful visitors/researchers for two more cycles of Calls (AP 19 & AP 20), before the expiry of the MoU in October, 2017.

**CALL AP 17 at SOLEIL**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Title of the Proposal</th>
<th>Name and Institutional affiliation of the Proposer</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Study of isotope effect in self-diffusion of Fe in nanocrystalline iron film</td>
<td>Dr. Ajay Gupta Amity University, Noida</td>
</tr>
</tbody>
</table>

**Name and Institutional affiliation of the Visitors Supported**

- Dr. Ajay Gupta Amity University, Noida
- Dr. Mukul Gupta UGC-DAE CSR, Univ. Campus, Indore
- Mr. Gagan Sharma Amity University, Noida

**CALL AP 18 at SOLEIL**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Title of the Proposal</th>
<th>Name and Institutional affiliation of the Proposer</th>
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<tbody>
<tr>
<td>1</td>
<td>Growth kinetics of gold nanocrystals and amorphous gold below the organic monolayer</td>
<td>Prof. Sarthi Kundu Institute of Advanced Study in Science and Technology (IASST), Guwahati</td>
</tr>
</tbody>
</table>

**Name and Institutional affiliation of the Visitors Supported**

- Prof. Sarthi Kundu Institute of Advanced Study in Science and Technology (IASST), Guwahati
- Mr. Ashim Chandra Bhowal
- Mr. Kaushik Das
<table>
<thead>
<tr>
<th>S. No</th>
<th>Title of the Proposal</th>
<th>Name and Institutional affiliation of the Proposer</th>
</tr>
</thead>
</table>
| 2     | Spatial distribution and local electronic properties of the 1T phase in exfoliated few-layers MoS2 | Prof. D. D. Sarma
Indian Institute of Science, Bangalore                                                    |

Name and Institutional affiliation of the Visitors Supported

- **Mr. Banabir Pal**
  Indian Institute of Science
  Bangalore

- **Mr. Sumanta Mukherjee**
  Indian Institute of Science
  Bangalore

- **Mr. Akmal Hossian**
  Indian Institute of Science
  Bangalore
5. Brief Reports of Research Projects

A. Collaborative Scientific Research Programme
To explore whether CEs are synthesized in trout gonads like in catfish
To analyze the potential effect of CEs on trout in vitro oocyte maturation
To analyze the in vitro effect of physiological doses of CEs on the transcriptomes of both catfish and trout ovary and trout embryonic gonads using homologous oligonucleotide microarray technology
To get information on the effect of CEs on the expression of some major steroidogenic enzymes using quantitative real time polymerase chain reaction (qPCR)
To propose new models, including CE, for the estrogen implication in fish oocyte maturation and sex differentiation regulation

Catechol-estrogens (CE) were shown ineffective on trout ovary unlike catfish ovary
Molecular cloning and characterization of major catfish enzymes involved in catechol-estrogens metabolism (cyp1a1, cyp1b1 and comt) was achieved
mRNA of cyp1a1, cyp1b1 and comt, and cyp1a1 and comt proteins were localized in the follicular layer of the catfish ovary
Developmental stage-dependent expression of cyp1a1, cyp1b1 and comt was completed in the catfish
Gonadotropin (hCG) and 2-hydroxyestradiol-17β (CE) were shown to up regulate cyp1a1, cyp1b1 and comt gene expression during oocyte maturation
A new oligonucleotides micro-array has enabled to analyze changes in catfish ovary transcriptome under 2-hydroxyestradiol-17β exposure

Background
While world demand for fish and seafood is expected to grow steadily, capture fishery production remains relatively static since the late 1980s. In India, the global fish demand could increase by one third by 2030. World aquaculture now provides around half the fish for direct human consumption (49.8 million tonnes of finfish in 2014) and should be able to fit with the future demand (estimated to 94 million tonnes in 2030 by FAO under a baseline scenario). One major step in fish farming is the proper control of fish reproduction especially when developing selective breeding. The present project aims to bring very new original knowledge on the endocrine regulation of female reproduction. It has been chosen to focus at a molecular level on the synthesis and action of catechol-estrogens, which are a major group of active natural estrogen metabolites although very few studies exist in non-mammalian vertebrates.

Knowledge Generated/Products Developed
Catechol-estrogens (CE) were shown ineffective on trout ovary unlike catfish ovary
Molecular cloning and characterization of major catfish enzymes involved in catechol-estrogens metabolism (cyp1a1, cyp1b1 and comt) was achieved
mRNA of cyp1a1, cyp1b1 and comt, and cyp1a1 and comt proteins were localized in the follicular layer of the catfish ovary
Developmental stage-dependent expression of cyp1a1, cyp1b1 and comt was completed in the catfish
Gonadotropin (hCG) and 2-hydroxyestradiol-17β (CE) were shown to up regulate cyp1a1, cyp1b1 and comt gene expression during oocyte maturation
A new oligonucleotides micro-array has enabled to analyze changes in catfish ovary transcriptome under 2-hydroxyestradiol-17β exposure

Induction of oocyte maturation (MPF = Maturation Promoting Factor)
Pure & Applied Physics

REAL-TIME IMAGING THROUGH FOG OVER LONG DISTANCES (RITFOLD)

Background

Photons in turbid media are randomly scattered, losing their direction of propagation and polarisation, and thus their imaging capabilities. Methods devised so far to extract images need sophisticated equipment or enormous computational time. Polarisation-based imaging, an elegant and inexpensive technique, can provide 2D images, but not in real-time. With the availability of powerful yet cheap sources of light that may be electronically controlled, inexpensive fast cameras and portable devices with high computing capabilities, real-time long range imaging using ballistic photons now appears feasible. The project aims at obtaining visual images of a source despite intervening strongly scattering media. Innovative ideas on source modulation, detector synchronization and sampling, particularly suited for aircraft navigation, will be implemented in the field, in actual fog, and over ~ kilometer. This project will also provide data on atmosphere scattering, which is lacking in literature, and will help optimize existing theoretical models.

Objectives

The objective of the project is to develop a real-time, long-range imaging system providing visual assistance under low visibility conditions. The path of light in a heavily scattering medium (like fog, dust, suspension of particles, etc.) tends to be diffusive rather than ballistic, thereby rendering direct viewing or imaging through such media difficult. For this purpose, two imaging techniques will be explored, implemented, tested and optimized. Both techniques are based on the detection of ballistic photons, i.e. the potentially few photons that have not been scattered (or have been marginally scattered) by the diffusive medium. The first one is based on the use of polarised light, while the other technique will involve the use of a modulation technique, varying either the light polarisation state or its intensity.

Knowledge Generated/Products Developed

- Developed camera-control and automation software for imaging in any weather condition
- Developed rugged high-polarimetric source that can be in the field in all weather
- Optimised choices of polarimetric representation for contrast enhancement under different weather conditions
- Realization of unsuitability of intensified cameras for sub-sampling imaging due to unacceptable signal-to-noise ratio and dynamics for long-range viewing through fog
- Simulations confirmed speedup of data-processing by use of matched filtering for image retrieval of intensity-modulated light sources, instead of the usual Fourier decomposition. This is to be used in real situations
- Invention and development of an apparatus for imaging through turbid media using high-frequency modulated light (patent filed)

Publications

- No. of publications in SCI journals: 2
- No. of papers presented in conferences: 2

Principal Collaborators

Hema Ramachandran
Raman Research Institute
Bangalore

Mehdi Alouni
Institut de Physique de Rennes
Université de Rennes 1
Rennes

Mobility Support

- India to France: 2
- France to India: 2

(a) Comparison of the contrasts obtained for three representations of the polarimetric images for frames labeled as [I] and [J] in figure1(b).

The source region, is bounded by the 3 × 3 pixels red square and is the background region between the two blue squares of sizes 11 × 11 pixels and 21 × 21 pixels. (b) CNR-maximizing 1D search over values of v keeping u = 1 for the two frames.
A new nitrate transporter has been identified, NFP5.5 by functional expression in xenopus oocyte. The NPF5.5 gene is expressed in the embryo and is involved in nitrogen accumulation. An objective of the upcoming year is to analyse the role of this transporter in plant sodium sensitivity.

Root sodium ion, ROS, calcium and cell viability analysis (using CoroNa Green, H,DCFDA, Fluo AM and Propidium iodide stain, respectively) and expression analysis of salinity ion transporters genes reveals that roots of cbl9 and cipk23 KO mutants shows higher sodium, ROS, cell death and un-balanced calcium homeostasis and differential expression as compared with wild type (Columbia) under salt stress, which indicates the higher salinity sensitivity and role of CBL9 and CIPK23 in salinity stress.

CBL1 (calcium sensor) and ABI2 (protein phosphatase 2C family member) involved in regulation of nitrate transport, sensing and signalling. Moreover, in vitro kinase assays and bimolecular fluorescence complementation assays revealed that ABI2 interacted with and dephosphorylated CIPK23 and CBL1. Coexpression studies in Xenopus oocytes and analysis of plants deficient in ABI2 indicated that ABI2 enhanced NPF6.3-dependent nitrate transport, nitrate sensing, and nitrate signaling.

NPF5.5 mRNA localization demonstrates that it is the first NPF transporter reported to be expressed in Arabidopsis embryo. Two independent homozygous npf5.5 KO lines exhibit reduced total nitrogen content in the embryo as compared to WT plants, demonstrating an effect of NPF5.5 function on the embryo nitrogen content. Ultimately, NPF5.5 gene produces two different transcripts (AtNPF5.5a and AtNPF5.5b) encoding proteins with different N-terminal ends. Both proteins are able to transport nitrate in xenopus oocytes.
Completed Projects

Computational Science

ARITHMETIC CIRCUITS COMPUTING POLYNOMIALS

Background

The aim of this project is to better understand arithmetic circuit computations of polynomials and related counting and enumeration complexity questions, organised along three main axes:

• Proving lower bounds for restricted models of computations (multilinear branching programs), with a particular focus on the computation of the determinant.
• Finding new natural complete polynomials for the classes in the general theory defined by Valiant, in particular for the class of feasible computations VP, and understanding the role of the characteristic in results of VNP completeness.
• Defining or refining notions of reduction, completeness, parallel complexity, space bounded complexity for enumeration and studying enumeration questions related to polynomials computed by circuits.

Objectives

• Proving lower bounds for restricted computation models
• Capturing completeness of complexity classes (specifically, the class VP) via natural polynomial families
• Exploring the complexity of enumerating monomials

Knowledge Generated/Products Developed

• Establishing that the iterated matrix polynomial IMM(n,d) has no depth 4 formulas of different kinds. These results show that a recent upper bound by Tavenas (MFCS 2013) is tight and improve the lower bound of Nisan and Wigderson from 1997
• Showing VP-completeness of a polynomial family that is a variant of the polynomial that generalises counting graph homomorphisms, the first known example of a natural VP-complete polynomial
• Initiating a study of enumeration complexity for monomials of readrestricted formulas
• Extending Nisan’s non-commutative lower bounds to two different stronger models, thus getting the strongest noncommutative models for which there is a superpolynomial lower bound
• Obtaining lower bounds for depth-4 formulas computing the elementary symmetric polynomials, generalizing Nisan and Wigderson’s bounds

Principal Collaborators

Meena Mahajan  
The Institute of Mathematical Sciences  
Chennai

Guillaume Malod  
Institut Mathématique de Jussieu  
Université Paris Diderot - Paris

Publications

• No. of publications in SCI journals: 2
• No. of papers presented in conferences: 2

Mobility Support

• India to France: 4
• France to India: 7

The derivatives of IMMₙ
Life & Health Sciences

INTEGRATING Hox AND CHROMATIN MEDIATED TRANSCRIPTIONAL REGULATION

Project No. 4703-2  Jun. 2013 to May 2016

Background

How only a handful of highly specific transcription factors, the Hox proteins, accomplish rich functional diversity still remains poorly understood. Previous approaches on understanding their mode of action have focused mainly on studying how protein partners of the PBC and Meis family of sequence specific transcription factors influence Hox target gene recognition. As chromatin and not naked DNA is the in vivo template for Hox proteins, it is proposed to investigate how chromatin regulators mediate Hox protein function. According to the collaborators this may be the first attempt at merging Hox-mediated and chromatin-mediated control of transcription. Target gene selection and regulation by transcription factors is a highly coordinated series of events, including chromatin modification and functional interaction with the regulatory elements. The project aims to facilitate the understanding of these orchestrated events by better defining how Hox proteins function in the highly complex chromatin environment.

Objectives

- To better understand how the evolutionary conserved Hox transcription factors, with broadly recognised functions in development and disease, control gene expression by investigating the interplay with chromatin features and regulators

Knowledge Generated/Products Developed

- Characterisation of Hox chromatin interplays for gene regulation in *Drosophila* S2 cells
- Discovery and characterisation of Hox associated PTMs and protein domains: functional and structural characterisation
- Discovery and characterisation of a Hox generic function in the *Drosophila* fat body: repression of autophagy
- Defining the chromatin landscape for Hox generic functions
- Functional relevance of abdA in the posterior domain where identity is determined by AbdB

Models for distinct Hox cofactor partnership for Dll repression. (A) Model for repression of Dll by Ubx/AbdA in anterior abdominal segments A1-7. Repression relies on the assembly of a Hox/Exd/Hth protein complex [20]. DNA binding by Hox proteins is not essential (depicted by a dashed delineated pink zone of contact between the Hox protein and the DNA), as supported by the limited loss of repressive activity of a DNA binding deficient Ubx protein (Figure 7), and by the limited derepression associated to mutation in Hox binding sites. The non-essential character of Hox DNA binding may result from acting in a context of a multiprotein complex containing two additional DNA binding proteins (Exd and Hth). (B) Model for repression of Dll by AbdB in posterior abdominal segments in A8-9. AbdB represses Exd and Hth, and consequently act without the aid of Exd and Hth to repress Dll. This difference likely imposes a strict requirement for AbdB DNA binding for efficient

Principal Collaborators

Rakesh K Mishra
Centre for Cellular and Molecular Biology
Hyderabad

Yacine Graba
Institute for Developmental Biology Marseille Luminy (IBDML), CNRS
Marseille

Publications

- No. of publications in SCI journals: 8
- No. of papers presented in conferences: 15

Mobility Support

- India to France: Nil
- France to India: 1
The objectives of the project are to study nonequilibrium quantum phenomena in strongly correlated nanoscale systems like for instance interacting quantum dots in the Kondo regime. By means of these techniques, we will study charge- and spin-currents driven by a time-independent bias voltage across the dot and will derive current noises at finite frequency and third cumulant making use of full counting statistics. Examine other ways of achieving non-equilibrium by applying a time-dependent bias or gate voltage. Photo-assisted charge- and spin-noise will be computed for an ac modulation of the external field. Address the issues related to charge and spin dynamics after a fast switching (step pulse) of the gate voltage. The whole results will be discussed in light of recent experiments.

Schematic representation of the experimental setup constituted by a QD connected to the two electrodes, sources and drain D, and a QPC responsible for the generation of the current IE injected from the emitter E into S. An external magnetic field is applied to the system with the plane of the device tilted by a small angle to the axis of the magnetic field.

Objectives

The objectives of the project are to study nonequilibrium quantum phenomena in strongly correlated nanoscale systems like for instance interacting quantum dots in the Kondo regime. By means of these techniques, we will study charge- and spin-currents driven by a time-independent bias voltage across the dot and will derive current noises at finite frequency and third cumulant making use of full counting statistics. Examine other ways of achieving non-equilibrium by applying a time-dependent bias or gate voltage. Photo-assisted charge- and spin-noise will be computed for an ac modulation of the external field. Address the issues related to charge and spin dynamics after a fast switching (step pulse) of the gate voltage. The whole results will be discussed in light of recent experiments.
Completed Projects

Pure & Applied Physics

ROTATING AND CURVED BOUNDARY-LAYER INSTABILITIES

Project No. 4704-3  May 2013 to Jan. 2017

Background

Shear flows display a wide range of instabilities and undergo transition to turbulence by vastly different routes. The dynamics of wall-bounded shear flows determines global flow quantities such as friction coefficients and heat transfer rates. In many practical configurations of interest, fluid flows around objects that are curved and rotating. Curvature and rotation both have a major role in stability and transition to turbulence, but the combination has not been studied very much. The combination is likely to display different behaviour from merely the sum of its parts. The current project is therefore aimed at completely understanding the fundamental dynamics of a geometrically simple prototype of such flows. By bringing together the expertise of the two principal collaborators, linear and nonlinear analyses will be carried out so as to completely characterize the complex three-dimensional dynamics leading to turbulence in this context.

Objectives

While continuing work on the axial flow developing along a rotating cylinder, we are also investigating related flow configurations: the flow through rotating channels and pipes cross flow past a rotating rough cylinder. These configurations all fall into the category of flows which form the focus of the project and their study is expected to better reveal different aspects of dynamics involving rotation and curvature. The mathematical and numerical tools used in these different sub projects are all very similar.

Knowledge Generated/Products Developed

- Boundary layer flow along a rotating cylinder - Base flow completely documented and published
- Boundary layer flow along a rotating cylinder - Stability analysis completed and published
- Rotating channel flow: study completed and submitted for publication
- Rotating rough cylinder with crossflow: two-dimensional simulations in progress
- Flow through a rotating pipe: linear and nonlinear dynamics completed

Principal Collaborators

Rama Govindarajan
TIFR Centre for Interdisciplinary Sciences
Hyderabad

Benoît Pier
École centrale de Lyon
(CNRS-Université de Lyon)
Ecully

Publications

- No. of publications in SCI journals: 2
- No. of papers presented in conferences: 4

Mobility Support

- India to France: 1
- France to India: 3

The critical curve for various rotation rates $S$. Zeta is a measure of the streamwise distance and $Re$ is the Reynolds number.
Earth & Planetary Sciences

DEEP STRUCTURE OF THE INDIAN CONTINENT

Background

The present day configuration of the Indian tectonic plate is a consequence of its breakup from the Gondwana supercontinent possibly due to a large plume, about 130 Myr ago. Paleomagnetic data demonstrates that the Indian continent moved northwards from 65 Myr at exceptionally high speeds (18-20 cm/year) and subsequently slowed down to 4-5 cm/year after its collision with Asia ~40 Myr ago. This super mobility has been explained by an unusually thin Indian lithosphere (~100 km) in contradiction with the thick lithosphere that commonly underlies old cratonic nuclei. It is pertinent to note that the thermobarometric estimates on the ultramafic xenoliths from a 65 Myr kimberlites of the Central India suggest an approximately 175 km thick lithosphere. Also, analysis of heat flow data and P-T estimates on mantle xenoliths from the Dharwar craton reveal low mantle heat flow, 14-20 mW m^-2, that indicate a thick lithosphere beneath south India. In order to solve this apparent contradiction, the collaborators propose a multidisciplinary approach to investigate the lithospheric and asthenospheric structure underneath the Indian cratons and the Indian plate. Seismological studies (receiver functions, SKS and surface waves) in conjunction with heat flow, petrological and paleomagnetic data would be utilised to image the 3D-tomographic velocity and anisotropic structure of the whole continent and trace its evolution through time.

Objectives

• To investigate the causative factors that determine the unique nature of the Indian continent, with emphasis on its origin, deformational history, interactions with Asia and its tectonic evolution, in order to constrain the thermal structure of the Indian shield lithosphere
• The final objectives are to derive a consistent evolutionary model of the Indian continent by synthesiging all seismic results and constraints from heat flux, petrological and paleomagnetic data

Knowledge Generated/Products Developed

• Assembled teleseismic data registered at all the Indian broadband seismological stations
• Characterized the seismic structure and deformation through application of recent methodologies (P- and S- receiver functions, SKS splitting)
• Obtained a 3-D anisotropic, heterogeneous mantle model of the Indian continent and surrounding oceans, mapped lateral variations in the lithosphere asthenosphere boundary

Principal Collaborators

M. Ravi Kumar
National Geophysical Research Institute
Hyderabad

Jean-Paul Montagner
Institut de Physique du Globe(IPGP)
Paris

Publications

• No. of publications in SCI journals: 2
• No. of papers presented in conferences: Nil

Mobility Support

• India to France: 6
• France to India: 6

High shear wave velocity anomaly (bottom) in the Indian plate subducting beneath the Asia along profile AB in map (top)
The objective of the project is to explore, at the gene level, the functional biodiversity of soil eukaryotic microbial communities living in stressful polluted soil environments. This will allow characterization of genes implicated in adaptation to these stressful conditions such as: heavy metal resistance mechanisms but also genes implicated in basic processes such as organic matter degradation under stressful conditions.

- A new method for constructing sized eukaryotic environmental libraries was implemented
- Isolated 94 cDNA sequences of which the majority corresponds to new metal-resistance mechanisms
- These sequences were analysed along with cysteine rich proteins-encoding environmental cDNA sequences
- 22 clones tolerant to Cd and 14 clones tolerant to Cobalt were isolated
- Studied the role and induction in presence of metals of several metallothioneins from two basidiomycetes *Lacaria bicolor* and *Pisolithus albus*
- Developed a new process/protocol to construct sized eukaryotic cDNA libraries using low input of total environmental RNA from soil samples
MOLECULAR MECHANISMS OF IMMUNE EVASION BY M. TUBERCULOSIS

Background
The central theme of the project concerns molecular dissection of immune evasion mechanisms of M. tuberculosis and designing tools for the conception of novel vaccines. The interaction of M. tuberculosis and immune system is of dynamic process and implicates several cellular and molecular partners. The collaborators will explore the role of microRNAs in the pathogenesis of tuberculosis in patients and experimental models, and regulation of microRNA expression by pathogen-associated molecules of M. tuberculosis and pattern-recognition receptor interaction and corresponding intracellular signaling dynamics. The contribution of regulatory T cells and hemoxygenase-1 in the suppression of host immune response to tuberculosis and strategies to target these molecules to design novel vaccine candidates will be investigated. Overall, the project addresses both basic and medical sciences and is expected to deliver preventive and therapeutic tools to combat tuberculosis.

Objectives
- To study differential microRNA (miRNA) profile of tuberculosis patients and to correlate its relevance to disease progression
- To explore the role of innate pattern recognition receptors (PRRs) and intracellular signaling dynamics in the modulation of miRNA expression by virulent antigens of M. tuberculosis
- To decipher the role of candidate miRNA in the pathogenesis/protection against tuberculosis in vivo
- To dissect molecular immnoregulatory function of Haemoxxygenase-1 (HO-1) and CD4+CD25+Foxp3+ regulatory T cells (Tregs), the two major regulators of immune response to an antigen/pathogen, in the pathogenesis of tuberculosis
- To study the impact of Tregs on miRNA expression pattern and HO-1-mediated immune regulation towards M. tuberculosis and to conceive novel vaccine and adjuvant candidates

Knowledge Generated/Products Developed
- M. bovis BCG-induced miR-31 and miR-150 fine-tunes pathogen-specific TLR2 signaling events and thus shape the course of infection
- M. bovis BCG-induced KLF4 was essential to orchestrate the epigenetic modifications mediated by miR-150 and calibrate CIITA/MHC-II expression
- miR-155 and miR-31-mediated augmentation of WNT and SHH pathways is necessary for the sustained and long term inhibition of autophagy of host cells
- miR-146a plays a crucial role to establish novel crosstalk between NOD2-SHH signaling during gut inflammation
- Rv3812 (PE_PGRS 62) is highly immunogenic and is a potential candidate for boosting BCG-induced immune responses
- Neutralization of programmed death-1 ligand 1 on dendritic cells enhances Mycobacterium-mediated IFN-γ production in CD4+ T cells

Principal Collaborators
- K N Balaji
  Indian Institute of Science
  Bangalore
- Jagadeesh Bayry
  INSERM UMR S 872
  Equipe 16
  Centre de Recherche des Cordeliers
  Paris

Publications
- No. of publications in SCI journals: 17
- No. of papers presented in conferences: Nil

Mobility Support
- India to France: 2
- France to India: 2

Ac2PIM-responsive, TLR2-SRC-FAK-PYK2-CREB-CBP/P300-dependent miRNAs, miR-150 and miR-143, target RIP2 and TAK1, respectively to suppress NOD2-induced PI3K-PKC-ζ-MAPK-α-catenin-mediated expression of immunomodulators like COX-2, SOCS-3, and MMP-9
Completed Projects

Life & Health Sciences

DNA-ENCAPSULATED QUANTUM DOTS FOR BIO-IMAGING


Background

It has proved non-trivial to functionalize quantum dots (QDs) with bioactive molecules such as proteins and nucleic acids due to the incompatibility between QD surface chemistries and bio-functionalization chemistries. It has also proved non-trivial to achieve bio-functionalization with well-defined stoichiometries in bulk. These limitations have severely restricted the applications of QDs for *incellulo* and *invivo* imaging. The project is to create and characterize synthetic host-cargo complexes where the host is a polyhedral DNA capsule and the encapsulated cargo is a QD. Encapsulation of the QD inside a synthetic DNA host nullifies the need for bio-functionalisation chemistry and QD surface chemistry compatibility. Furthermore, a DNA host has addressable locations for bio-functionalization and thus stoichiometry of bio-conjugation is exquisitely tunable in bulk. They propose to demonstrate the power of such DNA encapsulated QDs by showcasing their bio-imaging applications *incellulo*.

Objectives

1. Prepare DNA-functionalized quantum dots for biological applications
2. Make different types of quantum dots (QD) that are non-blinking
3. Functionalize QDs with known stoichiometry of DNA
4. Use these DNA-QD conjugates for biological applications

Knowledge Generated/Products Developed

- A novel method to conjugate DNA to Quantum dots directly
- Demonstration of general applicability of this method to other biomolecules (DNA, proteins, antibodies, peptides) and different nanoparticles (various types of QDs, gold nanoparticles and other colloidal systems)
- Use of this method to develop novel bioimaging probes with enhanced photostability and biological performance
- A novel method to encapsulate quantum dots in DNA nanocapsules
- Functionalized DNA-QDs with precise stoichiometry of endocytic ligand and used for endocytic tracking in live cells

Principal Collaborators

Praveen Kumar Vermula
National Centre for Biological Sciences
TIFR
Bangalore

Benoit Dubertret
UMR8213, CNRS – ESPCI Paris Tech
Laboratoire de Physique et d’Etude des Matériaux
Paris

Publications

- No. of publications in SCI journals: 2
- No. of papers presented in conferences: 1

Mobility Support

- India to France: 1
- France to India: 1
**Materials Science**

**HIGH ANISOTROPY MOLECULAR MAGNETS: SYNTHESIS AND MODELLING**

**Project No. 4808-1**  
**Sep. 2012 to Aug. 2016**

**Background**

Rational design and synthesis of single molecule magnets (SMMs) and single chain magnets (SCMs) with large negative magnetic anisotropies and high blocking temperatures is essential to raise the temperatures below which these phenomena are manifest. It was recently demonstrated, by the French investigator, that hepta coordinated transition metal complexes have very high magnetic anisotropies. The design principle involves use of these complexes as well as rare earth magnetic ions as building blocks for the synthesis of SMMs and SCMs with high magnetic anisotropy. Modelling these systems in which the magnetic exchange interaction strengths are comparable to the strength of magnetic anisotropy require new techniques. These have been developed recently by the Indian investigator for solving many-body electronic as well as magnetic models. Theoretical inputs will be provided for the design of SMMs and SCMs as well as to model the systems after they are synthesised and their properties are investigated.

**Objectives**

- Synthesis of low dimensional (discrete, 1-D) molecular magnets based on complexes with unusual coordination to enhance magnetic anisotropy
- Study of structure-property relations of the so synthesised magnets. Both static and dynamic magnetic properties would be studied, besides other properties such as optical properties, heat capacities and related thermodynamic properties
- Development of theoretical tools to model magnetic systems with strong anisotropy and exchange interactions for systems with assorted spins
- Application of these techniques to model the compounds synthesised by the French group

**Knowledge Generated/Products Developed**

- Synthesis of heptacoordinated Ni(II) and Fe(II) complexes in D5h surrounding
- Demonstration of their substantial magnetic anisotropy, and effect of ligands on it
- Preparation of heterometallic compounds with these Ni and Fe building units
- Novel hetero-trispin (2p-3d-4f) chain compounds
- Modeling of the magnetic behaviours by novel VB technique

**Principal Collaborators**

- **S. Ramasesha**  
  *Indian Institute of Science*  
  *Bangalore*

- **Jean Pascal Sutter**  
  *Laboratoire de Chimie de Coordination du CNRS*  
  *Toulouse*

**Publications**

- No. of publications in SCI journals: 23
- No. of papers presented in conferences: 14

**Mobility Support**

- India to France: 4
- France to India: 3

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Complexes in Hepta Coordination
Background

Skin pigmentation and photoprotection against ionizing radiations requires the synthesis of melanin by melanocytes. Melanin is produced in melanosomes that are transferred to keratinocytes. The previous studies provide a conceptual framework to decipher trafficking pathways that underlie the formation of functional melanosomes. These pathways are altered and/or impaired in melanoma. By using a fruitful combination of light and electron microscopy and biochemistry one challenge of this project is to provide a better understanding on molecular machineries and trafficking steps leading to melanosome biogenesis. The collaborators will focus on Small GTPases of the Rab and Arl families as potential candidates to regulate cell pigmentation. Investigators will decipher the intracellular trafficking steps at which these machineries act and will characterize their effectors. The acquired knowledge will allow identifying potential targets to manipulate pigmentation and will contribute to a better knowledge on alterations in melanoma.

Objectives

- Investigate the role of small GTPases Rab in endosomal trafficking in melanocytes and in the production of functional melanosomes
- Investigate the function of GTPases of the Arl family in the formation of melanosomes
- Investigate how trafficking in melanocytes controlled by these proteins and melanocyte biogenesis/transfer is influenced by interactions with keratinocytes

Knowledge Generated/Products Developed

- Characterized several endosomal Rab GTPases that regulate different protein trafficking steps from different endosomal domains during melanosome biogenesis
- Unraveled a previously unknown post Golgi-melanosome pathway required for melanogenesis and controlled by Rab6AA’ GTPases
- Highlighted a role for Arf-like GTPase (ARL4A) that regulate melanosome biogenesis by controlling AP-3 dependent cargo transport to melanosomes

Principal Collaborators

Subba Rao Gangi Setty
Indian Institute of Science
Bangalore

Graça Raposo
Institut Curie
CNRS UMR144
Paris

Publications

- No. of publications in SCI journals: 4
- No. of papers presented in conferences: 3

Mobility Support

- India to France: 1
- France to India: 4
Life & Health Sciences

STUDY OF NEURAL DEVELOPMENT IN hiPS MODELS OF MICROCEPHALY

Project No. 4903-2  Mar. 2013 to Feb. 2017

Background

The aim of this project is to create \textit{in vitro} models of complex human brain disorders. The collaborators chose to focus on microcephaly because animal models are inadequate to understand its pathophysiology. Furthermore, it is a disorder whose etiology begins very early in development in utero long before the phenotypic manifestation can be seen. To create models of human genetic diseases in a humanized context collaborators will make use of the human induced pluripotent stem cell (hiPS) technology. In this the patient’s own somatic cells will be taken and converted into embryonic-like stem cells. These hiPS cells will then be converted into neural stem cells and differentiated neurons. This powerful approach would be enabling the collaborators to study the development of neurons of the patient with a genetic mutation that causes mental retardation. Since there are no cures for several complex brain disorders and therefore this approach could prove very valuable in coming up with novel signaling pathways and potential drug targets.

Objectives

- To generate human induced pluripotent stem (hiPS) cell lines from normal human fibroblasts and patients fibroblasts mutated in MCPH1
- To differentiate normal and patient hiPS cell lines into neural progenitors and differentiated cortical neurons
- To study cell cycle and proliferation of neural progenitors from normal and patient hiPS lines
- To study cortical neurons specification (layer markers and connexions)
- To study mode of cell division and centrosome composition in neuronal progenitors derived from hiPS cell lines

Knowledge Generated/Products Developed

- Generation of 3 hiPSCs cell lines from unrelated microcephalic patient’s fibroblasts carrying various mutations in MCPH1.
- Characterization of 2 hiPSCs control cell lines and 3 MCPH1 cell lines(pluripotency, karyotype, self-renewal) & adaptation to feeder-free conditions.
- Neural differentiation of control andMCPH1 cell lines and comparison of RA vs Noggin protocols.
- Neuronal differentiation of control and MCPH1 cell lines into cortical neurons.
- Polarity assay in control & MCPH1 hFibs and mitotic abnormalities in hFibs & hiPSCs

Principal Collaborators

- **Naren Ramanan**
  Indian Institute of Science
  Bangalore

- **Pierre Gressens**
  Inserm U 676
  Hôpital Robert Debre
  Paris

Publications

- No. of publications in SCI journals: 8
- No. of papers presented in conferences: Nil

Mobility Support

- India to France: 3
- France to India: 3

Legend for attached picture. Top left – bright field image of a human neural rosette. Top right – organization of the rosette with the apical membrane aligned to the centre of the rosette as marked by ZO-1, an apical marker. Bottom left - Nestin positive cells that are labelled with the proliferation marker Ki67 to show that these are proliferating neural precursors. Bottom right - Pax6 staining to show their forebrain character

Annual Report | 2016-17
REVERSALS OF A LARGE SCALE FIELD ON A TURBULENT BACKGROUND

**Background**

The recent experimental observations of magnetic fields generated by turbulent flow have prompted new interest in the studies of magnetohydrodynamic (MHD) flows in liquid metals and plasmas. Such flows raise both fundamental problems, as well as find applications in geophysics, astrophysics, and various industrial processes. The collaborators will use numerical simulations and theoretical models to understand experimental results as well as observations related to a striking phenomenon: the dynamics of large scale fields on a turbulent background. This includes random reversals of the field polarity, as observed for the magnetic fields of the Earth or the Sun and for large-scale zonal wind in the Earth’s atmosphere. The collaborators will determine why a small number of large-scale modes accurately capture the dynamics of the reversals although these systems are strongly turbulent and will study how reversals are triggered and determine their correlation with the fluctuations of the energy flux that drives the large scale modes.

**Objectives**

- To study how and why these large scale fields abruptly change their polarity
- To understand why a small number of large scale modes nicely capture the reversal dynamics although these systems are strongly turbulent
- To study the geometry of the reversals, i.e. the modes that are involved in driving the system from one state to the one of opposite polarity, and their relation to the symmetries of the problem
- To identify some of the possible triggering mechanism for the random reversals and study their statistical properties

**Knowledge Generated/Products Developed**

- Flow reversals and condensate states in Kolmogorov flow in two-dimensional geometry. Excellent agreement between the simulations and experiments
- Numerical study of energy transfers during reversals of the magnetic field. Decrease of the power of the Lorentz force identified as reversal precursor
- Flow reversals in Rayleigh-Bénard convection. Analysis of the involved modes in term of symmetries of the flow
- Model of the large-scale reversal dynamics in Kolmogorov flows using the truncated Euler equation. Very good agreement with the experiments and numerical simulations
- Quantified reversing and non-reversing magnetic and velocity Fourier modes in a box using group-theoretic arguments

**Completed Projects**

**Pure & Applied Physics**

**REVERSALS OF A LARGE SCALE FIELD ON A TURBULENT BACKGROUND**

**Project No. 4904-1  Mar. 2013 to Dec. 2016**

**Background**

The recent experimental observations of magnetic fields generated by turbulent flow have prompted new interest in the studies of magnetohydrodynamic (MHD) flows in liquid metals and plasmas. Such flows raise both fundamental problems, as well as find applications in geophysics, astrophysics, and various industrial processes. The collaborators will use numerical simulations and theoretical models to understand experimental results as well as observations related to a striking phenomenon: the dynamics of large scale fields on a turbulent background. This includes random reversals of the field polarity, as observed for the magnetic fields of the Earth or the Sun and for large-scale zonal wind in the Earth’s atmosphere. The collaborators will determine why a small number of large-scale modes accurately capture the dynamics of the reversals although these systems are strongly turbulent and will study how reversals are triggered and determine their correlation with the fluctuations of the energy flux that drives the large scale modes.

**Objectives**

- To study how and why these large scale fields abruptly change their polarity
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- To study the geometry of the reversals, i.e. the modes that are involved in driving the system from one state to the one of opposite polarity, and their relation to the symmetries of the problem
- To identify some of the possible triggering mechanism for the random reversals and study their statistical properties

**Knowledge Generated/Products Developed**

- Flow reversals and condensate states in Kolmogorov flow in two-dimensional geometry. Excellent agreement between the simulations and experiments
- Numerical study of energy transfers during reversals of the magnetic field. Decrease of the power of the Lorentz force identified as reversal precursor
- Flow reversals in Rayleigh-Bénard convection. Analysis of the involved modes in term of symmetries of the flow
- Model of the large-scale reversal dynamics in Kolmogorov flows using the truncated Euler equation. Very good agreement with the experiments and numerical simulations
- Quantified reversing and non-reversing magnetic and velocity Fourier modes in a box using group-theoretic arguments

**Principal Collaborators**

- **Mahendra Kumar Verma**
  Indian Institute of Technology Kanpur
- **Stephan Fauve**
  Ecole Normale Supérieure Laboratoire de Physique Statistique Paris

**Publications**

- No. of publications in SCI journals: 9
- No. of papers presented in conferences: 3

**Mobility Support**

- India to France: 3
- France to India: 1
STUDIES OF SPIN LADDER AND HEAVY FERMION SYSTEMS IN EXTREME CONDITIONS OF HYDROSTATIC OR UNIAXIAL PRESSURE AND LOW TEMPERATURE


Background

Discovering and understanding the new states of matter found in the rich phase diagrams and competing ground states of strongly correlated electron systems represent some of the most challenging questions in condensed matter physics today, which even extend to some of the applications of tomorrow. Research in this field relies strongly on the use of high pressure to explore the complex landscape of phenomena but also to manipulate the delicate balance between the various phases. This project aims to harness the complementary expertise of the groups to tackle these questions in Spin Ladder systems where the low dimensionality of the magnetic correlations is fundamental, and Heavy Fermion systems, where the electronic interactions create a strong renormalisation of the energy scales.

Objectives

- To gain further understanding of the physics of the novel and competing orders that exist in two different families, namely spin ladder and heavy fermion systems
- To grow single crystals of SrFeO$_3$, and other spin ladder systems using floating zone furnace
- To grow single crystals of heavy fermion compounds with emphasis on anisotropic systems where the comparison of hydrostatic and uniaxial pressure is particularly interesting
- To setup thermal expansion measurements in Grenoble at zero pressure using a capacitive technique
- To design and fabricate using expertise from Grenoble the Diamond Anvil Cell for electrical resistivity and magnetization measurements suitable for PPMS and VSM respectively and to carry out research in CHPR
- To characterize the single crystals using powder and Laue diffraction, TEM, SEM, electrical
- To investigate electrical resistivity and magnetization measurements under uniaxial pressure at low temperature and high magnetic field
- To develop phase diagrams using uniaxial pressure, hydrostatic and quasi-hydrostatic method using corresponding pressure cells

Knowledge Generated/Products Developed

- Synthesis, characterization and magnetization under hydrostatic and uniaxial pressure of YbNi$_3$A$_5$ single crystals. Magnetic properties of CeRu$_5$Sn$_2$ Alloy under hydrostatic pressure upto 1 GPa. Electrical resistivity measurements of topological insulator CuIr$_2$S$_4$up under pressure up to 8GPa
- Synthesis, characterization, and orientation of spin ladder Sr$_3$Fe$_3$O$_7$, La$_{2-x}$Ca$_x$Cu$_2$O$_{4-y}$, CaCu$_{3}$O$_{6}$ crystals
- Structure, magnetic properties and magnetocaloric effect in LaMnSbO$_{6}$F$_{0.4}$, oxypnictide material and effect of hydrostatic pressure on the magnetic and superconducting transitions of GdFe$_{1-x}$Co$_x$AsO (x=0, 0.1&1) compounds
- Design and fabrication of DAC is completed in CEA and integrating with PPMS is under progress
- Design and fabrication of pressure cell for magnetization measurements under pressure is completed
Pure & Applied Chemistry

KINETICS AND SPECTROSCOPY IN EXTREME ENVIRONMENTS: APPLICATIONS TO ASTROPHYSICS AND ASTROCHEMISTRY

Background
The aim of the project is centred on the acquisition of some fundamental data relevant to Astrophysics and Astrochemistry. During collaborators previous project, a novel high temperature source was designed and developed. This could be used for spectroscopic and kinetics studies at high temperatures, typically in the range of 800 – 2000 K. In the current project, the collaborators would like to use this source for production of materials (simulating hot astrophysical atmospheres) and kinetics and spectroscopic studies at high temperatures. In parallel, the existing facilities at Rennes and Bangalore will be used to complement these experiments. In particular, shock tube studies on propargyl alcohol pyrolysis and combustion, C atom reactions with small hydrocarbons, FTMW investigations propargyl alcohol and its complexes will be carried out in Bangalore.

Objectives

• High temperature (HT) infrared (IR) tunable diode Laser Cavity Ring-Down spectroscopy (TDL-CRDS) of CH₄, C₂H₆, C₂H₂, C₂H₆ @ 1.6 μm
• Investigations of the complexes formed by CH₃F/H₂O mixture in Soleil with the objective of finding red-shift in C-F stretching mode for the ‘carbon bonded’ H₂O-CH₃F complex.
• Microwave spectroscopic studies on propargyl alcohol complexes.
• Shock tube experiments coupled with ex-situ characterization of gases and carbon particles
• IR TDL-CRD spectroscopy of hypersonic flows (grain formation and spectroscopy of radicals)
• HT kinetics (CN+C₂H₂, CN+NH₃, CN+C₂H₆, C₂H₆+C₂H₆, C₂H₆+1,3-butadiene)

Knowledge Generated/Products Developed

• The first experimental measurement on C+H₂ reactions addressing the initial formation of hydrocarbons in the early Universe. This experiment was suggested by the French group and the experiment carried out in the unique shock tube facility established in Bangalore. A cavity ring down spectrometer from the University of Grenoble was brought to Bangalore and used with the shock tube experiments.
• Direct observation of catalytic gas phase nucleation of H₂O by CH₃F/CH₂Cl. This unexpected observation was made at Soleil during the visit of Indian side to France in 2014. A joint project for beam time was submitted to observe the carbon bonded complex H₂O-CH₃F. This project was the result of microwave spectroscopic experiments carried out in Bangalore. When attempts were made to form the H₂O-CH₃F dimer, PI’s observed that (H₂O)n clusters started appearing when a small amount of CH₃F was added to the molecular beam.
• Establishing a hypersonic flow reactor for high temperature rate measurements extending the temperature range beyond 1000 K.
• Microwave spectrum of CH₃F/H₂O clusters were investigated at the University of Lille
• Both teams have been very happy with the collaboration and its outcome. This has also led to new directions for both teams. A novel high enthalpy flow reactor was developed at the University of Rennes and results from this reactor have been published in Journals. Astrophysics research has begun in Bangalore.
Earth & Planetary Sciences

TROPICAL CYCLONES IN THE BAY OF BENGAL: OCEANIC RESPONSE AND AIR-SEA INTERACTIONS

Background

The aim of the project is for a better understanding of the ocean response and air-sea coupling under tropical cyclones (TCs) in the Bay of Bengal. TCs intense winds drive strong vertical mixing, leading to surface cooling and chlorophyll blooms. The cooling can inhibit the TC intensification, while the chlorophyll bloom may lead to enhanced fish catches. The Bay of Bengal is unique amongst TCs prone regions, for its very strong salinity stratification related to the large fresh water input during the monsoon. This salinity stratification inhibits mixing, and could hence limit the ocean ability to negatively feedback on the cyclone intensity. To better quantify the influence of salinity stratification on the amplitude of TC-induced chlorophyll blooms and surface cooling, using an ocean model. Finally, the collaborators will quantify the skill improvement brought by accounting for air-sea interactions under TCs by developing a TCs statistical prediction models in the Bay of Bengal.

Objectives

- Quantify the oceanic control on tropical cyclones-induced surface temperature response in the Bay of Bengal, with an emphasis on the role of salinity stratification on the amplitude of TCs-induced chlorophyll blooms and surface cooling using a forced ocean model
- Understand how this surface cooling retroacts onto the TC characteristics in this region by using a regional coupled ocean-atmosphere model
- Develop statistical prediction schemes in this region in order to quantify the skill improvement brought by accounting for ocean-atmosphere interactions under TCs

Knowledge Generated/Products Developed

- Quantification of the impact of salinity stratification on TCs induced cooling
- Quantification of TCs contribution to chlorophyll and primary production
- Quantification of the impact of airsea coupling on TC characteristic
- Setup of consistent statistical scheme for airsea interactions under TCs
- Improvement of TCs intensity statistical scheme by using a non-linear scheme and including oceanic parameters

Principal Collaborators

S. Neetu
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Goa

Matthieu Lengaigne
LOCEAN, IRD/CNRS/UPMC/MNHN
Paris

Publications

- No. of publications in SCI journals: 3
- No. of papers presented in conferences: 7

Mobility Support

- India to France: 4
- France to India: 4
Background

The hypergeometric functions associated with root systems are representation-theoretical motivated multivariate hypergeometric functions. They originated in the work of Heckman and Opdam (with further contributions by Cherednik) and may be seen as a natural extension of the spherical functions, due to Harish-Chandra, for semisimple Lie groups and Riemannian symmetric spaces. The study of hypergeometric functions associated to root systems is nowadays a central theme in many areas of mathematics, such as harmonic analysis, representation theory, combinatorics and probability. For instance, several combinatorial conjectures due to Macdonald were settled with the help of this theory.

Objectives

- To develop the Heckman-Opdam theory of hypergeometric functions in several directions
- To develop a similar theory for root systems of Lie superalgebras and supersymmetric spaces

Knowledge Generated/Products Developed

- Developed Heckman-Opdam-Cherednik hypergeometric functions on the root system BC for some natural classes of non-positive multiplicities: positivity, estimates, asymptotic expansions
- Study of the radial parts of the invariant differential operators on homogeneous line bundles over non-compact Hermitian symmetric spaces $G/K$ associated with one dimensional representations of $K$.
- Construction of a 1-parameter family of (multivariable) hypergeometric functions as analytic continuation of the spherical functions on the homogeneous line bundles
- Study of the hypergeometric functions of the 1-parameter family of 3) and characterization of the bounded ones (under natural restrictions on the parameter).
- Paley-Wiener theorem, Plancherel and inversion formulas for the hypergeometric transform associated to the above hypergeometric functions.

Molecular structure of centrosymmetric 9. Biaryl dihedral angle in the cavitand subunits: 78.9°. Separation between the centroids of distal aromatic rings in each cavitand: 6.58 and 6.63 Å. Important bond lengths (Å) and angles (°): Pd-μ-Cl 2.3462(7) and 2.3951(7), Pd-Cl 2.2827(8), Pd-P 2.2421(7), μ-Cl-Pd-μ-Cl 90.78(3), Cl-Pd-P 91.29(3), P-Pd-μ-Cl 93.14(3), μ-Cl-Pd-μ-Cl 84.31(2)
**Earth & Planetary Sciences**

**CENOZOIC DENUDATION OF SOUTH INDIA**

**Objectives**

- Map the relict paleosurfaces bearing bauxites, ferricretes and Mn ore deposits across the WGE, i.e., from the lowland (coastal) to the highland area.
- Characterize the lateritic materials (i.e., autochthonous vs. allochthonous) and the underlying geochemical processes for each paleosurface to define the main morpholateritic groups.
- Analyze and date by 39Ar-40Ar radiometry the K-Mn oxides (cryptomelane) sampled at various depths in supergene Mn-ore deposits beneath the paleosurfaces of each group.
- Undertake a paleomagnetic study of Fe-oxhydroxides’ mineralization as a complementary dating Method.
- Quantify the Cenozoic denudation using the incision and ages of paleosurface groups.

**Knowledge Generated/Products Developed**

- Major periods of lateritic weathering identified by radiometric (40Ar/39Ar) dating of K-Mn oxides, and paleomagnetism of Fe-oxides.
- The Western Ghats escarpment is stabilized since at least 50 Ma ago.
- Since then, the denudation and surface incision at the foot of the escarpment are low (≤ 5-6 m/My).
- Reconstructions of topographies of paleolandscapes on traps and across the Western Ghats Escarpment.
- Geochemistry and mineralogy of bauxites and ferricretes.

**Background**

The aim of the project is to evaluate the relative influence of epeirogeny and long-term climate change on the denudation and maintenance of the high elevation escarpment of the passive continental margin of Peninsular India (Western Ghats) over the last 60 Ma. An integrated approach is proposed for detecting and dating erosional paleosurfaces and quantifying the chemical and mechanical surface mass transfers linked to the topographic evolution of the continental. The main tasks will include (1) mapping of relict paleosurfaces, and (2) geochemical, mineralogical and 39Ar/40Ar geochronological analyses of the laterites carried by these paleosurfaces. Ultimately, one will test the influence of the quantified mass transfers on the vertical lithospheric movements.

**Principal Collaborators**

- M. Jayananda, University of Hyderabad, Hyderabad
- Anicet Beauvais, IRD, CEREGE, Technopôle de l’Arbois, Aix en Provence

**Publications**

- No. of publications in SCI journals: 2
- No. of papers presented in conferences: 7

**Mobility Support**

- India to France: 4
- France to India: 2

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A: Stacked 40Ar-39Ar age spectra of supergene K-Mn oxides from the highland manganese ore occurrences. B: Spectra from the lowland manganese ore occurrences. C: Weathering periods derived from series of 40Ar-39Ar plateau ages including errors (s), with denudation rate curves derived from inversion model of apatite fission track data, both for the highland (HL) and lowland (LL). (From Beauvais et al., Geology, March 2016)
Completed Projects

**Computational Science**

**MONTE CARLO AND LEARNING SCHEMES FOR NETWORK ANALYTICS**

**Background**

The aim of the project is to approach various computation problems in network analytics by means of Markov Chain Monte Carlo (MCMC) and related simulation techniques as well as machine learning algorithms such as reinforcement learning, ant colony optimisation, etc. This will include network diagnostics such as ranking, centrality measures, computation on networks using local message passing algorithms, resource allocation issues pertaining to networks and network-based systems such as the internet, peer-to-peer networks, social networks. The work will involve both development of analytical tools and extensive validation thereof using simulation studies. The research will draw upon techniques from graph theory, probability, optimisation, and distributed computation.

**Objectives**

- Efficient computational methods for centrality measures. This encompasses fast algorithms for estimating between-ness centrality, spectral measures for ranking motivated by dynamic phenomena concerning evolving networks or dynamic phenomena on static networks (such as computation on networks). This will combine techniques from computational linear algebra, MCMC and quasi-MCMC, learning algorithms, in particular reinforcement learning algorithms;
- Decentralised algorithms on networks. This encompasses decentralised search (for e.g., an address, a piece of data, or information) based on random walks for realistic network models, decentralised or distributed computing of spectral ranking measures, multiarmed bandit-based online learning algorithms and/or ant-colony optimisation algorithms for learning routes, decentralised computing of localised centrality measures based on quasi-invariance and metastability

**Knowledge Generated/Products Developed**

- Whittle index based policies for crawling ephemeral content in web search engines was developed and analysed
- MCMC based algorithm for estimating edge conductance was developed with potential application to graph compression
- Decentralised stochastic approximation algorithm for semi-supervised learning on graphs was developed, analysed and tested
- Theoretical analysis of metastability in replicator dynamics with noise on complex networks was done and tested with Monte Carlo based approach
- Rumour source detection algorithm in absence of temporal information and partial precedence information was developed based on MCMC and tested

**Principal Collaborators**

- Vivek S. Borkar
  Indian Institute of Technology Bombay
  Mumbai
- Konstantin Avrachenkov
  INRIA Sophia Antipolis
  Sophia Antipolis

**Publications**

- No. of publications in SCI journals: 10
- No. of papers presented in conferences: 12

**Mobility Support**

- India to France: 3
- France to India: 2
GLYCOCHEMICAL STUDIES ON MYCOBACTERIAL ARABINOMYCOLAT

Background

*Mycobacterium tuberculosis* (MTb) causes Tuberculosis (TB), a century old disease that still kills more than 2 million humans annually. MTb cell surface among others has characteristic furanosyl form of arabinose & galactose, cyclopropanated lipids. Ethambutol, a drug used for the treatment of TB, found to arrest the arabinan biosynthesis; glycolipids of MTb are currently under investigation as targets for drug discovery. Presence of xenobiotic furanosyl forms of arabinose, galactose and cyclopropanes in the lipids can raise a few questions: (i) why MTb chose furanosyl over pyranoses; (ii) why MTb chose Araf over other pentoses; (iii) why MTb cell wall has rare cyclopropanes; (iv) Is there any relation between arabinolipid of MTb and its survival under extreme conditions? The project addresses them through physicochemical studies on a library of arabinofuranosyl lipids exploiting modern spectroscopic and microscopic techniques. Results from this study might pave way to the design of newer drugs which can target glycolipids.

### Objectives

To unravel the physicochemical significance of the glycolipids present in the cell wall of *Mycobacterium tuberculosis*:

- Development of chemistry for the synthesis of arabinolipids
- Chemoenzymatic synthesis of glycolipids
- Synthesis of glycolipids library
- Solvation dynamics by THz spectroscopy
- Physico-chemical studies on glycolipids
- *In vitro* Biological evaluations

### Knowledge Generated/Products Developed

- Development of chemistry for the synthesis of arabinolipids
- Chemoenzymatic synthesis of glycolipids
- Synthesis of glycolipids library
- Solvation dynamics by THz spectroscopy
- Physico-chemical studies on glycolipids

### Principal Collaborators

- **Srinivas Hotha**
  *Indian Institute of Science Education and Research, Pune*

- **Thierry Benvegnu**
  *Ecole Nationale Superieure de Chimie de Rennes, UMR CNRS 6226, Rennes*

### Publications

- No. of publications in SCI journals: 2
- No. of papers presented in conferences: 10

### Mobility Support

- India to France: 1
- France to India: 1
Environmental Science

CONTROLLING FOR UPSCALING UNCERTAINTY IN ASSESSMENT OF FOREST ABOVE GROUND BIOMASS IN THE WESTERN GHATS OF INDIA

Project No. 4509-1  Feb. 2013 to May 2017

Background

The aim of the project is to assess uncertainty in evaluation of forest aboveground biomass at critical steps of the upscaling process from local forest data to regional extrapolations, in order to improve large-scale biomass and carbon stock assessments. It focuses on the humid forests of the Western Ghats of India, for which field data, satellite images and detailed vegetation maps are available. The project is an accompanying research of the National Carbon Project (NCP). It is also part of a research programme, which searches for a pertinent integration of the allometric theory of plants with 3D simulations of forest stand dynamics and canopy texture analysis in order to predict properties of forest stands at multiple spatial scales. The project has great potential applications within the framework of NCP and more generally within the UN-REDD programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries.

Objectives

• The main objective of the project is to assess uncertainty in evaluation of forest aboveground biomass (AGB) at critical steps of the upscaling process from local forest data to regional extrapolations, in order to improve large-scale biomass and carbon stock assessments.

The specific objectives are:
- Conversion of tree measurements into plot-level AGB estimates
- Prediction of nominal forest-type AGB densities
- Landscape-scale extrapolation of AGB estimates

Knowledge Generated/Products Developed

• A consistent set of field plots (established by the team) and satellite image data was built in the Yellapur pilot landscape harboring different forest types. Lidar data were also acquired and processed by NRSC.
• The proof of concept of the main steps for upscaling biomass (AGB) from field, to landscape and region scales has been achieved.
• Predictions and associated errors assessment covered the three main types of forests, i.e. evergreen, moist and dry deciduous, though the latter type requested prior identification and specific treatment.

Principal Collaborators

Chandra Sekhar Jha
National Remote Sensing Centre (NRSC) (ISRO) Hyderabad

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UMR AMAP Botanique et bioinformatique de l’Architecture des Plantes Montpellier

Publications

• No. of publications in SCI journals: 4
• No. of papers presented in conferences: 2

Mobility Support

• India to France: 2
• France to India: 3
Biotechnology


Background

Ralstonia solanacearum genome has two genes for the alternative sigma factor, s54: rpoN1 (RSc0408) is located in the chromosome and rpoN2 (RSp1671) is located in the megaplasmid. Initial characterization of these two genes has revealed that rpoN1 is involved in virulence, twitching motility, nitrate utilization and natural transformation of R. solanacearum whereas rpoN2 is not involved in any of the above properties. Interestingly, rpoN2 expression is induced in minimal medium as well as in contact with plant cells whereas rpoN1 expression is constitutive. In addition, rpoN2 expression is dependent on rpoN1. Considering the above observations, the collaborators are interested to use a transcriptomic approach to find out the genes that are under the regulations of rpoN genes in this bacterium, some of which appear crucial for virulence and to investigate on different activators that interact with s54 to initiate transcription from s54 specific promoters in R. solanacearum.

Objectives

- The isolation of a R. solanacearum isolate in India phylogenetically related to strain GMI1000 and to establish an infection system on tomato seedlings
- Determination of additional phenotypic traits, to complement the rpoN1 mutation - instead a second independent mutation in rpoN1 was genetically characterized

Knowledge Generated/Products Developed

- Characterization of a second loss of function mutation in rpoN1
- Phenotypic analysis of rpoN1 mutants showing that this gene is also required for growth on nitrate (in addition to natural transformation, twitching motility and virulence) but not for swimming motility
- Isolation of a R. solanacearum strain (named F1C1) from a wilted chilli plant in India. F1C1 is phylogenetically close to the reference strain GMI1000 and was used to establish an in vitro infection assay on tomato seedlings
- Establishment of the transcriptomic profiling of the rpoN1 and rpoN2 mutants

Principal Collaborators

Suvendra Kumar Ray
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Publications

- No. of publications in SCI journals: 3
- No. of papers presented in conferences: 1

Mobility Support

- India to France: 3
- France to India: 1
Ongoing Projects

**Life & Health Sciences**

### GLOBAL TRANSCRIPTOMICS OF SEX-SPECIFIC SPLICING

**Project No. 4903-4**  **May 2013 to Apr. 2017**

**Background**

The LAMMER protein kinase *DOA* regulates the determination of somatic sexual identity in the fruitfly *Drosophila* via the phosphorylation of the SR-like proteins TRA and TRA2 and their induction of alternative splicing of transcripts encoding the binary switch sex determination protein DSX. Global transcriptomic analysis (RNA-Seq) of wild-type and Doa mutants recently revealed transcripts which are both sex-specifically spliced in wild-type but also under the control of *DOA*, independently of TRA and TRA2. The collaborators will analyze the role of these sex-specific transcripts in sexual determination in both *Drosophila* (male heterogametic sex) and the silkworm, *Bombyx mori* (female heterogametic sex), to identify loci which play conserved roles in insect sex determination. The data could have important commercial applications in the silkworm and lepidopterans in general, a group including a large number of agricultural pests, for which no clear model of sex-determination exists.

**Objectives**

- To characterize and compare the sex specific splicing of pre-mRNAs via highthroughput sequencing of cDNAs (RNA-Seq), in two insect species, a male heterogametic system (*Drosophila melanogaster*) and a female heterogametic system (*Bombyx mori*)
- To analyze the novel molecular players involved in sex determination in these two insect model systems

**Knowledge Generated/Products Developed**

- Generated RNA-seq data in sex specific early stage embryos (78, 96 and 120 hours post oviposition) in Bombyx mori, which is being used for different cellular processes including sex determination, dosage compensation and alternative splicing
- RNA-Seq data on wild-type male vs. female *Drosophila* heads, as well as versus Doa mutants (2 alleles, both sexes) and fne mutants, in duplicate biological and technical replicates at great sequence depth (up to 130 x 106 reads/sample/run). Data are publicly available on GEO (GSM928376, GSM928377, GSM928383, GSM928384, GSM928392, and GSM928393)
- Identification of novel genes encoding RNA-binding and other proteins participating in *Drosophila* sex-determination

**Principal Collaborators**

**Arun Kumar**
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**Leonard Rabinow**
UMR8195 Université Paris Sud Orsay

**Publications**
- No. of publications in SCI journals: 7
- No. of papers presented in conferences: 6

**Mobility Support**
- India to France: 3
- France to India: 3

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A model representing the influence of BmZNF-2 protein on splicing of BmDsx and Bmtra-2 pre-mRNAs
**MUSCLE SC SELF-RENEWAL: A STRESSFUL MATTER?**

**Objectives**

- To delineate the role of SelN as a novel key actor in the molecular control of self-renewal, activation or differentiation in muscle progenitors using *ex vivo* and *in vitro* strategies
- To define the link between SelN, oxidative stress and epigenetic regulation of muscle progenitor cell fate

**Background**

Selenoprotein N (SelN) is the only selenoprotein linked to a monogenic disease, SEPN1-related myopathy, presenting with severe muscle weakness and wasting. Increase of intracellular oxidant activity in the absence of SelN suggests an antioxidant role, but SelN interactions and functions are poorly understood. Loss of muscle stem cells (satellite cells; SC) and regenerative capacity in SelN KO mice has recently revealed SelN as a novel key actor in maintaining muscle stemness. Using a combination of *in vitro* and *ex vivo* expertise and models, the Project will clarify the role of SelN, associated oxidative stress and epigenetic modifications in SC self-renewal, and their response to pharmacological intervention. This will help to understand better the mechanisms determining muscle stemness and their therapeutic applications in regenerative medicine.

**Knowledge Generated/Products Developed**

- Assayed the ability of cells lacking SelN to be quiescent
- Examined the activation potential of primary cells from the SelN knockout mouse
- Over-expressed truncation mutations of SelN cDNA in culture to examine the effects of the individual domains on proliferation, quiescence and differentiation
- Expressed and purified an active SelN fragment in order to determine its interactome using mass-spectrometry

**Principal Collaborators**

- Jyotsna Dhawan  
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  Bangalore
- Ana Ferreiro  
  INSERM Université de Diderot-CNRS  
  Paris

**Publications**

- No. of publications in SCI journals: Nil
- No. of papers presented in conferences: 2

**Mobility Support**

- India to France: 3
- France to India: 1
Ongoing Projects

Pure & Applied Physics

ADVANCED COMPUTATIONAL MODELS TO FACILITATE SOLAR ACTIVITY AND SPACE WEATHER PREDICTIONS

Project No. 5004-1  Jan. 2015 to Jun. 2018

Background

The Sun’s activity varies primarily due to its magnetism. Solar variability modulates the near-Earth Space environment and creates what is known as space weather. Space weather is hazardous to satellite operations, telecommunications and air-traffic on polar routes. Slow-long term solar activity variation also influences the global climate. Studies of the Sun-Earth-Sytem is now a rapidly emerging multidisciplinary science, in which, a fundamental challenge is in understanding the origin of solar magnetic fields and forecasting it. Taking advantage of complementary expertise of the Indian and French PIs, collaborators propose to develop global, coupled computer models of magnetic field generation and dynamics from the solar interior to its surface and further intend to implement sequential observational data assimilation in this solar model to develop it towards realistic predictions of future solar activity, whose knowledge is essential for mitigating the impacts of space weather.

Objectives

- Understand how the decay and dispersal of the magnetic fields of bipolar sunspotspairs - mediated via observed solar surface flows – generate the solar dipolar field
- Using the experiences gained from the earlier approach construct a global, 3-D kinematic solar dynamo model which is coupled to a 3-D MHD magnetic flux tubodynamics model in the SCZ.
- Develop techniques for observational data assimilation in the 3-D global solar dynamo model to move towards data driven forecasts of future solar magnetic activity

Knowledge Generated/Products Developed

- In the year 2017 the development of the computational model for exploring solar surface magnetic field evolution was completed. This data driven model was utilized to reconstruct the last 100 years of solar activity evolution and showed a good match with observations.
- On another front, the development of the 3D global dynamo model for magnetic field evolution inside the Sun was also completed. This model has a efficient algorithm for handling the buoyant emergence of sunspot-forming magnetic flux tubes.
- To test their usefulness both these models were independently applied to study a) the organization of the large-scale coronal magnetic structure of the Sun and b) solar wind generation and distribution; these coronal magnetic structures and the solar wind it generates, impact space weather and thus are an important step towards understanding and predicting our space environment.

Principal Collaborators

Dibyendu Nandi
Indian Institute of Science Education and Research Kolkata

Laurène Jouve
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Publications

- No. of publications in SCI journals: 1
- No. of papers presented in conferences: 1

Mobility Support

- India to France: Nil
- France to India: Nil

Century-Scale Global Solar Surface Field Evolution
Ongoing Projects

Molecular structure of (1) showing the 30% probability level and the solvent


Objective

- The development of pyridyl-resorcinarene derivatives for substrate and product selectivity in cross-coupling reactions
- The synthesis of capped resorinarenes for function discrimination especially for carbonyl groups discrimination in hydrogen transfer or addition of TMSCN
- The generation of metallo-capsules able to induce shape selectivity in transition metal catalysed reactions
- The development of asymmetric phosphoramidites based on a resorin[4]arene platform and their catalytic applications

Knowledge Generated/Products Developed

- Phosphinated and nitrogenated resorcin were synthetised. Catalytic applications of these cavitands are undergoing.
- Generation of new knowledge in the areas of the synthesis of phosphinated and nitrogenated resorcin[4] arenes
- Succeeded to prepare chiral phosphites built on a resorcinarene platform, coordination and catalytic studies are undergoing

Background

The Project aims is at producing catalytic reactions taking place inside a molecular cavity. Four types of ligands based on the resorcin[4]arene platform will be considered, all having either pyridine moieties or phosphorus atoms connected to the larger rim of a conical resorcinarene backbone. The presence of a cavity able to host a catalytic centre is mainly expected to favour substrate or product discrimination. Moreover, the confinement of the catalytic center should introduce a high regioselectivity of the formed products. The resorcinarenyl-complexes will be assessed in carbon-carbon bond forming reactions, hydride transfer and addition of TMSCN to aldehyde. Recycling of the catalysts will be also studied, notably by preparing polymeric derivatives. The present research is a fundamental contribution to the discovery of homogeneous catalysts operating in a confined environment.

Principal Collaborators

- Rengan Ramesh
  Bharathidasan University
  Tiruchirappalli
- David Semeril
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  Université de Strasbourg
  Strasbourg

Publications

- No. of publications in SCI journals: 6
- No. of papers presented in conferences: Nil

Mobility Support

- India to France: 4
- France to India: 3

Molecular structure of (1) showing the 30% probability level and the solvent
Ongoing Projects

Pure & Applied Chemistry

DESIGN AND SYNTHESIS OF NEW C1-SYMMETRIC BIARYL-BASED LIGANDS AND CATALYSTS AND THEIR EVALUATION IN ASYMMETRIC CATALYTIC REACTIONS

**Background**

The aim of the Project is to design and develop new classes of C1 symmetric ligands or organocatalysts based on a biaryl backbone and to evaluate their catalytic efficiency for various catalytic reactions. To begin with ortho, ortho'- dibromobiaryls, ligands will be synthesized and further attempts will be made for the atropodiastereoselective functionalization towards enantiopure ligands. It is planned to synthesize C1-symmetric ligands such as O,O-, N,N-, or P,N- ligands as well as phosphate and phosphoramidite ligands. The compounds prepared in this way with or without metal complex will be screened for their catalytic activities and enantioselectivities. The catalytic reactions to be studied involve asymmetric aldol reaction, multicomponent C-C bond forming reaction, asymmetric conjugate addition, asymmetric hydrogenation and hydroboration, propargylation and Petasis reactions.

**Objectives**

The primary objective of the project is to design and develop new classes of C1 symmetric ligands based on a biaryl backbone and to evaluate their catalytic efficiency for various catalytic reactions. Based on the know-how developed by the French Partner, new biaryl based ligand families will be prepared:

- Synthesis of new classes of C1-symmetric ligands or organocatalysts based on a biaryl backbone
- Screening of the catalysts for their catalytic activities and asymmetric inductions. Based on the know-how in asymmetric reactions of the Indian Partner, the following reactions are planned using the above ligands

- **Knowledge Generated/Products Developed**

  - The C1 Symmetric biaryl-based phosphine catalysts with different substituents were prepared
  - Pd-catalyzed C-N cross-coupling reactions were chosen as model reaction to screen the catalyst. The results showed that steric bulk and the electronic properties of substituents on phosphorous atom play a crucial role in governing the catalytic activity of C-N cross-coupling reactions
  - The Pd-catalyzed reaction was found to be general as it works for coupling of a variety of aryl halides with both primary and secondary amines
  - The reaction requires longer time under reflux conditions while the same reaction under microwave irradiation is completed within 5-10 minutes. This is significant advancement over the reported methods

**Principal Collaborators**

- **Pradeep Kumar**
  National Chemical Laboratory
  Pune

- **Frédéric Leroux**
  Laboratoire de Chimie Moléculaire
  UMR CNRS 7509, COHA-lab
  Université de Strasbourg
  Strasbourg

**Publications**

- No. of publications in SCI journals: 2
- No. of papers presented in conferences: 7

**Mobility Support**

- India to France: 2
- France to India: 2

Two examples of electrostatic potential (ESP) surfaces (by plotting only their positive contribution and restraining the contour level with isovalue of 0.005 a.u. for both cases) associated to (a) 3 and (b) 12.
Computational Science

**eSYNAPSE BASED ON HETEROSTRUCTURES OF BINARY OXIDES**

**Ongoing Projects**

**Project No. 5102-1**  
**May 2014 to Apr. 2016**

**Background**

The aim of the project is to develop electronic nanodevices that mimic the conductivity properties of biological synapses at the size and energy scale of biology. The effective conductance of biological synapses is determined by the time of arrival of pulses at its input and output terminals. Such a device can be developed based on memristive devices that can be programmed to multiple stable resistive states. They will use single or multilayers of binary oxides such as HfO$_x$ and TiO$_x$ to design memristors and work on the engineering of the oxygen vacancies together with the nature of the top electrode to control ionic motions and filamentary path formation. After full physical and electrical characterization of the devices, timing dependent learning behaviour will be implemented.

**Objectives**

The goal of the project is to develop electronic nanodevices that mimic the conductivity properties of biological synapses at the size and energy scale of biology. The effective conductance of biological synapses is determined by the time of arrival of pulses at its input and output terminals. To achieve this, it is first necessary to engineer new memristive devices that can be programmed to multiple stable resistive states at switching voltages below 0.5V.

It was proposed to explore HfO$_2$-based heterostructures grown by different techniques (ALD, CVD and MBE).

**Knowledge Generated/Products Developed**

- Developed pad probable memristive devices made of Cu/SiO$_2$/W material stack
- Memristive switching is observed below 0.3V and 100uA switching current
- The fabricated device exhibits half-integer quantum conductance states
- Quantized behaviour can be explained based on subband transport in Cu nano-filaments formed within the SiO$_2$ dielectric
- Developed HfO$_2$-CVD/ALD/MBE growth and developed pad probable memristive devices made of TiN/HfO$_2$/TiN material stack

**Principal Collaborators**

- **Udayan Ganguly**  
  Indian Institute of Technology Bombay  
  Mumbai

- **Catherine Dubourdieu**  
  Institut des Nanotechnologies de Lyon  
  CNRS – Ecole Centrale de Lyon  
  Ecully

**Publications**

- No. of publications in SCI journals: Nil
- No. of papers presented in conferences: Nil

**Mobility Support**

- India to France: 2
- France to India: 2

Normalized Weight Errors in Randomized Kaczmarz (RK), Rank Centrality (RC) and Maximum Likelihood Estimator (MLE) for various number of comparisons per edge $k$ for a constant edge probability $p \{0.16, 0.32\}$
Ongoing Projects

Life & Health Sciences

THE IMMUNO-PSYCHIATRY IN SOUTH INDIA STUDY: IMMUNOGENETIC AND IMMUNO-PHENOTYPE CHARACTERIZATION OF MAJOR PSYCHOSES

Project No. 5103-1 May 2014 to Apr. 2018

Background

The objective of the present project is to characterize the nature and extent of dysimmunity associated with schizophrenia and bipolar disorders in two geographically distinct population groups (French Caucasians and South Indians) encountering distinct environmental factors which will provide insights into the genetic and biological heterogeneity of these disorders within and across the studied population groups. Immunogenetic basis of associated autoimmunity environmental influences on Human Endogenous Retroviruses-W family in establishing the disease and in relapsing the episodes. The expected outcome of this study is the generation of novel biomarkers that could assist in diagnosis, prognosis and in designing novel therapeutic approaches.

Objectives

• To determine the influence of genetic polymorphisms in the MHC gene cluster on disease susceptibility/resistance to schizophrenia and bipolar disorder.
• To characterize the immune-phenotype of schizophrenia and bipolar disorder by profiling serum inflammatory proteins, autoantibodies, cytokines and by profiling circulating lymphocyte subpopulations.
• To study the influence of ‘W’ family of Human Endogenous Retroviruses (HERV-W) in schizophrenia and bipolar disorder to stratify and analyze the clinical phenotype of patients based on their HERV-W status.
• To determine the role of infectious cofactors (potential triggers of the HERV-W) on disease etiology, expression and response to treatment.
• To study the innate immune related Toll like Receptor (TLR) gene polymorphisms in Schizophrenia and Bipolar Disorder and their influence on disease susceptibility and outcome.

Knowledge Generated/Products Developed

• Class II HLA DR, DQ Typing has been carried out for 145 patients (85 SZ, 60 BD) and 20 Super Normal Controls and 148 patients (90 SZ, 58 BD) and 18 Super Normal Controls respectively.
• Three SNPs in the non-classical HLA-G and 2 polymorphisms in the HLA-E genes have been profiled in 219 patients (136 SZ and 83 BD) and 110 Super Normal Controls.
• Revealed significant trends towards associations with HLA-G SNPs and significantly increased sHLA-G levels in BD.
• Study of Antinuclear antibodies (ANA) has been carried out in 270 cases and 131 controls. Further, other antibodies are also being characterized.
• Polyclonal IgG antibodies were purified from Schizophrenia (n=18) and Bipolar Disorder (n=11) using CIM-Histidine chromatography and examined for catalytic functions, if any, to understand autoimmunity pattern.

Principal Collaborators

Vir Singh Negi
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Ryd Tamouza
INSERM U1160, Saint Louis Hospital, Paris, Diderot (P7) Université de Paris, Paris

Publications

• No. of publications in SCI journals: Nil
• No. of papers presented in conferences: Nil

Mobility Support

• India to France: 3
• France to India: 1
OLFACTORY MODULATION OF INSECT FLIGHT

**Objectives**

- Map the developmental pattern of neural structures underlying motor aspects of walking and flying
- Establish the adult pattern of the central neural region(s) receiving the wing chemosensory modulatory inputs and their connection
- Manipulate these neural regions to evaluate their influence on walking orientation and on tethered and free flight in response to odorant cues. For free flight, we will measure (i) take-off, (ii) maintenance, (iii) directionality, and (iv) landing on/near a specific odorant source
- Manipulate the antennal and wing sensory systems to evaluate their respective contributions to each behavior

**Knowledge Generated/Products Developed**

The use of an automated system for tracking odor-driven free flight of insects has been developed. The use of this automated system has identified several novel features of insect flight:

- Role of wing chemosensors during free flight odor tracking
- Role of pheromonal-related tissues, both neuronal and non-neuronal, in free flight orientation
- Role of central dopaminergic neurons and their activation by octopamine for sustaining flight bout durations

**Background**

Most insects use odorant cues to orient and fly to food sources and conspecifics: this allows them to increase their dispersion and disseminate vegetal material. However, the neural mechanisms underlying chemorientated behaviour remain poorly understood. The collaborators propose to draw the anatomo-functional map of the neural circuitry involved in the olfactory modulation of chemo-oriented walking and flight behaviours in the model species *Drosophila melanogaster*. Using available and newly designed tools and methods, they will take advantage of the complementary expertise of the four teams to: (a) characterize the developing pattern of the neural structures connecting wing chemosensory afferents and central motor neurons, (b) manipulate the peripheral and central structures involved in olfactory-modulated flight, and (c) measure the influence of these neural structures on various aspects of chemo-oriented behaviours and free flight.

**Principal Collaborators**

- **Gaiti Hasan**
  Tata Institute of Fundamental Research
  Bangalore

- **Jean-François Ferveur**
  Centre des Sciences du Goût et de l’Alimentation (CSGA)
  Dijon

**Publications**

- No. of publications in SCI journals: 1
- No. of papers presented in conferences: 3

**Mobility Support**

- India to France: 4
- France to India: 4

Central dopaminergic neurons that regulate olfactory modulated flight and startle-induced climbing behaviour in *Drosophila*
Ongoing Projects

Life & Health Sciences

**GENOME-SCALE ANALYSIS OF DIFFERENTIAL PROPENSITIES OF DIFFERENT CHROMOSOMAL DOMAINS FOR HORIZONTAL GENE INSERTION IN *ESCHERICHIA COLI***

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**Project No. 5103-3 Apr. 2014 to Apr. 2018**

**Background**

Horizontal gene transfer is a major force in bacterial evolution. It is regulated at multiple levels, from acquisition to gene expression. This regulation is believed to emerge among other things, from the structure of the chromosome itself, as well as from the action of DNA-binding proteins such as H-NS. The project aims for use of a combination of comparative genomics, systems biology, and novel applications of next-generation sequencing technologies to address the contributions of the above factors in the insertion of acquired genetic loci in *Escherichia coli*. Specifically, it is proposed to use a combination of publicly available data and new chromosome conformation capture experiments to define structural domains of the genome. Using comparative genomics and a semi-quantitative measurement of relative frequency of transposon insertions into the genome, statistical tendencies for genomic islands to be inserted and fixed in specific chromosomal contexts.

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**Objectives**

- Description of the propensities of specific chromosomal loci and structural elements of the chromosome to be more receptive to horizontal gene integration, using a combination of comparative genomics and transposon mutagenesis
- The impact of specific chromosomal contexts identified in part 1 on gene expression levels and population variability thereof
- Development of novel methods applying deep sequencing data towards achieving these objective and the establishment of a publicly available web-server presenting our data and analysis

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**Knowledge Generated/Products Developed**

Discovery of a large chromosomal rearrangement – duplication of 40% of the chromosome centred around the origin – which suppresses the growth defect of desilencing horizontally-acquired genes encoded around the terminus of replication

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**Principal Collaborators**

- Aswin Sai Narain Seshasayee
  Tata Institute of Fundamental Research
  Bangalore

- Marco Cosentino Lagomarsino
  UMR 7238 CNRS
  University Pierre and Marie Curie
  Paris

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**Publications**

- No. of publications in SCI journals: 3
- No. of papers presented in conferences: Nil

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**Mobility Support**

- India to France: 1
- France to India: 2

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*Theoretical model for horizontal gene exchange*
Ongoing Projects

**DECIPHER THE SYMBIOTIC PROGRAM IN TROPICAL LEGUMES**

**Background**
Understanding the ‘molecular code’ associated with root nodule symbiosis (RNS) between plants and nitrogen-fixing bacteria is necessary for evaluating the prospects for extending symbiosis beyond current host range to reduce or eliminate the broad usage of fertilizers in our agricultural practices. To address this question the temperate legumes that have been retained as study models have unravelled a sophisticated infection process. However, an alternative mode of infection has been described in tropical Mediterranean legumes including *Arachis hypogaea* and *Aeschynomene evenia*. Those aeschynomenase legumes share an intercellular infection pathway considered to be the ancient mode of invasion of plant tissues and thus expected to have a relatively simple molecular code for RNS. Their efforts would identify the transcriptome involved in early global response associated with inception of symbiosis in *A. hypogaea* and *A. evenia* and allow comparing results obtained for each plant in order to discover common and/or divergent molecular actors implicated in such tropical symbiosis.

**Objectives**
- Characterization of *Arachis hypogaea* symbiotic transcriptome using Illumina flow cell run of sequencing
- Bioinformatics analysis of transcriptomic data sets generated from *Arachis hypogaea* and *Aeschynomene evenia*
- Identification of common and/or divergent molecular factors implicated in such tropical symbioses
- Identification of candidate genes associated with the early events like recognition/signaling and endocytosis of the microsymbiont.
- Functional analysis of candidate genes via RNA interference, analysis of their spatiotemporal expression pattern by qRT-PCR promoter/reporter gene fusion

**Knowledge Generated/Products Developed**
- The *Arachis hypogaea* transcriptome project was launched with MGX Genomix France on September 2014 who are also handling the *A. evenia* project for the French Group
- The progress of symbiosis in *Arachis* is divided into 5 different stages. RNA prepared from these stages is being sequenced by MGX, France, the analysis and output is awaited
- A Nod deficient *Bradyrhizobia BTAi1* nodulates *Arachis* indicating this legume to support Nod independent nodulation
- A broad host range *Bradyrhizobia ORS285* fails to nodulate *Arachis*. Normal nodulation by ORS 285ΔTTSS indicates presence of negative T3SS effectors in ORS285

**Principal Collaborators**

*Maitrayee Das Gupta*
University of Calcutta
Kolkata

*Fabienne Cartieaux*
Laboratoire des Symbioses Tropicales & Méditerranéennes (IRD) Montpellier

**Publications**
- No. of publications in SCI journals: Nil
- No. of papers presented in conferences: Nil

**Mobility Support**
- India to France: 5
- France to India: 2

In stage 2 at 4DPI we found bump like structure in Arachis root where a cluster of cells with large nucleus and no cell wall were infected with rhizobia. In case of *A. evenia* these infected cells were noted after 2DPI but these cells did not appear to have large nucleus.
**Ongoing Projects**

**Pure & Applied Physics**

**MAGNETIC NANOPARTICLES FOR HYPERTHERMIA AND SPINTRONICS**

**Project No. 5104-1  Apr. 2014 to Dec. 2017**

**Background**

Magnetic nanoparticles (MNPs) synthesized by chemistry have applications in diverse fields such as nanoelectronics, catalysis, biomedicine, etc. The aim of the project is at combining experimental, theoretical and computational studies on assemblies of MNPs for two focused applications: magnetic hyperthermia and spintronics. In both these applications, the magnetic interactions between MNPs strongly influence the system properties (e.g., heat dissipation in the former and amplitude of the tunnel magnetoresistance in the latter). The Indian partner has developed theoretical and computational tools to understand the role played by interactions and system parameters on the non-equilibrium properties of aggregates and suspensions of MNPs. The French partner has developed an expertise in the magnetic and magnetotransport measurements on assemblies of MNPs. During their collaboration, the two groups will converge towards the elaboration, measurements and simulations of model systems on which joint experimental and theoretical studies will be carried out.

**Objectives**

- To identify model systems for efficient experimental and theoretical comparisons for magnetic hyperthermia and spintronics
- To develop numerical simulations for the hysteresis loop calculation of assemblies of MNPs
- To study theoretically the influence of external parameters, in particular the anisotropy, size, disorder, concentration and aspect ratio
- To measure very precisely the structural properties of the model systems using electron microscopy
- To study experimentally the magnetic properties of the model systems
- To bring convergence between theoretical calculations and experiments (by finetuning parameters)

**Knowledge Generated/Products Developed**

- (a) Preparation and characterisation of Fe$_2$SiO$_2$ MNP5 for use as a model system in hyperthermia. (b) Synthesis of FeCo MNPs and Au or Pt NPs linked with spin crossover compounds for spintronics. (c) Heating power and high-frequency hysteresis loop measurements on the Fe$_2$SiO$_3$ system
- Development of mean field theory and formulation for calculation of hysteresis loops and area scaling laws for assemblies of MNPs (aggregates, beads, etc.)
- Development of e-beam lithography process to elaborate nanoscale electrodes for transport measurements (b) Integration of hybrid nanoparticles composed of Pt or Au combined with magnetic spin-crossover molecules. (c) Low-temperature transport measurements on these systems. (d) Development of protocols to integrate magnetic particles into the devices
- Development of Ewald summation technique to handle dipolar interactions in MC simulations for assemblies and arrays of MNPs

**Principal Collaborators**

- **Varsha Banerjee**  
  Indian Institute of Technology, Delhi  
  New Delhi

- **Julian Carrey**  
  Laboratoire de Physique et Chimie des Nano-Objets INSA, Toulouse

**Publications**

- No. of publications in SCI journals: 1
- No. of papers presented in conferences: Nil

**Mobility Support**

- No. of publications in SCI journals: 2
- No. of papers presented in conferences: 1
Ongoing Projects

• Extension of supercontinuum generation in photonic-crystal fibers (PCF)
• Self-similarity in the presence of high-order terms
• Scaling laws for pulse trains and ultra-high repetition rate optical source development
• Self-similar lasers for high-energy pulse delivery
• Scalable optical rogue wave formation

A variety of AS2S3 chalcogenide photonic crystal fiber coupler of special properties are proposed to study the role of birefringence in all optical coupling characteristics based on the projection operator method (POM)

• MI in different optical media has been investigated
• Rogue wave solutions of optical systems have been constructed and reason for the occurrence of rogue wave theory has been proposed
• Nonlinear chirping has been constructed with different higher order dispersion and nonlinear optical effects
• Impact of temperature on Supercontinuum in Water filled PCF has been investigated

Knowledge Generated/Products Developed

Background

Self-similarity is one of the fundamental dynamics observed in many fields of science (optics, hydrodynamics, cosmology), as well as occurring in natural environment (plant growth, etc.). Very recently, the implementation of this concept into nonlinear optics has produced a tremendous development among key subjects such as optical amplifiers and supercontinuum generation, propagation in tapered step-index and graded-index fibers, as well as in photonic-crystal fibers, mode-locked lasers dynamics and optical rogue wave formation. The project will combine the theoretical and experimental expertise of both Indian and French groups to develop innovative applications of the self-similar concept and intent to solve some of the open questions in the above areas.

Parameter-management in dissipative nonlinear systems shall be a central work, since it represents the step forward to implement the concept into realistic experimental situations, such as laser sources, with a view to developing advanced coherent pulse sources, in terms of pulse peak power and pulse width.

Objectives

Principal Collaborators

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Pondicherry

Ph. Grelu
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Dijon

Publications

• No. of publications in SCI journals: 14
• No. of papers presented in conferences: 8

Mobility Support

• India to France: 1
• France to India: 1

The MI gain spectra in the anomalous dispersion regime for different nonlinear configuration of three core directional coupler with NIM channel
Background

In a context of the limitation of fossil fuels, it is imperative to develop research aimed at enhancing CO$_2$. One of the most promising approaches is to transform it into reduced carbon forms that can generate hydrocarbons. But CO$_2$ is a very stable molecule, chemically difficult to activate. However, enzymes present in microorganisms are capable of effectively reducing CO$_2$ into formate. These enzymes, formate dehydrogenases, have a Mo active site where the catalytic reaction takes place. Inspired by these enzymes, the purpose of this project is to prepare peptide biomimetic/bioinspired Mo complexes in order to study and to decipher the molecular factors responsible for this remarkable reactivity to develop new biocatalysts Mo, robust and efficient for the reduction of CO$_2$.

Objectives

To develop a new class of catalysts capable of achieving the CO$_2$ reduction in soft conditions, which is a key step in the generation of biofuels in a green chemistry approach.

Knowledge Generated/Products Developed

- Synthesis of 2-amino-3-(3, 4-dimercaptophenyl) propanoic acid
- Synthesis of Fmoc-protected vinylalanine, will be used for cross coupling reaction to make peptide-based catalyst
- Synthesis of 3-allylbenzene-1,2-dithiol, will be used for cross coupling reaction on peptide backbone
- Synthesis of molybdenum complexes
- First electrocatalytic tests in sulfoxide and CO2 reduction

Principal Collaborators

Surajit Sinha  
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Publications

- No. of publications in SCI journals: 1
- No. of papers presented in conferences: 1

Mobility Support

- India to France: 2
- France to India: 2

X-ray structure of MoO$_3$(OPNO)$_3$ (left), and MoO$_3$(SPNO)$_3$ (right).
Ongoing Projects

PHOSPHORUS-SUPPORTED MULTISITE COORDINATING LIGANDS FOR THE ASSEMBLY OF POLYNUCLEAR HETERO METALLIC (3D-4F) AND HOMONUCLEAR (3D) ENSEMBLES: TOWARDS A NEW GENERATION OF MOLECULAR MAGNETIC MATERIALS

Project No. 5105-3  May 2014 to Apr. 2017

Background

The number of polymetallic cages reported increases every year and to date, approximately more than hundred SMMs have been reported - yet the barrier height for the reversal of magnetisation has not been significantly raised. Therefore the synthesis of a new generation of single molecule magnets with enhanced properties is still a major challenge. This project aims at synthesizing new generation magnetic materials based on polynuclear homo-(3d) and heterometallic (3d-4f) complexes.

Objectives

- Design and assembly of novel phosphorus-supported multi-site coordinating multi compartmental ligands
- Syntheses and structural characterization of polynuclear homoo (3d) and heterometallic (3d-4f) complexes with an emphasis on varying the transition metal ions (number of d electrons and their nature, t2g vs eg; magnetic anisotropy), their geometry (5, 6 and 7-coordinate, regular vs. distorted geometry), the lanthanide ions and the ligands
- To study the possible SMM properties of the isolated 3d-4f heterometallic complexes and to gain an understanding of the structural factors in terms of their impact on magnetic behavior. They would utilize Co(II) as the 3d metal ion in preparing 3d metal ion complexes. Although Co(II), with its strong spin-orbit coupling is a natural choice in design of SMMs, surprisingly the studies utilizing this metal ion alone are very limited
- To utilize discrete magnetic building blocks for the construction of novel SCMs and to study their magnetic behaviour
- Syntheses and structural characterization of polynuclear homo-(3d and 4f) and heterometallic (3d-4f) complexes with an emphasis on varying the transition metal ions (number of d electrons and their nature, t2g vs eg; magnetic anisotropy), their geometry (5, 6 and 7-coordinate, regular vs. distorted geometry), the lanthanide ions and the ligands
- Discrete magnetic building blocks for the construction of novel SCMs and study their magnetic behavior intensively
- Synthesis, structure and magnetic studies on the following 3d-4f heterometallic families has been completed
  a) Ni, Ln, and Ni, Y, compounds
  b) Mn, Ln, family

Knowledge Generated/Products Developed

- Designing and assembling of novel phosphorus-supported multi-site coordinating multicompartamental ligands. It is shown that utilizing hexakis (3-pyridyloxycyclotriphosphazene) it is possible to obtain molecular, 1D- and 2D-coordination polymers. Using acyclic nitrogenous multicompartamental ligand one can obtain 1D-coordination polymers with dinuclear 4f motifs
- Syntheses and structural characterization of polynuclear homo-(3d and 4f) and heterometallic (3d-4f) complexes with an emphasis on varying the transition metal ions (number of d electrons and their nature, t2g vs eg; magnetic anisotropy), their geometry (5, 6 and 7-coordinate, regular vs. distorted geometry), the lanthanide ions and the ligands
- Discrete magnetic building blocks for the construction of novel SCMs and study their magnetic behavior intensively
- Synthesis, structure and magnetic studies on the following 3d-4f heterometallic families has been completed
  a) Ni, Ln, and Ni, Y, compounds
  b) Mn, Ln, family

Ball and stick view of the repeating unit of the 1D coordination assembly containing two [Cu, Ho,] complexes in 3. All hydrogen atoms (except those from hydroxido groups and coordinated water molecules) and solvent molecules have been omitted for clarity

Principal Collaborators

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Hab. Rodolphe Clérac
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Publications

- No. of publications in SCI journals: 1
- No. of papers presented in conferences: Nil

Mobility Support

- India to France: 1
- France to India: 2
Ongoing Projects

Pure & Applied Chemistry

**sp3 C-H BOND ACTIVATION WITH RUTHENIUM(II) CATALYSTS: APPLICATION TO THE SYNTHESIS OF ALIPHATIC N-HETEROCYCLIC NATURAL PRODUCTS**

**Project No. 5105-4**
**Jul. 2014 to Dec. 2017**

**Background**

The aim of the project is the development of new Ruthenium based catalysts, their utilization for the sp3 C-H bond activation en route to the synthesis of diverse scaffolds and Target Oriented Synthesis (TOS) of natural products. Thus, both the teams have excellent complementarities in their expertise, having produced original results in their respective fields, to carry out the proposed activity. The efforts of both the teams together would result in novel catalysts for C-C and C-N bond formations, leading to diverse scaffolds with chirality. The contributions from the collaboration of the two teams from Rennes (France) and Hyderabad (India), would expand the domain of C-H bond activation, with the emphasis in the area of asymmetric TOS of natural products and inspired molecules.

**Objectives**

- To design and evaluate new ruthenium (or iridium) catalysts for sp3C-H bond activation
- To design and synthesize alicyclic nitrogen containing scaffolds (pyrrolidines, piperidines, piperazines, fused bicyclic amines)
- To establish appropriate reaction conditions for the metal catalyzed C-C and C-N bond formation with benzylic, allylic alcohols, diols and dialdehydes
- To apply ruthenium catalysts for the Target Oriented Synthesis (TOS) of nitrogen containing natural products
- To prepare chiral ruthenium complexes using non-natural amino acids (β3-, β2-, β2,2- and 4-) with carbohydrate side chains
- To explore chiral ruthenium complexes for the enantioselective C-C bond forming reactions through the C-H bond activation
- Synthesis of chiral diols to conduct cyclization reactions
- Synthesis of intermediates for chiral β amino acids / diamines
- Synthesis of chiral morpholine and piperazine derivatives for cyclization reactions
- Synthesis of polycyclic and heterocyclic amines via N-C, CC and C-O bond formation based on cascade catalytic transformations
- New ligands and transition metal catalysts for hydrogen transfer reactions and sp3C-H bond functionalization

**Knowledge Generated/Products Developed**

- Synthesis of chiral diols to conduct cyclization reactions
- Synthesis of intermediates for chiral β amino acids / diamines
- Synthesis of chiral morpholine and piperazine derivatives for cyclization reactions
- Synthesis of polycyclic and heterocyclic amines via N-C, CC and C-O bond formation based on cascade catalytic transformations
- New ligands and transition metal catalysts for hydrogen transfer reactions and sp3C-H bond functionalization

**Principal Collaborators**

G. V. M. Sharma  
CSIR-Indian Institute of Chemical Technology  
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Christian Bruneau  
UMR 6226: Institut des Sciences Chimiques de Rennes (ISCR) Organométalliques : Matériaux et Catalyse  
Université de Rennes 1, Rennes

**Publications**

- No. of publications in SCI journals: 4
- No. of papers presented in conferences: 2

**Mobility Support**

- India to France: 2
- France to India: 2
Materials Science

SYNTHESIS OF PHOTOCATALYTIC POROUS SILICON-CONTAINING NITRIDE AND OXYNITRIDE NANOCOMPOSITES

**Project No. 5108-1 May 2014 to Oct. 2017**

**Background**

The project envisions the synthesis and characterization of porous silicon-containing (oxy)nitride nanocomposites as foams and membranes via the Polymer-Derived Ceramics (PDCs) route. The idea behind the project is to prepare nanocomposites in which titanium and/or zirconium oxide/oxynitride/nitride nanocrystals are formed during the synthesis of the silicon nitride and silicon oxynitride matrices with photocatalytic activity & adsorbent capacity (by immobilizing adsorbents in the porosity of materials) concomitantly being stable in severe conditions. A complete characterization of the structure, kinetics of crystallization, mechanical & phase stabilities will be performed. The photodegradation of dye and photoassisted H2 production will be investigated. Performing thermodynamic calculations and combining experiments with computational approaches provide a comprehensive picture to exhibit immense scientific potential & industrial applications.

**Objectives**

- Preparation of Si-based (oxy)nitride ceramic nanocomposites foams/membranes
- Use the nanocomposites to immobilize/anchor adsorbents
- Structural Characterization & Evaluation of Mechanical Stability
- Thermochemistry and Phase relations
- Evaluation of the photocatalytic activity and adsorbent capacity

**Knowledge Generated/Products Developed**

- *In-situ* synthesis of (a) SiOC/TiO2, (b)SiOC/TiCN (c) SiON(C)/TiN foam, (d)SiOC/ZrO2 from polysiloxanes, (e) mesoporous Si,Ni monoliths from polysilazanes, (f) mesoporous TiN/Si, monoliths from polytitanosilazanes and (g) SiBCN foams from boron-modified polysilazanes
- Structural characterisation of the above developed porous materials
- Mechanical and textural characterisation
- Evaluation of catalytic and photocatalytic activity of (a), (b), (c), (f) and confinement of adsorbents (g)
- Reassessment of N-Zr, and assessment of Ti-Zr-N, Si-Zr-N thermocalc software
- Synthesis and characterization of mesoporous 3D supports for metal catalysts made from Si-based nitrides/carbides/carbonitrides
- Synthesis and characterization of Si,Ni-TiN nanocomposite as a 3D mesoporous support for metal catalyst in hydrogen generation reaction from chemical hydrides and as adsorbent material for dye removal
- Mechanisms governing the preparation of polymers Chemical reactions involved during the polymer-to-ceramic conversion

**Principal Collaborators**

- Ravi Kumar, N. V  
  Indian Institute of Technology, Madras  
  Chennai

- Samuel Bernard  
  Institut Européen des Membranes IEM Montpellier

**Publications**

- No. of publications in SCI journals: 7
- No. of papers presented in conferences: 42

**Mobility Support**

- India to France: 1
- France to India: 1

Band gap reduction: Optical transitions can occur from the carbon 2pπ to Ti dxy
Environmental Science

SURVEY OF SOIL-Si POOLS AND CONTRIBUTION OF Si FERTILIZATION IN A SUSTAINABLE RICE CULTIVATION IN SOUTH INDIA

Project No. 5109-1 Apr. 2014 to Oct. 2017

Background
Si is generally not considered as an essential nutrient for crops but many studies have proven its benefits for improving their yields, specifically for rice, a Si accumulator species. The application of silicon fertilizers has the potential to mitigate environmental stresses and soil nutrient depletion and as a consequence constitutes an alternative to the extensive use of phyto-sanitary and NPK fertilizers for maintaining sustainable agriculture. The integration of Si in agricultural practices is therefore effective in a few countries but not yet in India. The project will combine field and laboratory experiments to analyze Si speciation in the water/soil/plant compartments of aerobic and wetland rice ecosystems in order to assess if the South Indian soils are depleted in bioavailable Si. Various techniques will be used including mineralogical, chemical and isotopical techniques. The results will be used for improving the potential benefits of the Si fertilizers in sustainable rice cultivation practice in South India.

Objectives
• To characterize status of Si in the South Indian rice soils
• To assess the Si budget in wetland rice ecosystems
• To assess the bioavailability of different sources of Si in rice cropping system in acidic, neutral and alkaline soils

Knowledge Generated/Products Developed
• Mineralogy and geochemistry of 200 samples representing different agro climatic zones have been performed
• Quartz, Na and K feldspars, amphibole, and phyllosilicates (chlorite, muscovite) are the main primary minerals identified in most of the samples
• The bioavailable Si pools are assessed by 3 extractants: CaCl$_2$ for immediate dissolved Si; acetic acid for Si adsorbed on iron oxides mainly and Na$_2$CO$_3$ for amorphous silica and a fraction of clay minerals
• The first season experiment on budgeting of silicon in rice field was a great success. The first analytical results reveal that the application of Si slightly increased the yields
• Pot experiments reveal that contrary to what is generally stated, clay minerals can be a significant source of Si for rice

Principal Collaborators

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J.D. Meunier
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CNRS IRD
Aix en Provence

Publications
• No. of publications in SCI journals: Nil
• No. of papers presented in conferences: 1

Mobility Support
• India to France: 3
• France to India: 3

Core Solute Sampling - Experimental farm at Mandya, Karanataka
MOLECULAR STUDY OF Rh GENE VARIANTS IN INDIANS

Objectives

- To provide a molecular pattern of distribution of both the RHD and RHCE gene variants in the Indian population
- To define potential novel population-specific variants/clusters
- To delineate correlation between phenotypes and genotypes by functional studies

Knowledge Generated/Products Developed

- Molecular bases of weak D phenotype in the Indian population
- Molecular bases of RhD negativity in C/E+ Indian donors
- Molecular bases of Rhnull phenotype in two Indian families

Background

Among the 33 human blood groups, the Rh system is the most complex and polymorphic. It is linked to the two highly homologous RHD and RHCE genes including numerous variants that encode highly immunogenic surface antigens specifically expressed in red blood cells. Rh status of donors and patients is then a major concern of Public Health, especially in transfusion and obstetrical medicine. So far, little is known about the Rh genetics in the heterogeneous Indian population. This project aims to identify and characterize the Rh gene variants in Indians by combining the technical and scientific expertise and skills of the National Institute of Immunohaematology (NIIH, Mumbai, India) and the Blood Group Molecular Genetics Laboratory (EFS-Inserm U1078, Brest, France) in blood group phenotyping and genotyping, respectively. Beyond the scientific interest of this study, valuable data will help Indian physicians to guide transfusion medicine practice and to manage the alloimmunization risk in pregnant women.

Principal Collaborators

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KEM Hospital
Mumbai

Yann Fichou
Etablissement Français du Sang – Bretagne, INSERM UMR1078
Brest

Publications

- No. of publications in SCI journals: Nil
- No. of papers presented in conferences: 1
- Patent: 1

Mobility Support

- India to France: Nil
- France to India: Nil

Example of melting curves after specific amplifications for the genotyping of the week D, type 3 allele in 43 DNA samples. Weak D, type 3 samples
INSIGHTS ON PROTEIN STRUCTURAL AND EVOLUTIONARY DYNAMICS

Project No. 5203-2  Mar. 2015 to Jun. 2018

Background

Conformational flexibility of proteins is an essential consideration to understand the mechanistic basis of biological function. Variability in the 3-D structures of homologous proteins contributes to subtle or major functional diversity. The current project addresses three dimensions in the general theme of similarities and variations in structural and evolutionary dynamics of proteins and implications for recognition of functional sites. (1) Based on the recent joint publication on the allostery, the collaborators propose to employ protein blocks (PB) based analyses, normal mode analysis and molecular dynamics simulations on tertiary structures of proteins and modular complexes to predict allosteric sites in proteins. (2) To identify non-canonical functional sites in protein kinases using evolutionary trace analysis, normal mode analysis and PB analysis. (3) Extract information on structural dynamics from NMR ensembles and compare it with evolutionary dynamics derived from structures of homologues to understand permissive structural diversity.

Objectives

- Prediction of allosteric sites in single-domain and multi-domain proteins modulated by protein-protein and domain-domain interactions respectively
- Prediction and structural characterization of non-canonical functional sites in subfamilies of protein kinases
- To extract information on structural dynamics by simulations such as molecular dynamics and Normal Mode Analysis instead of extracting information on dynamics from NMR-derived structures
- For the first time it has been shown that inactive forms of protein kinases are characterized by higher dynamics than active forms
- It has been shown that extent of flexibility of protein kinases is correlated to hierarchical organization of kinases. Moreover, regions of unique flexibility in a kinase correlated to hierarchical organization of kinases
- Regions of unique flexibility in a kinase correspond to functionally sensitive sites
- 3-D structure of human splicing factor SF3b assembly elucidated using an integrated approach and cryo-electron microscopy-derived density maps shows substantial alteration in the structure of component proteins as a consequence of assembly formation
- Local regions of proteins that adopt ordered and disordered forms in different crystal structures are proposed to often contain post-translational modification and allosteric sites

Knowledge Generated/Products Developed

- Different residue types. The different residue types studied in this analysis are depicted on the structure of the naphthalene 1,2-dioxygenase beta subunit in complex with the alpha subunit. A) The structure of the complex is shown. The alpha subunit is shown as grey cartoon and the beta subunit as wheat-colored cartoon, with the different residue types shown in differential coloring and shapes. B) The surface residues are colored light blue, the buried residues are shown in spheres, the interacting residues as sticks, the core interacting residues are colored purple, the nearby interacting residues calculated with a 6 Å cut-off in green and those identified with a 8 Å cut-off in yellow.

Principal Collaborators

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DSIMB
Univ Paris Diderot
Paris

Publications

- No. of publications in SCI journals: 12
- No. of papers presented in conferences: 1

Mobility Support

- India to France: 2
- France to India: 2
HOST-VIRUS INTERACTIONS AND ANTIBODY THERAPY FOR JAPANESE ENCEPHALITIS

Objectives

- To understand the mechanism of JEV-host interaction, immune evasion, and virus persistence, with identification of pattern recognition receptors (PRRs) in dendritic cells and CD4+ T lymphocytes and viral envelope protein(s) responsible for binding to the PRRs and mediating viral internalization.
- To decipher the role of regulatory T cells in JEV pathogenesis, both in vitro and in vivo.
- To demonstrate the application of CCR4 antagonist in therapy and/or as adjuvant in new vaccine Preparations.
- To explore the therapeutic potential of in vitro generated JEV-reactive human monoclonal antibodies in Japanese encephalitis in a mouse model of disease.
- To understand the mechanism of JEV-host interaction, immune evasion, and virus persistence, with identification of pattern recognition receptors (PRRs) in neuronal cells, fibroblasts and viral envelope protein(s) responsible for binding to the PRRs and mediating viral internalization.
- Establishment of the JEV-envelope protein domain 3 (ED3) as an exploratory molecule to identify the JEV-receptor system.
- Identification of GRP78 as a crucial host factor for virus entry and replication in multiple cell types.
- Preliminary characterization of JEV interactions with monocytes and dendritic cells and activation of innate immune responses.
- Screening and identification of human monoclonal antibodies with acquired JEV-reactivity.
- Biochemical and functional characterization of in vitro generated JEV-reactive human monoclonal antibodies.
- First steps of the establishment of technology to clone V regions of immunoglobulins at single B-cell level, and express them as recombinant IgG.

Knowledge Generated/Products Developed

- Strategy for JEV-Virus like particle (VLP) production.
- Identification of pattern recognition receptors (PRRs) in dendritic cells and CD4+ T lymphocytes.
- Screening and identification of human monoclonal antibodies with acquired JEV-reactivity.
- Biochemical and functional characterization of in vitro generated JEV-reactive human monoclonal antibodies.
- First steps of the establishment of technology to clone V regions of immunoglobulins at single B-cell level, and express them as recombinant IgG.

Background

The central theme of the project concerns the molecular and biochemical dissection of the immune evasion mechanism of Japanese encephalitis virus (JEV) and investigation of novel therapeutic approaches for Japanese encephalitis. The precise nature of the interactions of JEV with cells of the innate and adaptive compartments of the host immune system remains to be elucidated, for the development of promising therapeutic measures and new prophylactic candidates with improved efficacy. The cellular PRRs and critical PAMPs of virus involved in pathogenesis will be identified. In the scenario of non-existing JE specific therapy, the novel approach of in vitro generated JEV-reactive human monoclonal antibody will provide the promising passive therapy candidate with the potential to translate into preclinical trials in JE.

Project No. 5203-3  Mar. 2015 to Mar. 2019
Ongoing Projects

Life & Health Sciences

NOVEL INHIBITORS OF NHEJ AGAINST RESISTANT TUMOUR CELLS

Project No. 5203-4  Mar. 2015 to Mar. 2018

Background

The emergence of tumour cells resistant to anti-cancer drugs and irradiation remains the frequent cause of failure of long term cancer therapies. Non-Homologous End-Joining (NHEJ) repair pathway plays a critical role in these resistance mechanisms. A major challenge is to characterize several inhibitors of the NHEJ pathway to increase the efficacy of the anti-cancer treatments against a large spectrum of resistant tumors. The first inhibitors of the NHEJ pathway have been characterized, in particular by the Indian Partner. In this project, the French and Indian Partners will join their highly complementary approaches to identify new inhibitors against two targets: the Artemis nuclease and the XRCC4-Cernunnos complex interaction site. The French Partner will realize protein production, high throughput small molecules screenings, and structural biology. The Indian Partner will realize molecular modelling, functional assays at the molecular, cellular and animal levels.

Objectives

- Expression in insect cells and purification of core NHEJ factors including Artemis, XRCC4-Ligase4 (XL4) and Ku70/Ku80 complexes
- Biophysical characterization and structural studies of XL4, Artemis, and Ku70/Ku80 in complex with ligands
- Design potential ligands of NHEJ inhibitors
- Screening and identification of potent NHEJ inhibitors
- Biological characterization of lead compound, in vitro, ex vivo and in vivo
- Investigation in radiation resistant cancer cells, alone or in combination with established chemo and radiotherapeutic agents
- -Ku70/Ku80 proved to be a major target since first crystals were obtained with this complex and different peptides

Knowledge Generated/Products Developed

- Expression and purification in high yield of XL4, Artemis, Ku70/Ku80, XLF
- Characterization by microcalorimetry of interactions of NHEJ factors with ligands
- Crystallization screenings of NHEJ factors and crystal structures of Ku70/Ku80 with peptidic ligands
- Virtual screening and identification of potential Ligase, XRCC4 and KU inhibitors
- Identification of different forms of SCR7 and their biological activity including specificity

Published Papers

- Crystals of Ku70/Ku80 heterodimer complexed with a DNA substrate and a potential inhibitor of the NHEJ pathway bound to the heterodimer. Crystals are rod shape with maximum size 300μm x 40μm x 40μm

Principal Collaborators

Sathees C. Raghavan
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Charbonnier Jean-Baptiste
IBITECS, CEA Saclay
CE Saclay

Publications

- No. of publications in SCI journals: 5
- No. of papers presented in conferences: 2

Mobility Support

- India to France: 1
- France to India: 2
Ongoing Projects

**CHARACTERISATION OF FACTORS THAT DETERMINE THE BALANCE BETWEEN GENOMIC INTEGRITY AND DIVERSITY IN *HELICOBACTER PYLORI***

**Project No. 5203-5**  
**Mar. 2015 to Mar. 2018**

**Background**

*Helicobacter pylori* is a major bacterial human pathogen, it colonises 50% of the human population responsible for gastritis, peptic ulcers and lymphomas. High level of genetic recombination provides *H. pylori* the ability to diversify, colonize, adapt, evade host immune responses and acquire antibiotic resistances. Thus, understanding the cellular pathways of transformation, recombination and its barriers becomes necessary. The aim of the proposed study is to understand interaction between these pathways during life cycle of *H. pylori*. Collaborators will address these questions by understanding the function of different proteins participating at different stages of these pathways. Genetic studies, cellular localization, protein-protein interaction studies and biochemical characterization of these proteins will allow to understand how these pathways help in diversification of *H. pylori* while maintaining its genomic integrity.

**Objectives**

- Functional characterization of *H. pylori* proteins (DprA, RecA and MutS2) involved in important stages of natural transformation and recombination pathways to understand mechanistic details of the process
- To study the role of *H. pylori* R-M systems in controlling genetic exchange
- Interaction studies between proteins of natural transformation, recombination and restriction.
- Cellular localization studies with R-M system and proteins involved in natural transformation and recombination

**Knowledge Generated/Products Developed**

- Identification a new nuclease activity of MutS2 and its impact in transformation.
- Determination of the role of the NTP binding and hydrolysis activities of MutS2 in the competence of *H. pylori*
- Development of an in vivo cell imaging system to monitor transforming DNA internalisation in real-time
- Determination of the role of TypeII Restriction-modification system in the competence of *H. pylori*
- Discovering a new form of epigenetic regulation in *H. pylori*

**Principal Collaborators**

- **D. Narasimha Rao**  
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  Bangalore

- **J. Pablo Radicella**  
  Institut de Radiobiologie Cellulaire et Moléculaire Commissariat à l’Energie Atomique, (CEA)  
  Fontenay aux Roses

**Publications**

- No. of publications in SCI journals: 3
- No. of papers presented in conferences: 2

**Mobility Support**

- India to France: 1
- France to India: 2

Direct visualization of the internalisation of exogenous DNA during Helicobacter pylori transformation
Ongoing Projects

Pure & Applied Physics

MONOMODE AND MULTIMODE PHASE SENSITIVE AMPLIFICATION AND LIGHT STORAGE

Project No. 5204-1  Feb. 2015 to May. 2018

Background

Potential applications of microwave photonics links in radiofrequency (RF) systems require to generate very stable RF oscillators, to amplify the RF signal and to be able to control the signal group velocities, without degrading the signal-to-noise ratio. Collaborators propose to work on these different aspects with both a fundamental and an applied point-of-view. The key point of this project is phase sensitive amplification that will be both studied for realizing a very low noise amplifier based on highly nonlinear fibers and for a more fundamental work on multimode amplification in a gas cell at room temperature. This system is also very promising for light storage. Another important point in two frequency VECSEL technology, which should allow us to conceive very low noise RF local oscillators based on the beat note between both lasing modes, that can be used in an RF link together with the fiber amplifier.

Objectives

- Phase sensitive amplification in fibers; To conceive noiseless amplifiers using nonlinear optical fibers for application to the transport of microwave signals and the design of low noise optoelectronics oscillators
- Two frequency VECSELs; To study and lower or even remove the coupling of the intensity and phase noises in dual-frequency solid laser
- Phase sensitive amplification in metastable helium; To study phase sensitive amplification in metastable helium. To demonstrate and study light storage using Λ and tripod systems in helium

Knowledge Generated/Products Developed

- Phase sensitive amplification in fibres; The first architecture (1 pump) was implemented and theoretical simulations were performed to optimize the second one (2 pumps)
- Two frequency VECSELs; The role of the thermal noise was modeled and a new VECSEL was designed at 1.5 μm
- Phase sensitive amplification and light storage in metastable helium; Phase sensitive amplification in metastable helium was recorded in metastable helium in different configurations, and we now work on a theoretical model and on the implementation of squeezing detection. Simulations of CPO were achieved but some discrepancies are currently studied

Principal Collaborators

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Shiv Nadar University
Greater Noida

Fabien Bretenaker
Laboratoire Aimé Cotton
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Fontenay aux Roses

Publications

- No. of publications in SCI journals: 1
- No. of papers presented in conferences: 3

Mobility Support

- India to France: 1
- France to India: 2

Set up for phase sensitive amplification in metastable helium. The helium cell is in the metal cylindrical shielding. The amplification is already visible.
Pure & Applied Physics

RADIO PROPERTIES OF CLUSTERS AND GALAXY LENSES

Objective

- Studying diffuse non-thermal emission and magnetic field in 25 Lensing clusters of galaxies (0 < z < 1) from the CLASH catalog and studying the SFR and emission line properties of faint galaxies (0 < z < 5) in the distant Universe using gravitational lensing technique. Studying the nature of lensing clusters using multi-wavelength (MUSE, GMRT, IRAM, ALMA) data
- Search for lens systems (galaxy-galaxy, cluster-galaxy) from the VLA and Green Bank survey and study their nature using multi-wavelength data
- Studying the diffuse non-thermal emission in Giant radio galaxies within the cluster environment and beyond Multi-wavelength (radio/mm/optical) properties of Giant Radio Galaxies
- Discovery of about 100 new Giant Radio Galaxies and Giant Quasars of >1 Mpc in radio size
- Discovery of 4C 35.06, an extremely unusual radio galaxy associated with multiple galactic black-hole mergers in the centre of galaxy cluster Abell 407 (Zwicky’s Nonet)
- Discovery of an extraordinary rare massive spiral galaxy ejecting 1.6 Mpc scale radio jets and its cold disk of molecular gas feeding the black hole. This is a unique object so far
- Non-thermal emission in 14 lensing galaxy clusters from our sample have been studied and new mini-haloes have been discovered in cool-core clusters
- SFR and emission line properties of faint galaxies in the nearby and distant (up to redshift 5) Universe using gravitational lensing technique has been made for the galaxies in the field of MACS J0416.1-2403 cluster
- Multi-wavelength study on 14 lens systems have been carried out in order to study the interplay between dark and baryonic matter.
- Radio data analysis on remaining 11 clusters- already collected

Background

One of the most fundamental problems in astrophysics concerns the processes by which large scale structures such as clusters and Mpc-scaled galaxies formed and evolved from the extremely smooth universe. Radio observations provide a key solution to this problem via probing the morphology, mass distribution, star formation rates and structure formation from sub-galaxy to cluster scales. In this project collaborators aim to provide the most complete set of radio data (ALMA, GMRT and IRAM) on clusters and galaxies (within cluster environment) lying at redshift range 0< z < 5 (epoch of star formation).

Knowledge Generated/Products Developed

- Discovery of about 100 new Giant Radio Galaxies and Giant Quasars of >1 Mpc in radio size
- Discovery of 4C 35.06, an extremely unusual radio galaxy associated with multiple galactic black-hole mergers in the centre of galaxy cluster Abell 407 (Zwicky’s Nonet)
- Discovery of an extraordinary rare massive spiral galaxy ejecting 1.6 Mpc scale radio jets and its cold disk of molecular gas feeding the black hole. This is a unique object so far
- Non-thermal emission in 14 lensing galaxy clusters from our sample have been studied and new mini-haloes have been discovered in cool-core clusters
- SFR and emission line properties of faint galaxies in the nearby and distant (up to redshift 5) Universe using gravitational lensing technique has been made for the galaxies in the field of MACS J0416.1-2403 cluster
- Multi-wavelength study on 14 lens systems have been carried out in order to study the interplay between dark and baryonic matter.
- Radio data analysis on remaining 11 clusters- already collected

Principal Collaborators

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Publications

- No. of publications in SCI journals: 9
- No. of papers presented in conferences: 8

Mobility Support

- India to France: 4
- France to India: 1
Ongoing Projects

Pure & Applied Physics

MODELLING PLASMA INSTABILITIES AND TRANSPORT IN A HALL THRUSTER

Project No. 5204-3  Mar. 2015 to Aug. 2019

Background

Hall effect thruster is a plasma propulsion device, whose studies have shown its suitability for station keeping, orbit control and interplanetary missions. In the proposed project, collaborators shall develop analytical models and carry out simulations of different instabilities likely to be responsible for anomalous electron transport through the magnetic field of Hall thrusters and shall give a quantitative estimate of the electrons flux generated by each of those instabilities using a Hamiltonian formalism. This project is a first step toward a modeling of the electron transport itself that will make it possible to build predictive simulations of Hall thrusters (not available presently). Such simulation would make it easier to optimize the magnetic configuration and the geometry of thrusters in order to improve its performance. Instabilities identified as possible candidate to generate electron transport are a Rayleigh-Taylor like instability, the resistive instability and a kinetic instability.

Objectives

- Investigations of stability of plasma under the effect of different profiles / gradients of magnetic field
- Studies on stability of plasma under the effect of impurity / dust grains in a Hall thruster
- Introducing Hamiltonian formalism to get an estimate of the electron transport driven by instabilities
- Quasi-linear equation for electron transport
- Derivation of Rayleigh-Taylor equation for different profiles of density and velocity
- Theoretical modelling of resistive instability under the effect of impurity
- Theoretical modelling of resistive instability in view of ionization and impurity
- Results for the growth of resistive instability
- Expressions for Lagrangian and Hamiltonian for N particles in the chamber with the coupling of the electromagnetic field in terms of vector potential

Knowledge Generated/Products Developed

- Derivation of Rayleigh-Taylor equation for different profiles of density and velocity
- Theoretical modelling of resistive instability under the effect of impurity
- Theoretical modelling of resistive instability in view of ionization and impurity
- Results for the growth of resistive instability
- Expressions for Lagrangian and Hamiltonian for N particles in the chamber with the coupling of the electromagnetic field in terms of vector potential

Principal Collaborators

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Publications

- No. of publications in SCI journals: 1
- No. of papers presented in conferences: Nil

Mobility Support

- India to France: 1
- France to India: Nil
Ongoing Projects

Pure & Applied Physics

HOLOGRAPHY AND IT APPLICATIONS

Background

Holography is one of the most important physical insights to emerge from the study of black holes which implies that the number of degrees of freedom in a quantum theory of gravity scales with area and not with volume as one might naively expect. A concrete realization of holography within string theory has led to the remarkable quantum equivalence between a theory with gravity described by strings moving in Anti de Sitter (AdS) space and a theory without gravity described by conformal quantum field theory (CFT) in one less dimension. It is planned to use this duality in two complementary ways: 1) Using known exact quantum results in CFT, it is proposed to develop new methods to study the gravitational effects in AdS at the full quantum level. This will enable a systematic computation of exact quantum corrections to the Bekenstein-Hawking formula going well beyond earlier semiclassical work. 2) It is proposed to use the simplicity of the classical gravitational description in AdS to analyze otherwise intractable strongly coupled dynamics in quantum field theories relevant for certain model systems in condensed matter physics.

Objectives

- To develop effective methods to evaluate the functional integral of quantum gravity in AdS space exactly using the ideas of localization
- To applying above results to study the functional integral in the AdS2 space
- To understand the physical origin of this mock modularity from the perspective of AdS/CFT holography

Knowledge Generated/Products Developed

- Heterotic and Closed string field theory has been developed. This is a fundamental aspect of string theory vital to the continued development of the field.
- Developed the subheading corrections to tensor quantum mechanics in the large N limit. This is relevant for AdS2 horizons of black holes.

Principal Collaborators

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Nick Halmagyi
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Paris

Publications

- No. of publications in SCI journals: Nil
- No. of papers presented in conferences: Nil

Mobility Support

- India to France: 2
- France to India: 2
Materials Science

PLASTICITY OF COVALENT NANOPARTICLES

Ongoing Projects

Project No. 5208-1  Mar. 2015 to Mar. 2018

Background

Collaborators propose to investigate the plasticity properties of covalent nanoparticles using both first-principles and classical molecular dynamics methods, with materials such as Si, considered as a model and well documented, and SiC, interesting for applications. It is known that nano-objects are characterized by specific properties due to high surface/bulk ratio, and that functionalization is possible by surface modification. Compared to nanopillars/nanotubes, there have been few studies of plasticity properties of nanoparticles. With numerical simulations, collaborators will perform mechanical testing of realistic nanoparticles, in order to determine the elasticity limits and identify the different plasticity mechanisms and their activation domains as a function of size, geometry, and surface state. Mechanisms like dislocation nucleation, twinning, phase transition, and eventually crack nucleation are expected. Moreover studies will be done on core/shell systems, mixing Si and SiC, or using amorphous materials as a surrogate for oxide.

Objectives

- Determination of elasticity limit as a function of size/surface state/geometry of Si and SiC nanoparticles
- Identification of possible plasticity regimes (twinning, dislocation nucleation, phase transition) and their activation conditions,
- Improving mechanical properties by tuning surface state (passivation)
- Investigation of different core/shell systems, such as Si/SiC, or using amorphous Si or SiC as surrogate of oxides

Knowledge Generated/Products Developed

- Determination of structure and linear elastic moduli and generalized stacking fault energy surface of Si from first-principles / Validation of interatomic potentials
- Implementation of external repulsive force fields in the Quantum Espresso package, allowing for ab Initio MD simulations of indentation of Si nano-particles
- Building of Si/SiC nanoparticles in various configurations (bare or H-passivated, spherical or faceted, in core/shell geometry)

Principal Collaborators

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Publications

- No. of publications in SCI journals: Nil
- No. of papers presented in conferences: Nil

Mobility Support

- India to France: 1
- France to India: 2
Materials Science

NOVEL NANOCATALYSTS SYNTHESIS GUIDED BY DNP NMR

Ongoing Projects

Project No. 5208-2  Oct. 2015 to Sept. 2018

Background

Nanomaterials are essential for the modern society as they can resolve two critical challenges: energy and environment. In particular, novel silica nanomaterials with fibrous morphology offer highly accessible active sites and are promising for various applications including nano-catalysis, non-conventional energy generation (solar cells, water splitting, bio fuels), and environment (CO₂ capture, green chemistry, water purification). However, the development of tunable synthesis and surface modification process for fibrous nano-silica require a better understanding of the structure of surface sites and their interactions with various substrates. This project aims at characterizing these sites and interactions via conventional and DNP-enhanced solid-state NMR. The obtained structural information will be used for a rational improvement of solid base nanocatalysis by nitridated fibrous silica.

Objectives

- Synthesis and characterization of fibrous nanosilica (KCC-1) with various textural properties by tuning the reaction time and temperature
- Development of novel multidimensional (DNP)-NMR techniques to probe internuclear proximities and connectivities in nanomaterials
- New insights into the DNP mechanisms (transfer depth, radical location) combining DNP-NMR, conventional NMR and EPR spectroscopy
- Surface modification of KCC-1 by nitridation and study of various active sites generated on its surface by NMR and DNP enhanced NMR and Probing interactions between the surface sites of nitridated KCC-1 and reagents or intermediates for chemical reactions catalyzed by nitridated KCC-1
- Size and Fiber Density Controlled Synthesis of KCC-1 is achieved
- Various active sites of nitridated silica was achieved
- Design of CO₂ sorbents using functionalized KCC-1 and insights into the effect of the silica morphology was achieved
- Solution phase synthesis and photocatalysis of KCC-1/TiO₂ is achieved and its NMR study is in progress
- Effect of KCC-1 fiber density on radical diffusion and then DNP enhancements is partly completed

Knowledge Generated/Products Developed

- Formation of Al hydrides on γ-Al₂O₃

Publications

- No. of publications in SCI journals: 6
- No. of papers presented in conferences: 5

Mobility Support

- India to France: 2
- France to India: 3

Principal Collaborators

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Formation of Al hydrides on γ-Al₂O₃
Ongoing Projects

Life & Health Sciences

DECIPHERING THE ROLE OF MYCOBACTERIUM TUBERCULOSIS SERINE/THREONINE PROTEIN PHOSPHATASE PstP

Background

*M. tuberculosis* encodes for 11 serine/threonine protein kinases, one tyrosine kinase (PtkA), one serine/threonine phosphatase (PstP) and two tyrosine phosphatases (PtpA, PtpB). All the phosphatases have been biochemically characterized and the structures have been determined. PstP dephosphorylates PknA and PknB and its activity is regulated by phosphorylation. In this project, it is aimed to comprehensively investigate the role played by the sole serine/threonine protein phosphatase PstP and to generate conditional gene deletion mutant of PstP in *M. smegmatis* and *M. tuberculosis*. The mutants generated would be used to delineate its impact on phosphorylation status of protein kinases PknA, PknB and some of their substrates. The project proposes to investigate the role of PstP in the virulence of *M. tuberculosis* in mouse models, and perform phosphoproteomic profiling of *M. tuberculosis* and pstP mutant to identify novel targets of PstP.

Objectives

- Generation of conditional gene replacement mutant of *M. tuberculosis* serine/threonine phosphatase PstP
- Deciphering the function of PstP using ΔpstP mutant and investigating its impact on phosphorylation status of protein kinases PknA, PknB and some of their substrates
- Global phosphoproteomic approach to identify novel targets for PstP
- Validation of the targets and determination of biological outcome of dephosphorylation
- Mouse infection studies to determine the role of PstP in mediating pathogen survival in the host

Knowledge Generated/Products Developed

- Phosphoproteomics to identify novel substrates of PstP in *M. smegmatis*
- Generation of *M. tuberculosis* PstP mutant that shows better depletion
- Characterization of identified novel substrates
- Generation of gene replacement mutants for the identified substrates
- Determine the role of phosphorylation in their functionality

Principal Collaborators

- **Vinay Kumar Nandicoori**
  National Institute of Immunology
  New Delhi

- **Virginie Molle**
  CNRS UMR5235- DIMNP (Dynamique des Interactions Membranaires Normales et Pathologiques)
  Universite Montpellier II, Montpellier

Publications

- No. of publications in SCI journals: 1
- No. of papers presented in conferences: Nil

Mobility Support

- India to France: Nil
- France to India: Nil
Life & Health Sciences

ORIGINAL BIOCOMPATIBLE PHOSPHORUS DENDRIMERS AS A NEW STRATEGY TO TACKLE PULMONARY TUBERCULOSIS

Project No. 5303-2  Sept. 2015 to Sept. 2018

Background
Dendrimers are nearly perfect tunable monodisperse macromolecules with a regular and highly branched three-dimensional architecture, and can be used as nanocarriers or as bioactive macromolecules active per se. Drugs can be either encapsulated into their void spaces or conjugated (prodrug approach) with cleavable covalent attachments on the functionalized surfaces by the introduction of specific chemical moieties. The needs of newly developed antitubercular agents are required for the control of tuberculosis (TB) in the present time. The emergence of multidrug-resistant and extensively drug resistant strains has encouraged the researchers to intensify the efforts to discover novel antitubercular drugs. The aim of this project is selectively to deliver new anti-TB compounds to alveolar macrophages using original biocompatible phosphorus dendrimers based on targeted strategy, in order to find new anti TB compounds with good PK/PD profiles. The goal is to develop these nanodevices as molecular image-guided theranostic strategy for TB personalized medicine.

Objectives
- To deliver new anti-TB compounds to alveolar macrophages using original biocompatible phosphorus dendrimers (PDnd) based on targeted strategy, in order to find new anti TB compounds with good PK/PD profiles
- To develop the new phosphorus dendrimers against TB as molecular image-guided theranostic strategy for personalized medicine
- To develop new active compounds against TBs conjugated/encapsulated/complexed with bio-active phosphorus dendrimers

Knowledge Generated/Products Developed
- Successes to combine talents, backgrounds, and knowledges for a common objective through India and France to get one team spirit
- Up-to-date, more than 70 original phosphorus dendrimers prepared (different generations and various surface modifications) and tested as anti-mycobacterial, anti-bacterial, anti-fungal, and anti-cancer agents
- More than 15 first-in-class phosphorus dendrimers are active against M. tuberculosis and M. bovis BCG
- More than 20 first-in-class phosphorus dendrimers are active against Gram+ and Gram- microbes, including several multi-drug resistant strains
- More than 10 original phosphorus dendrimers are active against solid and/or liquid tumours, for cytotoxicity evaluation and safety evaluation against normal cell line (patent under preparation)

Principal Collaborators

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Publications
- No. of publications in SCI journals: 6
- No. of papers presented in conferences: Nil

Mobility Support
- India to France: Nil
- France to India: 3

Dendritic effects of polycationic phosphorus dendrimers
Ongoing Projects

Pure & Applied Physics

THEORETICAL STUDIES ON ULTRA-COLD DIPOLAR GASES

Project No. 5304-1  May 2015 to  Apr. 2019

Background

Ultra-cold atoms, the atoms are laser-cooled to temperatures of the order of micro or Nano Kelvins. In the last two decades it emerged as an interdisciplinary field studying problems from different aspects of physics such as various phenomena in fluids, high energy physics, electromagnetism, nonlinear, atomic, quantum computation/information, quantum optics etc. In particular, dipolar gases emerged as a key system for many such studies. The dipole-dipole interactions can be either electric or magnetic in nature for e.g. due to the spin of the valence electron in an atom (magnetic dipole), or induced electric dipole moment in highly excited Rydberg atoms or polar molecules. Recent experimental achievements of Bose---Einstein condensates (BECs) of Chromium (2005 Stuttgart, 2007 Paris), Erbium (2012, Innsbruck) and Dysprosium (2011, Stanford) being the landmarks in this field and, in addition, molecular BECs and ultra cold Rydberg atoms have been realized in labs, which will pave a route to highly dipolar systems. The project explores various theoretical aspects, in particular, the microscopic properties of different dipolar systems and the associated novel phenomena/applications within the current experimental feasibilities.

Objectives

- To explore the microscopic (atomic) properties of atomic dipolar gases, especially for Rydberg atoms, with and without the presence of external fields, and the long-term promise is to address exotic many body quantum phenomena by making use of the microscopic properties, in general associated with dipole-dipole interactions
- To study non-local nonlinear effects focused on weakly interacting regime, in which a dipolar Bose-Einstein condensate (BEC) is realized in harmonic traps
- To study on strongly correlated regime, where dipolar gases are loaded in optical lattices, can be used as quantum simulators for condensed matter problems including frustrated magnetism

Knowledge Generated/Products Developed

- Rydberg-admixed atoms in a one-dimensional optical lattice
- A new cooling scheme has been demonstrated for dipolar chromium condensates
- Novel parameter regime for two-dimensional bright solitons are identified and studied as a function of tilting angle of dipoles. A two dimensional condensate self-trapped in one direction has been proposed
- Anisotropic roton quasi-particles with highly tunable roton momentum are identified for a condensate with tilted dipoles, and a stripe phase emerges as result of roton softening
- Non-equilibrium dynamics of dipolar bosons in optical lattice is studied using chromium atoms

Principal Collaborators

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Publications

- No. of publications in SCI journals: 5
- No. of papers presented in conferences: 2

Mobility Support

- India to France: 1
- France to India: 2

The stripe pattern and soliton gas formed
Ongoing Projects

- To study generalised-geometric and non-geometric objects, their mathematical structure and phenomenological implications, with emphasis on the quantum theory on both the space-time and the world-sheet
- To study discrete structures on the world-sheet and try to connect them to the continuum description based on world-sheet approach
- Stringy instanton corrections to the hypermultiplet moduli space in Calabi-Yau compactification has been extended to two instantons.
- Mock modular forms have been studied in this context.
- Study of mirror symmetry in higher-dimensional fluxcompactifications

Knowledge Generated/Products Developed

- Study of relevant mathematics literature undertaken.
- Stringy instanton corrections to the hypermultiplet moduli space in Calabi-Yau compactification has been extended to two instantons.
- Mock modular forms have been studied in this context.
- Study of mirror symmetry in higher-dimensional fluxcompactifications

Principal Collaborators

- **Debashis Ghoshal**
  Jawaharlal Nehru University
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Publications

- No. of publications in SCI journals: 1
- No. of papers presented in conferences: Nil

Mobility Support

- India to France: 1
- France to India: 1

Symmetries and Dynamics: Worldsheet and Spacetime

Project No. 5304-2  Jun. 2015 to May 2018

Background

Quantum consistency of string theory leads to a prediction that space-time is ten-dimensional. However, to relate the laws of particle physics in our four-dimensional world, six of the dimensions ought to be in the form of a compact space, or more precisely, an 'internal' conformal field theory. The microscopic details of this internal theory affect physics in four dimensions. One of the most interesting recent developments is that the internal theory may be non-geometric while still reproducing, on macroscopic scales, familiar particle physics in a four-dimensional world. However, our understanding of these non-geometric objects remains rather limited. The proposed collaboration aims at understanding such generalized-geometric and non-geometric objects, their mathematical structure and physical implications, using modern mathematical tools in the spacetime as well as world-sheet approach.
Ongoing Projects

Pure & Applied Physics

QUANTUM TRANSPORT IN 2D VAN DER WAALS HETEROSTRUCTURES BASED ON GRAPHENE AND BORON NITRIDE

Background

The project centred on the production and study of quantum electron transport properties of Graphene devices for which the carbon monolayer is encapsulated by Van-der-Waals interactions in between two layers of hexagonal Boron Nitride, side-contacted with lateral electrodes and gated with set of top electrodes. These sandwiches allow to prepare 2D electron/hole gases with very long mean free paths and high electronic mobilities while top electrode deposited over the sandwich allow to shape the gas and create quantum point contacts, quantum dots and tunnel barriers. One aim is to study the interplay of superconductivity and quantum Hall effect in high mobility devices. It is proposed to study the phase and charge of the quasiparticles in these hybrid devices using Shot noise and electronic interference (Fabry-Perot and Mach-Zehnder) measurements also.

Objectives

- Fabricate layered heterostructures by stacking graphene (single or bilayer) with other layered materials, such as boron nitride (BN), to achieve a new class of composite materials
- Study quantum transport in high mobility graphene/BN heterostructures and interplay of quantum Hall effect and superconductivity in high mobility graphene/BN heterostructures
- Investigate the ground state of charge-neutral modes in Fractional Quantum Hall (FQH) states

Knowledge Generated/Products Developed

- 12 successful stacks built with success rate of 50-60%
- Temperature variation of 1°C/min to 0.5°C/min followed. Less occurrence of bubbles as we go slowly
- 0.1°C/min temperature increase to be followed for bubble free stacks

Principal Collaborators

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Publications

- No. of publications in SCI journals: Nil
- No. of papers presented in conferences: Nil

Mobility Support

- India to France: Nil
- France to India: Nil

Picture of the dedicated transfer stage built at Institute Néel for project. It is based on a microscope (A) with video control (B) on top of a micromanipulation arm (E) approaching a heating stage (D) placed on a stepper motor (C)
Ongoing Projects

Pure & Applied Chemistry

AXIALLY CHIRAL BIARYLS FROM C-H ACTIVATION & RADICALS

Project No. 5305-1  Jun. 2015 to May 2018

Background
The aim of this project is the development of unprecedented stereoselective oxidative cross couplings based on a merge of a C-H activation and a radical chemistry. Such oxidative couplings of two non prefunctionalized coupling partners should enable to build-up high value added chiral scaffolds, such as axially chiral biaryls, in a straightforward way and under relatively mild reaction conditions. In order to achieve such ambitious goal two different approaches will be investigated: direct functionalization of prochiral biaryl scaffolds with a radical partner and direct radical arylation of phenyl derivatives bearing a chiral directing group. Such project tends, via the development of unprecedented coupling reactions, to bring promising and atom-economic solutions to organic chemistry, to investigate unprecedented fundamental transformations enabling chiral induction and therefore to design new handful approaches towards the synthesis of axially chiral skeletons.

Objectives
To design new strategies to build-up axially chiral biaryls. Proposed work
- Synthesis of axially chiral biaryl scaffolds via Pd-catalyzed direct functionalization of pro-axially chiral biaryls
- Stereoselective construction of axially chiral biaryl scaffolds via C-H activation/radical arylation

Knowledge Generated/Products Developed
- A method for the direct cross coupling of phenols with H-phosphates were achieved
- Across coupling of axially chiral phenols with di-alkyl phosphites were achieved
- A moderate success in diastereoselectively in the reaction between axially chiral phenols with racemic ethyl phenyl-phosphinate was achieved

Principal Collaborators

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Publications
- No. of publications in SCI journals: Nil
- No. of papers presented in conferences: Nil

Mobility Support
- India to France: 1
- France to India: Nil

Phosphorylation of p-tolylsulfoxidebiaryl phenol under Atherton-Todd reaction conditions
Earth & Planetary Sciences

ADVANCED TIME-DOMAIN INTEGRATION SCHEMES FOR THE SIMULATION OF EARTH AND PLANETARY CORE DYNAMICS

Project No. 5307-1 Sept. 2015 to Sept. 2018

Background
Over the past two decades, our understanding of Earth and planetary core dynamics, and magnetic field generation within planetary interiors, has greatly benefited from numerical simulations. The temporal discretization used in these simulations has surprisingly received little attention. However, if one is interested in the long-term behaviour of planetary cores and magnetic fields, an efficient and accurate time scheme is in order. The purpose of the present research project is to implement such an efficient scheme. The project comprises two stages: the first stage consists of the implementation of a high-order time integrator capable of treating rotational effects implicitly. The second stage aims at placing that time integrator at the heart of the so-called parareal algorithm. This novel method enables domain decomposition to be carried out in the time domain, in addition to the spatial domain. It has yet to be applied in a planetary core dynamics setting.

Objectives
- To design, implement, and validate novel time schemes for the numerical modelling of the dynamics of Earth and Planetary cores
- To initiate and lead an international benchmark initiative whose goal will be to better assess the efficacy of time schemes used among the community

Knowledge Generated/Products Developed
- Design and implementation of a numerical code of two-dimensional turbulent thermal convection in a spherical annulus
- Development of a complementary experimental facility to investigate the dynamics of thermal core-mantle interaction. Assembly and testing of this facility at a rotation rate of 300 revolutions per minute

Principal Collaborators

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Alexandre Fournier
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Publications
- No. of publications in SCI journals: Nil
- No. of papers presented in conferences: Nil

Mobility Support
- India to France: 1
- France to India: Nil

An overall view of the set-up mounted on the rotating frame. Figure 1 (right) gives a close-up of the concentric cylinder assembly within which convection subject to lateral heat flux variations will be studied.
To understand fundamental parameters in magnetic materials, such as magnetic anisotropy energy and spin polarization
- To measure the magnetic properties of new surface alloys using magneto-optical Kerr effect
- To calculate the magnetic properties, such as the magnetic structure, and magnetic anisotropy energies, of the surface alloys
- To study the interplay between the magnetic properties of the ferromagnetic electrode and the spin polarization of the molecular layer in order to better understand the key parameters for an efficient molecular spin polarization

The change in magnetic anisotropy energy of Co surfaces on depositing a monolayer of thiols has been measured experimentally and calculated theoretically
- STM images and scanning tunneling spectra have been obtained for TCNQ molecules on graphene and N-doped graphene
- The experimental data on TCNQ on graphene and N-doped graphene has been understood theoretically, and new systems for further investigation have been identified
- A magnetic code has been written to understand spin crossover systems

Project No. 5308-1  Jul. 2015 to Jun. 2019

Background
It is proposed to work both experimentally and theoretically on the magnetism of complex self-organized structures made out of surface bimetallic alloys and ferromagnetic/organic interfaces. Mainly two major issues will be addressed in magnetism, which are the increase of Magnetic Anisotropy Energy and Spin Polarization at the atomic scale. It is expected that the interaction between the groups, begun in a preceding contract focused on new structures at surfaces, to continue to be effective in this new direction, i.e., to address the questions on the magnetic properties at surfaces. The synergy between ab initio calculations performed in Bangalore, and magneto-optical Kerr effect (MOKE) and Spin Polarized Scanning Tunneling Microscopy (SP-STM) experiments done in Paris, should lead to important results on these topics.
Biotechnology

A COMPARATIVE SYSTEMS BIOLOGY APPROACH FOR UNDERSTANDING DESSICATION TOLERANCE IN FORAGE GRASSES AND SELAGINELLA SPS

Project No. 5300-B1 Jul. 2015 to May 2018

Background
Water supplies for agriculture are a major factor in limiting crop and livestock production. The project proposes to undertake comparative systems biology based evaluation of a new selection of grass species that have the ability to thrive under air dried conditions, for fresh and dry biomass production. For this purpose grasses of genera *Eragrostiella*, *Oropetium* and *Tripogon* that can survive total drying of its vegetative tissues, and produce sufficient quantity of (biomass) under three different water stress regimes will be used. These grasses will be compared with mosses like *Selaginella* that incorporates a constitutive mechanism of desiccation tolerance. Also, proven models of Desiccation tolerance (DT) and sensitivity (DS) like *Craterostigma* / *Myrothamnus* will be included for baseline comparison of DT/DS *Selaginella*, a vascular plant with true roots and shoots, occupy diverse habitats including arctic, temperate, tropical and semi-arid environments. Several members of the *Selaginella* genus have evolved desiccation tolerance (DT) and several species like *kraussiana*, *bryopteris* and *martensii* from sub-tropical forests of India have been tested its drought tolerance potential. A comparative systems biology approach will be used to understand the mechanism of desiccation tolerance, and to determine at which level of control the changes are affected.

Objectives

- Development of appropriate cultivation methods, physiological baseline studies and collecting/harvesting resurrection grasses and *Selaginella* sps
- Performing untargeted proteomic and metabolomic analyses of the resurrection plants selected and identified
- Implementing a range of wall profiling, cell wall proteomics and metabolomics analyses on the resurrection plants selected and identified
- Integration of -omics and wall profiling datasets, confirmation with gene expression studies and the use of multi variate, statistical and bioinformatic tools to determine potentially high impact genes

Knowledge Generated/Products Developed

- Two *Selaginella* species (*S. involvens* and *S. Kraussiana*) have been identified as strong desiccation tolerant phenotypes. These species conserve their chlorophyll during desiccation.
- *Eragrostiella brachyphylla*, a forage grass has also been identified as strongly desiccation tolerant.
- *Selaginella* and *Eragrostiella* are protected by anti-oxidant system during desiccation when the ROS and lipid peroxidation are found to be highest in concentration.
- Proline might also be play an osmo-protectant role during desiccation. First cell wall characterization in three *Selaginella* species.
- Arabinose and Xylose are two major sugars of the cell walls of *Selaginella* species indicating the abundance of Arabinoxylans.
- Arabinose content is very high in the cell wall of the desiccation-tolerant species *S. involvens* as compared to desiccation-sensitive species *S. moellendorffii* and *S. kraussiana*.
- Xyloglucan structure is unique in *S. Kraussiana* containing arabinose oligosaccharides.
- Mannan content is significantly higher in the cell wall of dehydrated *S. involvens* as compared to hydrated plants.
- The pectic fraction is mainly composed of Rhamnogalacturonans

Desiccation tolerant plants (A) *Selaginella rupestris* and (B) *Eragrostiella brachyphylla*. Hydrated frond (WC 90.80%). b. desiccated frond (DF, RWC 9.20%). c. and rehydrated (RF, RWC 90.68%)

Principal Collaborators

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Publications

- No. of publications in SCI journals: 1
- No. of papers presented in conferences: 7

Mobility Support

- India to France: 2
- France to India: Nil
Ongoing Projects

Pure & Applied Mathematics

SUMS OF INTEGERS: FOURIER, COMBINATORICS, COMPUTATION

Project No. 5401-1 Jan. 2016 to Dec. 2018

Background

Additive number theory, approached by the tools of harmonic analysis and combinatorics, is a "hot" topic, named as Additive Combinatorics. The aim of the project is to put together the efforts of nine Indian and French researchers, who have proved their expertise in this and connected fields, and who have (almost all of them) already some Indo-French joint publications. A further aspect we wish to develop is the computational approach which seems very promising for at least two of the four themes presented in the project. The itemized presentation by "themes" should not hide the will of all the participants to be involved in all the themes.

Objectives

- Theme 1. An inverse additive problem: sum-free sets. Let \( p \) be a prime number and \( A \) a subset of \( \mathbb{Z}/p\mathbb{Z} \) such that \( A+A \) and \( A \) are disjoint. Characterize \( A \)
- Theme 2. Large subsets of integer sequences. How they retain the additive properties of the initial sequence
- Theme 3. Expander functions. Let \( F \) a finite field. A binary expander is a function \( f(x,y) \) such that if \( A \) is a subset in \( F \) then \( |F(A,A)| \) is considerably bigger than \( |A| \). Known explicit expanders can be rewritten under the form \( a(x)b(y)+c(x) \)
- Theme 4. Functions « sum of digits

Knowledge Generated/Products Developed

- Progress both on the Fourier approach and the combinatorial tools seem to be sufficient to give the structure of a sum-free subset \( A \) of \( \mathbb{Z}/p\mathbb{Z} \) (\( p \) prime), when the cardinality of \( A \) is over 0.300p (previous result 0.318p in 2006). (Bordeaux-IMSc)
- Sárközy (András)’s problem asks for optimal bounds for \( s(K) \) in terms of \( K \). It is shown that \( s(K) < K \exp(C \log K / \log \log K) \), an almost optimal bound (only the value of \( C \) may be improved), much better than the projected \( K^{1+\varepsilon} \). (Marseille-HRI)
- A sharp estimate for the minimal size of a set of positive integers such that \( A^k + A \) covers all the integers. (Saint-Etienne-HRI)
- Let \( s_b(n) \) denote the sum of the digits of \( n \) in the base \( b \). There exist infinitely many \( n \) for which \( |s_3(n) - s_2(n)| < 0.146 \log n \) (first improvement known on the trivial bound 0.189 \log n). (Angers-Bordeaux-ISI Delhi)
- Let \( \tau \) be the Ramanujan function. Under the standard conjecture that \( \tau \) does not vanish, there are infinitely many integers \( n \) for which the change of size of the values of \( \tau(n), \tau(n+1), \ldots, \tau(n+k) \) can be arbitrarily prescribed. (CEFIPRA visits permitted a new Bordeaux-IMSc collaboration)

Principal Collaborators

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Université de Bordeaux-CNRS
Bordeaux

Publications

- No. of publications in SCI journals: 4
- No. of papers presented in conferences: 12

Mobility Support

- India to France: 6
- France to India: 3
**Ongoing Projects**

**Life & Health Sciences**

**PATHOGENIC ASPERGILLUS: INTERACTION WITH INNATE IMMUNE CELLS**

**Background**

This project aims at comparing the pathogenesis of two *Aspergillus* (*A. fumigatus* and *A. flavus*) which are the major aerial fungal pathogens in India and France.

*Aspergillus fumigatus* causes systemic infections worldwide, particularly in the immunocompromised individuals/patients, which are often fatal; whereas *A. flavus* causes superficial eye/corneal infection which is a major cause of keratitis in tropical part of the world.

In this collaborative project, it is proposed to use combined expertise to (i) unravel the pathogenic components and their role in modulating host immune responses during infection and (ii) in identifying common and uncommon aspects of two pathogens while establishing their pathogenicity, which might lead us to the development of universal or differential therapeutic strategies against these two fungal infections. The study will be focused on the fungal cell wall polysaccharides and the cell surface/secreted proteins as they are the first fungal components interacting with the host.

**Objectives**

- Analyzing the differential interactions of two *Aspergillus*, *A. fumigatus* and *A. flavus*, with their host in the context of their specific pathologies
- Understanding the phagocytic responses toward *Aspergillus* morphotypes (dormant and germinating conidia)
- Identifying and characterizing the fungal cell surface components which activate or repress the host immune response
- Studying in depth the immunogenic function of the core cell wall fungal polysaccharides uptake by phagocytes, surface receptor identification and degradation
- Recognizing the components of the phagolysosome involved in the intracellular recognition of the fungus

**Knowledge Generated/Products Developed**

- Dormant spores of *A. fumigatus* are immunologically inert, but not that of *A. flavus*, at least under in vitro studies using human monocyte derived macrophages
- Cell wall analysis of *A. fumigatus* and *A. flavus* have revealed major differences in the composition
- Conidial surface rodlet layer makes *A. fumigatus* immunologically inert, but *A. flavus* conidial surface contained proteins in addition to rodlet forming RodA protein
- Cell wall polysaccharide from *A. fumigatus* follow the classical endosome-phagolysosome pathway upon their uptake by immune cells
- Identified nearly 622 secreted proteins of germinating conidia of *A. flavus* and till date, there are no reports on such a large scale identification

**Principal Collaborators**

- Lalitha Prajna
  - Aravind Medical Research Foundation
  - Aravind Eye Hospital & PG Institute of Ophthalmology
  - Madurai

- Jean-Paul Latgé
  - Institut Pasteur
  - Paris

**Publications**

- No. of publications in SCI journals: Nil
- No. of papers presented in conferences: Nil

**Mobility Support**

- India to France: 2
- France to India: 1
Ongoing Projects

• Many-body physics in ultracold polar gases: quantum magnetism of dipolar bosonic and fermionic chromium atoms due to direct spin-spin coupling arising from dipolar interactions magnetic phases of chromium atoms in the 2D geometry (where dipolar interactions may be tuned) K-Rb molecules in an optical lattice

• Production of cold molecules and cold molecular ions: radiative association of molecular ions from ion-atommixtures creation and detection of an interacting gas of homonuclear and heteronuclear (with a dipole moment) molecules

• Cooling molecules: innovative deceleration method for polar molecules, based on electron attachment, deceleration and trapping

Discovered universal dissociation mechanism for trapped alkali dimer molecular ions

• Demonstration of cold atoms lasing into cavity mode
• New cooling mechanism for trapped ions has been demonstrated
• Spin mixing dynamics in a dipolar BEC, and dynamical protection of ferromagnetism
• Observation of beyond mean-field effects in an array of interacting spins
• Ro-vibrational Optical pumping of molecules in a beam
• Modelling of internal cooling of molecular ions by collision

LORIC: LONG-RANGE INTERACTIONS IN ULTRA COLD GASES

Project No. 5404-1
Mar. 2016 to Feb. 2019

Background
This project combined experimental and theoretical approaches that are expected to shed light on the fascinating properties of quantum gases with long-range interactions. The consortium will cover this field in a very broad way: at LPL, studies focus on many-body physics of bosons of fermions in optical lattices with $1/r^3$ interactions; at RRI, two-body and few-body long-range interactions will be studied, with a possibility to choose the exact power-law of the interaction $1/r^n$. At LAC, new strategies to produce dipolar or ionic molecules will be sought, including (experimentally) electronic attachment, deceleration and trapping, and (theoretically) photo-association to create neutral molecules and molecular ions. A strong collaboration between the groups would therefore create a research platform on long-range interacting systems which has probably no equivalent in the world.

Objectives

Knowledge Generated/Products Developed

Discovering a universal dissociation mechanism for trapped alkali dimer molecular ions

- Demonstration of cold atoms lasing into cavity mode
- New cooling mechanism for trapped ions has been demonstrated
- Spin mixing dynamics in a dipolar BEC, and dynamical protection of ferromagnetism
- Observation of beyond mean-field effects in an array of interacting spins
- Ro-vibrational Optical pumping of molecules in a beam
- Modelling of internal cooling of molecular ions by collision

Principal Collaborators

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Publications

- No. of publications in SCI journals: 2
- No. of papers presented in conferences: 3

Mobility Support

- India to France: 2
- France to India: Nil

Annual Report | 2016-17
Ongoing Projects

Pure and Applied Physics

GLIMPSES OF NEW PHYSICS

Project No. 5404-2  Feb. 2016 to Jan. 2019

Background

One of the important questions in the field of high energy physics is the following:

There is a strong indirect evidence that there should be new physics beyond standard model. This evidence is through the discovery of neutrino masses and oscillations, thenon Standard Model (SM) nature of dark matter particles etc. On the other hand, at the same time, the actual structure of new physics is lacking any direct evidence. Searches at colliders like LHC and B-factories have not yielded yet any positive results. In high precision experiments like rare decays of mesons or electric and magnetic momentsof leptons and atoms or nuclei there is also no evidence of new physics so far. There is however a hint of new physics in the measurement in the muon anomalous magnetic moment, which needs further confirmation. The recent discovery of the Higgs Boson has also opened several questions: whether the Higgs is composite or elementary; whether it has any further cousins, at what scale the Higgs potential is stable etc. In the present project, it is proposed to address these questions. More concretely, where is the new physics, what is its structure and where can we find it.

Objectives

The three main directions in which the extensions of the Standard Model are proposed are: (a) Higgs and Hierarchy Problem (b) Dark Matter and (c) Flavour Physics which includes neutrino masses and mixing

• Higgs and Hierarchy Problem:
  Low-energy Supersymmetry and Extra dimensions are theories which have been proposed, which are motivated from various theoretical ideas. The second Run of LHC might throw light on this important matter

• Dark Matter: To classify the different types of signals (from low keV energies to PeV events) and embed the observations within ultraviolet frame works (super symmetry or GUT like models for instance)

• Flavour Physics which includes neutrino masses and mixing:
  To redefine consequences of the various models in low-energy experiments in view of the present and forthcoming data

Knowledge Generated/Products Developed

• Dark matter models with Chern-Simons portal
• Construction of microscopically consistent models with Chern-Simons terms and symmetry responsible for dark matter stability
• Constructions of warped flavour models with grand unification sector containing composite states. Flavour constraints and predictions

Principal Collaborators

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Publications

- No. of publications in SCI journals: Nil
- No. of papers presented in conferences: 1

Mobility Support

- India to France: Nil
- France to India: 2
Ongoing Projects

**H₂ EVOLUTION: CHEAP CATALYSTS FOR NOBLE TASK**

**Project No. 5405-1**
Mar. 2016 to Feb. 2019

**Background**

The two applicant groups have already reported a set of biomimetic Fe-Fe, Ni-Fe, Ni-Mn and Mo based efficient H₂ producing catalyst with potential to replace noble metals in water-splitting electrolyzers. This project has two major goals. First, the mechanism of these HER catalysts will be studied in more details, both under homogeneous and heterogeneous conditions, using complementary electrochemical, analytical and spectroscopic (Resonance Raman, FTIR, XPS, EPR) methods available in both labs. Second, novel HER catalysts will be designed so as to improve their kinetics, allow for reactivity from water in the presence of O₂. Modifications include ligand variation in the Fe-Fe and Ni-Fe/Ni-Mn series, incorporation of pendant proton relays as well as incorporation of transition metal ions as dopant in the layered ammonium thiomolybdate material or development of similar tungsten-based materials.

**Objectives**

- Investigation of the H₂ evolution mechanism catalyzed by bio-inspired compounds
- Enhancing catalytic performances for H₂ evolution

**Knowledge Generated/Products Developed**

- A NiFe mimic has been deposited onto electrodes and its activity under reductive conditions in water has been demonstrated. XPS measurements confirmed retention of the molecular nature. Raman measurements are planned to characterize key intermediates.
- A new Cp*- derivative of a NiFe mimic has been synthesized and its catalytic activity as well as tolerance to CO has been tested. A paper is under review.
- The NiFe mimic has been immobilized in a MOF and was shown to retain its activity. A paper is under revision.
- A new FeFe mimic has been developed that shows bidirectional activity for both H₂ evolution and oxidation. A paper has been submitted for publication.
- A derivative of the same FeFe mimic has been covalently attached onto carbon nanotubes and the resulting electrode material displays interesting reactivity. This is currently under study.

**Principal Collaborators**

- **Abhishek Dey**
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  Kolkata

- **Vincent Artero**
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**Publications**

- No. of publications in SCI journals: 9
- No. of papers presented in conferences: 2

**Mobility Support**

- India to France: 2
- France to India: 1
Ongoing Projects

Computational Science

UNDERSTANDING MECHANICAL SIZE EFFECTS IN METALLIC MICRO-WIRES: SYNERGY BETWEEN EXPERIMENTS AND SIMULATION

**Project No. 5408-1**  |  **Nov. 2015 to Oct. 2018**

**Background**

The project aims at a comprehensive investigation on size effects in microwires, involving (a) microstructural control during the wire drawing process, (b) conventional mechanical testing, (c) in-situ mechanical testing in an SEM, (d) in-situ testing in synchrotron, (e) relevant microstructural studies including texture evolution, and (f) finite element modeling. The proposed program utilizes optimally the complementary expertise and facilities available with the investigators in India and France. Specifically, the role of grain size, dislocation density and texture on strengthening in microwires, together with any associated size effects will be evaluated. Of particular interest is shear banding that has been observed recently in Ni microwires, which may provide an additional contribution to strengthening by enhancing the geometrically necessary dislocation density. Contributions to the general understanding of size effect on materials mechanical properties are also anticipated with this project.

**Objectives**

- Micro-wires fabrication with controlled microstructure and texture
- Microstructural characterization by EBSD, XRD and TEM
- In-situ mechanical testing under synchrotron radiation: elastic-plastic transition, evolution of dislocation density and possible modification in crystallographic texture
- Development of a representative microstructure having a surface matching with experimental EBSD map, and the distribution of grains in the volume being statistically representative in term of grain shape (elongated grains), distribution of size, and distribution of crystallographic orientations
- Finite element modelling of the micro-wires behavior, taking into account microstructural and size effects
- Understanding size effects on strength in polycrystalline micro-wires and processing-microstructure-property correlation

**Knowledge Generated/Products Developed**

- Improved macroscopic tensile tests have been performed on microwires with different diameters;
- Two series of microwires have been produced by electropolishing or cold drawing, allowing for the assessment of microstructure impact on mechanical properties;
- In-situ tensile tests under synchrotron x-ray beam have been successfully performed with specifically adapted micro-deformation machine;
- In-situ diffraction data analysis revealed internal deformation mechanisms;
- First representative polycrystalline aggregates, based on relevant parameters from microstructure analysis, have been generated for Crystal Plasticity Finite Element modelling work that is going to start now

**Principal Collaborators**

- **Atul Chokshi**
  Indian Institute of Science
  Bangalore

- **Ludovic Thilly**
  Institut Pyrâme (UPR 3346 CNRS-Université de Poitiers-ENSMA) Futuroscope

**Publications**

- No. of publications in SCI journals: 1
- No. of papers presented in conferences: 1

**Mobility Support**

- India to France: 1
- France to India: 4
Computational Science

LARGE SCALE LOSS BASED LEARNING VIA ENERGY MINIMIZATION

Project No. 5302-1   Apr. 2016 to Mar. 2019

Background
The aim of our proposal is to enable the use of rich, complex models that are required to address the challenges of high-level computer vision. To this end, the work is planned along the following three directions. i) develop a novel loss-based learning framework that can estimate a model using raw image data with weak annotations. ii) build on the current self-paced learning formulation to accurately solve the highly non-convex optimization problem corresponding to the learning framework. iii) in order to make the optimization computationally feasible, develop efficient and accurate energy minimization algorithms for high-order models. The methodologies developed as part of this project will be thoroughly tested on the challenging problems of object detection and semantic segmentation of visual data.

Objectives

• To develop a novel loss-based learning framework that minimizes the amount of manual effort required to estimate a complex model
• To estimate an accurate model from the above learning framework by developing a principled self-paced learning formulation. Specifically, to design optimization algorithms that automatically adjust the sample, model and problem complexity to avoid inaccurate local minimum solutions
• To train and test the models efficiently by developing fast energy minimization algorithms that can handle a large number of variables and labels, as well as high-order potentials with a large number of free parameters

Principal Collaborators

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International Institute of Information Technology Hyderabad

Cordelia Schmid
INRIA, Montbonnot

Pure & Applied Physics

WAVELET GRAPHS FOR GRAVITATIONAL WAVE SEARCHES

Project No. 5504-1   Apr. 2016 to Apr. 2019

Background
The Theory of General Relativity predicts the existence of gravitational waves (GW). The direct search for astrophysical GW made notable progress with the advent of dedicated instruments. One of the prominent astrophysical sources are coalescences of compact binaries of neutron stars and/or black holes (CBC). With the installation of a world-wide network of new generation instruments (which includes both French and Indian participations), the first discovery of GW is expected within the decade. It is proposed to collaborate on the development of new methods to analyse the data from this global multi-detector network and investigate, implement and test alternative coherent multi-detector searches for GW chirp signals from CBC.

Objectives

• To improve the analysis of second-generation data and ensure its readiness for the upcoming first Gravitational Wave (GW) detection

Principal Collaborators

Archana Arun Pai
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**New Projects**

**Pure & Applied Physics**

**ELECTRICAL ADDRESSING AND CONTROL OF THE PLASMONIC PROPERTIES OF COUPLED METAL NANOWIRE**

*Project No. 5504-3*  
*May 2016 to May 2019*

**Background**

The aim of this work is to interface these two technologies to create an electron-plasmon device whose properties will be driven electrically. The project is centred around a series of innovative concepts based on an approach founded on metal nanowires synthesized by soft-solution processing. By assembling such nanowires, the modal characteristics become adjustable, particularly by precisely controlling the coupling region. It turns out to be a site of local light scattering whose directivity (angular distribution of scattered photons) changes with the angle subtended by the paired nanowires. In addition, the distance separating the two ends defines the degree of coupling and therefore dictates the propagation of the plasmon in the system. The advanced concept proposed is to develop a local source plasmon paired with the nanowires system that can be activated electrically. The concept requires electrically contacting the nanowires to achieve a planar tunnel junction by a controlled electromigration. The proposed device is a first step towards the development of electro-plasmonic component interface.

**Objectives**

- To control the directivity of plasmonic emission from nanowire junction by tailoring the angle between the coupled nanowires
- To electrically excite surface plasmon polaritons in single-crystalline coupled-nanowires made of silver
- To probe nano-optical emission effects at the junction of coupled plasmonic nanowires due to external electric bias and modulation

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**Pure & Applied Physics**

**COSMOLOGICAL EVOLUTION OF COLD GAS FROM QUASAR ABSORPTION LINES**

*Project No. 5504-2*  
*May 2016 to Apr. 2019*

**Background**

A key question in the modern astrophysics is to understand how the star formation in galaxies proceeds and leads to the present-day Universe. In recent years, radio and optical observations of the local Universe have established a strong relationship between the star formation rate and the properties of the cold atomic and molecular gas in galaxies. Although the overall star-formation history of the Universe is known to very high redshifts, very little is known about the evolution of cold gas beyond the local Universe. An unbiased census of the cold gas in normal galaxies, irrespective of their physical properties such as morphology and mass, is required to understand the physical processes that control the evolution of the star formation history of the Universe.

**Objectives**

- Identify targets for the MeerKAT Absorption Line Survey (MALS), design the data analysis pipeline and archive, and test the absorption line capabilities of MeerKAT.
- Develop tools to analyze spectra from the Extended Baryonic Oscillation Spectroscopic Survey (eBOSS) to identify quasar sight lines suitable for tracing the evolution of cold gas in galaxies.
- Multi-wavelength emission and absorption line follow-up observations of sight lines selected from MALS and eBOSS.
- Multi-wavelength emission and absorption line observations with existing facilities to address issues relevant for the cold gas evolution in galaxies and upcoming large surveys.
Environmental Science

CHROMITE: ASSESSMENT OF CHROMIUM RELEASE FROM SUKINDA MINING OVERBURDEN: AN ISOTOPIC, CHEMICAL, PHYSICAL AND MICROBIOLOGICAL STUDY

Project No. 5409-1  May 2016 to May 2019

Background
The proposal aims to understand the chemical and microbiological factors controlling Cr mobility during contrasted meteorological conditions in the Sukinda Valley. Towards an innovative multiple approach combining process-based laboratory experiments performed on natural field samples, with state-of-the art microbiologic, microscopic, spectroscopic and isotopic techniques will be undertaken. The mineralogy, the Cr solid speciation and Cr mobility of some selected Cr bearing phases picked up from the Sukinda's overburden will be characterized. The microbiological species at work in such environment, during both monsoon and dry season will be identified and the potential of these species for chromium bio remediation will be evaluated. The quality of surface and ground waters in the Sukinda Valley, with respect to Cr species concentrations, will be assessed. Biogeochemical processes that enhance or limit chromium mobility, from the alteration of over burden phases to surface and ground waters, will be identified through the use of Cr isotopic signatures.

Objectives
• To characterize the mineralogy, the chromium solid speciation and chromium mobility of some selected chromium bearing phases picked up from the Sukinda's overburden.
• To identify the microbiological species at work in such environment, during both monsoon and dry season, and to evaluate the potential of these species for chromium bio remediation (i.e. Cr(VI) => Cr(III) reduction);
• To evaluate the quality of surface and ground waters, in term of Cr species concentrations, in the Sukinda Valley;
• To identify the biogeochemical processes that enhance or limit chromium mobility, from the alteration of over burden phases to surface and ground waters, through the use of Cr isotopic signatures.

Life & Health Sciences

ELUCIDATION OF CONSERVED MOLECULAR SIGNATURES AND REGULATORS FOR BLOOD CELL PROGENITOR MAINTENANCE

Project No. 5503-1  Apr. 2016 to Apr. 2019

Background
Understanding how the balance between Hematopoietic Stem Cell (HSC) proliferation, quiescence and differentiation is regulated is a fundamental question with important scientific and medical outcomes. Though the phylogenetic conservation of several key features of blood cell development, pioneering works in mouse and more recently in Drosophila have helped decipher the complex regulation of blood cell progenitor fate. In both systems, hematopoietic stem/progenitor cells actively proliferate in early life before entering a slow cycling state in response to signaling from their niche. HSC quiescence is considered a critical feature for maintaining their integrity, as loss of quiescence is associated with HSC exhaustion and blood cell disorders, including leukemia. The project will give unprecedented insights into the molecular nature of Drosophila blood cell progenitor populations. It will also provide deeper insights into how a key regulator of the endocytic transport machinery modulates developmental signals and affects stemness, hematopoiesis and leukemia.

Objectives
• To understand mechanisms that control blood cell progenitor proliferation by using a combination of molecular, genetic and developmental approaches in two different animal models, the mouse and the fruit fly Drosophila melanogaster.
• To characterize two ontologically distinct blood cell progenitor populations in Drosophila larvae and identify the common and the specific feature of proliferative versus quiescent blood cell progenitors by whole genome expression profiling.
• To determine how this protein affects blood cell progenitor specification and proliferation in Drosophila and assessment of its function during normal blood cell development and leukemogenesis in mouse.
• To decipher the key conserved genes or signaling pathways that may govern HSC expansion and explore their function using the sophisticated genetic tools available in Drosophila.
**MOLECULAR ANALYSIS OF A CAPACITOR HOX PROTEIN MOTIF**

**Background**
Hox proteins are key developmental transcription factors whose deregulated activity is responsible of numerous cancers in humans. Recent results have showed that a conserved short motif called hexapeptide (HX) is important for restricting the interaction potential of Hox proteins with transcription factors in the Drosophila embryo. This buffering activity could be essential for stabilizing Hox transcriptional networks during development, which is reminiscent of the capacitor activity described for heat-shock proteins (Hsps). PI’s suggest that the HX is a capacitor protein motif that could be exploited together with Hsp proteins for the rewiring of Hox interactomes and, thereby, Hox functions under environmental stress. The project proposes to test this hypothesis in a sensitive developmental context and by using Hox proteins from different insect species. PI’s approach relies on innovative experimental tools and should provide fresh insights into the molecular cues underlying the evolvability of Hox developmental programs in animals.

**Objectives**
- To assess the functional and evolutionary contribution of the HX motif in Ubx proteins from different insect species.
- To identify the full set of interactions established between Ubx and transcription factors expressed in the haltere primordia. The analysis will be repeated with HX-deleted Ubx and under stress conditions. Experimental parameters will allow measuring subtle variations in protein-protein interaction affinity directly in the live tissue and with normal doses of Hox proteins. This objective will identify interactions that could be buffered by the HX motif.
- Genome-wide characterisation of the target genes underlying the capacitor activity of the HX motif in the haltere primordia.

**Principal Collaborators**
- L. S. Shashidhara
  - Indian Institute of Science Education and Research Pune
- Samir Merabet
  - Institut de Génomique Fonctionnelle de Lyon (IGFL), Ens de Lyon - CNRS UMR 5242 Lyon

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**P-ADIC ASPECTS OF AUTOMORPHIC FORMS AND THEIR L-FUNCTIONS**

**Background**
L-functions are ubiquitous in modern number theory. An L-function is a function of a complex variable attached to some interesting arithmetic or geometric object. The values of such an L-function at interesting points encode within them important structural information about the object to which the function is attached. For example, the fact that a classical Dirichlet L-function is non-vanishing at s=1 implies that there are infinitely many primes in arithmetic progressions. Furthermore, the values of these functions exhibit remarkable arithmetic properties; for example, for the Riemann zeta function $\zeta(s)$, one knows from the pioneering work of Kubota and Leopoldt that if two positive even integers n and n’ are close p-adically, i.e., if a high power of a prime p divides n-n’ then the values $\zeta(1-n)$ and $\zeta(1-n’)$ are close p-adically. This leads to the construction of a p-adic Riemann zeta function; the existence of which is tantamount to such p-adic properties of the special values of the classical Riemann zeta function.

The primary aim of this collaboration is to construct & study p-adic L-functions attached to a cohomological cuspidal automorphic representation of $GL(2n)$ over a totally real field admitting a Shalika model.

**Objectives**
- To study the p-adic properties of the special values of L-functions attached to automorphic forms on the general linear group. In particular, given a cuspidal automorphic representation of the general linear group over a totally real field (a very special case of which is a modular form), PIs propose to construct it’s associated p-adic L-function, which means they propose to study p-adic properties of the special values of complex valued L-functions.
Pure & Applied Chemistry

N-HETEROCYCLIC CARBENE (NHC)-PRGANOCATALYZED ENATIOSELECTIVE TRIFLUOROMETHYLATION AND TRIFLUOROMETHYLTHIOLATION OF UNACTIVATED C-H BONDS

Background
By merging the concepts of NHC-organocatalysis and fluorine chemistry, this research proposal envisions the development of new methods for the synthesis of enantiomerically pure fluorinated carbonyl compounds. It is posited to develop an efficient and new protocol to achieve unprecedented transformations so far inaccessible by using NHC-catalyzed asymmetric C-H functionalization reactions. Precisely, a new concept is envisioned for the direct a, b and g C-H trifluoromethylation and trifluoromethylthiolation of carbonyl compounds. By the judicious combination of chiral NHCs with electrophilic fluorinating reagents, this strategy is expected to offer transition-metal-free and enantioselective routes to fluorinated molecules under mild conditions. The resultant chiral a, b and g trifluoromethyl(thiol)ated compounds are expected to have interesting biological properties. Hence, we intend to bring promising and eco-friendly solutions for enantioselective C(sp)-CF₃ and C(sp)-SCF₃ bond constructions.

Objectives
• The enantioselective synthesis of organofluorine compounds is an extremely active research topic. The focal theme of this project is the synthesis of enantiomerically pure compounds bearing a fluorinated (CF₃, SCF₃) stereogenic carbon center at the remote position of a carbonyl group.
• To develop a novel and straightforward catalytic approach for the construction of a chiral fluorinated carbon center by means of C(sp)-CF₃ and C(sp)-SCF₃ bond formation at the a-, b- and g-position of carbonyl compounds.

Pure & Applied Chemistry

CHIRAL PHOSPHAHELICENES IN GOLD (I) ENANTIOSELECTIVE CATALYSIS

Background
Aim of this project is the parallel development of new gold (I) catalyzed processes, and the design and synthesis of new series of helically chiral ligands. The targeted catalytic processes are either intermolecular reactions or skeletal rearrangements of polyyn-saturated substrates which involve electrophilic activation of the substrates and carbene-gold derivatives as the key intermediates. The targeted ligands are phosphahelicenes that is ortho-fused polyaromatic compounds, terminated by a phosphole or a benzophosphole unit. Merging of the two tools will follow, so as to afford innovative catalytic methods for the easy, enantioselective synthesis of complex cyclic and heterocyclic molecules.

Objectives
• Design and synthesis of a broad array of chiral phosphahelicenes and phosphathiahelicene. At first modular methods will be established for the synthesis of helical scaffolds with embedded phosphorus functions (typified by phosphahelicenes I hereafter).
• Preparation of phosphahelicene and phosphathiahelicene gold complexes which are potential pre-catalysts in asymmetric catalysis.
• Development of new gold promoted catalytic reactions.
• Survey of the new phosphahelicene-metal complexes as catalysts for the cyclization, cycloisomerization, carbene transfer and CH functionalization of ynamides via carbene generation. For each single reaction, fine tuning of the helical scaffold and substitution patterns will be carried out for optimization purposes.
**Life & Health Sciences**

**FUNCTIONAL GENOMICS OF GLIOBLASTOMA: FROM EPIGENETICS TO PROTEOMIC INVESTIGATION OF TUMOR INITIATING CELL SECRETOME**

**Background**
Glioblastoma (GBM) is the most common primary brain tumor among adults with a median survival of 14-17 months in spite of advances in our understanding of biology and treatment modalities. Among the reasons for the failure of standard therapy, the existence of small proportion of resistant cells which are called Tumor Initiating Cells (TICs) or Cancer Stem Cells (CSCs) appears to stand out. TICs not only self-renew themselves but also differentiate to form bulk cells thus establishing the whole tumor mass. The aim to characterization of in-depth the TIC secretome in order to identify alternative targets for GBM therapy. The secretome of TICs and their corresponding differentiated cells will be compared using label-free quantitative proteomics. The TIC specific secretome will be further validated in mouse glioma models and further a specific selected set of pro-angiogenic molecules will be characterized for their importance in sphere maintenance in vitro and tumor development in vivo. Their potential as serum biomarkers of GBM will also be investigated.

**Objectives**
- Deciphering the TIC specific secretome signature. The secretome collected from four different TICs and their corresponding differentiated cell cultures will be subjected to label-free quantitative proteomic analysis to identify a TIC specific secretome signature.
- Validation and functional characterization of selected molecules from TIC specific secretome signature. Selected molecules based on the level of regulation and literature information will be validated at the level of transcript and protein. The importance of a set of validated proteins will be studied both in vitro using neurosphere cultures and angiogenesis assays, and in vivo using an intracranial glioma model in nude mice
- Characterizing of GBM specific serum proteome signature. Using label-free quantitative proteomics.

**Pure & Applied Physics**

**INTERPLAY BETWEEN MgO OXYGEN VACANCIES AND TUNNELLING SPIN TRANSFER TORQUE**

**Background**
Spin Torque Oscillator (STO) is a nano-sized magneto-resistive device that can produce microwave signals in the GHz range as a result of spin transfer torque- a phenomenon that is receiving increasing importance in contemporary spintronics research both for fundamental spin physics as well as a number of possible microwave applications e.g., oscillator, detectors and modulators. This proposal focuses on a fundamental understanding of the spin torque magnitude in an MgO-based magnetic tunnel junction (MTJ) based STO, which is also important for applications. This proposal aims to understand the interplay between localized states introduced by oxygen vacancies within the MgO tunnel barrier and the spin torque effect. The proposal will investigate spin torque physics in MgO-based MTJs from the standpoint of oxygen vacancies in the barrier, with the aim of achieving optical control over this phenomenon.

**Objectives**
- To understand the interplay between MgO oxygen vacancies and tunnelling spin transfer torque in an MgO-based magnetic tunnel junction. In particular the aim is to understand the bias dependence of spin torque in magnetic tunnel junction based spin torque oscillator and establish relationship between optical excitation and electrical output of spin torque oscillator.
New Projects

Pure & Applied Physics

EXTREME EVENTS AND LARGE DEVIATIONS IN STRONGLY CORRELATED MANY BODY SYSTEMS

Background

The goal of this project is to study the effects of strong correlations on the statistics of rare and extreme events. There are two major questions concerning the statistics of rare events: the first one concerns a static situation where the collaborators want to compute the probability of the occurrence of a rare event in a macroscopic system. The second question deals with the temporal situation. The goal is to understand the generic behaviour of such first-passage time distributions by studying simple solvable models. To explore simple models with strong correlations, such as the Coulomb gases in confining potentials, record increments for correlated time-series (e.g., those generated by random walks) and interacting many particle systems. These are cases where it is expected that accurate numerical studies are possible and analytic methods can be developed so as to obtain physical insights and a detailed understanding of the problems addressed.

Objectives

• Probability of the occurrence of an extreme event in a macroscopic system: Main goal here is to explore simple models with strong interactions where one can study analytically the probability of a rare event. Plan to study three specific models: (i) Coulomb gas in d-dimensions in a confining potential (ii) Record increments for random walks and (iii) large deviations in interacting particle systems
• Time at which a rare event occurs for the first time in a macroscopic system; when a macroscopic system evolves in time, it is natural to ask when a rare big event occurs for the first time. An obvious example is when a big earthquake happens.

Principal Collaborators

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Orsay

EXTREME EVENTS AND LARGE DEVIATIONS IN STRONGLY CORRELATED MANY BODY SYSTEMS

MODELING SOFT GLASSY FLOW FROM MICRO TO MACRO SCALE

Background

Amorphous materials are ubiquitous around us, and their complex mechanical properties are utilized in various forms in our daily lives. The spectrum of amorphous materials range from complex fluids like emulsions, colloids and foams, to granular materials, metallic glasses etc. Despite this broad range, these materials share similar features in the way they yield, when subjected to external forces. The aim of this project is to understand the complex dynamical features during the yielding and subsequent flow of dense soft disordered materials, via a multi-scale approach, using computational and analytical techniques. Such an approach is necessary in linking macroscopic experimental observations to material’s properties at micro-scale, thereby leading to designing new materials. To develop valid descriptions across the scales involved, investigators start from the scale of individual particles, grains or bubbles, which are modelled using molecular dynamics simulations.

Objectives

• To build a coarse-grained model for dynamical response of soft disordered materials to an externally applied stress and understanding the precursors to failure in terms of spatial organisation of plasticity
• To investigate the origin of residual stress in soft glasses that remains even after the external forcing is interrupted, focusing on the transient regime leading to this locked-in state and the corresponding statistical properties
• To probe the systems' response to oscillatory shear in order to characterize the yielding process as a dynamical phase transition and study the associated spatio-temporal features

Principal Collaborators

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New Projects

**Pure & Applied Chemistry**

**METAL CHELATORS DERIVED FROM IMIDAZOLE THIONES AND SELONES FOR DETOXIFICATION**

**Background**

It is proposed to develop innovative molecules efficient for metal detoxification, especially for Cu(I) and Hg(II) but also Cd(II), Pb(II) and Zn(II), by combining the expertise and knowledge in heavy metal detoxification. Several tripodal chelators functionalized with N-imidazole based thiones/selones will be developed to detoxify various heavy metals. High concentrations of copper are deleterious as it potentially damages cells, proteins, lipids, and nucleic acids by producing reactive oxygen and nitrogen species through initiation of Fenton-like reactions. Thus, the intracellular copper concentration needs to be controlled strictly so that it does not reach toxic levels. The main objective in this project is to use the novel tripodal ligands, developed in the first part of this project, to clear Cu(I) from hepatic tissue by targeting selectively hepatocytes using targeting units specific to the asialoglycoprotein receptor (ASGP-R), a hepatic lectin that is chiefly expressed at the surface of these cells. The most efficient tripodal ligands for Cu(I) will be functionalized with clusters of sugars already identified and synthesized by Delangle et al in order to obtain chelators able to enter liver cells, namely hepatocytes.

**Objectives**

- Imidazole based thiones and selones: synthesis and metal coordination
- Tripodal ligands derived from imidazole based thiones and selones: synthesis and metal coordination
- Targeting to hepatocytes for Wilson Disease: coupling with targeting units and cellular studies

**Principal Collaborators**

- Gouriprasanna Roy
  ShiV-Nadar University, Uttar Pradesh
- Pascale Delangle
  CEA Centre de Grenobles Grenoble

**Earth and Planetary Sciences**

**IMPACT OF THE INDIAN MONSOON CONVECTION ON THE TROPICAL TROPOPAUSE LAYER AND CLIMATE**

**Background**

The Tropical Tropopause Layer (TTL) is the gateway which processes the convective air, including anthropogenic pollution, and controls the composition of the stratosphere. Due to this role and the radiative effects of its ubiquitous cirrus clouds, the TTL is a key component of the climate system. During summer, it is mostly under the influence of the Indo-Asian monsoon. The distribution of ground sources and the transport properties across the TTL are still poorly understood. The project takes the opportunity of new observations, by the airborne StratoClim campaign in 2016, and by new satellites and the expertise of the two partners in modelling to advance our understanding of the processes ruling the composition of the TTL and the paths of air parcels going through. The project will use Lagrangian modelling to explore the paths of air within the TTL, with an emphasis on the role of small-scale dynamics and a meso-scale model with chemistry to map the intensity of the sources and the generation of ice clouds and aerosols. The satellite observations will be used to characterize the distribution and the physical properties of the cirrus and will be linked to the sources by Lagrangian transport.

**Objectives**

- To study the impact of the Indian Monsoon on the composition of the tropical tropopause layer which in turns controls the composition of the stratosphere and has strong climate impact.

**Principal Collaborators**

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Materials Science

BIODEGRADABLE CORE SHELL ELECTROSPUN MATS AND INTERCONNECTED POROUS SCAFFOLDS FOR TUNABLE ANTICANCER DRUG DELIVERY AND TISSUE ENGINEERING APPLICATION

Background
Unfortunately, the treatment methods of cancer also targets the fast growing normal cells and causes serious side effects such as metabolic imbalance, kidney damage, nausea etc. Hence researches are focused towards the targeted drug delivery using nanocarriers such as liposomes, micelles, and microsphere. Such systems unable to provide high drug loading efficiency and exhibit initial burst release which damages the normal cells in the gastro intestinal tract. Electro spun mats and interconnected porous scaffolds are the best alternate to overcome these difficulties due to: (i) a high drug loading efficiency, (ii) a tunable delivery of drugs and biomolecules, (iii) a high surface area, and (iv) the possibility to fabricate scaffolds with different shapes. Hence controlling and understanding the release of anti-cancer drugs and biomolecules using the electrospun mats is a focused area to achieve high therapeutic effect.

Objectives
• Extraction of biopolymer and achievement of a sustained drug release
• Engineered of the scaffolds using various technique like electrosinning and porogen assisted freeze drying technique.
• Control the initial burst release
• Achievement of high therapeutic effect by loading multiple drugs in the same system.
• Study of the pH effect and the release kinetics; Cancer cell death and proliferation

Principal Collaborators
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Materials Science

STUDIES ON THE TOPOLOGICAL INSULATOR BEHAVIOUR IN HEAVY METAL BASED TERNARY CHALCOGENIDES

Background
Topological insulators (TI) are fascinating quantum materials which are characterized by an insulating bulk and a conducting surface. The topological surface state is protected by time reversal symmetry and it is robust against scattering from non-magnetic scattering. They are expected to be useful for various applications including high frequency electronics, transparent electrodes, spintronics, and quantum computations. The main objective of this proposal is to synthesis of novel and theoretically proposed TI materials. The investigator propose the probability of new compounds and discover them using different synthesis strategies. After understanding the probable TI behaviour in these ternary compounds by theoretical calculations, it will be experimentally realized by temperature and pressure dependent XRD, Raman and Hall measurements on the polycrystalline samples. Investigators also try to grow the single crystals of the promising compounds by Bridgeman or vapour transport or even flux methods for the Angle resolved photo emission spectroscopy (ARPES) measurements. The project will be extended to further level with the possibility of doping heavy metals to tune the TI behavior.

Objectives
• Synthesis and crystal growth of known and novel heavy metal based chalcogenide having zero/narrow band gap at the Fermi level.
• Experimental realizations of the topological insulator behavior using high pressure XRD, RAMAN, resistivity and Hall measurements.
• Direct observation of the surface states by Raman and Angle resolved Photo Electron Spectroscopy (ARPES) Techniques.
• Electronic structure calculations will be performed to understand the band inversion and comparison between the experimental data.
• Examination for isostructural Electronic Topological Transition under high pressure by Raman scattering and Hall effect under pressure.

Principal Collaborators
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5. Brief Reports of Research Projects

B. High Impact Scientific Research Network Programme
CEFIPRA has been traditionally associated with bridging of individual scientists of two countries in collaborative mode. A rich plethora of scientists and scientific groups are well networked. In 2014, after 27 years of inception of the Centre, in order to harvest the strength of the network and as per the directive of the 27th meeting of the Governing Body held in March 2014, CEFIPRA launched first call on High Impact Scientific Research Network Programme in all the areas of interest in Science & Technology between India and France. The following two proposals were selected for support under the programme:

**INTERNATIONAL STUDY ON A TYPICAL HEMOLYTIC UREMIC SYNDROME**

**Principal Collaborators**

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St. Johns Medical College, Bangalore  
Armed Forces Medical College  
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BL Kapoor Hospital, New Delhi  
Christain Medical College, Vellore  
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Fortis Hospital, New Delhi  
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Aditi Saha, Uma Kang, Pankaj Hari, Amit K Dinda, Priyanka Khandelwal  
Debasis Dash

**Network**

**French laboratories**  
PH dans le service Laboratoire de Serologie-Virologie Dijon et Laboratoire Analyse et Modelisation pour la Biologie et l’Environnement at Université Evry-Val-d’Essonne, Evry.

**Indian laboratories**  
All India Institute of Medical Sciences, National Institute of Immunology and Institute of Genomics & Integrative Biology, New Delhi.

**Background**  
A clinical research on Hemolytic Uremic Syndrome (HUS), one of the commonest causes of acute kidney injury in children, is a multifactorial illness, determined by environmental factors that damage the endothelium and intrinsic factors that favor disease progression. Both centers in Paris and New Delhi are involved. It is proposed to establish a network of scientists and clinical researchers in the two countries involved in a clinical research on Hemolytic Uremic Syndrome for compiling and exchanging clinical and biological data of French and Indian patients that would enable phenotyping and follow up data of the cohort, epidemiological analysis and identify triggers of the disease.

On the medium term, the collaborative network shall improve our understanding of the pathogenesis of this disease and the reasons for variable prevalence of the disease. A precise knowledge of the etiology and outcomes of HUS is necessary to enable an understanding of the mechanisms of disease and impact of therapies, as well as improve outcomes by timely management. There is limited knowledge of underlying complement abnormalities among Indian patients with HUS. Tests for screening of complement regulatory proteins are only partially available. A comprehensive evaluation of complement regulatory proteins and documentation of clinical features and outcomes in relation to therapies are essential initial steps towards determining the etiology, pathogenesis and outcomes of HUS. The network shall enable complementary research on the pathogenesis and functional relevance of anti-CFH antibodies in patients with atypical HUS, and improved understanding of this rare disease.

**Knowledge Generated**

- Designing CRF; database Anonymized data entry Integration between centres
- Written protocols for biorepository -20 C, -80 C; cryopreservation facilities; Link to database; Sample storage (250+ specimens); Shipment
- PCR for shigatoxin Surface activity of CFH CFH-anti CFH complexes
- Estimating terminal MAC Epitope specificity antibodies Real time, end point PCR CFHR1
- One CME annually: Fellows, paediatricians & nephrologists
- Consensus development meeting for guidelines for management
High Impact Scientific Research Network Programme

INDO-FRENCH HIGH ENERGY PHYSICS NETWORK


Principal Collaborators

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Network

French laboratories
LAPTh - Annecy, IPhT-CEA-Saclay, LPT-Orsay, CPhT-Polytechnique, LPSC-Grenoble and IPN Lyon from France

Indian laboratories
Indian Institute of Science (IISc) including the Indian Institute of Mathematical Sciences (IIMSc), Tata Institute of Fundamental Research (TIFR) including Indian Institute of Science Education and Research-Pune (IISER-Pune), Harishchandra Research Institute (HRI) including Delhi University, Saha Institute of Nuclear Physics (SINP) including Indian Institute of Science Education and Research-Kolkata (IISER-Kolkata) and the Indian Association for the Cultivation of Science (IACS), Kolkata.

Background

This NETWORK involves a large fraction of the best experts in the theory, phenomenology and experimental high energy physics in both countries. This first group of laboratories could, in the future, open up to other laboratories in France and India.

The success of the Large Hadron Collider (LHC) has been as admirable as the triumph of the Standard Model (SM), of the fundamental interactions. The SM can now be elevated to the status of a fully-fledged theory. Indeed, the 7-8 TeV runs of the LHC confirmed the existence of what looks like the Higgs particle, the last missing entry of the theory and a cornerstone for the concomitant mechanism of electroweak symmetry breaking. This crowning is also deserved because the theory has been for some time practically on par with the theory of quantum electrodynamics in allowing for very precise predictions to be made. Yet, the fundamental dilemma with the formulation of the symmetry breaking mechanism and the existence of an elementary scalar particle, the Higgs, is even more persistent now. This is related to the so-called naturalness problem which is made more acute if one admits that the SM-theory is only part of a more complete theory. Dark Matter, for which there is overwhelming evidence, is one example of New Physics that should be described by this more complete theory. With present data, the LHC has not provided any evidence for New Physics, either through the discovery of new particles or through discrepancies with the SM-theory predictions.

The project will underline specific directions where there is added value and pooling of resources and expertise will be an advantage.

Knowledge Generated

During the period, the organization of the network has really stabilized and many other working groups have also started on collaborations.

i) Excellent quality research has emerged during the past few months because of the collaboration, some of which could have long-standing implications on the field. One such example is the set of newly proposed techniques for discovering new particles at the LHC.

ii) The total number of publications during this period is thirteen with explicit acknowledgements to CEFIPRA.

iii) The total number of visits from France to India have been 3 out of remaining 13 with one more planned in the later part of year 2017. Four visits out of 20 from India to France have taken place during this period.
GROUP FARMING AND COLLECTIVE ACTION

Principal Collaborators

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Background

This project is based on the premise that agricultural productivity and ecosystems conservation depend not only on the technical aspects of science and innovation, but also critically on the institutional structure of production. India (like much of the developing world) is characterized by millions of small family farms facing severe constraints in access to land (80% cultivate land is under 2 hectares), water, other inputs, credit, information and markets.

To revitalize agriculture and promote sustainable livelihoods and food security, we need institutional innovation—one that will help small farmers overcome production constraints, adopt new technologies, tap market opportunities and tackle climate change. Can group farming, with resource pooling and cooperation among farmers provide an answer?

This rather unique project uses a cross-learning approach to study the potential of group farming which has taken different forms in France and India. In particular, it seeks to research the long-standing (but little studied) French model of GAECs (Groupement Agricoles’ Exploitation en Commun)—through a primary survey as well as secondary data analysis, to identify the factors underlying the success and sustainability of GAECs, and to evaluate what features could be adapted India to strengthen and expand existing initiatives here. The Indian PI’s ongoing research on group farming in India will provide comparative lessons for theory and practice. In addition, the study will seek to identify features of GAECs which could have policy relevance for French agriculture. In this way the project will provide insights for both French and Indian farming futures and will also be of interest for on-going debates about the future of agricultural cooperatives in other parts of the world.

Objectives

The objectives of this research are as below:
1. To study GAECs in depth—their histories, functioning, design principles, production systems, the challenges they face, technical efficiency, & contribution to farmer welfare, in order to draw lessons for Indian agriculture (and other developing countries in similar situations).
2. To use our understanding of GAECs for the benefit of French group farms, by identifying which features of the model work well and which may need modification with changing social, demographic & economic conditions.
3. To examine and explain regional variations GAEC concentration and the type of farm activity they focus on—intensive livestock vs. mixed crops. This can also throw light on which contexts are more conducive to cooperation and group farming than others.
4. To compare the French model of group farming with somewhat different models in India, e.g. Telangan & Kerala that the Indian Principal Investigator (PI) has researched.
5. To contribute to collective action theory by identifying what makes for enduring cooperation in agricultural production, by comparing diverse GAECs (family or non-family; type of farm activity (milk, meat, crop) etc., within France.

Knowledge Generated/Product Developed

1. An interdisciplinary survey of a sample of 60 GAECs & control sample of individual farms in two departments of France—Ain & Saône-et-Loire
2. Survey data has been gathered on GAECs across 3 activity categories (milk, meat and crops), based on a carefully selected sample of 60 functioning GAECs and a complementary sample of individual family farms.
3. Capacity building of young French scholars.
Brief Reports of Research Projects

C. Industry Academia Research & Development Programme
**Completed Projects**

**FINANCIAL-INCLUSION BASED UPON RURAL MOBIQUitous SERVICES TECHNOLOGICAL PLATFORM**

**Domain: Computer Science**  
**Sept. 2012 to Jun., 2015**

**Background**

Financial exclusion has been a major problem for India and other developing countries with most of the rural population excluded from banking and other financial services. In India, Government has taken major initiatives for 'Bottom of Pyramid' to use smartcards in the Rural Inclusion scenarios like FI (Financial Inclusion), PDS (Public Distribution System), RSBY (Rastriya Swathya Bima Yojana – insurance scheme) and NRGEA (National Rural Employment Guarantee Act). However success of such initiatives largely depends on the selected technology and presence of an integrated platform/ecosystem. At the same time, with all struggle Government is aggressively pursuing unique identification program (UIDAI) for citizen of India which is valid for his/her life. The unique identification program has a strong impact on the security and accountability of all services offered by Government and all other sectors like Banks, Private/Public organization. But, all of the noble initiatives are facing the following serious problems to be sustainable in future.

1) Implementations of the initiatives in silos  
2) Right business model, technology and infrastructure to reach rural community  
3) Lack of integrated common security and accountability infrastructure  
4) Lack of adequate standards and ecosystem  
5) Need of very high capital and operational cost

**Objectives**

The primary objective of FIRST Project is to develop a unified and integrated platform as well as to create/offer a sustainable ecosystem having variable business models with low-cost, secured services involving Banks, MNOs and other stakeholders to support rural initiatives in India. To demonstrate FI and PDS scenario using FIRST platform, which can be taken to next level in addressing the digital initiatives in India

**Knowledge Generated/Products Developed**

- **FIRST Rural Integration Hub**  
  - Central component of the FIRST platform  
  - Robust and secured messaging by TCS' DMSI platform.  
  - Provides simplified Portal for service integration, service mapping, device management

- **FIRST Mobile App Store and Remote Management System (RMS)**  
  - A common cloud based storage for all FIRST mobile Apps.  
  - Manages Apps lifecycle.

- **TSM for Secure Element (SE) Management:**  
  - Gemalto’ Trusted Service Manager (TSM) for managing applications and services on Secure Elements (SE).  
  - UNS’ WOLF library from UNS to access to SE.

- **Financial Inclusion with VM/Virtual Coins**  
  - Offers easy banking services for the unbanked people and  
  - Provides a small community money exchange ecosystem based on virtual coins eliminating the need of any physical cash.

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**Indian Partners**

- **C. E. Veni Madhavan**  
  **Indian Institute of Science**  
  **Bangalore**

- **Sundeep Oberoi**  
  **Tata Consultancy Services**  
  **Mumbai**

- **Debi Prasad Pati**  
  **Tata Consultancy Services**  
  **Kolkata**

**French Partners**

- **Serge Miranda**  
  **Université de Nice Sophia Antipolis**

- **J. P. Tual**  
  **GEMALTO**  
  **Paris**
• Rural Services (FI, RSBY, NAREGA, PDS etc) with Virtual Coins

   Rural Services like Financial Inclusion with virtual coins offers multi-fold benefits to the rural population. Firstly, it offers easy banking services for the unbanked people and secondly it provides a small community money exchange ecosystem based on virtual coins eliminating the need of any physical cash. As part of the virtual coin integrated FI solution, Android mobile applications have been developed for bank agents, FI beneficiaries and merchants for coin exchange and other banking transactions.
Ongoing Projects

TILLING IN CUCURBITS: A NON-TRANSGENIC REVERSE GENETIC APPROACH FOR MUSKMELON CROP IMPROVEMENT


Background

Experts predict that we will need to double food production in order to feed a global population projected to reach 9.7 billion by 2050, nearly 1.7 billion in India alone. Furthermore, it is forecast that India will overtake China as the world’s most populous country by 2030. Food security is now threatened globally by climate change, increased demand, unstable production, post-harvest losses and volatile prices as well as an impending shortage in oil production due to declining reserves. It is, therefore, imperative for the country to begin work on adopting new technologies in agriculture for ensuring that its people have enough food to eat. In a recent 2016 report it has been shown that about maximum post-harvest losses occur in India for vegetable and fruits (16%) valued at Rs 40,811 crore ($6 billion). Till date LSL melons are not commercialised in India unlike in France. However considering the losses incurred in the field, in transit and on storage, there are significant benefits of LSL trait in melons. Furthermore, this trait will also allow export of melons to the Middle East from India.

Objectives

- Creation of EMS-mutagenized mutant collection from NSL Lines (NSL+BBIO)
- DNA extraction from 6000 M2 families (BBIO)
- Detection of mutants in the LSL (Long Shelf Life) gene (INRA)
- Phenotypic evaluation of mutants, Trait integration and commercial product development (NSL)
- The NSL910 mutant population carried low mutation frequency hence the DNA was not screened for LSL trait. Instead of NSL910, we screened the French Charnetais mutant population. This was informed to CEFIPRA in Sept 2014 (25th Progress report).

1. 3000 M2 plants in NSL910 was completed for LSL trait screening. DNA extracted from a 3000M2 families
2. 3300M2 plants in second variety NSL5 completed for Gynoecious trait screening. DNA extracted from 3300 M2 families
3. The French PI created 6352 M2 in a French variety Charantais in France. DNA was extracted by the French PI lab
4. Screening of the French muskmelon population (6352 M2s) was done by the post-doc successfully at URGV lab for Four LSL genes.
5. Mutants (9 mut +9 Wild type) from one of the candidate genes (Gene5) has been transferred to NSL.
6. Backcrossing of LSL mutant (Gene 5) ongoing at NSL to transfer the trait to NSL line

Knowledge Generated/Products Developed

1. 3000 M2 plants in NSL910 was completed for LSL trait screening. DNA extracted from a 3000M2 families
2. 3300M2 plants in second variety NSL5 completed for Gynoecious trait screening. DNA extracted from 3300 M2 families
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Indian Partners

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Uday Singh
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French Partner

Abdelhafid Bendahmane
Institut national de la recherche agronomique (INRA)
Paris

Gynoecious muskmelon line creation by TILLING the G gene

Tilling of flower sex genes in Melons
Ongoing Projects

ADHESIVE BOND INSPECTION TECHNIQUE DEVELOPMENT USING ELECTROMAGNETIC ACOUSTIC TRANSDUCER (EMAT) FOR AEROSPACE COMPANY

Domain: Aerospace  Apr. 2014 to Apr. 2019

Background
Light-weighting considerations have led to increased use of composites in aerospace components, with consequent rise in adhesively bonded structural joints. While there is much interest in guided waves for rapid inspection of large structures from single transducer location, in an immediately preceding project the PIs showed much promise for Shear Horizontal (SH) waves for inspection of bond quality. This project aims to evaluate the advantages of using SH guided waves and Electromagnetic Acoustic Transducers (EMATs) for characterization of structural bondings in aerospace components. Wave interactions with bond defects is sought to be understood first, in order to achieve a method to detect poor bonding.

Objectives
- Understanding SH guided wave behaviour in composite lap joints
- Design EMAT sensors adapted for composite lap joint
- Obtain experimental result on metallic and composite lap joints

Knowledge Generated/Products Developed

Simulation of guided waves in single and Lap-joined metallic plate structures using Finite Element (FE) models
- FE simulation study of guided wave propagation in isotropic solids completed
- First simulation studies of Lamb and SH-guided wave interaction with epoxy adhesive layer in Al-Al lap joint completed
- Model dimensions and material properties as relevant to samples given by AIRBUS

Simulation of Lamb waves in single and Lap-joined plate structures using Spectral Finite Element (SFEM) and 3D Finite Element (FE) models
- Detailed literature survey and SFEM formulation for SH wave propagation in metallic structures
- Validation of SFEM results using conventional FEM ongoing: PhD student learning FE simulation for better coordination with IITM
- SFEM model formulation and validation for composite plate structures ongoing
- Metallic specimen samples manufactured; Reference / Double thickness / Not sanded / Polluted
- Obtain a model helping to design EMAT sensors adapted for composite lap joint
- Obtain a theoretical model for understanding of the SH behaviour in composite lap joints
- Obtain experimental result on metallic and composite lap joints
Industry Academia R&D Projects

Ongoing Projects

DEVICE-TO-DEVICE D2D COMMUNICATION FOR LTE ADVANCED CELLULAR NETWORKS

Domain: Telecommunication  Apr. 2015 to Mar. 2018

Background

Information-theoretic analysis of Device to Device (D2D) and cellular communications has recently gained considerable attention as it lays out the fundamental limits of D2D communications. A related body of literature aims at characterizing the fundamental limits of communications under the spectrum overlay model in cognitive radio communications. In this model, a primary transmitter non-causally shares its messages with a secondary transmitter, and, in return, the secondary transmitter ensures that its message causes no loss of rate to the primary transmitter. Such studies aim at characterizing the maximum data rates or capacity region that can be achieved over networks that employ D2D communication.

The Device to Device paradigm considered by both academia, industry and 3GPP standards to handle the next LTE evolution use cases, and lead to future novel wireless applications for proximity services, content sharing, distributive storage, multiparty gaming, monitoring and control of cyber physical systems. D2D changes the cellular architecture by allowing two devices to communicate directly when in proximity of each other. It also has the added advantage of being supported by control and coordination functions implemented by eNodeBs and the core network.

Objectives

- Design and performance evaluation of dynamic centralized and distributed opportunistic spectrum allocation and sharing mechanisms for D2D in LTE-Advanced networks
- Derive the fundamental achievable rates of D2D communications when the eNodeB is D2D-aware
- Design of signal processing algorithms to facilitate D2D communications, such as beam-forming vector design and fast spectrum sensing for intra-cell resource scheduling
- Develop algorithms for peer and link discovery protocols for D2D communication in LTE-Advanced, and evaluation of the signalling overhead vs. throughput trade-off
- Propose new versions of Mobile Ad-hoc Networks (MANET) protocols such as Optimized Link State Routing Protocol (OLSR) for D2D multi-hop communications
- Devise Relaying, Cooperation and self-organization strategies for heterogeneous networks using distributed computations over networks

Knowledge Generated/Products Developed

- Online matching algorithms for both homogenous model (no distinction between cellular and D2D nodes) and heterogeneous model (D2D nodes are only help providers and not help seekers) that match a D2D user on its arrival with one of the cellular/D2D users that has not been matched before
- Pricing mechanism for D2D association developed that are truthful and have constant performance gap from the optimal
- Developed a visualization tool for demonstrating the throughput improvement achievable in D2D enabled networks. Displayed the tool at the open day at IISc and at the May 2017 project review meeting
- Developed online and offline algorithms for user trajectory optimization with theoretical guarantees
- Develop a new resource allocation algorithm for joint scheduling, rate adaptation, and mode selection by the BS when it has very limited information about the instantaneous channel conditions in the cellular system
- Extended the D2D routing algorithm to the case where there is a delay constraint on the relays

Indian Partners

- Rahul Vaze  Tata Institute of Fundamental Research  Mumbai
- Ketan Rajawat  Indian Institute of Technology  Kanpur
- Neelsh B. Metha  Indian Institute of Science  Bangalore

French Partners

- Chandra R. Murthy  Indian Institute of Science  Bangalore
- Michele Wigger  Telecom Paris Tech  Paris
- Cedric Adjih  Institut national de recherche dédié aux numériques (Inria)  Pairs - Rocquencourt
- Paul Muhlethaler  Institut national de recherche dédié aux numériques (Inria)  Pairs - Rocquencourt
- Amira Alloum  Alcatel Lucent Bell Labs France (ALBLF)  Nozay (Now: Nokia Bell Labs  Nozay)
- Marceau Coupechoux  Institut Mines-Telecom  Telecom Paris Tech  Paris
**Ongoing Projects**

**INDIRA_B: INDICATORS OF RELIABILITY AND VARIABILITY OF BRT**

**Domain: Automobile**  
**Jan. 2016 to Dec. 2018**

**Background**

The sustainable development of cities depends on developing safe and low-carbon transport systems which provide access to the required goods, services and activities for all citizens. An efficient public transport system helps meet the mobility needs of a city, using fewer financial and energy resources, compared to private vehicle-oriented mobility. It also helps in improving the public health and well-being of inhabitants by reducing pollution and improving safety on roads.

Bus systems form the backbone of public transport system in Indian cities. Most Indian cities have low per capita incomes and vehicle ownership rates. As a result, usage of personal cars and two-wheelers is still prohibitively expensive for large sections of the society, who rely on public transport (Census 2012a). Modern bus systems require efficient management of bus operations, fleet management and serving the needs of bus commuters. This is based on analysing bus operation data and developing performance measures which can benefit the operators, policy makers and bus commuters. Therefore the focus of the current project is to assess some of the existing well known quality-of-service indicators, and to develop new ones.

**Objectives**

- The objective is to assess some of the existing well known quality-of-service indicators, and to develop new ones.
- To develop a computer-based research tool consisting of different modules which could be integrated into an operational platform for analysis and diagnosis of the quality of service of BRTS/ bus systems lines in different operational use.
- To design a bus fleet "supervision cockpit” for both operators and public transport authorities, and to set up the ClaireSiti platform on the Indian data (Delhi data)

Revised objectives, if any: Focus on bus system instead of BRTS/buses moving on exclusive lane.

**Knowledge Generated/Products Developed**

- Development of new indicators.
- Exploratory analysis of AVL data and ETM data from 35 routes in Delhi
- Offline interface between the ClaireSITI platform and DIMTS data (sample routes)
- Two workshops-Delhi, Paris
- 25 bus route data shared by DIMTS with more complete information
- Estimation of travel time from AVL data and passenger volumes from ETM data for 25 routes in progress
- Preparation of OD matrix from ETM data in progress
- Interface between ETM data and the Claire-Siti platform and matching the two data bases networks (AVL and ETM)
- Implementation of the ETM data within the bus cockpit (boarding, alighting, bus loading)
- Analysis of the 25 bus regularity with classical indicators (speed, headway, delay) and new ones (Headway adherence, Gini index and Lorenz curve, travel time reliability, and headway reliability)
- Understanding resilience of bus network if routes/links/bus stops don’t function and alternates have to be used

**Indian Partners**

- **Geetam Tiwari**  
  Indian Institute of Technology  
  Delhi

- **Neel Paliwal**  
  Asso. Vice President – IT  
  Delhi Integrated Multi-Modal Transit System Ltd., Delhi

**French Partner**

- **Neila Bhouri**  
  IFSTTAR  
  Marne la Vallée

Cockpit replay Demo
Industry Academia R&D Projects

Ongoing Projects

INNOVATIVE WHEEL DRIVE TO ENABLE WIDESPREAD ELECTRIC BICYCLE TRANSPORTATION

Domain: Automobile | Jan. 2016 to Dec. 2018

Background

With massive urbanisation trends that are recently witnessed in India, it is estimated that demands on urban infrastructure and urban services including transportation would continue to rise. As public transport system is barely adequate to meet the needs of burgeoning urban population, dependence on private or individual means is more dominant than ever before. With more than 60% of urban population falling under the categories of middle class or lower middle class, the use of two wheelers continue to grow with consequential impacts of higher consumption of fossil fuels and debilitating environmental effects. Increased use of electric vehicles, to be particular electric bicycles can offer one of the potential solutions. Incidentally the uptake of electric bicycles has been severely hampered by the following issues.

Objectives

The design and development of innovative wheel drive for electric bicycle and wheel chair. The Automotive Industry Standards Committee of India limits the speed of electric bicycles to 25kmph for licence free riding. Hence the top speed for the Indian prototype is revised from 35kmph to 25kmph, which will be realised by installing an electric limiter.

Knowledge Generated/Products Developed

1. a) Primary deliverable:
   6 prototypes of industry grade wheel drive (500 W / 150 rpm) with inherent design modularity and versatility and design modularity. The power electronics has a plug and play system added with readily programmable architecture by adding a JTAG –USB converter circuit

   b) Secondary deliverable:
   (i) Two prototypes of electrical power assisted bicycle (Maximum speed of 30 KMPH using the designed wheel drive

   (ii) Two prototypes Electrical power assisted wheel chair using the designed wheel drive

2. Analyzed the steady state & dynamic Parameters of electric motor and drive system in System Level Concept Design

3. Fundamental Design of electric motor parts was achieved using CATIA Software

4. Design and simulation of electronics circuit for power control and battery management system was developed

Price negotiation for CNC Vertical Machine centre completed and the Lab setup was done by partial procurement of consumables required for the proposed system

Indian Partners

P. Sarasu
Director R&D
Vel Tech Dr. RR & Dr. SR Technical University,
42 & 60, Avadi – Vel Tech Road, Avadi, Chennai

Chandan Bhattacharjee
M/s. Turnpoint Technologies Private Limited
New-Delhi

Makarand Joshi
M/s. Joshi Electronics & Electicals Private Ltd.
Pune

French Partners

Jean Claude VANNIER
Département Électrotechnique,
Centrale Supélec, Gif-sur-Yvette

Francois Bernot
FranceCol Technology,
ZA Grande Neuve, 37230, Luynes
5. Brief Reports of Research Projects

D. Targeted Programmes
Under DST- ANR targeted programme, total six projects are ongoing. In the first call, four projects in areas of Infectious Diseases and Engineering Sciences while in second call, two projects in areas of Neuroscience and Engineering Sciences have been supported.

**DENSE PARTICULATE SYSTEMS**

**Feb. 2014 to Dec. 2017**

**Background**

The project concerns the rheology of particle-fluid suspensions and dry granular materials, in the regime where the particle and fluid inertia play no role. A principal objective is to bridge the descriptions between the fluid-dominated Stokesian suspension and the contact-dominated granular medium. The collaborator’s aim to quantify the extent to which the fluid and contact play role in the rheology of suspensions and saturated granular materials. The Principal Collaborators will address this problem by using the unconventional experimental tools that they have developed using particles of controlled rough and stiffness, and by computations. Other objectives are to attempt to answer some open questions, such as what are the normal stress differences in dry granular materials?; how does the rheology depends on the particle roughness; and how do microstructural features vary between dense suspensions and dry granular materials? Answers to these will lead to a fundamental understanding of the rheology of particulate materials, and thereby more accurate constitutive models.

**Objectives**

- To study the rheology and dynamics of dense particulate systems with and without a viscous interstitial fluid, and understand the relation between the particle-scale properties and the macro scale response

**Knowledge Generated/Products Developed**

- Dry granular flows
- Particle-liquid suspensions
- Synthesis and characterization of soft microspheres
- Synthesis of rough microspheres
- Rheological experiments of experiments in a yield stress fluid

**Principal Collaborators**

- **Prabhu Nott**
  
  Indian Institute of Science
  
  Bangalore

- **Elisabeth Guazzalli**
  
  Aix-Marseille Univ., CNRS
  
  Marseille

**Publications**

- No. of publications in SCI journals: 4
- No. of papers presented in conferences: 10

**Mobility Support**

- India to France: 2
- France to India: Nil

(a) Schematic of the cylindrical Couette apparatus. The granular (glass beads) is in the annular gap between the two coaxial cylinders.

(b) Image of the free surface of the granular material. Each bright spot represents a glass bead.
**UNRAVELLING NEW FUNCTION FOR H-NS FAMILY OF PROTEINS IN GRAM NEGATIVE BACTERIAL PATHOGENS**

**Objectives**

- Investigation of virulence regulation by H-NS and Ler proteins through analysis of nucleoprotein complexes and gene transcription at AFI and LEE pathogenicity islands and control genomic loci.
- Identification of RNAs from enteropathogenic *E. coli* and *E. coli*K-12 that specifically bind to StpA, H-NS, and Ler homomeric and heteromeric complexes, and characterizing their role in transcriptional and post transcriptional gene regulation.
- In vivo and in vitro delineation of the roles of H-NS family proteins in modulation of Rho dependent transcription termination.

**Background**

This project aims at unravelling the molecular mechanisms underlying essential aspects of regulation in bacteria by proteins of the nucleoid associated H-NS family in the context of enterobacterial virulence. The family members include H-NS, StpA, Hha, YdgT, and the pathogen specific Ler protein, which will be examined for (i) silencing of genes that are encoded by bacterial pathogenicity islands, (ii) binding to specific sequences in DNA and RNA in mediating nucleoid structure and gene regulation at the transcriptional and post transcriptional levels, and (iii) modulation of the process of Rho dependent transcription termination by formation of polymeric scaffolds on DNA and/or RNA. It is expected that these studies will help illuminate the mechanisms by which the H-NS protein family acts as pleiotropic regulators of adaptation of bacteria to different environmental conditions and of bacterial pathogenesis in humans and other mammalian hosts.

**Knowledge Generated/Products Developed**

- Demonstrated for the first time directly that the proteins Ler and H-NS share similar specificities for binding to DNA, and that the antagonistic effect of Ler against H-NS action is likely to be related to the former’s subtly different mode of binding to the DNA motifs recognized by H-NS
- Presence of Ler and H-NS proteins are necessary to observe a novel bimodality in the cell population relating to expression of the LEE operon.
- RNA-Seq experiments indicate that the proteins H-NS, StpA and HU, all of which are well described as DNA-binding proteins, can also bind specific species of bacterial RNAs.
- H-NS inhibits transcription in vitro in Initiation + Elongation and Elongation only assays, and several dominant-negative H-NS variants including L26P, I119T and Δ92 reverse this inhibition. H-NS Δ64 and Hha proteins by themselves inhibit transcription in vitro, perhaps through an auto inhibitory domain. The effects of H-NS and its variants on Rho-dependent transcription termination in vitro are also being tested.
- RNA-Seq experiments have been undertaken to test and to validate a novel hypothesis that the potential extent of antisense transcription in bacteria is being underestimate because of both Rho-dependent transcription termination and by the generation of R-Loops from the nascent untranslated transcripts.

**Principal Collaborators**

- **J Gowrishankar**  
  Centre for DNA Fingerprinting & Diagnostics, Hyderabad
- **Sylvie Rimsky**  
  Dynamique des chromosomes, Centre Interdisciplinaire de Recherche en Biologie (CIRB), College de France, Paris

**Publications**

- No. of publications in SCI journals: 2
- No. of papers presented in conferences: 1

**Mobility Support**

- India to France: 2
- France to India: 1
COMPLEX OXIDE NANO-CRYSTALLINE SYSTEMS FOR CHEMICAL SENSORS

Apr. 2014 to May 2017

Background
The project is on complex oxide systems including spinel ferrites and their response towards sensing low reactive gases like CO₂. The work done include working with sensors of various forms including pellets made from nano crystalline powders, thick films prepared by screen printing and tape casting (using double doctor’s blade) and thin films deposited by RF sputtering and PLD. This project also aims to probe in to the sensing mechanisms in order to understand the reasons for the reactivity of certain metal oxide systems to specific gases. It aims to improve the performance of chemical sensor in terms of sensitivity, selectivity and stability. The interest will also be to reduce the response time, recovery time and the operating temperature of the sensor.

Objectives
- To find suitable combination of semiconducting metal oxide composite materials comprising of iron containing nanocrystal line spinel ferrites (e.g. Mg ferrite and Ni ferrite in conjunction with oxides like copper oxide) which may work as sensors for the detection of low reactive gases like CO₂
- To minimise the response time, recovery time and operating temperature for such sensors
- To improve the sensitivity of complex oxide nanocrystalline sensors towards through systematic experiments on the chosen systems CO₂ and other reducing gases e.g. ethanol vapour and hydrogen.
- To improve selectivity towards certain gas species

Knowledge Generated/Products Developed
Gas sensing device made from fresh zinc ferrite nano powder which was annealed at 800°C showed 40% response at the operating temperature of 300°C towards 5000 ppm of CO₂. Degradation of response towards CO₂ gas of the zinc ferrite samples might be recovered by the calcination at 800°C. The change in resistance of the zinc ferrite sensor sample during CO₂ sensing, might be due to carbonate formation. The FTIR absorption peaks around 1350 cm⁻¹ and 1520 cm⁻¹ of asymmetric vibration (3) of –CO₃ band was observed in the sample which was treated with CO₂.

Principal Collaborators
D.N. Ventakata Ramani
Indian Institute of Technology- Bombay
Mumbai
Antonie Barnabe
Université Paul Sabatier - Toulouse III
Toulouse

Publications
- No. of publications in SCI journals : 2
- No. of papers presented in conferences: 1

Mobility Support
- India to France: 3
- France to India: 1
Targeted Programmes

SOLUBLE MEDIATORS OF THE HOST INNATE IMMUNE SYSTEM AGAINST ASPERGILLUS FUMIGATUS

Objectives

- To decipher the influence of *A. fumigatus* morphotypes and their cell wall components on the activation of the soluble mediators of the immune system
- To analyze the role of *A. fumigatus* secreted proteins on the complement system and collectins and antimicrobial peptides
- To study the antifungal effect of host defense (antimicrobial) peptides, alone or in combination with other drugs

Knowledge Generated/Products Developed

- *fumigatus* secreted metalloprotease, Mep1p, is capable of shutting down all the three major pathways of complement activation; Mep1p is conidia associated and secreted into the medium containing collagen and albumin, which exists in the lung environment.
- Mep1p inhibits phagocytosis by blocking C3b deposition, which likely enables their colonization and invasion.
- Mep1 also inactivates all the three anaphylatoxins – C3a, C4a and C5a.
- Opsonisation of Conidia with rhSP-D induced pro-inflammatory cytokines in monocytes derived macrophages (MDMs).
- Melanin ghost reduce cytokine expression by the SP-D knockout mice

Background

*Aspergillus fumigatus*, though a saprophyte growing on decaying vegetation, is the most ubiquitous opportunistic human fungal pathogen. It causes a number of diseases such as lung/sinus aspergilloma and allergic bronchopulmonary aspergillosis in the predisposed immunocompetent human population. However, the most fatal one is the invasive aspergillosis (IA), a systemic infection in the immunocompromised individuals; the frequency of IA has risen more than 10-folds worldwide in the last two decades. *A. fumigatus* spores (conidia) entering the human lung alveoli are confronted with the innate immune system, both cellular barriers and soluble mediators. The role played by cellular barriers in evading *A. fumigatus* is quite well studied but that of the soluble mediators (complement system, collectins and antimicrobial peptides) is yet to be deciphered. The project is focused on the interaction between *A. fumigatus* and the soluble mediators of the innate immune system.

Principal Collaborators

- **Arvind Sahu**
  National Centre for Cell Science
  Pune

- **Taruna Madan Gupta**
  National Institute for Research in Reproductive Health
  Mumbai

- **Vishnukumar Aimanianda**
  Institut Pasteur
  Paris

Publications

- No. of publications in SCI journals: 1
- No. of papers presented in conferences: 1

Mobility Support

- India to France: 2
- France to India: 2
STUDY OF THE ASSOCIATION OF MICRO RNA AND MITOCHONDRIA AND THEIR ROLE IN REGULATION OF NEURONAL CELL DEATH IN FRAGILE X TREMOR ATAXIA SYNDROME (FXTAS)

Feb. 2015 to Feb. 2018

Background

Fragile X-associated Tremor/Ataxia Syndrome (FXTAS), characterised as an X-linked inherited neurodegenerative disorder of adult males carrying CGG repeats in the Fragile X Mental Retardation 1 (FMR1) gene. FXTAS can be characterized by progressive intention tremor, ataxia and neuropsychological problems, including Parkinsonism, peripheral neuropathy, memory impairment, dementia and cognitive decline. Since, not much is known about the mechanisms of cellular pathology and the exact mechanisms of neuronal cell death, it would be interesting to decipher the root causes. Moreover, owing to the recent discovery of the micro RNA association to FXTAS and mitochondrial dysfunctions in a closely related neurodegenerative disease like Parkinson’s, PIs set to investigate the cross linkage of mitochondrial dysfunction and spatiotemporal involvement of miRNA in FXTAS. This may open a whole new horizon to the project and may help in understanding several other neurodegenerative diseases severely affecting the society.

Objectives

- Analysis of micro RNAs association with mitochondria in FXTAS cell models, mouse models and patient brain samples
- Analysis of altered association of mitochondrial-specific micro RNAs on cellular processes specifically on mitochondrial function and neuronal cell survival
- Determine whether re-expression of a specific subset of micro RNAs could rescue neuronal cell death in models of FXTAS

Knowledge Generated/Products Developed

- Validation of CGG repeats constructs:
- CGG repeats decreases cellular viability:
- Pathogenic repeats form nuclear inclusions:
- The smaller inclusions outside the nucleus interacts with mitochondria:
- Pathogenic repeats alters mitochondrial functions:
- miRNAs alter in cellular model of FXTAS:
- Effect of CGG repeats on TRIM NHL proteins.
- Optimizing of PCR condition for detecting FMR1 mutation and genetic testing for fragile X mutation in patients with motor symptoms.

Principal Collaborators

- Rajesh Singh
  M.S. University of Baroda
  Vadodara

- N. Charlet Berguerand
  INSERM DR2
  Illkirch

Publications

- No. of publications in SCI journals : Nil
- No. of papers presented in conferences: 2

Mobility Support

- India to France: 2
- France to India: Nil

Association of GFP fused 99X CGG expansion repeats with various fractions of HEK293ebna cells
SELF-SORTING DONOR AND ACCEPTOR ASSEMBLIES

Jan. 2015 to Dec. 2018

Background

The project aims towards understanding the structural nuances that influence the H-bonding mediated co-assembly of bis-amide functionalized dialkoxy-naphthalene (DAN) donors and naphthalene-diimide (NDI) acceptors using state-of-the art facilities including isothermal titration calorimetry (ITC), Cryo-TEM, small angle X-ray scattering (SAXS) and neutron scattering experiments (SANS) in addition to the NMR, UV/vis and fluorescence spectroscopy. In the recent past, PIs have demonstrated that self-sorting, alternate stacking or co-existence of both possibilities may arise in such D-A systems depending on the variation of the relative distances between the two amide units in the DAN and NDI units. However, so far studies have been limited to understanding the molecular scale interaction while the project aims for better understanding of their macroscopic properties which will ultimately decide the relevance of the knowledge developed (even if not the actual materials) in device applications. PIs also propose to extend the structural diversity of the building blocks by bringing in amphiphilicity to explore further structural variation and solvent combinations for tunable co-assembly.

Objectives

- To understand the role of H-bonds in the mode of co-assembly (alternate or segregated) and in the shape of the self-assemblies
- To identify the molecular parameters that govern the co-assembling mode or its reorganization (strength and number of H-bonds)
- To understand the role of the solvent, especially when reorganization occurs
- To find and optimize the conditions to obtain solid state films with the same structures and photo physical properties as in solutions; these films will be oriented and the self-assemblies studied by electron diffraction. The charge mobility will be measured in relation with the morphology of the aggregates
- (a) Synthesis of various structurally related amide/urea functionalized DAN and NDI building blocks and understanding role of H-bonding on co-assembly

Knowledge Generated/Products Developed

- Synthesis of donor and acceptor based gelators
- Study on their self-assembly pathway and attempts to correlate their structure with self-assembly mechanism
- Determination of structure of self-assembled NDI molecule (one among few synthesized molecules)
- Self-assembly studies of π-amphiphiles

Principal Collaborators

Suhrit Ghosh
Indian Association for the Cultivation of Science
Kolkata

Philippe Mesini
Institut Charles Sadron
Strasbourg

Publications

- No. of publications in SCI journals : 2
- No. of papers presented in conferences: Nil

Mobility Support

- India to France: 2
- France to India: Nil

Optical micrographs of the polymorphs of NDI-C8. From left to right: Form I – helices, Form II – spherulites, Form III – fibres
The programme was initiated during the FY 2013-14, where CNRS & Inria support the French component of the programme, DST supports the Indian component. On behalf of DST, CEFIPRA manages the implementation of programme on the Indian side and coordinates between French & Indian organizations. The focus of DST-Inria-CNRS Targeted programme is on the areas of Big Data, Cyber-Physical Systems, High Performance Computing, Embedded Systems, Reliable and Scalable Computation, Computer Science for Biology and Life Sciences, Cyber Security and Machine Learning etc.

Visit of Delegation from Institut national de recherche en informatique et automatique (Inria) to CEFIPRA

A delegation (Dr. Angélica BIARD of INRIA & Dr. Priol, Director of European and International Partnerships Department) from Institut national de recherche en informatique et automatique (Inria) visited the CEFIPRA Office on 11th May, 2016 for a meeting. The aim of the meeting was to have discussions about the next Call for Proposals, ongoing projects and renewal of MoU between the funding agencies for the DST-Inria-CNRS Targeted Programme.

BASAL GANGLIA AT LARGE

Sept. 2014 to Sept. 2017

Background

Structures such as the Pre-Frontal Cortex (PFC), the Basal Ganglia (BG) and the Hippocampus are studied in cognitive neuroscience to understand reasoning and planning particularly through the consequences of lesions in the system and neurodegeneration. Computer science is playing an increasingly important role in the domain of Computational Neuroscience. Currently there is a worldwide trend to construct large scale computational models of various brain structures. In line with that trend, the current project seeks to model the Basal Ganglia at large scale. One approach to large scale modelling of brain function believes that such models must incorporate extremely detailed descriptions – at the level of dendritic geometries, axonal connectivities etc – which makes such models computationally expensive. But we believe that large scale network models, constituted by slightly simplified, point neurons can be very useful in gaining systems level understanding of the brain and also in translating such understanding to clinical domain.

Objectives

- To select a few classical models of the Basal Ganglia (BG), the prefrontal cortex (PFC) and the Hippocampus and of their interconnections and to expand them to larger scale, with realistic anatomical and functional connectivity.
- To implement and test these models on tasks where the input (sensory) and output (motor) information flows are larger and hence more realistic.

Knowledge Generated/Products Developed

- Developed a large scale model of basal ganglia along with a cortical pathway, that can control an arm model and produce reaching movements as well as other tasks such as probabilistic learning task
- A biological plausible architecture of the striatum was designed to solve contact dependent-Reinforcement learning task

Principal Collaborators

Bapi Raju
International Institute of Information Technology (IIIT), Hyderabad

V. Srinivasa Chakravarthy
Indian Institute of Technology Madras, Chennai

Frédéric Alexandre
Inria Bordeaux Institut des Maladies Neurodegeneratives UMR Bordeaux

Publications

- No. of publications in SCI journals : 2
- No. of papers presented in conferences: 9

Mobility Support

- India to France: 1
- France to India: Nil
ALGORITHMIC VERIFICATION OF REAL TIME SYSTEMS (AVERTS)

Sept. 2014 to Aug. 2017

Background

Digital systems control most of the devices that surround us. Timing constraints are often crucial for cyber-physical systems that are designed to interact with the physical world. Correctness of cyber-physical systems that work under time-constraints is an ongoing challenge since traditional methods based on testing are no longer applicable in a safety-critical setting. This project aims at enlarging the applicability of formal verification for certifying correctness of timed systems. The model of timed automata has been introduced more than 25 years ago and has been an object of intensive study. It has also been successfully used in verification of cyber physical systems. A verification system Uppaal based on the timed automata model, has been developed for the last 20 years. In 2013, it has received the Computer Aided Verification award for “becoming an industrial-strength tool for computer-aided verification of computing systems that has been applied to many case studies by several research groups in academia and industry”. Since the last four years, collaborators are working on improving state of the art algorithms for the verification of timed cyber physical systems. The research results open a way to new approaches to algorithmic verification of timed systems. The goal of this project is to explore these new possibilities, and to make them accessible to industrial designers.

Objectives

The project aims at developing formal methods for the automatic design and analysis of real-time systems. Digital systems control most of the devices that surround us. Timing constraints are often crucial for cyber-physical systems that are designed to interact with the physical world. Correctness of cyber-physical systems that work under time constraints is an ongoing challenge since traditional methods based on testing are no longer applicable in a safety-critical setting. The project aims at enlarging the applicability of formal verification for certifying correctness of timed systems. In the last years, PCs have been working on improving state of the art algorithms for the verification and synthesis of timed cyber-physical systems. The results have opened a way to new approaches to algorithmic verification of timed systems. The goal of this project is to explore these new possibilities, and to make them accessible to industrial designers.

Knowledge Generated/Products Developed

- Distributed systems, Timed Logics and Others
- Reachability Problems in Timed and Hybrid Automata

Principal Collaborators

S. Krishna
Indian Institute of Technology-Bombay
Mumbai

Frédéric Herbreteau
Institut Polytechnique de Bordeaux, LabRI CNRS UMR 5800, Talence

Publications

- No. of publications in SCI journals: 1
- No. of papers presented in conferences: 5

Mobility Support

- India to France: 2
- France to India: 1
OPTIMAL INFERENCE IN COMPLEX AND TURBULENT DATA

September 2014 to August 2017

Background
The main emphasis is on data fusion in earth observation and monitoring. Non-linear physics puts strong evidence of the fundamental role played by multiscale hierarchies in complex and turbulent data: in these data, the information content is statistically localized in geometrical arrangements in the signal’s domain, while such geometrical organization is not attainable by classical methods in linear signal processing. This is one of the major drawbacks in the classical analysis of complex and turbulent signals. The goal of this associated team is to show that inference of physical variables along the scales of complex and turbulent signals can be performed through optimal multiresolution analysis performed on non-linear features and data extracted from the signals, resulting in novel and powerful approaches for data fusion between different acquisitions (in temporal/spatial/spectral resolutions. The project is focused on specific applications in Earth Observation and monitoring.

Objectives
• New methods in data fusion of signals acquired at different spatial resolutions and having different spectral characteristics: for instance data fusion of optical, radar and hyper spectral data for enhanced classification
• Non-linear methods to fuse the satellite images for bringing the different sensor data in same scale characterization of universality classes in observed data. Comparison with compressive sensing approaches
• Enhancement of data fusion techniques in Earth observation data between datasets acquired at different spatial resolutions. Application to radar and optical data for the development of Earth’s monitoring system
• Derivation of new non-linear methods for reconstructing a perturbed phase in Adaptive Optics from low resolution subgradients
• Effective Application of huge satellite data with different variety by using/developing Fusion techniques for development of specification of certain Earth monitoring system like agricultural, land cove and ocean dynamics
• Research on development of missing data using Non-linear signal processing techniques, so spatial ambiguity of huge satellite data set may be resolved
• Research and development for resolving the difficulties of huge satellite data veracity from different sensors (because different satellite has different quality, different time line and different accuracy data) for making the usable data in same scale
• Development of monitoring methods, based on change detection, pattern recognition techniques and nonlinear signal processing, for analyzing time series of satellite data in order to detect possible precursors of imminent changes in agricultural field

Knowledge Generated/Products Developed
• Specification for huge satellite data has been identified which can monitor the earth surface especially land cover with minimum human interaction
• An adaptive land cover change monitoring algorithm has been developed which will be quite useful for development of earth monitoring system

Principal Collaborators
Dharmendra Singh
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Roorkee
Hussein Yahia
Institut national de recherche en informatique et automatique (Inria)
Talence

Publications
• No. of publications in SCI journals : 4
• No. of papers presented in conferences: 3

Mobility Support
• India to France: 1
• France to India: 1

Figure: Classified satellitic image of Roorkee region, India with overall classification accuracy more than 85%
Evolving Communities and Information Spreading

Aug. 2014 to Dec. 2017

Background
This project primarily deals with two major aspects of complex network (a) information diffusion (b) community detection. The study of information flow on networks has attracted considerable recent attention in the computer science community. In this project, we focus on two types of information flow (i) knowledge information flow (flow of ideas, innovations etc. mainly among scientists) and (ii) social information flow (flow of news, gossips, opinions etc.). Knowledge propagation in scientific domain is specifically indicated by citations (where the citing author borrows ideas from the cited author) and collaborations (where both the collaborating authors share ideas, produce joint results). So knowledge diffusion can be simply mimicked by the creation of a citation or collaboration link between two authors. On the other hand, social information flow is basically the spread of any information among socially connected (friends, family, colleagues etc.) people.

Objectives
- Information diffusion in temporal networks: (a) predict temporal links taking the community signals in consideration (b) understand the role of communities in enhancing/slowing the speed of information spread – we would like to formulate the role of communities in robustness of temporal graphs (c) go beyond spread and try to understand the role of dynamic communities in making various topics / events viral (trending) over network
- Dynamic communities: The main goal is to develop new methodologies / frameworks for analyzing dynamic communities because the traditional algorithms are unable to handle temporal aspects of the communities
- Big Dataset: Aims at collecting and generating data – both synthetic and real. Plans to work with two types of data set – (a) citation-collaboration network of Computer Science and Physics (b) twitter networks along with the tweets posted by users

Knowledge Generated/Products Developed
- PIs have developed a benchmark multilayer network generator with ground truth communities to construct the synthetic dataset.
- Performed rigorous experimentations to evaluate our community detection algorithms on the benchmark synthetic networks as well as empirical networks (Meetup and Yelp) with respect to the baseline algorithms.
- Analyzed the computational complexities of our algorithms and mathematically proved that both our algorithms converge smoothly.
- Improved proposed modularity definition.

Publications
- No. of publications in SCI journals : 2
- No. of papers presented in conferences: 4

Mobility Support
- India to France: 2
- France to India: 3

Principal Collaborators
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Community Detection
Illustration of community detection using dendrogram

Modularity maximization
POST-STROKE TELE-NEUROREHABILITATION USING AN OPERANT CONDITIONING PARADIGM UNDER VOLITIONALLY DRIVEN TRANSCUTANEOUS NEUROMUSCULAR ELECTRICAL STIMULATION

Sept. 2014 to Aug. 2017

Background
Stroke is a global health problem and fourth leading cause of disability worldwide. In France, stroke is the leading cause of acquired disability in adults. While the incidence of stroke is decreasing in developed world, the incidence is increasing in India. Unfortunately, India is in dire need for neuro-rehabilitation facilities and this may strain India’s health care system in the coming years. One of the most common complications after stroke is lack of balance and falls that adversely affects most day-to-day activities. This research project aims to develop a use-inspired neuro-physiology-based operant conditioning paradigm that is based on volitionally-driven Neuro-muscular Electrical Stimulation to generate functional movement for restorative neurorehabilitation. Collaborators plan to develop a clinically valid, low-cost home-based tool for post-stroke balance and movement therapy, which can be used both in rural and urban community settings, will be a paradigm shift for neuro-rehabilitation in India.

Objectives
• To develop a cyber-physical system for tele neuro rehabilitation by integrating bio signal sensors, eye tracker, and motion capture to deliver volitionally driven multi-channel neuromuscular electrical stimulation (NMES)
• To develop gaze interaction with biofeedback as the human-machine interface for the cyber physical system to enforce active supra spinal participation for operant conditioning
• To validate the cyber physical system for individualized post-stroke tele neuro rehabilitation

Knowledge Generated/Products Developed
• A bench-tested cyber physical system, integrating biosignal sensors, eye tracker, and motion capture along with its programmable user interface. This cyber physical system along with its programmable user interface had been used to develop a human-machine interface for gaze interaction with biofeedback to enforce active supraspinal participation for operant conditioning in virtual reality (VR).
• A human-machine interface for the cyber physical system using gaze interaction with biofeedback to identify subject-specific sensory deficits in a VR-based environment and expose participants to different stages of learning thereby enforcing corresponding supraspinal participation in VR for operant conditioning.
• A clinically validated cyber physical system for individualized post-stroke tele-neurorehabilitation and its feasibility results for home or community based teleneurorehabilitation.

Principal Collaborators
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Publications
• No. of publications in SCI journals : 3
• No. of papers presented in conferences: 1

Mobility Support
• India to France: 3
• France to India: 3
AUTOMATED VERIFICATION OF CONCURRENT SOFTWARE (AVECSO)

Oct. 2015 to Sept. 2018

Background
There is a real need to investigate both foundational as well as practical issues related to the automated verification of modern concurrent and distributed software. The need concerns both (1) methods for efficient bug detection, which are very useful to programmers at early stages of software development, and (2) methods that allow us to establish the correctness of a system, which is useful to certify the software before its release. The goal of this project is to design such new, advanced algorithmic methods, guided by the recent developments in multi-core architectures and cloud-computing.

Objectives
To design algorithmic methods for the automated verification of concurrent software systems
• Models and verification algorithms for concurrent programmes
• Verification of concurrently shared data structures
• Verification of distributed, geo-replicated data structures

Knowledge Generated/Products Developed
• Verification of concurrent programs under phase-bounding
• Verification of event-driven asynchronous programs concurrent programs
• Verifying web services
• Speculative consistency
• Specification and verification of quantitative properties of concurrent programs
• Grammar controlled vector addition systems

Principal Collaborators

Madhav Mukund
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Paris

Publications
• No. of publications in SCI journals : 1
• No. of papers presented in conferences: 2

Mobility Support
• India to France: 2
• France to India: 2
BiDEE- A BIG DATA PERSPECTIVE FOR ENERGY MANAGEMENT IN GRIDS AND DWELLINGS

Oct. 2015 to Sept. 2018

Background
Smart grids and smart buildings allow information exchange and processing between electricity consumers and/or producers, and therefore opens the gate to consumer behavior analysis and potentially more effective energy management. Moreover, with the huge amount of energy related data being collected regularly, scalability of the developed algorithms to big data becomes an important consideration. There are two levels at which the project is approached: 1) The building level and 2) the grid level. The aim of the project is to apply game theoretic, optimization and learning techniques to the problem of energy management in smart grids and smart buildings. The enormous amount of data during the analysis process is to be handled by Big Data analysis.

Objectives
• At a building level, the main objective is estimation of human activity and adapting it to be relevant to grid requirements
• At a grid level, the main objective is the study of strategic interactions, both unilateral and collaborative, between micro-grids

Knowledge Generated/Products Developed
• At building level, PI worked on estimation and adaptation of human activities. Sensors were used which recorded the human activities and its impact in terms of thermal and air quality dissatisfaction. Multiobjective Optimization with Differential Evolution was used provide a set of actions which optimizes the comfort of the occupant in a building
• Considering the Demand Side Management in smart buildings, PI worked on data-driven appliance usage prediction framework. Also, to handle larger datasets, we defined a data parallel distributed architecture for our machine learning models
• Another work on Demand Side Management aimed to reduce peak to average demand ratio. A game theoretic model, Stakelberg Games were utilized with an effort to encourage users to shift their consumption pattern to the off-peak hours
• Simulated Annealing based discrete time model has been used to study the optimal generation schedule for the Distributed Energy Resources. This was done by minimizing the operational cost under situations where micro grid is islanded and when it is connected with the main grid
• Demand-side management is integrated with distributed energy generation and storage. A day-ahead optimization process is used which motivates the users to reduce their monetary energy expense by producing or storing energy rather than just purchasing their energy needs from the grid
• Keeping the environmental effects into consideration, renewable energy resources are being utilized in smart grids.

Principal Collaborators

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Indian Statistical Institute
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G-SCOP lab UMR CNRS 5272, Grenoble INP
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Publications
• No. of publications in SCI journals : 2
• No. of papers presented in conferences: 3

Mobility Support
• India to France: 3
• France to India: 2
New Projects

LEARNING FROM BIGDATA: FIRST-ORDER METHODS FOR KERNELS AND SUBMODULAR FUNCTIONS

**Background**
Machine learning is a recent scientific discipline involving Applied Mathematics, Statistics and Computer Science. Its goals are the optimization, control, and modeling of complex systems from observations generated by the system. It applies to data from numerous engineering and scientific domains (e.g., vision, bioinformatics, neuroscience, audio processing, text processing, E-Commerce, nanoscience, etc.), the ultimate goal being to derive general theories and algorithms which can contribute to solving important problems in each of the respective domains. Recent advances in sensor technologies have resulted in large amounts of data being generated in a wide array of scientific disciplines. Deriving models from such large datasets, often known as Big Data, is one of the important challenges facing many engineering and scientific disciplines. In this proposal, PIs investigate the problem of learning supervised models from Big Data, which has immediate applications in Computational Biology, Natural language processing, Web, E-commerce, etc., where specific structure is often present and hard to take into account with current algorithms. The aim of this project is to develop convex optimization methods for solving large scale problems arising in Supervised Machine Learning. The focus of this investigation will be to examine different convex relaxations of discrete regularization functions often expressed as sub-modular functions.

**Objectives**
PIs consider problems arising in the context of regularized learning. It is well known in the machine learning literature that regularizers encode the prior information regarding the structure of the models (their sparsity pattern), which often lead to better solutions. The major questions which arise in the context of regularization are:

a) What is the generalization error and does the solution lead to consistent solutions?
b) How do we solve the problem computationally?
c) How efficient is the solver?
d) To study these problems in the context of Graph Transduction & large scale algorithms for learning with Sub-modular regularization.

**Principal Collaborators**

- **Chiranjib Bhattacharyya**
  Indian Institute of Science (IISc), Bangalore

- **Francis Bach**
  Research Professor, Equipe-Project SIERRA, INRIA Paris-Rocquencourt

MODELLING AND CONTROL OF MOBILE CO-OPERATING BIONIC ARMS

**Background**
The project is about modelling and control of mobile cooperating bionic arms. It involves modelling, fault tolerant control, validation of control, communication and coordination among robots, reconfiguration of robot systems. Improve the performance of the overall control and supervision of collaborative system of bionic handling manipulator robots, based on unified modeling for both organizational and behavioral aspects.

**Objectives**

**Modelling:** Kinematic and dynamic modelling of the component system mobile and bionic handling manipulator in interaction with appropriate environment; Organisational with behavioural coupling model of system of bionic handling manipulators

**Control:** Development of model based controller for such a component system. According to the technical task specification, the controller can be based on kinematic or dynamic models

**Supervision:** Development of a fault tolerant control/reconfiguration scheme for such a component system, of Communications and coordination among the robots to realize the global mission of system of systems.
Targeted Programmes

New Projects

REFLECTION AWARE ICC ANALYSIS FRAMEWORK FOR ANDROID APPS

Background

The main aim of the project is to detect privacy/sensitive data leakage through one or more (colluding) Android apps that are reflection-aware as well as equipped with anti-detection features employed for evading dynamic analysis. Such apps cannot be analysed by existing static methods alone. Android is being considered as it is open source and has largest presence in mobile OS. Smartphones are becoming a store of personal information and used in financial transactions such as online shopping, net banking, and utility bill payments, etc. Internet-readiness coupled with constrained resources in terms of processing power, memory, etc. expose these devices to advanced malware threats. If not protected, malware disguised as a real app may enter the device and be used for stealing credentials without any knowledge of the user. A defence mechanism needs to block/monitor all entries whereas malware needs to find only one entry to gain access. Android is being preferred choice for IoT (Internet of things) – smart TVs, embedded systems, automobile systems, medical devices, wearable computing devices, etc. Synchronisation among devices owned by the same user increases the attack surface and through a smartphone device, an attacker may gain access to user’s automobile/home, etc. A monetary or identity stealth threat may translate to the physical threat as well. It is imperative that security solutions for mobile systems handle all known/uncovered vulnerabilities.

Malicious apps developed for Android are becoming increasingly sophisticated to evade detection by existing anti-malware solutions. Such malware can detect virtualized/emulated environment used for dynamic analysis and evade them. The code is obfuscated or encrypted to circumvent static analysis. Reflection and dynamic code loading are employed by malware writers for obfuscating the code. As most of the existing solutions analyse one app at a time, distribution of code among colluding apps can defeat the detection methods.

This project shall aim at improving existing analysis tools through an incorporation of reflection-aware and detection-aware features in the generation of CFG (control flow graph). The main objective is to identify if an app is capable of privacy leakage on its own or in collaboration with other apps present on the device. The accuracy of such analysis methods depends on modeling of app components and their interactions as per Android semantics (which needs to be formulated from the description as no formal description by Android).

Objectives

The main aim of the project is to detect privacy/sensitive data leakage through one or more (colluding) android apps that are reflection-aware as well as equipped with anti-detection android apps employed for evading dynamic analysis.

- Graph based representation of Android app and modeling components’ interaction with system
- Creation of database of apps that use reflection, obfuscation and/or collusion for privacy leakage. Identification of sensitive sources and sinks in respect of privacy leakage. Automation of sources and sinks as per textual description of an API in the Android manual shall be investigated. Such automations can be used for adapting technique for any Android version.
- Devising techniques for identifying anti-detection code and bypass it.
- Mapping reflection to API nodes in the graph and devising techniques for graph reduction so that only relevant paths (source to sink) are explored without incurring time overhead. These reduction techniques may also employ targeted traversal in which only the portion of graph relevant to the task shall be carried out. Identification of target subgraph shall be the crux of the solution.
- Evaluation and cross-validation of developed approaches
New Projects

STUDY OF PRIVACY ACCOUNTING AND OWNERSHIP IN IOT

**Background**

It is quite imperative that IoT requires a distributed framework of software and services (e.g., protocols, algorithms, systems, software) which would enable objects (maybe heterogeneous in nature) to connect to each other using Internet as the primary communication backbone. However, Internet as the communication channel in applications would naturally become the target of attacks that can either disrupts (e.g., data fabrication, user impersonation, data leakage, denial of service attacks) the provisioning of services. Furthermore, in the IoT infrastructure, majority of objects (‘things’) are pervasive, resource constrained and they also allow easy access to malicious adversaries. Importantly, the conventional security solutions like SSL/TLS may not be feasible for implementation in all scenarios. Therefore, IoT applications demand lightweight, resource-efficient security and privacy solutions. In addition, data privacy, data loss, accountability, trust relationships are important concerns in modern and future Internet applications. While transmitting data among many intermediate entities located in different places/countries, data ownership, accountability and regulatory norms are also crucial factors that must mutually be addressed before IoT gets its desired shape in real world applications.

**Objectives**

1) Research on secure network connectivity mechanisms and protocols that assure the confidentiality, integrity, authentication and accountability properties in IOT applications
2) Research on privacy of data as well as users owned data that assure the privacy-preserving, Leakage resilient and accountability properties in IOT-enabled applications
3) Design of security protocols with services such as access control, authorization, delegation, privacy-preserving and trust management that provide security and privacy services to IOT applications
4) Development of lightweight primitives, suitable for resource-constrained environments like wireless sensor networks and RFID systems, for authenticated data aggregation keeping privacy as a factor to be preserved depending on the nature of applications
5) Formal analysis of protocols that ensure security services designed for the target applications and set the ground for facilitating the research outcomes for further research for formal verification of protocols
6) Development of a proof-of-concept or prototype to demonstrate the research outcomes with smart devices/phones, NFC protocols, sensors and RFID tags

**Principal Collaborators**

- **Manik Lal Das**
  - Dhirubhai Ambani Institute of Information and Communication Technology, Gandhinagar
- **Pascal Lafourcade**
  - University of Clermont, Auvergne

**POLYHEDRAL COMPILATION AND OPTIMIZATION FOR DATAFLOW PROGRAMMING LANGUAGES**

**Background**

The project aims to develop new scalable compiler optimization techniques based on the polyhedral framework. The polyhedral framework is an abstraction relying on linear algebra and linear programming to represent, analyse, transform, and optimize sequences of loop nests for parallelism, locality, and memory usage. The framework has been used in compilers for general-purpose languages, high-performance domain-specific languages, and data-flow programming languages such as LabVIEW. Our work will be structured into two complementary tasks, in which we will leverage our common background and tool flows to experiment with new language semantics and compilation algorithms. PIs will also continue our investment into more mature demonstrators, within software tools developed in our groups (e.g., Pluto+, PolyMage, LLVM/Polly, and ISL), most of them free software, and through direct industry transfer.

**Objectives**

To develop new compiler optimization techniques for dataflow or dataflow-style programming languages

**Principal Collaborators**

- **Uday Kumar Reddy Bondhugula**
  - Indian Institute of Science (IISc), Bangalore
- **Albert Cohen**
  - PARKAS project team
  - Inria Paris and Ecole Normale Superieure (ENS), Paris
CEFIPRA initiated its first targeted programme in 2012 between DST and INRA in the area of integrated water management in agriculture in the context of climate change. One project was completed under this programme. The following CEFIPRA project AICHA was a successful experience of a bilateral multi-disciplinary collaboration aimed at addressing the urgent and extremely challenging problem of groundwater management in agricultural areas in India.

**ADAPTATION OF IRRIGATED AGRICULTURE TO CLIMATE CHANGE**

**Feb. 2013 to Jan. 2017**

**Background**

The expected impact of climate change on agriculture and water resources is the subject of an ever growing literature. The problem of excessive groundwater extraction has resulted in declining groundwater levels, water quality deterioration, rise in extraction costs, depletion of well yield and failure of wells in peninsular India. Addressing this question requires considering the interactions between all the components of the system, including hydrology, economics and agronomy. Few attempts of integrative assessment using coupled economic and agro-hydrogeological models for optimizing the economic benefits of agriculture and sustainable groundwater levels are found in the literature. The impact of climate change on local agricultural producers has been addressed in some cases. However, there is lack of integration between the water management aspects, the agronomic issues and the perspective of climate change.

**Objectives**

In the context of climate change and of agriculture increasingly relying on groundwater irrigation, it is crucial to develop reliable methods for sustainability assessment of current and alternative agricultural systems. The project aims to develop an integrated model (in agronomy, hydrogeology and economics) and scenarios of evolution of agricultural systems and water management policies, which is being tested both at the farm scale and the watershed scale in the case of an experimental watershed in Peninsular India. It is proposed to combine both economic impacts on the crop production and hydrogeological regime and hydro-economic feedbacks on the future land use and productivity. A methodology combining remote sensing, field surveys and inverse modeling for retrieving spatially distributed relevant biophysical parameters and factors determining cropping systems will be used. A farmer decision model will be developed to investigate the farming system adaptability to changing climate or economic context.

**Knowledge Generated/Products Developed**

- Calibration of the model Stics for 5 main crops
- Inverse modelling for soil parameter retrieval from satellite (radar)
- Reconstitution of land use land cover change for the period 1973-2012 by remote sensing
- Typologies of agricultural practices and farms, assessment of farmers vulnerability to climatic and non-climatic stressors
- Development of the model NAMASTE, coupling crop, hydrology, economics and farmer decision models
- The knowledge (processes understanding, new methodological approaches, integrated modelling) acquired through the AICHA project is now being used within the other projects, by ANR in France and (Karnataka Watershed Department in which agro-hydrological monitoring is carried out in 14 experimental watersheds across the Karnataka state, with a strong involvement of Karnataka research institutions, extension services and stakeholders

**Principal Collaborators**

- Sekhar Muddu
  - Indian Institute of Science
  - Bangalore

- Laurent Ruiz
  - Institut National de la Recherche Agronomique
  - Rennes-Quimper

**Publications**

- No. of publications in SCI journals : 5
- No. of papers presented in conferences: 16

**Mobility Support**

- India to France: 4
- France to India: 6

**Web portal AICHA to share spatial and time-series databases**
Indo-French Water Network (IFWN)

Considering the strong urge of the Indian and French Governments to reinforce scientific collaboration to address prevalent and emerging challenges in the area of Water, the French Embassy in India and the Department of Science & Technology (DST), Govt. of India have joined hands for Indo-French scientific networking programme in this area. This networking programme has been implemented by CEFIPRA under the name of Indo-French Water Network (IFWN) programme. The objectives of this programme are to form dedicated networks of Indian and French research groups & industries to address identified water related issues; to strengthen and expand the quality and potential of water research in both countries by building greater interaction between France and India and to build stronger relationships between industry and academic communities in France and India coupled with better knowledge exchange, to form the basis for future collaborations, research projects, and joint endeavor related to water technology, research & innovations. The following two projects are undergoing in the first call for this programme, launched in 2015.

**Objectives**

**A. Data collection and review-**
- Existing water availability/potential
- Population projection/growth
- Wastewater generation and projection
- Inventory of existing wastewater management practices
- Geographical and metrological data
- Land use land cover data
- Regulatory standards

**B. Treatment technologies-** Develop an evaluation matrix to screen the various alternative technologies for wastewater treatment and disposal, including residuals disposal.

*Selection of treatment technologies based on criteria-*
- Quantification and characteristics
- Nano-cellulose from waste and analysis to use it as filter
- CNT/Fullerene based treatment technology
- Performance evaluation of various already developed, membrane and cost effective adsorbents
- An awareness drive shall be conducted in these regions to identify the gaps. Some specific sites in France & India will be considered. One of such area is in Uttarakhand, in the vicinity of IIT-R and UPES-Dehradun, identified in report of ‘WAR for Water’ by DST-Govt. of India

**C. Demonstration and future action plan -**
- Thematic learning programs in affected areas
- Preparation of preliminary cost estimates for construction and operation of the screened alternative technologies
- Compilation of data, Preparation and submission of publications
- Workshop organization and action plan for future research and collaboration

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**Background**

The present project is aimed to make a strong network involving expertise from eminent institutes of both the countries for undertaking challenging projects. To develop management training plan and give thrust to technologies giving equal weightage to augmentation of supplied water as well as development of wastewater treatment facilities with recourse to recycling, recovery, recharging, and storage so as to increase water usage efficiency and to make it available for different industrial and non-industrial end uses such as pisciculture, irrigation, forestry, horticulture, cleaning, washing etc.

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**May 2016 to May 2018**

**SWACHH NEER - UNE VIE MEILLEURE: COMBATING WATER ISSUES THROUGH INDO-FRENCH NETWORKING**
Knowledge Generated/Products Developed

A. Data collection and review-
- Data for exiting water availability in selected regions
- Waste water generation and projection in selected area of Uttarakhand and Region Aquitaine (France)
- Inventory of existing wastewater management practices
- Technological assessment
- France and Indian scenario for water quality management

Work initiated and in progress

B. Treatment Technologies-
- Review of technology has been done
- Extraction process of nano-cellulose have successfully completed
- Performance analysis of in-house developed technology:
  - CNT Fullerene based technology in progress
  - Performance of adsorbent technology

C. Demonstration and future action plan
- Thematic learning programs in affected areas. 22 – 25 Feb 2017

Principal Collaborators - India

- Jitendra K Pandey
  University of Petroleum and Energy Studies
- Parsenjit Mondal
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Principal Collaborators - France

- Benoit Teychene
  Université de Poitiers Poitiers Cedex
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  Université de Rennes 1, Rennes
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- Jean Milidakis
  WASTE & WATER S.A.R.L, Villers-lee-Nancy (Industrial Partner)
GREYWATNET: NETWORK ON DECENTRALIZED GREY / WASTE WATER TREATMENT & RECYCLE

Jun. 2016 to May 2018

Background
The aim of this project is to put together a network of expertise that can address the issue of grey-water treatment and recycling as also evolve a few demonstrable technology options that are sustainable and can be run on ‘hands-free’ mode coupled with long mean times between maintenance and failures (MTBF).

Objectives
- Evolve a network of experts who can address the emerging challenge of decentralized greywater treatment technologies
- Assess, standardize and demonstrate two proof-of-concept streams for anaerobic-aerobic mode of greywater treatment options possessing low sludge and low maintenance characteristics
- Assess the impact of various antimicrobials grey water from domestic discharges on the treatment processes
- Subject post treated water to solar catalysis and Fenton-H₂O₂ reagent based treatment to maximize bacterial removal and assess their utility for purified greywater

Knowledge Generated/Products Developed

Start-off meeting in Bangalore July 5th to 8th 2016
About 30 persons participated in this meeting with 2 French scientists, 4 Indian scientists, 1 French student, 8 Indian students, 6 project staff and 8 water Professionals.
To summarize, the major outcomes of the first meeting have been a. Specifying the goals, tasks and targets; b. Agreeing upon management and monitoring plan and; c. Seeking research funds jointly. The need for an efficient and robust Greywater /dilute Wastewater Treatment system for Indian households (HH) was highlighted.
- Each partner made a general presentation of his/her laboratory and of its main research topics and the state of technology development in their respective Centres
- Various stakeholders and practitioners gave their inputs on our topic (sewerage boards, pollution control boards, ATREE, technology providers /’early adopters) While all of them favoured the concept of small scale greywater recycling, this also brought out various issues and parameters to be addressed in greywater devices.
- A field trip was organized to visit a wastewater fed urban lake that has been restored predominantly by ‘citizen actions’ to show how our technology could be embedded in society.
- The network partners planned the subsequent activities to be taken up and also decided to seek parallel funding to take up the R&D activities which were identified

Principal Collaborators - India

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Sarkar
Tata R&D, Jamshedpur
(Industrial Partner)

Principal Collaborators - France

Michel Torrijos
INRA, Narbonne

Florent Chazarenc
Ecoles des Mines de Nantes (EMN), Nantes

Joëlle Paing
Company Jean Voisin, Beaumont-la-Ronce
(Industrial Partner)
5. Brief Reports of Research Projects

E. Innovation Programme Through Public Private Partnerships
CEFIPRA has expanded its activity by bringing Bpifrance (a public investment bank) as a new stakeholder and launched the Indo-French health technology programme in association with Bpifrance and BIRAC in the area of Red Biotechnology up to pre-commercialization stage. First Call was launched in the areas of Cancer, Cardiac and Infectious Diseases with themes such as identification of new targets or biomarkers, development of new therapeutic, affordable process development for existing therapeutics having potential implication on effective industrial scale-up for cost effective production. One proposal was received which was not selected for support. Second Call for Proposal was launched in November, 2015 in the areas of digital healthcare (e-health, tele-care, health IT, m-health etc.) and individualized medicine (therapeutic solutions for individual patients, pharmacogenetics etc.). Two proposals were received and evaluated in the meeting of the Joint Selection Committee held on 7th December, 2016. The proposal entitled “Medio-India” was recommended for support.

Biotechnology Industry Research Assistance Council (BIRAC), CEFIPRA and French Embassy in India had launched an Indo-French challenge oriented programme in the area of Red Biotechnology up to pre-commercialization stage in 2+2 model. The areas for collaboration under the first Call were Molecular diagnostics for prediction of Cardiac diseases, Alzheimer's disease and/or Dementia, Cerebral palsy and generation of new assistive technologies for mobility of the physically challenged. Two projects, both of which are in the area of cardiovascular diseases, are ongoing under the first Call. Second Call was launched in October, 2015 in the areas of Molecular diagnostics for prediction of Alzheimer's disease and other Dementia, new assistive technologies for mobility of physically challenged (including prosthesis and robotics applications), Biomaterials and cell engineering for health applications. One proposal received was recommended, in principle for support under the second Call, by a Joint Selection Committee during its meeting held on 13th September, 2016 at CEFIPRA Office, New Delhi.
OXIDIZED HDL-APOLIPOPROTEIN A1 AS A RISK PREDICTOR OF CARDIOVASCULAR DISORDERS AND DEVELOPMENT OF NOVEL DIAGNOSTICS

Background

Atherosclerosis is one of the major causes of cardiovascular disease and is a chronic inflammatory condition. It is generally believed that the High Density Lipoprotein (HDL) helps in reducing the risk of cardiovascular diseases since it moves cholesterol from arteries and peripheral tissues to the liver via reverse cholesterol transport. In addition, HDL also contributes to general well-being of the cardiovascular system through its anti-inflammatory, antioxidant and anti-thrombotic properties. These protective effects of HDL are mainly believed to be mediated by Apolipoprotein A-I (ApoA1), which is the major protein component of HDL. Attempts to increase the HDL levels or HDL-Cholesterol levels pharmacologically have not been successful.

Furthermore, recent studies have suggested that the Myeloperoxidase-mediated modification of ApoA1 impairs its function as a cholesterol acceptor, in turn hampering HDL’s cardio protective nature. A number of modifications, such as chlorination/nitration of Tyrosine, oxidation of Methionine, hydroxylation of Tryptophan and carbamylation of Lysine, have detrimental consequences including loss of cholesterol acceptor activity, which could significantly contribute to plaque formation. These modifications not only render HDL dysfunctional, but some of the modifications such as conversion of Tyr192 to Chl-Tyr192 or Nit-Tyr192 render ApoA1 proinflammatory and proatherogenic and this may exacerbate the CVD risks in humans.

Hence, early detection of Tyrosine modifications is the key to rapid diagnosis of cardiovascular disorders. In this project, PCs will focus on developing novel methods to identify specific modification of residues in ApoA1 using immunological methods, and test their efficacy on patients.

Objectives

- Development of murine monoclonal antibodies against nitrated, chlorinated peptides of HDL ApoA1, and its subsequent purification
- Characterization of the purified anti-Chlorinated ApoA1 and anti-Nitrated ApoA1 mAbs in terms of specificity and sensitivity
- Screening cardiovascular stroke patient samples for the effectiveness of anti-ChlApoA1 and anti-NitApoA1 mAbs
- Development cDNA expression clones for highly specific mAbs and standardization of recombinant mAb expression, pilot scale production and purification of mAbs
- Imaging studies of antibody specificity to plaques
- Large scale screening both native and recombinant anti-ChlApoA1 mAbs and anti-NitApoA1 mAbs known CVD patients
- Best mAbs will be further developed for commercialization

Knowledge Generated/Products Developed

- Successfully generated following monoclonal antibodies which were highly specific against oxidized ApoA1 (i.e., two mAbs against anti-chloro-192Tyr-ApoA1 and one mAb against anti-nitro-166-Tyr-ApoA1)
- Highly specific rabbit polyclonal antibody has been developed against recombinant produced native/unmodified ApoA1
- Developed simple purification steps to enrich HDL-ApoA1 from serum/plasma of both healthy subjects and CVD patient samples
- Serum Myeloperoxidase activity was significantly (~3 fold) higher than the healthy control subjects
- Genext Genomics has established contacts with cardiologists from MGIMS, Sevagram and Wockhart Hospital, Nagpur for screening patient samples
- CBSTVIT team successfully transferred following items to University of Bordeaux team through World Courier Services. hybridoma clones producing anti-192chloro tyrosine and anti166-nitro tyrosine ApoAI bodies, purified anti-192chloro tyrosine and anti166-nitro tyrosine ApoAI monoclonal antibodies bodies purified polyclonal ApoAI antibody and purified human ApoAI.
AMIR-PEPKIT IVD: R&D OF A PEPTIDE-BASED - DIAGNOSTIC KIT FOR AN EARLY DETECTION OF A FATAL IMMUNE RESPONSE IN ACUTE MYOCARDIAL INFARCTION PATIENTS

**Objectives**

- Identification of Antigenic Proteomic Markers
- Validation and Selection of initial markers
- Selection of Peptide Antigens/Receptors for identified antigenic proteins
- Synthesis and Purification of the Peptides
- Optimization of Peptide-Based ELISA Diagnostics for Acute Myocardial Infarction

**Knowledge Generated/Products Developed**

- Seven blood samples belonging to different groups were collected.
- Antibody/antigen complexes were successfully purified from serum samples.
- Protein Microarray was performed for each group and approximate 20,000 hits were obtained.
- Selected 30 proteins (autoantibodies) from protein microarray result and after network analysis 10 focused molecules were reported to have role in cell death and survival along with cardiovascular system development and function.
- Four proteins mentioned below out of 30 proteins against which differentially expressed autoantibodies were detected in group A (patient with myocardial infarction with heart failure) compared to healthy control were selected for further study on the basis of A score, signal intensity and their role in cell survival, death and cardiovascular system development.

1. Myogenic Differentiation 1 (Myod1)
2. Serum Response Factor (SRF)
3. Cytoplasmic Polyadenylation Element Binding Protein 4 (CPEB4)
4. Arf-GAP with SH3 domain, ANK repeat and PH domain-containing protein 2 (ASAP2)

**Background**

Cardiovascular diseases represent a leading cause of morbidity and mortality all over the world. The disease is a complex interaction of various physiological, structural, and biochemical mechanisms, which could be symptomatic at a stage where heart has exhausted all ability to compensate for the injury. Myocardial Infarction is the occlusion of a coronary artery, preventing the supply and oxygen to cardiac cells. This cardiovascular problem leads to heart failure.

The early strategies towards understanding the very early changes that the myocardium undergoes following an ischemic event may be important as that will ultimately enable diagnosing a cardiac ischemic event before it has caused significant damage to the heart. The idea of this proposal is to investigate the expression of proteins and/or aberrantly modified proteins that could have antigenic properties in AMI and try to correlate the possible antibody response to them with disease activity. In fact, recognition of specific antibodies present in sera of patients affected by diseases involving an immune response is a relevant goal because these antibodies may have not only a diagnostic but mainly a prognostic value.

Therefore, a relevant technical goal is to isolate autoantigens by affinity chromatography, identify their differential expression in MI in comparison to healthy controls by DIGE and to develop simple immunoassays using specific peptides to detect them. The advantage of using peptides compared to proteins as antigens to detect antibodies is that we can have higher specificity of recognition.

**Indian Collaborators**

- Savita Yadav
  - AIIMS
  - New Delhi
- Arjun Surya
  - Curadev Pharma Private Limited
  - Noida

**French Collaborators**

- Anna Maria Papini
  - Université de Cergy-Pontoise
- Elian Lati
  - SAS GENEX – Longjumeau

**Signal intensity of four proteins in protein microarray**

- A: Patients with acute myocardial infarction with heart failure
- B: Patients with acute myocardial infarction without heart failure
- C: Age and sex matched healthy subjects (no coronary artery disease, no heart failure)
- D: Patients with heart failure due to primarily myocardial disease and with normal coronary arteries (non-ischemic heart failure)
Saint Gobain Research India (SGRI) Programme

In a first initiative of CEFIPRA for PPP (Public Private Partnership) mode, CEFIPRA entered into a MoU with SGRI on 23rd October, 2013 to launch programme of ‘sustainable habitat for hot and/or humid climates’

Ongoing Project

STRUCTURAL PERFORMANCE OF OPEN GROUND STOREY (OGS) BUILDINGS: GLASS FIBRE REINFORCED GYPSUM (GFRG) BUILDING SYSTEMS VS. CONVENTIONAL RC FRAMED STRUCTURE

Objectsives

- To carry out numerical analysis of GFRG building systems with open ground storey, subject to gravity and earthquake loading
- To propose a design basis and design guidelines for GFRG buildings with open ground storey & validate through experimental study
- To compare the proposed GFRG building system with conventional RC framed building, both having open ground storey parking, for 4 to 8 storeyed buildings
- To evaluate the moisture resistance properties of GFRG panels
- To investigate experimentally durability of the GFRG panels in hot and humid conditions in India and to evaluate primer performance in enhancing durability

Knowledge Generated/Products Developed

- A state of the art report based on all the works reported so far on GFRG including the national and international scenarios was prepared
- The performance of GFRG panels under extreme weather conditions was evaluated
- Numerical study on GFRG – OGS buildings systems was performed
- The available facilities in the laboratory were modified and improved to suit the proposed testing
- Long term test methods to evaluate durability of GFRG by converting weather data of an Indian city to lab-scale test method were developed and tested for flooding situations

Background

Glass Fibre Reinforced Gypsum (GFRG) panels are prefabricated building products, suitable for rapid, affordable and sustainable mass construction. These panels, manufactured to a standard size of 12m × 3m with a thickness of 124 mm, can be used as load bearing walls, slabs, staircases and shear walls. The present design criteria for these buildings demand the walls to start from the foundation itself. But, the building community of our country demands the provision for open ground storey (without any walls) for facilitating car parking. This forms the basis of this research project which intends to provide a feasible and safe solution for the scenario by providing guidelines for the design of GFRG – OGS buildings. In addition, the performance of GFRG in hot and humid conditions in India needs to be evaluated under various environmental conditions (marine environment, acid rain, intense monsoon rainfall and flood). This will pave way to assess the durability of the material.

Principal Collaborators

Devdas Menon
Indian Institute of Technology Madras
Chennai

Satish Gunturi
Saint Gobain Research India Private Ltd
Chennai

Publications

- No. of publications in Journals: 1
- No. of papers presented in conferences: 3

Test set up for the GFRG - OGS specimen
Innovation Programme

Ongoing Project

MULTI-OBJECTIVE OPTIMIZATION OF DAY LIGHTING SYSTEMS

Background
Day lighting devices such as light shelves have the potential to reduce the energy consumption of buildings. A light shelf is a device meant to enhance daylight transmission into buildings. It is usually a horizontal or inclined projection attached to a window with a highly reflective surface. It operates by reflecting sunlight off to the ceiling from where it is further reflected to the work plane. The light shelf should ideally produce an improved daylight distribution at the back of a room for any sky condition. However, there is a controversy over the potential of light shelves to increase illuminance levels in the rear of a room and it is reported that improvements in illuminance and energy savings are not always achievable. Careful design is essential for obtaining adequate performance. Another issue is the heat reflected by the light shelves into the room. These issues have not been thoroughly evaluated experimentally. This project aims to evaluate existing solutions for light shelf configurations both experimentally and through simulations. This would bring out under what circumstances; light shelves are able to improve the performance of buildings with respect to daylighting, thermal comfort and energy. The quantitative evaluation will also lead the way to arrive at optimal light shelf configurations.

Objectives
The primary goal of this proposal is to develop day lighting solutions that help improve the performance of existing buildings. The specific objectives are:

- Evaluation of existing solutions for improving lighting, thermal comfort and energy performance of buildings
- Development of actively controlled lighting and shading devices that are optimized with respect to criteria such as energy, cost and visual comfort

Knowledge Generated/Products Developed

- An ideation session was conducted at SGRI in which about 40 new daylighting concepts were developed. Out of these, seven were shortlisted for detailed evaluation and a few potentially patentable designs have been developed
- Existing solutions for static and rotatable light shelves have been evaluated through simulations. A laboratory prototype was constructed. Heat and light measurements were taken using the concept of rotatable light shelves
- The data was analyzed statistically and the performance of the light shelf was evaluated for various configurations. The experiments showed that about 21% increase in illuminance can be achieved using horizontal light shelves made of aluminum or glass mirror. By rotating the external light shelf, almost three fold increase in illuminance is achieved without much infra-red transmission

Principal Collaborators

Benny Raphael
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Arunvel T
SGRI Chennai

Publications

- No. of publications in Journals: 1
- No. of papers presented in conferences: Nil

An experimental chamber with a rotatable light shelf
Ongoing Project

DEVELOPMENT OF DESIGN GUIDELINES FOR BUILDING ENVELOPES IN TROPICAL CLIMATES

CEFI/PPP/SGRI/2014/3  Mar 2015 to Feb 2018

Background

This project aims at developing a set of design guidelines for building envelop for minimum energy consumption in the building for space cooling/heating and lighting. This design methodology is specific to tropical climates with special reference to Indian subcontinent [with 5 (earlier 6) climatic zones]. The occupancy classes targeted are small and medium sized conditioned residential buildings. The design guidelines will be obtained through an optimization scheme using a multi objective optimization. Using the algorithm, the optimal solution for several cases would be arrived at, with kind of building façade construction available at the moment. Hence a survey of currently available wall and roof construction including glasses and skin for fenestration covers for building envelope is required and will be done. The properties of materials in the construction would be taken from available sources. Using the optimization procedure proposed the best and near best solutions and the values of all decision variables would be obtained for various cases and consolidated to obtain design guide lines for different climatic zones.

Objectives

• To carry out the comprehensive literature survey on:
  – Type of wall and roof construction used now in India and rest of the world
  – Their relevant properties in the context of building design
• To develop an analytical model for Optimization as proposed in the summary
• To validate the model with available robust commercial software
• To propose design solution based on obtained results

Knowledge Generated/Products Developed

• A MATLAB code for the calculation of thermal properties of the multi-layer building construction material have been developed
• A program for the calculation of cooling load of a building using transmission matrix method have been developed
• The validation of the above program with the real time data and simulation software has been completed
• The formulation of single objective optimization model is complete and some results have been obtained for thermal performance of buildings in three representative climate zones
• Two optimization tools were compared to determine the best optimization tool which gives robust solutions in lesser time (hybrid and GA)
• A validation study has been done to check the adequacy of the existing sky models to predict the sky luminance distribution in tropical climates by comparing with the Indian design sky

Principal Collaborators

B Bhattacharjee
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New Delhi

Vinay Natarajan
SGRI Chennai

Arunvel T
SGRI Chennai

Publications

• No. of publications in Journals: Nil
• No. of papers presented in conferences: Nil

Comparison of GA and Hybrid Model for Delhi Climate
Ongoing Project

CONTROLLED EXPERIMENT FOR ESTIMATING THE ENERGY SAVING POTENTIAL AND INDOOR THERMAL COMFORT IMPROVEMENT BY USE OF HIGH ALBEDO SURFACES ON PITCHED CONCRETE ROOFS

CEFI/PPP/SGRI/2014/4  Mar 2015 to Dec 2017

Background

In India there is an increase in trend of high end homes and resort to have steep sloped roofs particularly in places with high precipitation and coastal regions. Based on the market input collected by the collaborator SGRI, shingles are preferred to be used in sloped roofs for better moisture management, thermal benefits and aesthetics.

Currently there are only very few studies and standards for choosing the roof albedo for sloping roofs. Energy Conservation Building Code (ECBC) prescribes roof albedo only for low sloped roofs (less than 20° from the horizontal).

To understand the effects of high albedo roof and to test future materials and technologies developed by industries, it is proposed to have test huts in two different climatic zones of India. Using this ground data a virtual model will be created using energy simulation programs, which will help in quickly understanding the benefits of cool roofs.

Objectives

- Quantify the energy saving potential and comfort improvements by using high albedo pitched roofs
- Update the existing cool roof calculator to perform simulation for sloped roof buildings

Knowledge Generated/Products Developed

- A test facility with two near identical test chambers have been constructed in two climatic zones (Hot & Humid Chennai, Temperate Delhi)
- These huts have been instrumented to monitor temperature, heat flux and energy consumption
- The huts have been calibrated against in the same location and a baseline has been established to monitor performance of high albedo roofs (Chennai huts have a baseline of 91% match between the test chambers, Bhiwadi huts have a baseline of 94% between the test chambers)
- A Solar reflective shingle has been used which has a solar reflectivity of 0.4 (typical shingle has a solar reflectivity of 0.2)
- Since shingles are used for aesthetics these solar reflective shingles retain the same colour as regular shingles (visible spectrum) and reflect solar radiation in Near Infra-red spectrum
- An virtual model has been created in EnergyPlus to model the energy performance and this model will be calibrated with the data collected from the huts

Principal Collaborators

Dr. Vishal Garg
International Institute of Information Technology, Hyderabad

Mr. Rathish Arumugam
Saint-Gobain Research India Pvt. Ltd., Chennai

Publications

- No. of publications in Journals: Nil
- No. of papers presented in conferences: Nil

Test huts during calibration phase (Near identical construction)
6. Analysis of Scientific Activities
The Indo-French S & T cooperation, which has spanned over last several decades took the shape of a Bilateral Centre (CEFIPRA) in 1987 to harness the complementary strengths of Indian and French scientific communities and to streamline the different ongoing activities through a proper organizational mechanism in addition of its Collaborative Scientific Research Programme (CSRP) and Industry-Academia Research & Development Programme (IARDP) and Seminars/Workshops etc. The Governing Body in its 25th meeting directed to expand the mandate of CEFIPRA. Accordingly, CEFIPRA added newer programmes into its portfolio like Targeted Programmes with National Funding Agencies of India and France, Dedicated Student Mobility Support Programmes, Public Private Partnerships (PPPs) Programmes, Utilization of Large Scale Facilities etc.

In year 2016-17, eighteen new projects were initiated under the Collaborative Scientific Research Programme (CSRP) of CEFIPRA, while 66 projects were ongoing from the previous years, out of which, 22 were completed during the period. During two calls in the year 2016-17, CEFIPRA received 120 new proposals. CEFIPRA reviewed 121 new proposals (120 fresh proposals and one deferred proposal) in its 57th and 58th Scientific Council (SC) meetings. Out of these, 16 proposals were recommended for support by the Scientific Council in its two meetings. A total of 19 ongoing projects were reviewed during mid-term of the project cycle in the areas of Computational Science, Life and Health Sciences, Materials Science, Pure and Applied Chemistry, Pure and Applied Physics, Pure & Applied Mathematics, Earth & Planetary Sciences and Biotechnology. Figure 1 below, depicts the status of total number of CEFIPRA projects handled w.e.f. from 1st April 2016 to 31st March 2017.
New Projects Commenced:

The SC evaluated the scientific merit of the 121 proposals on the basis of comments from the referees and discussions amongst the members. As a result, the Scientific Council in its 57th and 58th meetings, recommended and accepted 16 proposals for funding. However, two recommended proposals from previous year also started during the period. The thrust area-wise distribution of the proposals received and recommended for support during the year 2016-17 is given in figures 2 and 3. From the figures 2, 3, 4 and 5, it is prominent that the areas of Life and Health Sciences, Materials Science and Pure & Applied Physics continue to have a higher share of the proposals received and recommended.

A total of 18 new projects were initiated during the year 2016-17 and figure 4 depicts the thrust area-wise distribution of projects commenced.
Ongoing Projects:
As on 31st March 2017, 44 projects (excluding 18 new projects) were under implementation at various Indian and French research institutes. During the two Scientific Council meetings, the members carefully monitored the mid-term progress of 19 ongoing projects and suggested their assessments for smooth operation of projects. In figure 5, an area-wise distribution of ongoing projects is depicted.

Figure 4- Area-wise Distribution of New Projects Initiated

Figure 5- Area-wise Distribution of Ongoing Projects
Completed Projects:

Twenty two projects, completed during the reported year, were reviewed in two Scientific Council meetings during the year (figure 6). The Scientific Council had graded the projects based on the achievements made vis-à-vis aims and objectives, the number and quality of publications including joint publications and the scientific excellence of the research outputs. Out of twenty two completed projects, the performance index of fifteen projects were rated as ‘Excellent’, four as ‘Very Good’, two as ‘Good’ and one as ‘Satisfactory’ by Scientific Council during final review of the projects.

The 15 projects (65%) graded as ‘Excellent’ were from the areas of Astrophysics, Immunology, Oceanography, Quantum Physics, Nanotechnology etc. Additionally, 4 projects (17%) graded as ‘Very Good’ were in the areas of Genetics, Nanotechnology, Machine Learning etc. A total of 21 projects underwent for the final review and 1 was pre-closed.

A total of 100 persons as Human Resource Development (69 in India & 31 in France) were supported through training, comprising of Doctoral and Post-Doctoral students and 127 mobility/exchange visits (60 from India to France and 67 from France to India) were supported (figure 7) under 22 completed projects.

![Figure 6- Area-wise Distribution of Completed Projects](image)

![Figure 7- Outcomes in terms of Exchange Visits and HR supported under completed projects.](image)
The break-up of the exchange visits/mobility support of the 22 completed projects shows that there were total 127 visits under completed projects in year 2016-17. In figure 8, subject-wise analysis indicates that maximum exchange visits were in Earth & Planetary Sciences (28) followed by Pure & Applied Physics (21), Computational Science (21) and Life & Health Sciences (19).

**Significant Process Developed and it’s Potential for Knowledge Forward Chain under Completed Projects**

**Life and Health Sciences**
- An Agilent oligonucleotides 58K microarray has been specifically designed for any kind of, without a priori transcriptomics, studies to be developed in the Indian catfish, *H. fossilis* (4603-3)
- Discovery and characterization of Hox Associated PTMs and protein domains: functional and structural characterization (4703-2)
- Identification of biomarker and therapeutic molecules, important in therapy of tuberculosis (4803-1)
- A novel method developed to conjugate DNA to quantum dots directly (4803-2)
- Characterization of several endosomal Rab GTPases that regulate different protein trafficking steps from different endosomal domains during melanosome biogenesis done (4903-1)
- Used hiPSC for drug discovery platforms (4903-2)

**Pure & Applied Physics**
- Imaging in actual fog was performed in field over distance of 1.3 km using polarimetric imaging with a Wollaston-based snapshot polarimetric camera (4604-4)
- Developed an equation of motion approach for the single-impurity Anderson model in non-equilibrium conditions (4704-2)
- Boundary layer flow along a rotating cylinder - Base flow completely documented and published (4704-3)
- Flow reversals and condensate states in Kolmogorov flow in two-dimensional geometry; excellent agreement between the simulations and experiments (4904-1)
- Design and fabrication of the Diamond Anvil Cell for electrical resistivity and magnetization measurements suitable for PPMS and VSM (4904-2)
Analysis of Scientific Activities

**Pure and Applied Chemistry**
- A novel high enthalpy flow reactor was established at the University of Rennes (4905-1)
- A new glycosidation methodology was identified. A series of arabinofuranosyl lipids present on the cell surface of the *Mycobacterium tuberculosis* was synthesized and shared with ENSCR, France. The protocol that was developed during the course of the project has long term ramifications as this philosophy can be applied to the synthesis of wide range of glycolipids (5105-1)

**Environmental Science**
- Identification of protein involved in regulation of nitrate transport (4609-1)
- A new process/protocol to construct sized eukaryotic cDNA libraries using low input of total environmental RNA from soil samples was developed. This technique is simple and cost effective. It will facilitate the cloning of environmental expressed eukaryotic genes to contribute for a better understanding of basic biological and/or ecological processes carried out by eukaryotic microbial communities (4709-1)

**Computational Science**
- The iterative Bayesian update rule developed as part of study has already been used by other French researchers in a machine learning context of identifying an odd arm with minimal delay and vanishing probability of error. Inria team has also applied for the industrial grant suggesting further studies of Whittle index based and stochastic approximation based techniques for optimization of several technological processes in a search engine (5100-IT-1)

**Earth & Planetary Sciences**
- Assembled teleseismic data registered at all the Indian broadband seismological stations; Characterized the seismic structure and deformation through application of recent methodologies (4707-1)
- A statistical forecast models for TCs intensity change has been developed which can greatly benefit the agencies responsible for operational TCs forecast (4907-1)
- Major periods of lateritic weathering identified by radiometric (40Ar/39Ar) dating of K-Mn oxides, and paleomagnetism of Fe-oxides (5007-1)

**Materials Science**
- The demonstration of large anisotropy magnetic systems is a way forward for obtaining molecular systems with large blocking temperatures which could be useful in developing applications involving molecular materials (4808-1)

**Pure & Applied Mathematics**
- Study of the Heckman-Opdam hypergeometric functions on the root system BC for some natural classes of non-positive multiplicities: positivity, estimates, asymptotic expansions(5001-1)

**Publications Emanated from Completed Projects**
The 22 completed projects have resulted in 140 publications. The areas of Life Health Sciences, Pure and Applied Physics and Materials Science (figure 9) are having highest share of publications. These research publications have been published in reputed peer reviewed journals such as Cell Host and Microbe, Physical Review Letters, Science Signalling, ACS Applied Materials and Interfaces, Current Opinion in Structural Biology, Plos Genetics, Journal of Materials Chemistry C, Development, Cell Death and Disease and Other Scientific Reports.
The completed projects based on sum of impact factor as per NISCAIR (CSIR) study are as follows-

<table>
<thead>
<tr>
<th>Projects Title/Number</th>
<th>Papers</th>
<th>Sum-IF</th>
<th>Avg. IF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular mechanisms of immune evasion of <em>M. tuberculosis</em> (4803-1)</td>
<td>2</td>
<td>21.375</td>
<td>10.688</td>
</tr>
<tr>
<td>Integrating hox and chromatin mediated transcriptional regulation (4703-2)</td>
<td>2</td>
<td>13.587</td>
<td>93.382</td>
</tr>
<tr>
<td>Nutrient sensing in plants (4609-1)</td>
<td>2</td>
<td>11.650</td>
<td>5.825</td>
</tr>
<tr>
<td>Kinetics and spectroscopy in extreme environments: Applications to Astro-physics and Astro-chemistry (4905-1)</td>
<td>5</td>
<td>10.875</td>
<td>2.175</td>
</tr>
<tr>
<td>Study of neural developments in hiPS models of microcephaly (4903-2)</td>
<td>2</td>
<td>9.580</td>
<td>4.790</td>
</tr>
<tr>
<td>Real time imaging through for over long distance (RTIFOLD) (4604-4)</td>
<td>3</td>
<td>9.413</td>
<td>3.138</td>
</tr>
<tr>
<td>Correlations and transport far from equilibrium in nanosystems (4704-2)</td>
<td>3</td>
<td>7.989</td>
<td>2.663</td>
</tr>
<tr>
<td>Cenozoic denudation of South India (5007-1)</td>
<td>2</td>
<td>7.982</td>
<td>32.686</td>
</tr>
<tr>
<td>Reversals of a large scale field on a turbulent background (4904-1)</td>
<td>3</td>
<td>4.329</td>
<td>9.451</td>
</tr>
<tr>
<td>Study of neural developments in hiPs models of microcephaly (4903-1)</td>
<td>1</td>
<td>4.279</td>
<td>18.310</td>
</tr>
</tbody>
</table>

Table 1: Some of Completed Projects Based on Sum of Impact Factor [Source: CEFIPRA-NISCAIR (CSIR) Study]

Industry Academia Research & Development Programme (IARDP)

Five projects were ongoing during the year and one project was completed. The area-wise distribution of ongoing & completed projects is given in figure 10.

The 28th Meeting of the Industrial Research Committee was held on 20-21st May, 2016 at Tours, France and 29th Meeting on 26-27th November, 2016 at Varanasi, India. During these meetings, the Committee considered fifteen proposals and five were considered for support in areas of E-Transport, 3D Printing, Hemophilia & Printing Techniques. A total of 4 projects underwent for the mid-term review (EMAT, D2D, INDIRA-B and Tilling) and 1 project (FIRST) for final review.
Significant Outcomes under IARDP projects

**FIRST Project**
- FIRST Rural Integration Hub
- FIRST Mobile App store and Remote Management System (RMS)
- TSM for Secure Element (SE) Management
- Financial Inclusion with VM/Virtual Coins

**TILLING Project**
- The Long Shelf Life line prototype developed from the project entitled “Tilling in cucurbits: a non-transgenic reverse genetic approach for muskmelon crop improvement” and development of gynoecious line prototype is underway

### Non-Core Programmes

Under the Non-Core Programmes, CEFIPRA acted as a facilitator for different programmes with Indian National Funding Agencies like Department of Science and Technology (DST) and Biotechnology Industry Research Assistance Council (BIRAC) with French funding agencies like French National Research Agency (ANR), French National Institute for Agricultural Research (INRA) and French Institute for Research in Computer Science and Automation (Inria) for collaborative research. Figure 11 depicts the thrust area-wise distribution of ongoing projects under the Targeted Programmes (DST-ANR, DST-INRA, DST-Inria), BIRAC-CEFIPRA-French Embassy in Health Care Technology and Indo French Water Network (IFWN).

Figure 11- Area-wise Distribution of Ongoing Projects under Different Non-Core Programmes
Spatial Aspects of Analysis

Activities of CEFIPRA have a broad spatial footprint across the S&T ecosystem and institutional landscape of India and France. This shows CEFIPRA’s ability to reach out to a significant proportion of S&T stakeholders across the two countries. The participating states/regions of India and France with respective numbers of collaboration are depicted in the following maps.

Figures below show the cities in India and France that have attracted maximum number of Collaborative Scientific Research Projects.
Thematic Distribution of Projects in India

The following three Indian maps are showing the spatial heterogeneity with respect to completed (22) ongoing (44) and new initiated (18) Collaborative Scientific Research Projects of CEFIPRA in different subject domains.
Geographic Distribution of Projects in France

Map 5

Geographic Distribution of Projects in France

- Completed (22)
- Ongoing (44)
- New (18)
Thematic Distribution of Projects in France

The following three French maps are showing the spatial heterogeneity with respect to completed (22) ongoing (44) and new initiated (18) Collaborative Scientific Research Projects of CEFIPRA in different subject domains.
7. Mobility Support of Scientists & Students under Research Projects
Mobility of Scientists & Students

Mobility of Scientists and researchers across international barriers offer a wide range of benefits. Apart from personal development and career enhancement, researchers benefit from diversifying their competence by working on projects in universities/companies in countries other than their own. CEFIPRA provided support to concerned scientists and students for exchange visits. These visits between the collaborating groups are an important aspect of scientific research projects. These visits are usually intended to carry out a designated set of experiment/s related to the project and can also led to a transfer of experimental material, protocol or methodology and ideas across the participating laboratories. Academic interaction is significantly enhanced by these visits for the researchers/institutions. At country level, mobility enhances international competitiveness. In addition, exchange visits also provide an opportunity for cultural exchanges. The visits undertaken during the year from April, 2016 to March, 2017 under programmes are given below in a tabular form.

### Mobility of Scientists Supported Under CEFIPRA Projects from April, 2016 to March, 2017

#### April - June 2016

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Project Title</th>
<th>Name &amp; Institute Affiliation (From)</th>
<th>Name &amp; Institute Visited (To)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Understanding mechanical size effects in metallic micro wires: synergy between experiments &amp; simulation</td>
<td>Prof. Ludovic Thilly, Université de Poitiers, Poitiers</td>
<td>Prof. Atul Chokshi, Indian Institute of Science, Bangalore</td>
</tr>
<tr>
<td>2</td>
<td>Understanding mechanical size effects in metallic micro wires: synergy between experiments &amp; simulation</td>
<td>Prof. Loïc Signor, Université de Poitiers, Poitiers</td>
<td>Prof. Atul Chokshi, Indian Institute of Science, Bangalore</td>
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<tr>
<td>3</td>
<td>Design and synthesis of new C1 symmetric biaryl based ligands and catalysts and their evaluation in asymmetric catalytic reactions</td>
<td>Dr. Armen Panossian, Laboratoire de Chimie Moleculaire, UMR CNRS, 7509, COHA-lab, University of Strasbourg, Strasbourg</td>
<td>Dr. Pradeep Kumar, National Chemical Laboratory, Pune</td>
</tr>
<tr>
<td>4</td>
<td>Survey of soil Si pools and contribution of Si fertilization in a sustainable rice cultivation in South India</td>
<td>Dr. Doris Barboni, CEREGE, UM 34 Aix Marseille Université, CNRS, IRD, Aix en Provence</td>
<td>Dr. N.B. Prakash, University of Agricultural Sciences, Bangalore</td>
</tr>
<tr>
<td>5</td>
<td>Glycochemical studies of Mycobacterial Arabinomycolate</td>
<td>Dr. Loïc Lemiègre, Ecole Nationale Superieure de Chimie de Rennes, Rennes</td>
<td>Dr. Srinivas Hotha, Indian Institute of Science Education and Research, Pune</td>
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<td>Dr. Srinivas Hotha Indian Institute of Science Education and Research, Pune</td>
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<tr>
<td>8</td>
<td>Collective migration in the fly nervous system</td>
<td>Dr. Angela Giangrande IGBMC, Illkirch Strasbourg</td>
<td>Prof. K. Vijayaraghavan National Centre for Biological Science, Bangalore</td>
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<tr>
<td>9</td>
<td>Kinetics and spectroscopy in extreme environments: Applications to Astrophysics and Astrochemistry</td>
<td>Dr. Robert Georges UMR6251 CNRS - Université de Rennes 1, Rennes</td>
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<td>12</td>
<td>Self similar optical patterns in non linear media</td>
<td>Prof. Philippe Grelu Université de Bourgogne UMR CNRS N°6303, Dijon</td>
<td>Prof. K Porsezian Pondicherry University Pondicherry</td>
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<td>13</td>
<td>Effect of correlations in the statics and dynamics extended system</td>
<td>Dr. Sanjib Sabhapandit Raman Research Institute Bangalore</td>
<td>Prof. Alberto Rosso Laboratoire de Physique Theorique et Modeles Statisques, Université Paris Sud, Orsay</td>
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<td>14</td>
<td>Correlated studies of response properties of open shell molecules in the relativistic framework</td>
<td>Dr. Debashis Mukherjee Indian Association of Cultivation of Science Kolkata</td>
<td>Prof. Trond Saue Laboratoire de Chimie et Physique Quantiques Universite de Toulouse 3 Paul Sabatier, Toulouse</td>
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<td>15</td>
<td>Holography and its applications</td>
<td>Mr. Abhishek Chowdhury Harish Chandra Research Institute, Allahabad</td>
<td>Prof. Nicholas Halmagyi Laboratoire de Physique Théorique et Hautes Energies - LPTHE, Paris</td>
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<td>16</td>
<td>Molecular study of RH gene variants in Indians</td>
<td>Dr. Swati Kulkarni National Institute of Immunohaematology Mumbai</td>
<td>Dr. Yann Fichou INSERM UMR 1078 Etablissement Français du Sang – Bretagne, Brest</td>
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<td>17</td>
<td>Host-Virus Interactions and Antibody Therapy for Japanese Encephalitis</td>
<td>Ms. Anupama Karnam Indian Institute of Science Bangalore</td>
<td>Dr. Sebastian Lacroix Desmazes INSERM UMRS 1138, Centre de Recherche des Cordiliers Escalier, Paris</td>
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<td>18</td>
<td>Theoretical studies on ultra-cold dipolar gases</td>
<td>Prof. Rejish Nath Indian Institute of Science Education and Research Pune</td>
<td>Prof. Paolo PEDRI Laboratoire de Physique des Lasers-CNRS UMR 7538, Université Paris 13, Institut Galilée Villetaneuse</td>
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<td>20</td>
<td>Novel nanocatalysts synthesis guided by DNP NMR</td>
<td>Prof. Ullas Kolthur Seetharaman Tata Institute of Fundamental Research Mumbai</td>
<td>Dr. Anne Gonzalez de Peredo Institut de Pharmacologie et de Biologie Structurale Toulouse</td>
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<td>21</td>
<td>Studying the interactome of NAD-dependent deacetylase Sirt1 in the testis</td>
<td>Prof. Rejish Nath Indian Institute of Science Education and Research Pune</td>
<td>Prof. Paolo PEDRI Laboratoire de Physique des Lasers-CNRS UMR 7538, Université Paris 13, Institut Galilée Villetaneuse</td>
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<td>22</td>
<td>Extreme QCD in the LHIC era</td>
<td>Prof. Rajeev Bhalerao Tata Institute of Fundamental Research Mumbai</td>
<td>Prof Jean Yves Ollitrault IPhT-Institut de Physique Théorique, Centre de Saclay-Orme Des Merisiers, Gif sur Yvette Cedex</td>
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<td>23</td>
<td>Reversals of a large scale field on a turbulent background</td>
<td>Prof. Mahendra Kumar Verma Indian Institute of Technology Kanpur Kanpur</td>
<td>Prof. Stephan Fauve Laboratoire de Physique Statistiques, Ecole Normale Superieure Paris</td>
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<td>24</td>
<td>H2 Evolution : Cheap catalysts for noble task</td>
<td>Prof. Abhishek Dey Indian Association of Cultivation of Science, Kolkata</td>
<td>Dr. V. Artero CEA Grenoble, Université Grenoble Alpes</td>
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<tr>
<td>25</td>
<td>Glimpses of new Physics</td>
<td>Dr. Gautam Bhattacharya Saha Institute of Nuclear Physics Kolkata</td>
<td>Dr. Emilian Dudas Ecole Polytechnique Palaiseau</td>
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<td>26</td>
<td>Glimpses of new Physics</td>
<td>Dr. Sudhir Vempati Indian Institute of Science Bangalore</td>
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<td>27</td>
<td>Flexible thermoelectric devices</td>
<td>Dr. D.K. Aswal BARC, Mumbai</td>
<td>Dr. Mohd. Chehimi ICMPE, Universite Paris EST Creti Val de Marne</td>
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<td>28</td>
<td>High anisotropy molecular magnets: Synthesis &amp; Modelling</td>
<td>Prof. S. Ramasesha Indian Institute of Science Bangalore</td>
<td>Prof. Jean Pascal Sutter Laboratoire de Chimie de Coordination du CNRS Toulouse</td>
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<td>29</td>
<td>Mechanisms of new long-lasting luminescence biomarkers</td>
<td>Prof. Kaustubb Priolkar Goa University Goa</td>
<td>Dr. Aurélie Bessiere Institut de Recherche de Chimie Paris</td>
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<td>30</td>
<td>Studying the role of rpoN the alternative sigma factor, in the pathogenicity of R solanacearum the causal agent of bacterial wilt in plants</td>
<td>Prof. Suendra Kumar Ray Tezpur University Tezpur</td>
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<td>Axially chiral biaryls from C-H activation &amp; radicals</td>
<td>Dr. Rajendra K. Reddy Indian Institute of Chemical Technology Hyderabad</td>
<td>Dr. Françoise Colobert ECPM-Chimie Moleculaire Université de Strasbourg Strasbourg</td>
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<td>32</td>
<td>Cenozoic denudation of South India</td>
<td>Dr. Shazia Janwary University of Hyderabad Hyderabad</td>
<td>Dr. Anicet Beauvais IRD, CEREGE, Aix Marseille Universite, Aix en Provence</td>
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<td>33</td>
<td>Gene resources from contaminated sites</td>
<td>Dr. M. Sudhakara Reddy Thapar University, Patiala</td>
<td>Dr. Fraissinet Tachet Universite de Lyon Villeurbanne</td>
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<td>34</td>
<td>Symmetries and dynamics: worldsheet and spacetime</td>
<td>Dr. Debasish Ghoshal School of Physical Sciences, Jawaharlal Nehru University New Delhi</td>
<td>Prof. Ruben Minasian Institut de Physique Théorique CEA-Saclay</td>
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<td>35</td>
<td>Sums of integers: Fourier, combinatorics, computation</td>
<td>Prof. Shanta Laishram Indian Statistical Institute New Delhi</td>
<td>Prof. Jean Marc Deshouillers Institut Mathematique de Bordeaux Universite de Bordeaux, and Marseille St. Etienne (CO Pis)</td>
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<tr>
<td>36</td>
<td>Self similar optical patterns in nonlinear media</td>
<td>Prof. K. Porsezian Pondicherry University Puducherry</td>
<td>Prof. Philippe GRELU Laboratoire Interdisciplinaire Carnot de Bourgogne Universite de Bourgogne, Dijon</td>
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| 37    | Phosphorus-supported multisite coordinating ligands for the assembly of polynuclear heterometallic (3d-4f) and homonuclear (3d) ensembles: Towards a new generation of molecular magnetic materials | Prof. V. Chandrasekhar  
Tata Institute of Fundamental Research  
Hyderabad                                                                 | Dr. Hab.Rodolphe Clerac  
Universite Bordeaux, Pessac                                         |
| 38    | Insights on protein structural and evolutionary dynamics                       | Prof. Narayanaswamy Srinivasan  
Indian Institute of Science  
Bangalore                                                               | Dr. Alexandre De Brevern  
Université Paris Diderot  
Paris                                                                    |
| 39    | Adaptation of irrigated agriculture to climate change                          | Prof. Sekhar Muddu  
Indian Institute of Science  
Bangalore                                                               | Dr. Laurent Ruis  
INRA Science & Impact Rennes  
UMR LERNA Toulouse  
UMR EMMAH Avignon                                                        |

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| 1     | sp3 C-H Bond Activation with Ruthenium(II) Catalysts: Application to the Synthesis of Aliphatic N-Heterocyclic Natural Products | Dr. Mathieu Achard  
Université de Rennes 1, UMR6226 : Institut des Sciences Chimiques de Rennes, Rennes | Dr. G. V. M. Sharma  
CSIR-Indian Institute of Chemical Technology  
Hyderabad                                                          |
| 2     | Original biocompatible phosphorus dendrimers as a new strategy to tackle pulmonary tuberculosis | Dr. Serge Mignani  
Laboratoire de Chimie de Coordination  
Toulouse                                                             | Prof. Kishore K Srivastva  
Central Drug Research Institute  
Lucknow                                                              |
| 3     | Original biocompatible phosphorus dendrimers as a new strategy to tackle pulmonary tuberculosis | Dr. Jean-Pierre Majoral  
Laboratoire de Chimie de Coordination  
Toulouse                                                             | Prof. Kishore K Srivastva  
Central Drug Research Institute  
Lucknow                                                              |
| 4     | Correlated studies of response properties of Open-shell molecules in the relativistic Framework | Dr. Trond Saue  
Université de Toulouse 3  
Toulouse                                                              | Prof. Ankan Paul  
Indian Association for the Cultivation of Sciences  
Kolkata                                                            |
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| 5     | Hypergeometric functions: harmonic analysis and representation theory          | **Dr. Angela Pasquale**  
Université de Lorraine – Metz Nancy | **Dr. E. K. Narayanan**  
Indian Institute of Science  
Bangalore |
| 6     | Sums of integers: Fourier, combinatorics, computation                          | **Prof. Jean-Marc Deshouillers**  
Institut Mathématique de Bordeaux  
Talence | **Prof. Balasubramanian Ramachandran**  
The Institute of  
Mathematical Sciences  
Chennai |
| 7     | Molecular mechanisms of immune evasion by *M. Tuberculosis*                    | **Prof. Jagadeesh Bayry**  
INSERM, Centre de Recherche des  
Cordeliers, Paris | **Prof. K.N. Balaji**  
Indian Institute of Science  
Bangalore |
| 8     | CHROmITe: Assessment of CHromium Release from sukinda mining Overburden: an  
IsoTopic, chemical, physical and microbiological study                         | **Prof. Yann Sivry**  
Institut de Physique du  
Globe de Paris, Paris | **Prof. S. Subramanian**  
Indian Institute of Science  
Bangalore |
| 9     | Advanced time-domain integration schemes for the simulation of Earth and  
planetary core dynamics                                                           | **Dr. Binod Srinivasan**  
Indian Institute of Science  
Bangalore | **Dr. Alexandre Fournier**  
Institut de Physique du Globe  
Paris |
| 10    | Study of neural development in hiPS models of microcephaly                     | **Dr. Shyamala Mani**  
Indian Institute of Science  
Bangalore | **Dr. Pierre Gressens**  
INSERM, Hôpital Robert Debre  
Paris |
| 11    | Molecular mechanisms of immune evasion by *M. Tuberculosis*                    | **Dr. K.N. Balaji**  
National Centre for Biological Sciences  
Bangalore | **Prof. Benoit Dubertret**  
Laboratoire de Physique et d'Etude des Matériaux  
Paris |
| 12    | LORIC: LOng-Range Interactions in ultraCold gases                              | **Dr. Sadiq Abbas Rangwala**  
Raman Research Institute  
Bangalore | **Dr. Olivier Dulieu**  
Laboratoire Aimé Cotton  
Orsay |
| 13    | Hypergeometric functions: harmonic analysis and representation theory          | **Prof. E.K. Narayanan**  
Department of Mathematics  
Bangalore | **Prof. Angela Pasquale**  
Université de Lorraine – Metz  
Vandoeuvre Nancy |
| 14    | Survey of soil-Si pools and contribution of Si fertilization in a sustainable  
rice cultivation in South India                                                   | **Dr. G.G. Kadali**  
University of Agricultural Sciences  
Bangalore | **Dr J.D. Meunier**  
CEREGE-Université d’Aix-Marseille III  
Marseille |
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<tr>
<td>15</td>
<td>Monte Carlo and learning schemes for network analytics</td>
<td>Prof. V.S. Borkar Indian Institute of Technology-Bombay Mumbai</td>
<td>Dr. Konstantin Avrachenkov Inria Sophia Antipolis – Méditerranée Nice</td>
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<td>16</td>
<td>Olfactory modulation of insect flight</td>
<td>Prof. Sanjay Sane National Centre for Biological Sciences, TIFR Bangalore</td>
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### October - December, 2016

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<td>1</td>
<td>Decipher the symbiotic program in tropical legumes</td>
<td>Dr. Maitrayee Dasgupta Department of Biochemistry University of Calcutta Kolkata</td>
<td>Dr. Fabienne Cartieaux Laboratoire des Symbioses Tropicales &amp; Méditerranéennes (IRD) Montpellier</td>
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<td>Radio properties of clusters and galaxy lenses</td>
<td>Prof. Joydeep Bagchi Inter University Centre for Astronomy and Astrophysics Pune</td>
<td>Dr. Bruno Guiderdoni Centre de Recherche Astrophysique de Lyon, Saint Genis Laval</td>
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## Mobility Support to Students

**October - December, 2016**

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<td>Deep structure of the Indian continent</td>
<td><strong>Dr. Ravi Kumar</strong> National Geophysical Research Institute Hyderabad</td>
<td><strong>Prof. Jean Paul Montagner</strong> Institut de Physique du Globe Paris</td>
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<td>9</td>
<td>Magnetic nanoparticles for hyperthermia and spintronics</td>
<td><strong>Mr. Manish Anand</strong> Indian Institute of Technology-Delhi New Delhi</td>
<td><strong>Mr. Julian Carrey</strong> Laboratoire de Physique et Chimie des Nano-Objets INSA Toulouse, Toulouse</td>
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<td>10</td>
<td>Catecholestrogens in fish reproductive endocrinology</td>
<td><strong>Dr. Radha Chaube</strong> Banaras Hindu University Varanasi</td>
<td><strong>Dr. Alexis Fostier</strong> Institut National de la Recherche Agronomique INRA Rennes</td>
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<td>11</td>
<td>Novel inhibitors of NHEJ against resistant tumour cells</td>
<td><strong>Dr. Sathees Raghavan</strong> Indian Institute of Science Bangalore</td>
<td><strong>Dr. Jean-Baptiste Charbonnier</strong> Institute of Biology and Technologies of Saclay Gif-sur-Yvette</td>
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<td>Holography and its Applications</td>
<td><strong>Mr. Ashish Shukla</strong> Tata Institute of Fundamental Research Mumbai</td>
<td><strong>Dr. Nick Halmagyi</strong> Chargé de Recherche, CNRS UPMC Université Sorbonne Paris</td>
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<td>13</td>
<td>Controlling for upscaling uncertainty in assessment of forest aboveground biomass in the Western Ghats of India</td>
<td><strong>Mr. Rakesh</strong> National Remote Sensing Centre Hyderabad</td>
<td><strong>Dr. Pierre Couteron</strong> Botanique et bioinformatique de l'Architecture des Plantes Montpellier</td>
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<td>Muscle SC self-renewal: A stressful matter?</td>
<td><strong>Prof. Jyotsna Dhawan</strong> Tata Institute of Fundamental Research Bangalore</td>
<td><strong>Dr Ana Ferreiro</strong> Institut National de la Santé et la Recherche Médicale Paris</td>
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<td>Plasticity of covalent nanoparticles</td>
<td>Dr. Laurent Pizzagalli CNRS-ISAE-ENSMA Université de Poitiers Futuroscope</td>
<td>Prof. Umesh Waghmare Indian Institute of Science Bangalore</td>
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<td>19</td>
<td>Plasticity of covalent nanoparticles</td>
<td>Ms. Celine Gernard CNRS-ISAE-ENSMA Université de Poitiers Futuroscope</td>
<td>Prof. Umesh Waghmare Indian Institute of Science Bangalore</td>
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<td>20</td>
<td>Rotating and curved boundary-layer instabilities</td>
<td>Dr. Benoit Pier Laboratoire de Mecanique des fluids et d’acoustique Ecully</td>
<td>Dr. Rama Govindaraj Tata Institute of Fundamental Research Hyderabad</td>
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<td>Prof. Suvendra Kumar Ray Tezpur University Tezpur</td>
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<td>22</td>
<td>Characterisation of factors that determine the balance between genomic integrity and diversity in Helicobacter pylori</td>
<td>Dr. J. Pablo Radicella Commissariat à l’Energie Atomique CEA Fontenay aux Roses</td>
<td>Prof. Desirazu Narasimha Rao Indian Institute of Science Bangalore</td>
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<td>23</td>
<td>Control of melanosome biogenesis by small GTPases</td>
<td>Dr. Guillaume Van Niel JC Institut Curie Paris</td>
<td>Dr. Subha Rao Gangi Setty Indian Institute of Science Bangalore</td>
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<td>24</td>
<td>Adaptation of irrigated agriculture to climate change</td>
<td>Dr. Laurent Ruiz Institut National de la Recherche Agronomique Rennes</td>
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<td>25</td>
<td>Host-Virus interactions and antibody therapy for Japanese Encephalitis</td>
<td>Dr. Sebastien Lacroix-Desmazes Institut National de la Santé Et de la Recherche Médicale (INSERM) UMR S 872 –Centre de Recherche des Cordeliers 75006, Paris</td>
<td>Dr Manjula Kalia Translational Health Science and Technology Institute (THSTI) Gurgaon</td>
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<td>26</td>
<td>CEFIPRA- High Impact Scientific Network Programme (Network-2 INFRE-HEPNET)</td>
<td>Dr. Jean-Yves Ollitrault Ollitrault Institut de Physique Théorique, Orme des Merisiers, batiment 774, Point courrier 136 CEA/DSM/IPH CEA/Saclay</td>
<td>Prof. Sourendu Gupta TIFR, Homi Bhabha, Mumbai &amp; Indian Institute of Science Education and Research (IISER) Pune</td>
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### October - December, 2016

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<td>CEFIPRA- High Impact Scientific Network Programme (Network-2 INFRE-HEPNET)</td>
<td><strong>Dr. Susan Gascon-Shotkin</strong> Institut de Physique Nucléaire de Lyon Lyon</td>
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### January-March, 2017

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<tr>
<td>1</td>
<td>Insights on protein structural and evolutionary dynamics</td>
<td><strong>Ms. Himani Tandon</strong> Indian Institute of Science Bangalore</td>
<td><strong>Prof. G Alexandre de Brevern</strong> INSERM UMR-S 665, DSIMB Univ Paris Diderot Paris</td>
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<td>2</td>
<td>Quantum transport in 2D van der waals heterostructures based on graphene and boron nitride</td>
<td><strong>Mr. Hemanta Kumar Kundra</strong> Indian Institute of Science Bangalore</td>
<td><strong>Dr. Vincent Bouchiat</strong> NEEL, CNRS-Grenoble Grenoble</td>
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<td>3</td>
<td>Monte Carlo and learning schemes for network analytics</td>
<td><strong>Prof. R. Sundaresan</strong> Indian Institute of Science Bangalore</td>
<td><strong>Dr. K.E. Avrachenkov</strong> INRIA Sophia Antipolis Sophia Antipolis</td>
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<td>4</td>
<td>H2 evolution: cheap catalysts for noble task</td>
<td><strong>Md. Estak Ahmed</strong> Indian Association for the Cultivation of Science Kolkata</td>
<td><strong>Dr. Vincent Artero</strong> Laboratoire de Chimie et Biologie des Métaux, CEA-Grenoble Grenoble</td>
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<td>5</td>
<td>sp3 C-H Bond Activation with Ruthenium(II) Catalysts: Application to the Synthesis of Aliphatic N-Heterocyclic Natural Products</td>
<td><strong>Dr. G.V Sharma</strong> CSIR-Indian Institute of Chemical Technology Hyderabad</td>
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<td><strong>Dr. S. Suresh</strong> CSIR-Indian Institute of Chemical Technology Hyderabad</td>
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<td>Molybdenum-containing enzymes: bioinspired peptidic catalysts for CO2 reduction</td>
<td><strong>Dr. Surajit Sinha</strong> Indian Association for the Cultivation of Science Kolkata</td>
<td><strong>Dr. Reglier Marius</strong> Institut des Sciences Moléculaire de Marseille, UMR CNRS 7313 Aix Marseille Université Marseille</td>
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<td>Prof. J. Pablo Radicella Institut de Radiobiologie Cellulaire et Moléculaire Commissariat à l’Energie Atomique, (CEA) 18 route du Panorama 92265 Fontenay aux Roses</td>
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<td>10</td>
<td>Network-2 INFRE--Hepnet: Indo--French High Energy Physics Network</td>
<td>Dr. Jean-Yves Ollitrault Ollitrault Institut de Physique Théorique, Orme des Merisiers, batiment 774, Point courrier 136 CEA/DSM/IPhT CEA/Saclay</td>
<td>Prof. Sudhir Kumar Vempati Centre for High Energy Physics Indian Institute of Science Bangalore</td>
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<td>11</td>
<td>N-Heterocyclic Carbene (NHC)-Organocatalyzed enantioselective trifluoromethylation &amp; trifluoromethylthiolation of unactivated C-H bonds</td>
<td>Dr. Tatiana Besset CNRS Researcher (chargée de recherche CR2), Université de Rouen Mont st. Aignan</td>
<td>Dr. Akkattu T Biju CSIR-National Chemical Laboratory Pune</td>
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<td>12</td>
<td>Monte Carlo and learning schemes for network analytics</td>
<td>Dr. Konstantin Avrachenkov INRIA Sophia Antipolis Sophia Antipolis</td>
<td>Prof. Vivek S. Borkar Indian Institute of Technology Bombay Mumbai</td>
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<td>13</td>
<td>Glimpses of new Physics</td>
<td>Ms. Maira Dutra Centre de Physique Théorique Ecole Polytechnique Palaiseau</td>
<td>Dr. Gautam Bhattacharyya Saha Institute of Nuclear Physics (SINP) Kolkata</td>
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<td>14</td>
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<td>Mr. Mathias Pierre Centre de Physique Théorique Ecole Polytechnique Palaiseau</td>
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<td>Self-similar optical patterns in nonlinear media</td>
<td>Dr. Philippe. Grelu UMR 6303 CNRS- Université’ Bourgogne Franche-Comté Dijon</td>
<td>Dr. K. Porsezian Pondicherry University Pondicherry</td>
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<td>16</td>
<td>Arithmetic circuits computing polynomials</td>
<td>Prof. Guillaume Malod Institut Mathématique de Jussieu Université, Paris Diderot UFR de mathématiques Paris</td>
<td>Prof. Meena Mahajan The Institute of Mathematical Sciences Chennai</td>
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<td>Development of carbon nanotube-metal hybrid catalysts</td>
<td><strong>Dr. Eric Doris</strong> Alternative Energies and Atomic Energy Commission (CEA) Saclay, Gif-sur-Yvette Cedex</td>
<td><strong>Dr. Irishi N N Namboothiri</strong> Indian Institute of Technology Bombay Mumbai</td>
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<td>18</td>
<td>Molecular study of RH gene variants in Indians</td>
<td><strong>Dr. Yann Fichou</strong> Etablissement Français du Sang – Bretagne INSERM UMR1078 Brest Cedex 2</td>
<td><strong>Dr. Swati Kulkarni</strong> National Institute of Immunohaematolog KEM Hospital, Parel Mumbai</td>
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<td>19</td>
<td>Molecular analysis of a capacitor Hox protein motif</td>
<td><strong>Dr. Samir Merabet</strong> Centre de Biologie du Développement, 118 route de Narbonne Paris</td>
<td><strong>Prof. Maneesha S Inamdar</strong> Jawaharlal Nehru Centre for Advanced Scientific Research Bangalore</td>
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<td>20</td>
<td>Elucidation of conserved molecular signatures and regulators for blood cell progenitor maintenance</td>
<td><strong>Dr. Lucas Waltzer</strong> Centre de Biologie du Développement, 118 route de Narbonne Paris</td>
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<td>p-adic aspects of automorphic forms and their L-functions</td>
<td>Dr. Mladen Dimitrov CNRS / University Lille 1 Villeneuve d'Ascq</td>
<td>Prof. Anantharam Raghuram Indian Institute Science Education and Research Pune</td>
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<td>28</td>
<td>Understanding mechanical size effects in metallic micro-wires: synergy between experiments and simulation</td>
<td>Prof. Ludovic Thilly Institut Pprime (UPR 3346 CNRS-Université de Poitiers-ENSMA) Futuroscope</td>
<td>Prof. Atul Chokshi Indian Institute of Science Bangalore</td>
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<td>Dr. Surajit Sinha Indian Association for the Cultivation of Science Kolkata</td>
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<td>32</td>
<td>(Network-1 AHUS) International Study on Atypical Hemolytic Uremic Syndrome</td>
<td>Dr. Marie-Agnès Dragon-Durey UMRS 1138, team 10 &quot;Complement and diseases&quot; Paris</td>
<td>Prof. Arvind Bagga Professor of Pediatrics All India Institute of Medical Sciences New Delhi</td>
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<td>33</td>
<td>Indo-French Water networking for Swach Neer-</td>
<td>Dr. Benoit. Teychene École nationale supérieure d'ingénieurs de Poitiers TSA 41105, 86073 POITIERS CEDEX 9 France</td>
<td>Dr Jitendra Pandey University of Petroleum and Energy Studies Dehradun</td>
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<td>Indo-French Water networking for Swach Neer</td>
<td>Prof Anthony SZMCZY University of Rennes, UMR6226 Equipe CIP BAT 10 A 35042 Rennes Cedex</td>
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<td>Dr Jitendra Pandey University of Petroleum and Energy Studies Dehradun</td>
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8. Indian and French Organizations
## Collaborative Scientific Research Projects

### INDIAN ORGANIZATIONS

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### Industry Academic Research Projects

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### Collaborative Scientific Research Projects

#### FRENCH ORGANIZATIONS

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<td>Université de Paul Sabatier</td>
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<tr>
<td>16</td>
<td>University Pierre and Marie Curie</td>
</tr>
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<td>17</td>
<td>Université de Poitiers</td>
</tr>
<tr>
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<td>Université de Reims Champagne-Ardenne</td>
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<td>29</td>
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**Ecole**

<table>
<thead>
<tr>
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<td>Ecole Nationale Supérieure de Chimie de Rennes</td>
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### Industry Academic Research Projects

#### FRENCH ORGANIZATIONS / INDUSTRIES

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<td>ASTRIUM-ST</td>
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<td>Ariane Group, Les Meureux</td>
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<td>Las – Université de Lille</td>
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<td>École Normale Supérieure</td>
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<td>29.</td>
<td>Centre Inter-universitaire de Recherche et d’Ingénierie des Matériaux (CIRIMAT)</td>
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The CEFIPRA receives grants-in-aid of Euro 1.55m each from the Indian and French Governments annually. The nodal agency on the Indian side is the Ministry of Science and Technology and on the French side is the Ministry for Europe and Foreign Affairs. The grants-in-aid are released based on the budgetary projections made by the Centre and duly approved by the Governing Body of the Centre.

a) Core Programmes

The grants-in-aid received from both the Governments are utilized towards expenditure, which is **shared on equal basis** on the following core programmes of the Centre:

i) Collaborative Scientific Research Programme (CSRDP)
ii) Industry Academia Research and Development Programme (IARDP)
iii) Seminars/Workshops
iv) Others (SGRI, ESONN etc.)

During the year 2016-17, Rs 119.40 Million (Euro 1.72 million) and Rs.115.43 million (Euro 1.55 million) grants-in-aid were received from Government of India & Government of France respectively for the core programmes. The details of fund position for the last three years under the core programmes are given below in the Table 1.

Table 1- Fund Position: Grants-in-Aid received from Government of India & Government of France for core programmes during FYs 2014-15, 2015-16 & 2016-17

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Grant-in-aid received from Govt. of India</th>
<th>Grant-in-aid received from Govt. of France</th>
<th>Total Funds available</th>
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<td>C/F from last year</td>
<td>Grant received during the year</td>
<td>C/F from last year</td>
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<tr>
<td>2016-17</td>
<td>14.79</td>
<td>119.40</td>
<td>19.71</td>
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<td>2015-16</td>
<td>1.18</td>
<td>131.88</td>
<td>35.22</td>
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<td>2014-15</td>
<td>2.00</td>
<td>125.00</td>
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During the Financial Year 2016-17, one hundred nineteen (119) new collaborative scientific research project proposals under CSRP and fifteen (15) under IARDP were received. Out of which, sixteen (16) proposals of CSRP at budgeted cost of Rs. 187.60 million (Euro 2.50 million) and five (05) proposals of IARDP at budgeted cost of Rs.70.26 million (Euro 0.94 million) respectively were recommended. The details of expenditure incurred during the year towards core activities are given on next page:
i) As on 31st March 2017, sixty two projects of CSRP were under implementation. The core expenditure of the Centre towards collaborative scientific research projects has increased to 78% in the year 2016-17 as compared to previous year, where it remained at 65%. An amount of Rs. 170.99 million (Euro 2.47 million) was spent on scientific research projects during the year.

ii) As on 31st March 2017, six projects of IARDP were under implementation. Rs. 3.99 million (Euro 0.06 million) was spent on the Programme during the financial year.

iii) Seminars and workshops have always been used as a platform for enabling interactions between the scientific communities of the two countries. During the year, five seminars/workshops were supported by the Centre at a cost of Rs. 5.21 million (Euro 0.08 million).

iv) In the expanded mandate of CEFIPRA beyond its 25 years, the Centre initiated programme of Public Private Partnership (PPP) with Saint Gobain Research India (SGRI) Ltd. CEFIPRA launched its CEFIPRA-SGRI PPP Programme in 2014-15 and during the FY 2016-17, an amount of Rs. 1.49 million (Euro 0.02 million) was spent. Expenditure of Rs 21,883 was also spent on Airbus project on 8th & 9th June 2016 and 11th July 2016 in the year 2016-17. However, Airbus project could not start during the year.

v) General scientific expenses of Rs. 8.43 million (Euro 0.11 million) included Rs. 2.40 million (Euro 0.03 million) towards the ESONN programme for supporting the participation of Indian doctoral students to the prestigious European School of Nano-sciences and Nano-technologies-(ESONN) being implemented by the University of Joseph Fourier (now Universite of Grenoble Alpes), Grenoble.

vi) Rest of the expenses of Rs. 29.04 million (Euro 0.42 million) are for expense on meetings of Governing Body, Scientific Council and Industrial Research Committee (Rs. 9.52/Euro 0.14millions) as well as running expenses (Rs. 19.52/Euro 0.27 million).

The details of the expenditure incurred by the Centre during the year 2016-17 for the core programmes, under various budget heads are given in the Table 2 and Figure X. A comparison of fund position and expenditure with the previous two years has also been provided in Table 2 and Figure Y.
Table 2: Expenditure incurred for the core programmes during the financial years 2014-15, 2015-16 & 2016-17

(Rs./Euro in million)

<table>
<thead>
<tr>
<th>Budgetary Components</th>
<th>2014-15</th>
<th>2015-16</th>
<th>2016-17</th>
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<tr>
<td></td>
<td>Expenditure Rs.</td>
<td>% of total</td>
<td>Expenditure Rs.</td>
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<tr>
<td>1. Scientific Research Projects</td>
<td>178.42 (2.25 M Euro)</td>
<td>69.41%</td>
<td>148.33 (1.98 M Euro)</td>
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<td>Industrial Research Projects</td>
<td>13.31 (0.17 M Euro)</td>
<td>5.18%</td>
<td>12.09 (0.16 M Euro)</td>
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<td>Seminars &amp; Workshops</td>
<td>17.18 (0.22 M Euro)</td>
<td>6.68%</td>
<td>14.16 (0.19 M Euro)</td>
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<td>PPP Programme (SGRI Projects &amp; Airbus)</td>
<td>4.30 (0.06 M Euro)</td>
<td>1.67%</td>
<td>4.33 (0.06 M Euro)</td>
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<tr>
<td>General Scientific Expenses (activities like publication of research papers, short visits of scientists other than project visits, ESONN Programme etc.)</td>
<td>7.73 (0.10 M Euro)</td>
<td>3.01%</td>
<td>8.60 (0.11 M Euro)</td>
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<tr>
<td>Governing Body, Industrial Research Committee &amp; Scientific Council meetings</td>
<td>11.13 (0.14 M Euro)</td>
<td>4.33%</td>
<td>12.52*** (0.17 M Euro)</td>
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<tr>
<td>Running expenses of the Centre (Salaries, Office maintenance &amp; Travel)</td>
<td>25.34 * (0.31 M Euro)</td>
<td>9.72%</td>
<td>26.61** (0.35 M Euro)</td>
</tr>
<tr>
<td>** TOTAL **</td>
<td>** 257.41 (3.25 M Euro) @ 1 Euro = Rs. 79,2000 **</td>
<td>** 226.64 (3.02 M Euro) @ 1 Euro = Rs. 75,0955 **</td>
<td>** 219.17 (3.15 M Euro) @ 1 Euro = Rs 69,2476 **</td>
</tr>
</tbody>
</table>

* i) Excludes expenses of Rs. 7.06 million (Euro 85.984) in FY 2014-15 incurred towards renovation of the Centre.
ii) Increase due to upgradation of communication and leased line for internet, increase in legal and other expense and liability provision for expenses made due to change over to mercantile system.
** Increase due to one-time expenditure of Rs. 2.60 million towards recruitment of Director, CEFIPRA, Rs. 1.37 million towards expenses incurred on “Project Proposal Management System” grouped under Office expenses and Rs. 2.59 million paid to LIC towards Pension Contribution for the FYs 2013-14 & 2014-15 (2.89%).
*** Increase due to two meetings of the Governing Body held during the FY 2015-16 (April 2015 & March 2016).
Figure X: Annual Expenditure Over the Years - Core Programmes
(Figures in Rs/Euro in Million)

- 2014-15: Rs 257.41 / Euro 3.25
- 2015-16: Rs 226.64 / Euro 3.02
- 2016-17: Rs 219.17 / Euro 3.15

Figure Y: Fund Position v/s Expenditure - Core Programmes
(Figures in Rs/Euro in Million)

- 2014-15: Rs 288.03 / Euro 3.59
- 2015-16: Rs 284.68 / Euro 3.79
- 2016-17: Rs 269.33 / Euro 3.88

- C/F Balance
- Grant Government of India
- Grant Government of France
- Expenditure
b) Non-Core Programmes

As per earlier directives of the Governing Body of CEFIPRA, the Centre has initiated its activities for expansion beyond the core programmes and has undertaken a number of scientific programmes (including TDB-CEFIPRA-Bpifrance programme, started during the Financial Year 2016-17), which are funded by various organizations from India and France. The details of fund position and expenditure incurred for the non-core programmes during the year 2016-17 are given in the Table 3A (Rs million), Table 3B (in Euro) and Figure Z.

### Table 3A - Non-Core Programmes:
**Fund Position & Expenditure incurred during FY 2016-17**

(Rs. in million)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Funds Available</th>
<th>Received during the year</th>
<th>Total funds available during the year (a)</th>
<th>Expenditure during the year</th>
<th>Total Expenditure (b)</th>
<th>Balance Available (a-b)</th>
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<td>1</td>
<td>IFCAM (DST-CNRS)</td>
<td>9.23</td>
<td>8.99</td>
<td>2.76</td>
<td>0.29</td>
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<td>2</td>
<td>RAMAN CHARPAK FELLOWSHIP (DST-Fr.Embassy)</td>
<td>12.23</td>
<td>7.50</td>
<td>10.46</td>
<td>0.59</td>
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<td>4.03</td>
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<td>-</td>
<td>0.03</td>
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<td>DST-Inria-CNRS PROJECTS</td>
<td>2.04</td>
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<td>-</td>
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<td>DST-ANR PROJECTS</td>
<td>1.27</td>
<td>9.50</td>
<td>-</td>
<td>0.14</td>
<td>10.91</td>
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<tr>
<td>6</td>
<td>BIRAC-FRENCH EMBASSY PROJECTS</td>
<td>12.52</td>
<td>6.36</td>
<td>-</td>
<td>0.02</td>
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<td>-</td>
<td>-</td>
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<td>9</td>
<td>FRENCH EMBASSY (SST)</td>
<td>12.50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>12.50</td>
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<tr>
<td>TOTAL</td>
<td>61.900</td>
<td>44.640</td>
<td>16.210</td>
<td>1.281</td>
<td>124.031</td>
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</table>

**NOTE:**

1. The C/F balances includes interest earned in the FY 2015-16 and Programme Implementation charges and overhead charges and is after necessary adjustment required as per audited Financial Statement.
2. The Grants received from Indian Side and French side (IFCAM and Raman Charpak) includes Programme Implementation and Overhead Charges.
3. Expenditure incurred during the year also includes expenses that have been met out of Programme Implementation and Overhead charges.
4. The Closing balance includes Programme Implementation and Overhead Charges.
5. Indo French Water Network Programme includes 80,000 euro (Rs 53,60,880/-) transferred from French Embassy, SST programmes.
6. French Embassy, SST programmes includes Economic Diplomacy programme and Group Farming projects."
Table 3B - Non Core Programmes:
Fund Position & Expenditure incurred during FY 2016-17

(in Euro)

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<tr>
<th>S.No</th>
<th>Funds Available</th>
<th>C/F Balance</th>
<th>Received during the year</th>
<th>Total funds available during the year (a)</th>
<th>Expenditure during the year</th>
<th>Total Expenditure (b)</th>
<th>Balance Available (a-b)</th>
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<td>Indo-French Water Network</td>
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NOTE:
(1) The C/F balances includes interest earned in the FY 2015-16 and Programme Implementation charges and overhead charges and is after necessary adjustment required as per audited Financial Statement.
(2) The Grants received from Indian Side and French side (IFCAM and Raman Charpak) includes Programme Implementation and Overhead Charges.
(3) Expenditure incurred during the year also includes expenses that have been met out of Programme Implementation and Overhead charges.
(4) The Closing balance includes Programme Implementation and Overhead Charges.
(5) Indo French Water Network Programme includes 80,000 euro (Rs 53,60,880/-) transferred from French Embassy, SST programmes.
(6) French Embassy, SST programmes includes Economic Diplomacy programme and Group Farming projects."
The statutory audit of the accounts of the Centre was carried out by M/s. K.K.Ghei & Co. 806, Hemkunt House, 6, Rajendra Place, New Delhi-110008. The accounting currency of the Society is Indian Rupee (INR) and Euro. Separate books of accounts are maintained for recording respective transactions occurring in INR and Euro Currencies and accordingly separate Financial Statements i.e. Balance Sheet, Income & Expenditure and Receipt & Payment are drawn in respective currencies.

For presentation of INR accounts the grant received in foreign currency for core programme is converted into INR on the exchange rate prevailing on the date of transaction as declared by the RBI. The expenditure of the Centre for core programmes and income and expenditure for non-core programmes are converted on average rate determined on the basis of exchange rate prevailing on the date of opening bank balance and date of grant received. The Assets & Liabilities of Euro account are converted to INR at the rate prevailing on the Balance Sheet date, as declared by RBI, i.e. 31st March of the Financial Year.

INR accounts to Euro, the Income & Expenditure account, Balance Sheet and Receipt & Payment account of INR are translated to Euro on the basis of rate of exchange prevailing as on Balance Sheet date, as declared by RBI, i.e. 31st March of the Financial Year.

The Auditors’ Report with its attachments viz. Receipt & Payment Account, Income & Expenditure Account and Balance Sheet in terms of INR and Euro are given in the following pages.
INDEPENDENT AUDITOR'S REPORT

To The Governing Body of
Indo French Centre for the Promotion of Advanced Research
Lodhi Road
New Delhi

We have audited the accompanying financial statements of Indo French Centre for the Promotion of Advanced Research, New Delhi (a Society registered under Societies Registration Act, 1860) which comprise the Balance Sheet as at 31st March 2017, the Income and Expenditure Account, the Receipt and Payment Account for the year then ended, and a summary of significant accounting policies and other explanatory information.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position and financial performance of the Society. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditors' Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with the Standards on Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor’s judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal controls relevant to the Society’s preparation and fair presentation of the financial statements that give a true and fair view in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Company’s internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.
We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

In our opinion and to the best of our information and according to the explanations given to us, the financial statements give a true and fair view of the financial position of Indo Frech Centre for the Promotion of Advanced Research for the year ended 31st March, 2017 in conformity with the accounting principles generally accepted in India.

For K.K. GHEI & CO.
Chartered accountants
Firm Registration No. 001342N

(RAJNEESH GHEI)
Partner
M.No.086329

Place: New Delhi
Date: 15th October 2017
INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH (IFCPAR)

SCHEDULE ANNEXED TO AND FORMING PART OF THE BALANCE SHEET, INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH, 2017

SCHEDULE-H

SIGNIFICANT ACCOUNTING POLICIES AND NOTES TO ACCOUNTS

A. SIGNIFICANT ACCOUNTING POLICIES

1. OVERVIEW & BASIS OF PREPARATION

1.1 IFCPAR/CEFIPRA has been created under a bilateral cooperation agreement between the Government of France and Government of India to promote, catalyse, strengthen and expand cooperation in advanced areas of Science, Technology and Innovation for the public good.

1.2 The IFCPAR/CEFIPRA has been registered under Societies Registration Act, 1860 and under section 12A of the Income Tax Act, 1961.

1.3 The financial statements have been prepared under historical cost convention and on accrual basis of accounting.

2. Income Recognition

2.1 Grant due, in accordance with the bilateral agreement between Government of India and Government of France, and received during the year is recognized as Income.

2.2 Non-Core programs are administered on behalf of the granting agencies. Grants received for such programs are committed funds and expenses of these programs are directly charged to the respective grants received. The unutilised balance amount of non-core grants are shown under current liabilities in the balance sheet.

3. Expenditure Recognition

3.1 Grants to an awardee for research projects are recognized as expenditure to the extent of payment made to each awardee during the year. First year releases are made on the basis of approved budget and subsequent releases are made only on receipt of the statement of expenditure of the previous years.

3.2 Common costs incurred for implementation and management of non-core programs are apportioned to these programs on an estimated resource allocation basis at 25% of the common costs incurred by the Centre.

4. Fixed Assets

4.1 Fixed Assets are stated at cost less accumulated depreciation. The cost of an asset comprises of its purchase price and directly attributable costs of bringing the asset to working condition for its intended use.

4.2 All assets acquired for research projects remain with the institutions where the research work is carried on. The centre, has, however, retained the right to transfer these assets to other institutions, if so required, on the completion of the Project for which these assets were purchased. The expenditure incurred on those assets are accounted for in the Income and Expenditure account under the head “Research project”. Assets purchased for non-core program are considered as Application of Fund and are charged to the respective grant as expenditure.
5. Depreciation

5.1 Depreciation on fixed assets has been charged on written down value method at the rates prescribed under the Income Tax Rules, 1962.

6. Foreign Currency Transactions

6.1 Grant received in foreign currency for Core Programs is converted into INR on the exchange rate prevailing on the date of transaction. This policy has been changed during the year. In the previous year the exchange rate prevailing on the date of the Balance Sheet was applied for translating the grant amount into INR.

6.2 Grant received in foreign currency for Non-Core Programs, expenditure incurred for Core and Non-Core Programs and repatriation of funds are converted into INR on average rate. The average rate is determined by taking into account the opening bank balance in foreign currency and core grant received during the year. This policy has been changed during the year. In the previous year the exchange rate prevailing on the date of the Balance Sheet was applied for translating these transactions.

6.3 Current Assets and Current liabilities except Non-Core Program balances are converted into INR on the exchange rate prevailing on the date of Balance Sheet.

7. Employee Benefits

7.1 Gratuity & Pension

The Centre has taken a policy with LIC of India for payment of Gratuity and Pension to employees who are eligible for such benefits.

7.2 Leave Encashment

Leave encashment is accounted for at the time of payment and no provision for the same is made in the books.

B. NOTES TO ACCOUNTS:

1. Grant received during the year from Government of India is in excess of their share of 50% by Rs.39,66,229 and the same has been set off against shortfall in the Grant received in the earlier years. The receipt of excess grant has been recognized as Income during the year.

2. The balance in bank accounts of non-core programs is more than the aggregate liability of the unspent balance of non-core programs. Reconciliation of non-core program balances with their respective bank accounts and transfer of funds from non-core bank accounts to core bank accounts on account of apportionment of common expenditure is under progress.

3. Due to the change in exchange rate applied as stated in Accounting Policy No. 6.1 and 6.2 the Core Program Reserve has decreased by Rs.7,93,445/- and Non-Core Program balance has decreased by Rs.3,95,395/-.

4. Exchange Fluctuation Adjustment account liability of Rs.86,02,216/- as on 31st March 2016 has been reduced to Rs.23,79,827/- after translating the bank balance at new closing rate.

5. No contribution was made to LIC of India towards annual premium for Group Gratuity Accumulation Scheme maintained with LIC of India for the FY 2015-16 and FY 2016-17. However the matter has
been taken up with the LIC and the same is in progress. In respect of premium of pension the
decision is under consideration of the Governing Body.

6. Provision has not been made for leave encashment liability of Rs.30,80,155 as on 31st March 2017
as the same is accounted for on cash basis.

7. A Grant of Euro 775,000 for the financial year 2017-18 has been received in advance from the
French Government.

8. The Centre was granted exemption from payment of Income Tax vide notification issued by CBDT
renewal of exemption u/s 11(1)(c) of the Income Tax Act, 1961 for FY 2016-17 will be filed in due
course of time. Keeping in view the previous approvals given by CBDT, no provision of Income Tax
has been made for FY 2015-16 and 2016-17

9. During the year total ongoing projects were 62 and the total liability towards these projects as per
sanctioned amounts aggregates to Rs.45,917,889/- for the Indian side and Euro 7,87,769 for the

For K.K.GHEI & CO.
Chartered Accountants
Firm Registration No.
001342N

RAJNEESH GHEI
Partner
Membership No.086329
Place : New Delhi
Date :15.10.2017

PRANAV SHARMA
Assistant Accounts Officer

N.S.PADMANABHAN
Manger (Admn. & Accts.)

Dr. MUKESH KUMAR
Director
<table>
<thead>
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<th>Non Core Programmes</th>
<th>A</th>
<th>16,265,384.00</th>
<th>286,899.51</th>
<th>20,301,569.00</th>
<th>36,565,963.00</th>
<th>14,823,009.00</th>
<th>215,599.74</th>
<th>15,364,231.00</th>
<th>29,987,240.00</th>
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<td>51,411.00</td>
<td>51,411.00</td>
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<td>772,724.00</td>
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<tr>
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<td>1,114,060.80</td>
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| INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
| BALANCE SHEET AS AT 31ST MARCH 2017 |

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<th>Liabilities</th>
<th>Transaction in INR</th>
<th>Transaction in Euro</th>
<th>Total Amount in INR</th>
<th>Amount as on 31.03.2017</th>
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<tr>
<td>Non Core Programmes</td>
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<td>36,565,963.00</td>
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<td>French Embassy programme Grant</td>
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<td>358,879.00</td>
<td>25,015,737.00</td>
<td>35,855,221.00</td>
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<tr>
<td>Programme Implementation Charges</td>
<td>695,393.00</td>
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<td>695,393.00</td>
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<tr>
<td>Bncs Meeting</td>
<td>51,411.00</td>
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<tr>
<td>Expenses Payable</td>
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<td>TDS Payable</td>
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<tr>
<td>TOTAL</td>
<td>105,908,383.00</td>
<td>2,101,633.94</td>
<td>145,491,558.00</td>
<td>251,399,941.00</td>
</tr>
<tr>
<td>II. Assets</td>
<td>Transaction in INR</td>
<td>Transaction in Euro</td>
<td>Euro Equivalent in INR</td>
<td>Total Amount in INR</td>
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<td>------------</td>
<td>------------------</td>
<td>--------------------</td>
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</tr>
<tr>
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<td>4,762,327.00</td>
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<td>4,728,388.00</td>
<td>4,618,039.00</td>
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<td>64,347.00</td>
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# INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

**BALANCE SHEET AS AT 31ST MARCH 2017**

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<tr>
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<th>Transaction in Euro</th>
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<td>180,779,620.00</td>
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**Accounting policies and notes to accounts are an integral part of financial statements.**

**AUDITOR'S REPORT**

As per our report of even date attached.

For K.K. GMBU & CO.
Chartered Accountants
Firm Registration No. 001341H.

(FAJNEESH GMBK)
Partner
Membership No. 588329
Place: New Delhi
Date: 15.10.2017

PRANAV SHARMA
Assistant Accounts Officer

N.S. PADMANABHAN
Manager (Admin. & Accts.)

Dr. MUKESH KUMAR
Director
## INCOME

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<td>Grant-in-aid</td>
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<td>Interest from Bank Accounts</td>
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<td>Gain/(Loss) on repatriation</td>
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## II. EXPENDITURE

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<td>F. EXPENDITURE</td>
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<td>Running Expenses of the Centre</td>
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</table>

Accounting policies and notes to accounts are integral part of financial statements.

AUDITOR’S REPORT

As per our report of even date attached.

For K.K.CHEI & CO.

Chartered Accountants
Firm Registration No. 001344N

RANEE DEB
Partner
Membership No. 086329
Place: New Delhi
Date: 15.10.2017

PRANAV SHARMA
Assistant Accounts Office

N.S.PADMANABHAN
Manager(Admin. & Accts.)

Dr. MUKESH KUMAR
Director
<table>
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<tr>
<th>Sch</th>
<th>Amount for the year ended March 31, 2017</th>
<th>Amount for the year ended March 31, 2016</th>
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<td>115,433,770.00</td>
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<td>Axis bank Interest</td>
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<td>Misc.Income</td>
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<td>Repatriation of Funds</td>
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<td>TOTAL (A+B)</td>
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<td>Sch</td>
<td>Amount for the year ended March 31, 2017</td>
<td>Amount for the year ended March 31, 2016</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Transaction in INR</td>
<td>Transaction in Euro</td>
</tr>
<tr>
<td></td>
<td>Transaction in INR</td>
<td>Transaction in Euro</td>
</tr>
<tr>
<td>II. PAYMENTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running Expenses of the Centre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office and Running Expenses of the Centre</td>
<td>18,505,922.00</td>
<td>2,629.99</td>
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<tr>
<td>Travel Expenses</td>
<td>1,150,252.00</td>
<td>1,837.16</td>
</tr>
<tr>
<td>GB/SC/IR/C/SEP/Vision Group Expenses</td>
<td>6,932,526.00</td>
<td>68,227.10</td>
</tr>
<tr>
<td>Non Shareable Expenses</td>
<td>2,150,964.00</td>
<td>3,402.60</td>
</tr>
<tr>
<td>Total Running Expenses of the Centre(A)</td>
<td>28,740,654.00</td>
<td>76,096.85</td>
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<tr>
<td>Scientific Expenses of the Centre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Scientific Expenses</td>
<td>3,024,874.00</td>
<td>72,310.51</td>
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<tr>
<td>Research Projects/ Seminar and Workshop</td>
<td>88,600,510.00</td>
<td>1,286,539.02</td>
</tr>
<tr>
<td>SGRI Programmes/ Airbus Projects</td>
<td>1,512,980.00</td>
<td>-</td>
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<tr>
<td>Total Scientific Expenses of the Centre(B)</td>
<td>93,158,364.00</td>
<td>1,338,845.53</td>
</tr>
<tr>
<td>Other Payments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non Core Programmes</td>
<td>33,744,670.00</td>
<td>144,834.35</td>
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<tr>
<td>Non Core Programmes Programmied Implementation and Overhead charges</td>
<td>2,168,382.00</td>
<td>-</td>
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<tr>
<td>Purchase of Assets Net of sales</td>
<td>210,250.00</td>
<td>-</td>
</tr>
<tr>
<td>RRICS Meetings</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Programme Implementation and overhead charges</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other Deposit</td>
<td>71,323.00</td>
<td>156,212.40</td>
</tr>
<tr>
<td>Total Other Payments(C)</td>
<td>36,194,630.00</td>
<td>301,046.75</td>
</tr>
<tr>
<td>TOTAL PAYMENTS(D)</td>
<td>150,073,658.00</td>
<td>1,735,869.13</td>
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### III. Cash & Cash Equivalent

#### Balance carried forward

<table>
<thead>
<tr>
<th>Account</th>
<th>INR</th>
<th>Euro</th>
<th>Equivalent INR</th>
<th>Total Amount INR</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Union Bank of India Raman Charpak Account</td>
<td>9,341,165.00</td>
<td>9,341,165.00</td>
<td></td>
<td>8,041,970.00</td>
</tr>
<tr>
<td>b) Union Bank of India DST INRA Account</td>
<td>2,571,733.00</td>
<td>2,571,733.00</td>
<td></td>
<td>2,715,696.00</td>
</tr>
<tr>
<td>c) Union Bank of India DST INRA Account</td>
<td>643,032.00</td>
<td>643,032.00</td>
<td></td>
<td>710,682.00</td>
</tr>
<tr>
<td>d) Union Bank of India FCAM Account</td>
<td>3,858,669.00</td>
<td>3,858,669.00</td>
<td></td>
<td>6,531,507.00</td>
</tr>
<tr>
<td>e) Union Bank of India DST ANR Account</td>
<td>5,914,751.00</td>
<td>5,914,751.00</td>
<td></td>
<td>2,155,217.00</td>
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<tr>
<td>f) Union Bank of India TDB</td>
<td>316,150.00</td>
<td>316,150.00</td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>g) State Bank of Hyderabad Account</td>
<td>48,920,656.00</td>
<td>48,920,656.00</td>
<td>56,066,204.00</td>
<td>56,066,204.00</td>
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<tr>
<td>h) Union Bank of India QEFIPRA Account</td>
<td>406,427.00</td>
<td>406,427.00</td>
<td></td>
<td>391,844.00</td>
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<tr>
<td>i) Axis Bank Account</td>
<td>761,518.00</td>
<td>761,518.00</td>
<td></td>
<td>731,804.00</td>
</tr>
<tr>
<td>j) State Bank of Hyderabad (Gratuity Fund) Account</td>
<td>2,522,522.00</td>
<td>2,522,522.00</td>
<td></td>
<td>2,232,233.00</td>
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<tr>
<td>k) State Bank of Hyderabad - BRAC</td>
<td>5,887,793.00</td>
<td>5,887,793.00</td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>l) State Bank of Hyderabad - IFVN</td>
<td>3,551,900.00</td>
<td>3,551,900.00</td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>m) CIC Paris</td>
<td>1,852,039.36</td>
<td>128,249,281.00</td>
<td>128,249,281.00</td>
<td></td>
</tr>
<tr>
<td>Exchange Rate Fixation</td>
<td>7,256,462.00</td>
<td>7,256,462.00</td>
<td></td>
<td></td>
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<tr>
<td><strong>TOTAL CLOSING BANK BALANCE (D+E)</strong></td>
<td>84,696,360.00</td>
<td>135,505,743.00</td>
<td>220,202,049.00</td>
<td></td>
</tr>
</tbody>
</table>

### Accounting policies and notes to accounts are integral part of financial statements.

**AUDITOR’S REPORT**

As per our report of even date attached.

For K.K.GHE & CO.
Chartered Accountants

Firm Registration No. 001342

**RAJNEESH GHE**
Partner
Membership No. 086329
Place : New Delhi
Date : 15.10.2017

**PRANAV SHARMA**
Assistant Accounts Officer

**N.S. PADMANABHAN**
Manager(Admins. & Accts.)

**Dr. MUKESH KUMAR**
Director
### Schedule 'A'

#### Core Programme Reserve

<table>
<thead>
<tr>
<th>Description</th>
<th>Transaction in INR</th>
<th>Transaction in Euro</th>
<th>Euro Transaction Equivalent in INR</th>
<th>Total Amount in INR</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Balance b/f</td>
<td>73,815,502.00</td>
<td>507,627.94</td>
<td>32,498,900.00</td>
<td>106,314,402.00</td>
</tr>
<tr>
<td>(ii) Surplus/(Deficit) from Income &amp; Expenditure account</td>
<td>2,853,001.00</td>
<td>157,807.49</td>
<td>1,06,02,385.00</td>
<td>1,34,55,386.00</td>
</tr>
<tr>
<td>(iii) Adjustments for Non Core and Extra Mural Reserve</td>
<td>453,747.00</td>
<td>-</td>
<td>-</td>
<td>453,747.00</td>
</tr>
<tr>
<td>(iv) Adjustment of opening balance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(v) Adjustment during the year</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(vi) Balance Carried forward to next year</td>
<td>77,122,250.00</td>
<td>665,435.43</td>
<td>4,31,01,285.00</td>
<td>12,02,23,535,00</td>
</tr>
</tbody>
</table>

#### Schedule 'A1'

#### Foreign fluctuation reserve

<table>
<thead>
<tr>
<th>Description</th>
<th>Transaction in INR</th>
<th>Transaction in Euro</th>
<th>Euro Transaction Equivalent in INR</th>
<th>Total Amount in INR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening balance</td>
<td>8,602,216.00</td>
<td>8,602,216.00</td>
<td>8,602,216.00</td>
<td>8,602,216.00</td>
</tr>
<tr>
<td>Current Year(Adjustment)-Asset</td>
<td>(62,22,389.00)</td>
<td>(62,22,389.00)</td>
<td>8,602,216.00</td>
<td>8,602,216.00</td>
</tr>
<tr>
<td>Balance Carried forward to next year</td>
<td>-</td>
<td>-</td>
<td>23,79,827.00</td>
<td>23,79,827.00</td>
</tr>
<tr>
<td>Targeted Programmes</td>
<td>Amount as on 31st March, 2012</td>
<td>Amount as on 31st March, 2016</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------------</td>
<td>--------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opening Balance(A)</td>
<td>14,623,099.00 215,599.74 15,364,231.00 29,987,240.00</td>
<td>9,400,049.00 102,213.00 6,849,396.00 16,250,345.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Add: Grant and Interest Received</td>
<td>31,645,823.00 177,000.00 13,228,608.00 44,872,431.00</td>
<td>27,313,144.00 175,343.32 13,167,495.00 40,480,639.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Income received during the Year(B)</td>
<td>31,645,823.00 177,000.00 13,228,608.00 44,872,431.00</td>
<td>27,313,144.00 175,343.32 13,167,495.00 40,480,639.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less: Expenditure Incurred (C)</td>
<td>29,951,435.00 95,700.23 7,151,353.00 37,102,788.00</td>
<td>22,091,084.00 61,956.58 4,652,660.00 28,743,744.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excess of Income over Expenditure (D=B-C)</td>
<td>1,694,388.00 81,299.77 6,075,255.00 7,769,643.00</td>
<td>5,222,060.00 113,386.74 8,514,835.00 13,736,895.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjustment for Core Programmes(E)</td>
<td>(923,191.00) - - (923,191.00)</td>
<td>- - -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Add: Prior Period Items</td>
<td>18,630.00 - - 18,630.00</td>
<td>- - -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programmes Implementation of DST-ANR Programme programme</td>
<td>(3,051.00) - - (3,051.00)</td>
<td>- - -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repatriation of Funds</td>
<td>755,569.00 (10,000.00) (755,569.00) -</td>
<td>- - -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain/(Loss) on repatriation of Funds</td>
<td>63,093.00 63,093.00</td>
<td>- - -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluctuation on account of exchange rate</td>
<td>(445,441.00) (445,441.00)</td>
<td>- - -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance (A=D+E)</td>
<td>16,265,384.00 286,899.51 20,301,569.00 36,566,953.00</td>
<td>14,623,009.00 215,599.74 15,364,231.00 29,987,240.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
### SCHEDULES FORMING PART OF THE BALANCE SHEET AS AT 31ST MARCH 2017

<table>
<thead>
<tr>
<th></th>
<th>Amount as on 31st March, 2017</th>
<th>Amount as on 31st March, 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transaction in INR</td>
<td>Transaction in Euro</td>
</tr>
<tr>
<td><strong>French Embassy SSI Programmes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opening Balance(A)</td>
<td>5,779,399.00</td>
<td>387,013.12</td>
</tr>
<tr>
<td>Add: Total income received</td>
<td>6,220,769.00</td>
<td>40,000.00</td>
</tr>
<tr>
<td>Total income received during the Year(B)</td>
<td>6,220,769.00</td>
<td>40,000.00</td>
</tr>
<tr>
<td>Less: Expenditure Incurred( C)</td>
<td>1,657,728.00</td>
<td>49,134.12</td>
</tr>
<tr>
<td>Excess of Income over Expenditure ( D=B-C)</td>
<td>4,263,041.00</td>
<td>(9,134.12)</td>
</tr>
<tr>
<td>Adjustment for Core Programmes(E)</td>
<td>369,414.00</td>
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</tr>
<tr>
<td>Transfer to Group Farming Projects</td>
<td>-</td>
<td>(11,000.00)</td>
</tr>
<tr>
<td>Programme Implementation of IFWN programme</td>
<td>(166,934.00)</td>
<td>-</td>
</tr>
<tr>
<td>Repatriation of funds</td>
<td>594,564.00</td>
<td>(8,000.00)</td>
</tr>
<tr>
<td>Gain/(Loss) on repatriation of Funds</td>
<td>63,838.00</td>
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</tr>
<tr>
<td>Fluctuation on account of exchange rate</td>
<td>50,046.00</td>
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</tr>
<tr>
<td><strong>Balance c/f(A+D+E)</strong></td>
<td>10,639,484.00</td>
<td>358,879.00</td>
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</tbody>
</table>
### Schedule 'B1 Non Core Programmes

<table>
<thead>
<tr>
<th></th>
<th>Amount as on 31st March, 2017</th>
<th>Amount as on 31st March, 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transaction in INR</td>
<td>Transaction in Euro</td>
</tr>
<tr>
<td><strong>Programme Implementation and Overhead Charges</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Opening Balance(A)</strong></td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td><strong>Transfer from DST-ANR Programme</strong></td>
<td>3,051.00</td>
<td>3,051.00</td>
</tr>
<tr>
<td><strong>Transfer from Indo French Water Network Programme</strong></td>
<td>166,934.00</td>
<td>166,934.00</td>
</tr>
<tr>
<td><strong>Add: Programme Implementation Charges received during the year</strong></td>
<td>2,693,790.00</td>
<td>2,693,790.00</td>
</tr>
<tr>
<td><strong>Total Funds Available(B)</strong></td>
<td>2,693,790.00</td>
<td>2,693,790.00</td>
</tr>
<tr>
<td><strong>Less: Expenditure Incurred(C)</strong></td>
<td>2,168,382.00</td>
<td>2,168,382.00</td>
</tr>
<tr>
<td><strong>Balance c/f(B-C)</strong></td>
<td>695,393.00</td>
<td>695,393.00</td>
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</tbody>
</table>
### Schedule 'B' Non Core Programmes

<table>
<thead>
<tr>
<th></th>
<th>Amount as on 31st March, 2017</th>
<th>Amount as on 31st March, 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transaction in INR</td>
<td>Transaction in Euro</td>
</tr>
<tr>
<td>IFCAM Projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opening Balance(A)</td>
<td>4,248,813.00</td>
<td>61,236.00</td>
</tr>
<tr>
<td>Add: Grant Received during The year</td>
<td>8,990,000.00</td>
<td>37,000.00</td>
</tr>
<tr>
<td>Add: Bank Interest</td>
<td>285,949.00</td>
<td>-</td>
</tr>
<tr>
<td>Programme Implementation and Overhead Charges</td>
<td>(150,000.00)</td>
<td>-</td>
</tr>
<tr>
<td>Total Income received during the Year(B)</td>
<td>9,125,949.00</td>
<td>37,000.00</td>
</tr>
<tr>
<td>Less: Expenditure Incurred(C)</td>
<td>10,199,491.00</td>
<td>-</td>
</tr>
<tr>
<td>Excess of Income over Expenditure (D=B-C)</td>
<td>(1,073,542.00)</td>
<td>37,000.00</td>
</tr>
<tr>
<td>Adjustment for Core Programmes(E)</td>
<td>782,311.00</td>
<td>-</td>
</tr>
<tr>
<td>Foreign Currency fluctuation</td>
<td>(202,723.00)</td>
<td>(202,723.00)</td>
</tr>
<tr>
<td>Balance of[(A-D)+C]</td>
<td>3,435,982.00</td>
<td>98,236.00</td>
</tr>
</tbody>
</table>

### DST-ANR Projects

<table>
<thead>
<tr>
<th></th>
<th>Amount as on 31st March, 2017</th>
<th>Amount as on 31st March, 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transaction in INR</td>
<td>Transaction in Euro</td>
</tr>
<tr>
<td>Opening Balance(A)</td>
<td>1,337,958.00</td>
<td>(948.00)</td>
</tr>
<tr>
<td>Add: Grant Received during The year</td>
<td>9,500,000.00</td>
<td>-</td>
</tr>
<tr>
<td>Add: Bank Interest</td>
<td>139,590.00</td>
<td>-</td>
</tr>
<tr>
<td>Programme Implementation and Overhead Charges</td>
<td>(700,000.00)</td>
<td>-</td>
</tr>
<tr>
<td>Total Income received during the Year(B)</td>
<td>8,398,590.00</td>
<td>-</td>
</tr>
<tr>
<td>Less: Expenditure Incurred(C)</td>
<td>5,835,523.00</td>
<td>-</td>
</tr>
<tr>
<td>Excess of Income over Expenditure (D=B-C)</td>
<td>2,562,967.00</td>
<td>-</td>
</tr>
<tr>
<td>Adjustment for Core Programmes(E)</td>
<td>(77,816.00)</td>
<td>(77,816.00)</td>
</tr>
<tr>
<td>Transfer to Programme Implementation Reserve of Previous year(1)</td>
<td>(3,051.00)</td>
<td>-</td>
</tr>
<tr>
<td>Prior Period Items(G)</td>
<td>14,011.00</td>
<td>-</td>
</tr>
<tr>
<td>Adjustment from DST-ANR Programme</td>
<td>948.00</td>
<td>63,526.00</td>
</tr>
<tr>
<td>Balance of[(A=D)+C]</td>
<td>4,375,969.00</td>
<td>-</td>
</tr>
</tbody>
</table>
### Schedule B 2 Non Core Programmes

<table>
<thead>
<tr>
<th>Transaction in INR</th>
<th>Transaction in Euro</th>
<th>Euro Transaction Equivalent in INR</th>
<th>Total Amount in INR</th>
<th>Transaction in INR</th>
<th>Transaction in Euro</th>
<th>Euro Transaction Equivalent in INR</th>
<th>Total Amount in INR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DST-INRA Projects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opening Balance(A)</td>
<td>35,915.00</td>
<td>50,000.00</td>
<td>3,390,550.00</td>
<td>3,314,632.00</td>
<td>2,225,921.00</td>
<td>50,000.00</td>
<td>3,390,550.00</td>
</tr>
<tr>
<td>Add: Bank Interest</td>
<td>27,836.00</td>
<td>-</td>
<td>27,836.00</td>
<td>100,938.00</td>
<td>-</td>
<td>100,938.00</td>
<td>-</td>
</tr>
<tr>
<td>Total Income received during the Year(B)</td>
<td>27,836.00</td>
<td>-</td>
<td>27,836.00</td>
<td>100,938.00</td>
<td>-</td>
<td>100,938.00</td>
<td></td>
</tr>
<tr>
<td>Less: Expenditure Incurred(C)</td>
<td>855,574.00</td>
<td>-</td>
<td>855,574.00</td>
<td>2,362,774.00</td>
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<td>Excess of Income over Expenditure (D=B-C)</td>
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<td>(827,738.00)</td>
<td>(2,281,836.00)</td>
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<td>Adjustment for Core Programmes(E)</td>
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<td>746,497.00</td>
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<td>Prior Period Items(F)</td>
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<td>Adjustment for Non Core Programmes</td>
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<td>(100,650.00)</td>
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<td>Repatriation of Funds</td>
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<td>(766,969.00)</td>
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<td>(Gain)/Loss on Repatriation of Funds</td>
<td>63,093.00</td>
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<td>63,093.00</td>
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<td>38,488.00</td>
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### Schedule B 2 Non Core Programmes

<table>
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<th>Total Amount in INR</th>
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<th>Transaction in Euro</th>
<th>Euro Transaction Equivalent in INR</th>
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<td><strong>DST-INRA Projects</strong></td>
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<td>Opening Balance(A)</td>
<td>2,087,049.00</td>
<td>(554.60)</td>
<td>(37,124.00)</td>
<td>2,049,925.00</td>
<td>89,802.00</td>
<td>(554.60)</td>
<td>(37,124.00)</td>
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<td>6,427,051.00</td>
<td>6,830,073.00</td>
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<td>-</td>
<td>6,830,073.00</td>
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<td>Add: Bank Interest</td>
<td>89,201.00</td>
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<td>89,201.00</td>
<td>28,862.00</td>
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<td>28,862.00</td>
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<td>Programme Implementation and Overhead Charges</td>
<td>(350,000.00)</td>
<td>-</td>
<td>(350,000.00)</td>
<td>(500,000.00)</td>
<td>-</td>
<td>(500,000.00)</td>
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<td>Total Income received during the Year(B)</td>
<td>5,995,852.00</td>
<td>-</td>
<td>5,995,852.00</td>
<td>6,538,934.00</td>
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<td>-</td>
<td>6,538,934.00</td>
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<tr>
<td>Less: Expenditure Incurred(C)</td>
<td>6,594,206.00</td>
<td>-</td>
<td>6,594,206.00</td>
<td>4,361,687.00</td>
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<td>4,361,687.00</td>
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<td>(629,354.00)</td>
<td>-</td>
<td>(629,354.00)</td>
<td>1,987,247.00</td>
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<td>1,987,247.00</td>
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<td>Adjustment for Core Programmes(E)</td>
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<td>Adjustment from DST-INRA Programmes</td>
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<td>37,124.00</td>
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<td><strong>Balance off(A+E)</strong></td>
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<td>1,410,508.00</td>
<td>2,087,049.00</td>
<td>(554.60)</td>
<td>(37,124.00)</td>
<td>2,049,925.00</td>
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### Roman Charpak

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<th>Total Amount in INR</th>
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<th>Transaction in Euro</th>
<th>Euro Transaction Equivalent in INR</th>
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<td>Opening Balance(A)</td>
<td>6,987,104.00</td>
<td>105,865.74</td>
<td>7,683,423.00</td>
<td>14,675,537.00</td>
<td>5,411,522.00</td>
<td>32,979.00</td>
<td>5,444,501.00</td>
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<td>Add: Grant Received During the year</td>
<td>7,590,000.00</td>
<td>140,000.00</td>
<td>10,461,244.00</td>
<td>17,961,244.00</td>
<td>5,000,000.00</td>
<td>141,000.00</td>
<td>55,088,466.00</td>
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<td>Add: Bank Interest</td>
<td>585,594.00</td>
<td>-</td>
<td>585,594.00</td>
<td>260,265.00</td>
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<td>-</td>
<td>260,265.00</td>
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<td>Programme Implementation and Overhead Charges</td>
<td>(500,000.00)</td>
<td>-</td>
<td>(500,000.00)</td>
<td>(662,338.00)</td>
<td>(6,156.88)</td>
<td>(668,494.88)</td>
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<td>Total Income received during the Year(B)</td>
<td>7,585,396.00</td>
<td>140,200.00</td>
<td>10,461,244.00</td>
<td>16,047,320.00</td>
<td>8,417,535.00</td>
<td>134,843.32</td>
<td>10,126,378.00</td>
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<tr>
<td>Less: Expenditure Incurred(C)</td>
<td>6,465,241.00</td>
<td>95,709.23</td>
<td>7,151,353.00</td>
<td>13,617,264.00</td>
<td>3,241,874.00</td>
<td>61,958.58</td>
<td>4,652,860.00</td>
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<td>Excess of Income over Expenditure (D=B-C)</td>
<td>1,119,155.00</td>
<td>44,490.77</td>
<td>3,310,371.00</td>
<td>4,430,020.00</td>
<td>1,576,682.00</td>
<td>72,886.74</td>
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<tr>
<td>Adjustment for Core Programmes(E)</td>
<td>(2,296,466.00)</td>
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<td>(2,296,466.00)</td>
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<td>Foreign Currency Fluctuation</td>
<td>(242,719.00)</td>
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<td>(242,719.00)</td>
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<td>-</td>
<td>-</td>
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<tr>
<td><strong>Balance off(A=E)</strong></td>
<td>5,890,283.00</td>
<td>150,169.51</td>
<td>10,797,078.00</td>
<td>16,691,369.00</td>
<td>6,997,104.00</td>
<td>105,865.74</td>
<td>7,683,423.00</td>
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214
### Schedule B 2 Non Core Programmes

<table>
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<tr>
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<th>Amount as on 31st March, 2017</th>
<th>Amount as on 31st March, 2016</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Transaction in INR</td>
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<td><strong>Birla French Embassy Programme</strong></td>
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<td>Opening Balance(A)</td>
<td>(293,626.00)</td>
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<td>6,362,440.00</td>
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<td>Add: Bank Interest</td>
<td>22,382.00</td>
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<td>Programme Implementation and Overhead Charges</td>
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<td>Total Income received during the Year(B)</td>
<td>5,994,609.00</td>
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<td>Less: Expenditure Incurred(C)</td>
<td>538,267.00</td>
<td>20,000.00</td>
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<td>Excess of Income over Expenditure (B-C)</td>
<td>5,556,352.00</td>
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<td>Adjustment for Core Programmes(E)</td>
<td>279,852.00</td>
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<td>Foreign Currency fluctuation</td>
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<tr>
<td>**Balance off/(A+B-E)</td>
<td>5,827,578.00</td>
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### Economic Diplomacy R. D Programme

<table>
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<th>Amount as on 31st March, 2016</th>
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<tbody>
<tr>
<td></td>
<td>Transaction in INR</td>
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<td>(199,113.00)</td>
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<td>965.12</td>
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<td>Excess of Income over Expenditure (B-C)</td>
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<td>(965.12)</td>
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<tr>
<td>Transfer from French Season in India Programme(E)</td>
<td>742,703.00</td>
<td>(107.00)</td>
</tr>
<tr>
<td>Transfer from India SI House and Innovation</td>
<td>-</td>
<td>(562.00)</td>
</tr>
<tr>
<td>Transfer from Project with IIT Rajasthan</td>
<td>-</td>
<td>17,238.00</td>
</tr>
<tr>
<td>Transfer from India France Tech Summit</td>
<td>1,134,454.00</td>
<td>40,000.00</td>
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<tr>
<td>Transfer from Region to Region.SBI Programme</td>
<td>-</td>
<td>-</td>
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<td>Foreign Currency fluctuation</td>
<td>5,288.00</td>
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<tr>
<td>**Balance off/(A+B-E)</td>
<td>1,788,044.00</td>
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### Project With IIT Rajasthan

<table>
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<th>Amount as on 31st March, 2016</th>
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<tbody>
<tr>
<td></td>
<td>Transaction in INR</td>
<td>Transaction in Euro</td>
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<tr>
<td><strong>Opening Balance(A)</strong></td>
<td>(594,163.00)</td>
<td>36,238.00</td>
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<td><strong>Total Income received during the Year(B)</strong></td>
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</tr>
<tr>
<td>Less: Expenditure Incurred(C)</td>
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<td>Excess of Income over Expenditure (B-C)</td>
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<td>Transfer to Group Farming Projects</td>
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<td>(17,238.00)</td>
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<td>Repatriation of Funds</td>
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<td>(8,000.00)</td>
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<tr>
<td>**Balance off/(A+B-E)</td>
<td>(594,163.00)</td>
<td>36,238.00</td>
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### Indo-French Centre for the Promotion of Advanced Research, New Delhi

**Schedules Forming Part of the Balance Sheet as at 31st March 2017**

#### Schedule B2 Non-Core Programmes

<table>
<thead>
<tr>
<th></th>
<th>Amount as on 31st March, 2017</th>
<th>Amount as on 31st March, 2016</th>
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</thead>
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<tr>
<td></td>
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<td>INR</td>
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<tr>
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<td>1,893,314.00</td>
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<td>120,007.00</td>
<td>120,007.00</td>
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<tr>
<td></td>
<td>8,041,789.00</td>
<td>8,041,789.00</td>
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<tr>
<td></td>
<td>9,178,243.00</td>
<td>9,176,103.00</td>
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<tr>
<td>Less: Expenditure Incurred(C)</td>
<td>-</td>
<td>758,860.00</td>
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<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Excess of Income over Expenditure (D=B-C)</td>
<td>(758,860.00)</td>
<td>(758,860.00)</td>
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<tr>
<td>Transfer to Economic Diplomacy Programme Reserve</td>
<td>(1,134,454.00)</td>
<td>(3,815,363.00)</td>
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<td>Transfer to Indo French Water Network</td>
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#### India French Water Network

<table>
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<td>INR</td>
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<td>8,069,939.00</td>
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<td>2,989,064.00</td>
<td>2,989,064.00</td>
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<tr>
<td>Add: Bank Interest</td>
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<td>125,960.00</td>
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<td>Programme Implementation and Overhead Charges</td>
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<td></td>
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<td>Total Income received during the Year(B)</td>
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<td>4,840,210.00</td>
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<td>28,169.00</td>
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<tr>
<td>Transfer to Programme Implementation Charges</td>
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<td>(166,934.00)</td>
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<td>Transfer From India France Tech Summit</td>
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#### India Science & Innovation House

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<th>Amount as on 31st March, 2016</th>
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<td>INR</td>
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<tr>
<td></td>
<td>(39,000.00)</td>
<td>(39,000.00)</td>
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<tr>
<td>Transfer to Economic Diplomacy Programme Reserve</td>
<td>582.00</td>
<td>39,000.00</td>
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<tr>
<td>Balance of(A+B+C)</td>
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#### French Season in India

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<th>Amount as on 31st March, 2016</th>
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<td>INR</td>
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<tr>
<td><strong>Opening Balance(A)</strong></td>
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<td>742,703.00</td>
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<td>(107.00)</td>
<td>(107.00)</td>
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<td>(7,179.00)</td>
<td>(7,179.00)</td>
</tr>
<tr>
<td>Transfer to Economic Diplomacy Programme Reserve</td>
<td>742,703.00</td>
<td>(7,179.00)</td>
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<td>Balance of(A+B+C)</td>
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<td>-</td>
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<tr>
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<td>742,703.00</td>
<td>742,703.00</td>
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<tr>
<td>Sch-B3 Programme Implementation and Overhead Charges - Non Core Programmes</td>
<td></td>
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<tr>
<td><strong>DST-ANR Projects</strong></td>
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<tr>
<td><strong>Opening Balance</strong></td>
<td></td>
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<tr>
<td>INR: 3,051.00</td>
<td>INR: 3,051.00</td>
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<tr>
<td><strong>Add: Programme Implementation and Overhead Charges</strong></td>
<td></td>
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<tr>
<td>INR: 700,000.00</td>
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<tr>
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<tr>
<td>INR: 703,051.00</td>
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<tr>
<td><strong>Less: Expenditure Incurred</strong></td>
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<tr>
<td>INR: 618,307.00</td>
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<td><strong>Balance carried forward</strong></td>
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<td>INR: 84,744.00</td>
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<tr>
<td><strong>DST-INRIA Projects</strong></td>
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<td><strong>Opening Balance</strong></td>
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<td></td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Add: Programme Implementation and Overhead Charges</strong></td>
<td></td>
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<tr>
<td>INR: 550,000.00</td>
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<tr>
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<td><strong>Less: Expenditure Incurred</strong></td>
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<tr>
<td>INR: 503,440.00</td>
<td>INR: 503,440.00</td>
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<td>INR: 46,560.00</td>
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<td><strong>Raman Chagpar Fellowship</strong></td>
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<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Add: Programme Implementation and Overhead Charges</strong></td>
<td></td>
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<tr>
<td>INR: 500,000.00</td>
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<td><strong>Total Available Funds</strong></td>
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<tr>
<td>INR: 500,000.00</td>
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<tr>
<td><strong>Less: Expenditure Incurred</strong></td>
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<tr>
<td>INR: 454,217.00</td>
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<td><strong>Balance carried forward</strong></td>
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<td>INR: 45,783.00</td>
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<td><strong>TDB-Programme</strong></td>
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<td><strong>Opening Balance</strong></td>
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<td></td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Add: Programme Implementation and Overhead Charges</strong></td>
<td></td>
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</tr>
<tr>
<td>INR: 500,000.00</td>
<td>INR: 500,000.00</td>
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<td><strong>Add: Bank Interest</strong></td>
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<tr>
<td>INR: 503,777.00</td>
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<tr>
<td>INR: 183,850.00</td>
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<tr>
<td>INR: 319,927.00</td>
<td>INR: 319,927.00</td>
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<td><strong>BIRAC French Embassy Projects</strong></td>
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<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Add: Programme Implementation and Overhead Charges</strong></td>
<td></td>
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<tr>
<td>INR: 290,013.00</td>
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<td>-</td>
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<td><strong>Total Available Funds</strong></td>
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<tr>
<td>INR: 290,013.00</td>
<td>INR: 290,013.00</td>
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</tr>
<tr>
<td><strong>Less: Expenditure Incurred</strong></td>
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<tr>
<td>INR: 258,568.00</td>
<td>INR: 258,568.00</td>
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<td><strong>Balance carried forward</strong></td>
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<tr>
<td>INR: 31,445.00</td>
<td>INR: 31,445.00</td>
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<tr>
<td>Water Network</td>
<td>transaction in INR</td>
<td>Transaction in Euro</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Opening Balance</td>
<td>166,934.00</td>
<td>-</td>
</tr>
<tr>
<td>Add: Programme Implementation received</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Available Funds</td>
<td>166,934.00</td>
<td>166,934.00</td>
</tr>
<tr>
<td>Less: Expenditure Incurred</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Available Funds</td>
<td>166,934.00</td>
<td>166,934.00</td>
</tr>
<tr>
<td>IFCAM Projects</td>
<td>transaction in INR</td>
<td>Transaction in Euro</td>
</tr>
<tr>
<td>Opening Balance</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Add: Programme Implementation received</td>
<td>150,000.00</td>
<td>150,000.00</td>
</tr>
<tr>
<td>Total Available Funds</td>
<td>150,000.00</td>
<td>150,000.00</td>
</tr>
<tr>
<td>Less: Expenditure Incurred</td>
<td>150,000.00</td>
<td>150,000.00</td>
</tr>
<tr>
<td>Total Available Funds</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

**SCHEDULES FORMING PART OF THE BALANCE SHEET AS AT 31ST MARCH 2017**

#### Schedule C Expenses Payable

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount as on 31.03.2017</th>
<th>Amount as on 31.03.2016</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transactin in INR</td>
<td>Euro</td>
</tr>
<tr>
<td>1) Office Expenses Payable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K.S. Gupta &amp; Co.</td>
<td>13,290.00</td>
<td>-</td>
</tr>
<tr>
<td>Communication Expenses</td>
<td>8,210.00</td>
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</tr>
<tr>
<td>Maintenance Charges</td>
<td>4,568.00</td>
<td>-</td>
</tr>
<tr>
<td>Professional &amp; Legal</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Electricity Expenses</td>
<td>25,908.00</td>
<td>-</td>
</tr>
<tr>
<td>Postage &amp; Courier</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Management Service</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Office Maintenance- Helpline Facility</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total Office expense Payable</strong></td>
<td>51,976.00</td>
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<tr>
<td>b) TDS Payable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On Professional Services</td>
<td>5,250.00</td>
<td>-</td>
</tr>
<tr>
<td>On Salaries</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>On Contractors</td>
<td>8,285.00</td>
<td>-</td>
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<tr>
<td><strong>Total TDS Payable</strong></td>
<td>13,535.00</td>
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<tr>
<td>c) Seminar &amp; Workshops Liability</td>
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</tr>
<tr>
<td>Seminar on New Trends in Chemistry (11-138)</td>
<td>288,000.00</td>
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<tr>
<td>Seminar on Organic Photovoltaics (11-136)</td>
<td>-</td>
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<tr>
<td>Seminar on Organic Semiconductor(11-139)</td>
<td>275,400.00</td>
<td>3,820.00</td>
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<tr>
<td><strong>Total Seminar &amp; Workshop Liability</strong></td>
<td>563,400.00</td>
<td>3,820.00</td>
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#### Schedule D Current Assets

<table>
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<tr>
<th>Description</th>
<th>Amount as on 31.03.2017</th>
<th>Amount as on 31.03.2016</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transactin in INR</td>
<td>Euro</td>
</tr>
<tr>
<td>a) Seminar &amp; Workshops</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seminar on Futuristic Approach</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Seminar on Catalysis for Green</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Seminar on Application of Structured Biology</td>
<td>758,400.00</td>
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<tr>
<td>Seminar on processing</td>
<td>805,200.00</td>
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<tr>
<td>Registrar, Bharatiatn University</td>
<td>596,000.00</td>
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<tr>
<td>Tata Institute of Fundamental</td>
<td>816,000.00</td>
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<td>Seminar on Catysis by Design Using NMR</td>
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<td>13,482.00</td>
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<tr>
<td>Seminar on Plasticity, Rheology and Nonlin</td>
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<td>12,320.00</td>
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<tr>
<td><strong>Total Seminar &amp; Workshop Advances</strong></td>
<td>2,975,600.00</td>
<td>25,802.00</td>
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#### Other deposit

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount as on 31.03.2016</th>
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<tbody>
<tr>
<td>India Habitat Centre</td>
<td>5,000.00</td>
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<tr>
<td>Rent-Director Residence</td>
<td>21,951.00</td>
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<tr>
<td>Cellular Connection</td>
<td>17,220.00</td>
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<tr>
<td>Other Advances</td>
<td>47,686.00</td>
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<tr>
<td>Deposit with Petro Card</td>
<td>55.00</td>
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<tr>
<td>Festival Advances</td>
<td>7,800.00</td>
</tr>
<tr>
<td>Internet Charges</td>
<td>4,600.00</td>
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<tr>
<td>Campus France</td>
<td>126,235.08</td>
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<tr>
<td>NPS deduction Recoverable</td>
<td>1,230.00</td>
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<td>Cash Imprest</td>
<td>14,758.00</td>
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<td><strong>Total Deposit</strong></td>
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<tr>
<td>S.N</td>
<td>Particulars</td>
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<tr>
<td>1</td>
<td>CAR</td>
</tr>
<tr>
<td>2</td>
<td>FURNITURE &amp; FIXTURE</td>
</tr>
<tr>
<td>3</td>
<td>OFFICE EQUIPMENT</td>
</tr>
<tr>
<td>4</td>
<td>COMPUTER</td>
</tr>
<tr>
<td>5</td>
<td>LAND &amp; BUILDING</td>
</tr>
<tr>
<td>6</td>
<td>PHOTOCOPIER</td>
</tr>
<tr>
<td>7</td>
<td>TELEPHONE SYSTEM</td>
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</table>

Previous Year

|         |                   |       | 24,717,005.00   | 189,750.00       | 44,500.00       | 450,097.00       | 24,591,158.00           | 18,109,381.00 | 1,026,853.00 | 366,721.00     | 18,770,113.00         | 5,751,045.00           | 6,607,024.00 |

|         |                   |       | 24,888,213.00   | 191,410.00       | 141,491.00      | 564,109.00       | 24,717,005.00           | 16,972,971.00 | 1,363,620.00 | 226,610.00    | 18,109,981.00         | 5,751,045.00           | 6,607,024.00 |
### INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

**SCHEDULES FORMING PART OF THE INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED ON 31ST MARCH 2017**

<table>
<thead>
<tr>
<th>Schedule F Expenditure</th>
<th>Amount as on 31.03.2017</th>
<th>Amount as on 31.03.2016</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Transcation in INR</td>
<td>Transcation in Euro</td>
</tr>
<tr>
<td></td>
<td>Transcation in INR</td>
<td>Transcation in Euro</td>
</tr>
<tr>
<td><strong>Running Expenses of the Centre</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Office and Running Expenses of the Centre</strong></td>
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<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>14,266,400.00</td>
<td>16,184,861.00</td>
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<tr>
<td>Office Expenses</td>
<td>3,770,077.00</td>
<td>7,112,846.00</td>
</tr>
<tr>
<td></td>
<td>2,629.99</td>
<td>1,231.40</td>
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<tr>
<td><strong>Total Office and Running Expenses</strong></td>
<td>18,036,477.00</td>
<td>23,297,707.00</td>
</tr>
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<td>2,629.99</td>
<td>1,231.40</td>
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<tr>
<td><strong>Office Expenses</strong></td>
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<tr>
<td>Communication Expenses</td>
<td>626,008.00</td>
<td>991,775.00</td>
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<td>Conveyance Expenses</td>
<td>38,688.00</td>
<td>144,238.00</td>
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<td>Entertainment Expenses</td>
<td>12,447.00</td>
<td>21,831.00</td>
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<tr>
<td>Repair &amp; Maintenance</td>
<td>16,784.00</td>
<td>124,952.00</td>
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<td>Electricity Expenses</td>
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<td>206,405.00</td>
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<tr>
<td>Security Charges</td>
<td>296,047.00</td>
<td>278,298.00</td>
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<td>117,419.00</td>
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<td>Bank Charges</td>
<td>5,784.00</td>
<td>23,400.00</td>
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<td>639,919.00</td>
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<td>Books &amp; Periodicals</td>
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<td>32,983.00</td>
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<td>Canteen Expenses</td>
<td>37,655.00</td>
<td>108,827.00</td>
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<td>Festival Expenses</td>
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<td>80,166.00</td>
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<td>Office Insurance</td>
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<td>Lixires</td>
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<td>21,821.00</td>
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<td>Management Service</td>
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<td>677,490.00</td>
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<td>Staff Car Expenses</td>
<td>121,195.00</td>
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<td>Professional &amp; Legal Expenses</td>
<td>141,258.00</td>
<td>195,257.00</td>
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<td>Recruitment Expenses</td>
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<td>Advertisement Expenses</td>
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<td>1,135.00</td>
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<td>IIC Membership</td>
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<td>Website Maintenance</td>
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<tr>
<td><strong>Total Office Expenses</strong></td>
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<td>7,465,779.00</td>
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<td>2,629.99</td>
<td>1,231.40</td>
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<tr>
<td>Loss: Office Expenses for Non Core</td>
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<td>Office Expenses</td>
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<td></td>
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<tr>
<td></td>
<td>3,770,077.00</td>
<td>7,112,846.00</td>
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<tr>
<td></td>
<td>2,629.99</td>
<td>1,231.40</td>
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### Office Expenses-Non Shareable

<table>
<thead>
<tr>
<th></th>
<th>Amount as on 31.03.2017</th>
<th>Amount as on 31.03.2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance Charges IIC</td>
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<td>1,006,543.00</td>
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<td>Maintenance Charges-Office Premises</td>
<td>294,806.00</td>
<td>333,330.00</td>
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<td>Municipal Tax</td>
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<td>206,160.00</td>
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<tr>
<td>Computer Software</td>
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<tr>
<td>Group Farming Projects</td>
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<td>1,168,464.00</td>
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<td>Network Projects</td>
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<td>5,764.00</td>
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<tr>
<td><strong>Total Office Expenses-Non Shareable</strong></td>
<td>2,150,964.00</td>
<td>3,980,700.00</td>
</tr>
<tr>
<td></td>
<td>3,402.60</td>
<td>65,765.00</td>
</tr>
</tbody>
</table>
### INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

**SCHEDULES FORMING PART OF THE INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED ON 31ST MARCH 2017**

<table>
<thead>
<tr>
<th></th>
<th>Amount as on 31.03.2017</th>
<th>Amount as on 31.03.2016</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transact in INR</td>
<td>Transact in Euro</td>
</tr>
<tr>
<td><strong>Travel Expenses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic Travel</td>
<td>352,193.00</td>
<td></td>
</tr>
<tr>
<td>International Travel</td>
<td>801,193.00</td>
<td>1,837.16</td>
</tr>
<tr>
<td><strong>Total Travel Expenses</strong></td>
<td>1,153,376.00</td>
<td>1,837.16</td>
</tr>
<tr>
<td><strong>GB/SC/IRC/SEP/Vision Group Expenses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Governing Body</td>
<td>1,217,197.00</td>
<td>4,827.22</td>
</tr>
<tr>
<td>Scientific Council</td>
<td>2,939,855.00</td>
<td>30,483.09</td>
</tr>
<tr>
<td>Industrial Research Council</td>
<td>1,245,785.00</td>
<td>13,249.22</td>
</tr>
<tr>
<td>Standard Expert Panel</td>
<td>6,757.00</td>
<td></td>
</tr>
<tr>
<td>Vision Group Meeting</td>
<td>275,368.00</td>
<td>2,710.07</td>
</tr>
<tr>
<td><strong>Total GB/SC/IRC/SEP/Vision group Expenses</strong></td>
<td>5,684,962.00</td>
<td>51,269.60</td>
</tr>
</tbody>
</table>

#### Schedule G

**2) Scientific Expenses of the Centre**

**a) General Scientific Expenses**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount as on 31.03.2017</th>
<th>Amount as on 31.03.2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation of R &amp; D Cellpru Projects</td>
<td>83,830.00</td>
<td></td>
</tr>
<tr>
<td>Expenses on outreach</td>
<td>262,402.00</td>
<td>145.60</td>
</tr>
<tr>
<td>Scientific Publication</td>
<td>412,530.00</td>
<td>3,093,171.00</td>
</tr>
<tr>
<td>Expenses in Connection with Elsevier</td>
<td>966,988.00</td>
<td>19,200.00</td>
</tr>
<tr>
<td>Cellpru Lecture Series</td>
<td>320,028.00</td>
<td>21,152.92</td>
</tr>
<tr>
<td>Region to Region</td>
<td>423,015.00</td>
<td>31,967.69</td>
</tr>
<tr>
<td>Synchrotron Meetings</td>
<td>900,680.00</td>
<td>1,597,731.00</td>
</tr>
<tr>
<td>Other Scientific Expenses</td>
<td>1,633.00</td>
<td></td>
</tr>
<tr>
<td><strong>Total General Scientific Expenses</strong></td>
<td>3,024,874.00</td>
<td>72,310.51</td>
</tr>
</tbody>
</table>

**Research Projects/Seminar and Workshop**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount as on 31.03.2017</th>
<th>Amount as on 31.03.2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seminars &amp; Workshops</td>
<td>4,038,849.00</td>
<td>15,696.11</td>
</tr>
<tr>
<td>Research Projects</td>
<td>78,279,779.00</td>
<td>1,240,648.91</td>
</tr>
<tr>
<td>Industrial Research Projects</td>
<td>3,863,091.00</td>
<td>4,388.00</td>
</tr>
<tr>
<td><strong>Total Research Project/Seminar and workshop</strong></td>
<td>85,981,719.00</td>
<td>1,260,733.02</td>
</tr>
</tbody>
</table>

**SGRI Programmes**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount as on 31.03.2017</th>
<th>Amount as on 31.03.2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGRI Programmes</td>
<td>1,461,097.00</td>
<td></td>
</tr>
<tr>
<td>Airbus</td>
<td>21,883.00</td>
<td></td>
</tr>
<tr>
<td><strong>Total SGRI Programmes/Airbus</strong></td>
<td>1,512,980.00</td>
<td></td>
</tr>
</tbody>
</table>
## INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
### BALANCE SHEET AS AT 31ST MARCH 2011

**Conversion Rate Rs/Euro = 69.2476**  
**Conversion Rate Rs/Euro = 75.0955**

### I. Liabilities

<table>
<thead>
<tr>
<th>Description</th>
<th>Total Amount in INR</th>
<th>Total Amount in EURO</th>
<th>Total Amount in INR</th>
<th>Total Amount in EURO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reserve Fund</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core Programmes</td>
<td>12,02,23,535.00</td>
<td>17,36,140.00</td>
<td>106,314,402.00</td>
<td>1,415,723.00</td>
</tr>
<tr>
<td>Current Liabilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non Core Programmes</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Targeted Programmes-Grant</td>
<td>36,56,953.00</td>
<td>528,061.00</td>
<td>29,987,240.00</td>
<td>428,428.00</td>
</tr>
<tr>
<td>French Embassy programme Grant</td>
<td>35,85,521.00</td>
<td>517,783.00</td>
<td>32,688,140.00</td>
<td>409,181.00</td>
</tr>
<tr>
<td>Programme Implementation Charges</td>
<td>695,393.00</td>
<td>10,042.00</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Brics Meeting</td>
<td>51,411.00</td>
<td>742.00</td>
<td>51,411.00</td>
<td>686.00</td>
</tr>
<tr>
<td>Group Farming Projects</td>
<td>761,724.00</td>
<td>11,000.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Expenses Payable</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office Expenses Payable</td>
<td>51,976.00</td>
<td>751.00</td>
<td>116,001.00</td>
<td>1,545.00</td>
</tr>
<tr>
<td>TDS Payable</td>
<td>13,535.00</td>
<td>195.00</td>
<td>45,470.00</td>
<td>605.00</td>
</tr>
<tr>
<td>Seminar &amp; Workshop</td>
<td>827,926.00</td>
<td>11,956.00</td>
<td>1,050,265.00</td>
<td>13,986.00</td>
</tr>
<tr>
<td>SC/IRG Meetings</td>
<td>-</td>
<td>-</td>
<td>1,250,000.00</td>
<td>16,645.00</td>
</tr>
<tr>
<td>GB/SC Expenses Payable</td>
<td>2,436.00</td>
<td>35.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Expenses on Publication</td>
<td>299,990.00</td>
<td>4,332.00</td>
<td>674,475.00</td>
<td>8,361.00</td>
</tr>
<tr>
<td>Travel Expenses Payable</td>
<td>3,124.00</td>
<td>45.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Grant-2017-18</td>
<td>53,666,890.00</td>
<td>775,000.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Foreign Currency Adjustment Account</td>
<td>23,79,627.00</td>
<td>34,367.00</td>
<td>8,602,216.00</td>
<td>114,550.00</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>25,13,99,941.00</td>
<td>36,30,449.00</td>
<td>180,779,820.00</td>
<td>2,407,329.00</td>
</tr>
</tbody>
</table>

### II. Assets

<table>
<thead>
<tr>
<th>Description</th>
<th>Total Amount in INR</th>
<th>Total Amount in EURO</th>
<th>Total Amount in INR</th>
<th>Total Amount in EURO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Assets</strong></td>
<td>5,73,045.00</td>
<td>82,762.00</td>
<td>6,607,024.00</td>
<td>87,982.00</td>
</tr>
<tr>
<td>Cash &amp; Cash Equivalents</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Core Bank Balances</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>State Bank of Hyderabad Account</td>
<td>48,920,655.00</td>
<td>706,460.00</td>
<td>56,086,204.00</td>
<td>746,865.00</td>
</tr>
<tr>
<td>Union Bank of India</td>
<td>406,427.00</td>
<td>5,869.00</td>
<td>391,844.00</td>
<td>5,218.00</td>
</tr>
<tr>
<td>Axis Bank Account</td>
<td>761,518.00</td>
<td>10,997.00</td>
<td>731,804.00</td>
<td>9,745.00</td>
</tr>
<tr>
<td>State Bank of Hyderabad (Gratuity) Account</td>
<td>2,522,522.00</td>
<td>36,428.00</td>
<td>2,232,233.00</td>
<td>29,725.00</td>
</tr>
<tr>
<td>CIC, Paris Account</td>
<td>128,249,281.00</td>
<td>1,852,039.00</td>
<td>79,904,755.00</td>
<td>1,064,038.00</td>
</tr>
<tr>
<td><strong>Non Core Bank Balances</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Union Bank of India - Raman Charpak Account</td>
<td>9,341,165.00</td>
<td>134,895.00</td>
<td>8,041,370.00</td>
<td>107,960.00</td>
</tr>
<tr>
<td>Union Bank of India - DSTD INRIA Account</td>
<td>2,571,734.00</td>
<td>37,138.00</td>
<td>2,715,895.00</td>
<td>36,163.00</td>
</tr>
<tr>
<td>Union Bank of India - DSTD INRA Account</td>
<td>643,032.00</td>
<td>9,286.00</td>
<td>710,582.00</td>
<td>9,462.00</td>
</tr>
<tr>
<td>Union Bank of India - IFCAM Account</td>
<td>3,856,659.00</td>
<td>55,723.00</td>
<td>6,531,507.00</td>
<td>86,976.00</td>
</tr>
<tr>
<td>Union Bank of India- DSTD ANR Account</td>
<td>5,914,751.00</td>
<td>85,415.00</td>
<td>2,156,217.00</td>
<td>28,700.00</td>
</tr>
<tr>
<td>Union Bank of India-TDB Programme</td>
<td>316,150.00</td>
<td>4,566.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>State Bank of Hyderabad-BIRAC</td>
<td>3,551,900.00</td>
<td>51,293.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>State Bank of Hyderabad-BIRAC</td>
<td>5,887,793.00</td>
<td>85,025.00</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
## Balance Sheet as at 31st March 2017

### Euro Version

<table>
<thead>
<tr>
<th>Current Assets</th>
<th>Total Amount in INR</th>
<th>Total Amount in EURO</th>
<th>Amount as on 31.03.2017</th>
<th>Amount as on 31.03.2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seminars &amp; Workshops</td>
<td>4,762,327.00</td>
<td>68,772.00</td>
<td>2,539,200.00</td>
<td>33,813.00</td>
</tr>
<tr>
<td>Income Tax &amp; TDS Receivable</td>
<td>4,728,388.00</td>
<td>68,282.00</td>
<td>4,618,039.00</td>
<td>61,496.00</td>
</tr>
<tr>
<td>Other Deposits</td>
<td>8,929,627.00</td>
<td>128,952.00</td>
<td>3,873,306.00</td>
<td>51,578.00</td>
</tr>
<tr>
<td>Tour Advances</td>
<td>4,975,678.00</td>
<td>71,853.00</td>
<td>2,993,287.00</td>
<td>39,860.00</td>
</tr>
<tr>
<td>Tour Advances-Non Core</td>
<td>2,482,745.00</td>
<td>35,853.00</td>
<td>647,233.00</td>
<td>8,618.00</td>
</tr>
<tr>
<td>Accrued Interest-IFCAM</td>
<td>64,347.00</td>
<td>929.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Accrued Interest-ANR</td>
<td>56,337.00</td>
<td>842.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Accrued Interest-TDB</td>
<td>3,777.00</td>
<td>55.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Accrued Interest-Core Programmes</td>
<td>4,009.00</td>
<td>58.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>G8 SCI/RC Advance</td>
<td>1,174,266.00</td>
<td>16,957.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Security Deposit Campus France</td>
<td>5,539,808.00</td>
<td>80,000.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>251,399,941.00</td>
<td>3,630,449.00</td>
<td>180,779,620.00</td>
<td>2,407,329.00</td>
</tr>
</tbody>
</table>

**Accounting policies and notes to accounts are integral part of financial statements**

### AUDITOR'S REPORT

As per our report of even date attached
For K.K.GHEI & CO.
Chartered Accountants

**Partner**

(RAJNEESH GHEI)

**Assistant Accounts Officer**

PRANAV SHARMA

Manager(Admin. & Accounts)

N.S.PADMANABHAN

**Director**

Dr. MUKESH KUMAR

Membership No. 096329
Place : New Delhi
Date : 15.10.2017
<table>
<thead>
<tr>
<th>I. INCOME</th>
<th>Total Amount in INR</th>
<th>Total Amount in EURO</th>
<th>Total Amount in INR</th>
<th>Total Amount in EURO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grant-in-aid</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grant from Govt. of France</td>
<td>115,433,770.00</td>
<td>1,550,000.00</td>
<td>115,398,025.00</td>
<td>1,550,000.00</td>
</tr>
<tr>
<td>Govt. of India</td>
<td>119,400,000.00</td>
<td>1,724,247.00</td>
<td>131,681,152.00</td>
<td>1,756,180.00</td>
</tr>
<tr>
<td>Grant from Govt. of France-Group Farming</td>
<td>-</td>
<td>-</td>
<td>463,865.00</td>
<td>6,177.00</td>
</tr>
<tr>
<td>BRICS Meeting</td>
<td>-</td>
<td>-</td>
<td>234,500.00</td>
<td>3,123.00</td>
</tr>
<tr>
<td><strong>Interest from Bank Accounts</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State Bank of Hyderabad</td>
<td>1,691,802.00</td>
<td>24,431.00</td>
<td>958,640.00</td>
<td>12,756.00</td>
</tr>
<tr>
<td>UBI-Bank</td>
<td>16,015.00</td>
<td>231.00</td>
<td>15,216.00</td>
<td>203.00</td>
</tr>
<tr>
<td>Axis Bank</td>
<td>29,714.00</td>
<td>429.00</td>
<td>28,631.00</td>
<td>381.00</td>
</tr>
<tr>
<td>State Bank of Hyderabad-Gratuity Account</td>
<td>256,900.00</td>
<td>3,710.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Misc. Income</td>
<td>54,995.00</td>
<td>794.00</td>
<td>50,769.00</td>
<td>676.00</td>
</tr>
<tr>
<td>Programme Implementation &amp; Overhead Charges</td>
<td>-</td>
<td>-</td>
<td>2,187,321.00</td>
<td>-</td>
</tr>
<tr>
<td>Gain/(Loss) on repatriation</td>
<td>-</td>
<td>-</td>
<td>(834,201.00)</td>
<td>(12,440.00)</td>
</tr>
<tr>
<td>Exchange Rate Fluctuation</td>
<td>-</td>
<td>-</td>
<td>180,014.00</td>
<td>2,397.00</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>236,883,196.00</td>
<td>3,305,842.00</td>
<td>251,463,972.00</td>
<td>3,348,590.00</td>
</tr>
</tbody>
</table>

| II. EXPENDITURE | | | | |
| **Running Expenses of the Centre** | | | | |
| Office and Running Expenses of the Centre | 18,233,007.00 | 263,302.00 | 23,390,179.00 | 311,472.00 |
| Travel Expenses | 1,290,661.00 | 18,638.00 | 3,215,997.00 | 42,825.00 |
| GRSC/IRC/SEP/Vision Group Expenses | 9,516,165.00 | 137,422.00 | 12,523,849.00 | 166,772.00 |
| Non Shareable Expenses | 2,405,229.00 | 34,734.00 | 8,919,355.00 | 118,773.00 |
| **Total Running Expenses of the Centre** | 31,445,062.00 | 454,096.00 | 48,049,380.00 | 639,842.00 |

| **Scientific Expenses of the Centre** | | | | |
| General Scientific Expenses | 8,428,393.00 | 121,714.00 | 8,594,868.00 | 114,453.00 |
| Research Projects/Seminar and Workshop | 180,192,011.00 | 2,602,141.00 | 174,570,973.00 | 2,324,653.00 |
| SGRI Programmes/Airbus Project | 1,512,980.00 | 21,849.00 | 4,334,365.00 | 57,716.00 |
| BRICS | - | - | 183,089.00 | 2,438.00 |
| **Total Scientific Expenses of the Centre** | 190,133,384.00 | 2,746,704.00 | 187,883,295.00 | 2,499,262.00 |
| **Total Expenditure of the Centre (II)** | 221,578,446.00 | 3,199,800.00 | 235,732,675.00 | 3,139,104.00 |

| Excess of Income over Expenditure (II) | | | | |
| Depreciation on Assets | 15,304,750.00 | 104,042.00 | 15,731,297.00 | 209,486.00 |
| Loss on Sale assets | (1,026,853.00) | (14,829.00) | (1,363,620.00) | (18,158.00) |
| Less: Programme Implementation Charges and Operational Expenses | (59,376.00) | (807.00) | (26,393.00) | (351.00) |
| Acct: Prior period Items | 34,436.00 | 497.00 | 155,008.00 | 2,054.00 |
| Transfer for specific Meeting-BRICS | (797,571.00) | (11,518.00) | (51,411.00) | (685.00) |
| Rounding off | - | - | - | (2.00) |
| **Balance of Surplus Funds** | 13,455,386.00 | 77,335.00 | 12,258,672.00 | 163,242.00 |

Accounting policies and notes to accounts are integral part of the financial statements

AUDITOR'S REPORT
As per our report of even date attached
For K.K. GHEI & CO.
Chartered Accountants
Firm Registration No. 001342R

<table>
<thead>
<tr>
<th>SIGNED:</th>
<th>PRANAV SHARMA</th>
<th>N.S. PADMANABHAN</th>
<th>Dr. MUKESH KUMAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partner</td>
<td>Assistant Accountant Officer</td>
<td>Manager (Admin. &amp; Accounts)</td>
<td>Director</td>
</tr>
<tr>
<td>Membership No: 086329</td>
<td>Place: New Delhi</td>
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Indo-French Centre for the Promotion of Advanced Research/ Centre Franco-Indien pour la Promotion de la Recherche Avancée (CEFIPRA) is a model for international collaborative research in advanced areas of Science & Technology. The Centre was established in 1987 being supported by Department of Science & Technology, Government of India and the Ministry for Europe & Foreign Affairs, Government of France. CEFIPRA is actively involved in supporting Indo-French Science, Technology & Innovation system through various activities. Collaborative Scientific Research Programme focuses on Academia-to-Academia Collaborations between Indian and French Academic Collaborators in various domains. Industry Academia Research & Development Programme emphasizes to develop the linkage between Industry and Academia from France and India. Dedicated mobility support programmes of CEFIPRA provide exposure to young researchers of the working, social and cultural environment of the partnering country. Targeted Programmes of CEFIPRA provide platform for Indian and French National Funding Agencies to implement programmes for specific areas. Innovation programmes through PPP mode are the programmes where industries join hands with CEFIPRA as a funding partner for supporting R & D in defined priority areas.

For further information, please contact:

**Director**

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