CEFIPRA

Annual Report 2018-19

Indo-French Centre for the Promotion of Advanced Research

Centre Franco-Indien pour la Promotion de la Recherche Avancée

CEFIPRA

Indo-French Centre for the Promotion
of Advanced Research
(IFCPAR)

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

Annual Report
2018-19

CEFIPRA

From **Director's Desk**

The Indo-French STI partnership was further strengthened through CEFIPRA's programmes during the year 2018-19. CEFIPRA was commended, by stakeholders, for its remarkable role in facilitating research and innovation across numerous areas of science and technology.

CEFIPRA has been playing a pivotal role in bringing Indian and French industry counterparts to work together on various facets of multidisciplinary research. For the dissemination of its exclusive goals and vision for the industries, CEFIPRA had successfully organized a Business-to-Business Summit, involving industries, startups and SMEs based in Bangalore, on 14 September 2018.

CEFIPRA has supported many projects under its various schemes to address intricate societal needs. The Centre also organized 2nd Indo-French seminar on "Women in Science" during 24-25 September 2018 at CNRS headquarters, Paris, France. This event was graced by Dr. Antoine Petit, President, CNRS and Mme Laurence AUER, French Co-Chair of CEFIPRA, Ministère de l'Europe et des affaires étrangères, Paris, Govt. of France. The objective of this seminar was to highlight the scientific contributions and achievements of women scientists working in Indo-French collaborative projects. During this event, CEFIPRA's publication on "Women in Science" was also released. In our effort to engage and inspire more women scientists towards mainstream research, CEFIPRA is proposing to launch a Post-Doctoral fellowship scheme soon which would also support their scientific growth and career oriented aspirations.

In the year 2018-19, CEFIPRA supported six seminars/workshops in areas such as magnetism of molecular systems, new frontiers in the understanding of treating liver & pancreatic diseases, multi-fragmentation, collective flows & functional metagenomics, radiation damage in nuclear materials and robotics for rehabilitation etc.

CEFIPRA has set its sights on facilitating even greater support for nurturing research and innovation in the coming years. We hope you will enjoy reading our Annual Report which will provide you insights into the extent and range of our activities and their outcome in the year 2018-19.

PRupal

Purnima Rupal

CEFIPRA

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CEFIPRA

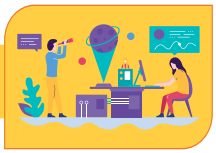
CEFIPRA

1. Overview & Activities of the Centre

A seamless journey in the last three decades - At a Glance

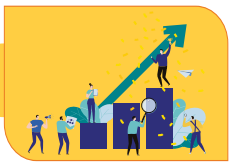
CEFIPRA

MOBILITY
Scientists & Students : ~ 3500



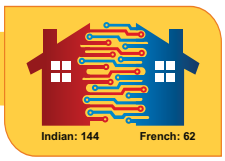
HUMAN RESOURCE TRAINED
~ 3300 including 1000 PhDs and Post Docs

CITATIONS RECEIVED
~ 60,000



PUBLICATIONS
~ 2700

INSTITUTIONAL LINKAGES
Indian: 144+; French: 62+



SEMINARS/WORKSHOPS
156

INDUSTRIAL
Projects: 35

COLLABORATIVE
Projects: 534

TECHNOLOGICAL OUTPUTS

Process: 143+

Designs: 27+

Indo-French Centre for the Promotion of Advanced Research (IFCPAR)
Centre Franco-Indien pour la Promotion de la Recherche Avancée (CEFIPRA)

Products: 22+

Patents: 29+

The year under review....

During the year 2018-19, 18 proposals were recommended for support under the **Collaborative Scientific Research Programme (CSRP)** in the 61st & 62nd Scientific Council (SC) meetings of CEFIPRA held during 14-16 May 2018, Grenoble, France and 19-21 November 2018, at Thiruvananthapuram, India. The new recommended projects were in the areas of Pure and Applied Mathematics (2), Computational Science (2), Earth and Planetary Science (1), Life and Health Science (4), Pure and Applied Physics (3), Pure and Applied Chemistry (3), Environmental Science (1) and Materials Science (2) while support was further continued for 59 ongoing projects. Mobility of 110 scientists and students between the two countries was supported. 20 past projects were also completed during this period which resulted in more than 193 publications in SCI journals. Within the High Impact Scientific Research Network Program, two projects each in High Energy Physics (ENP) and Health Sciences were also accomplished.

The 32nd and 33rd **Industrial Research Committee (IRC)** meetings were held from 18-19 May 2018 at Grenoble, France and from 23-24 November 2018 at Thiruvananthapuram, India. A project under Industry-Academia Research & Development Programme (IARDP) on "Design of flexible sweat sensors and stretchable batteries embedded in e-textile to monitor personal health and fitness parameters" was supported under IARDP. In addition, the Knowledge-Product pathway was further catalyzed through nine ongoing projects in the areas of urban mobility, anti-counterfeit printing techniques for medicine packaging, loop heat pipe for avionics and terrestrial applications, piezoelectric actuator systems for automotive, etc. under the aegis of IARDP.

CEFIPRA supported six bilateral seminars in various areas of Science & Technology during the current year. The scrutiny criterion focused on specific topics of current relevance and interest to both India and France. These seminars helped CEFIPRA to bring together more than 350 scientists/students/researchers from India and France for sharing their valuable knowledge and innovative ideas for future collaboration in the advanced areas of scientific research. One such industrial seminar on "Robotics for rehabilitation (Robo-Rehab-2019)" in Feb. 2019 brought 125 industrialists and scientists together to exchange information and their knowledge in the area of Robotics for various rehabilitation applications such as assisted mobility and assistance in daily living tasks. This seminar's platform was also utilized to encourage research students for securing doctoral/post-doctoral positions within the domain of Robotics.

The Centre continues to offer a platform to facilitate **"Targeted Programmes"** of the National funding agencies to bring together and support collaborative scientific research in the focused areas of mutual interest. These include (i) DST-ANR programme under which two projects in Neurosciences and Materials Science areas were completed, (ii) DST-Inria-CNRS Programme, under which 15 projects are on-going and two were completed in the broad areas of Information and Communication Technology. Further, the 6th Call for Proposals was announced in the month of July 2018 with focus areas like Big Data, Computer science for Biology and Life Sciences, Artificial Intelligence, Cyber-Physical Systems, in ICST and Applied Mathematics. CEFIPRA had received 7 proposals, of which two were supported based on the recommendations received from the Expert Committee (3-4 Jan. 2019) and a Joint Selection Committee (18 Jan. 2019) for project evaluation and (iii) DST-CNRS Programme; the 1st Call for this programme was launched in July 2018, under which 59 proposals were received. The Expert Committee met twice on 3-4 Jan. 2019 & 28 Jan. 2019 and the Joint Selection Committee met twice on 18 & 31 Jan. 2019 under which six proposals were recommended for support.

Under the **Indo-French Water Networking (IFWN) programme;** two projects were completed during the year. The group of Grey water network was able to freeze parameters and prepare a prototype design, under late phase of

steady state condition, so that sludge degeneration and its aerobic/anaerobic oxidation in endogenous respiration phase will prevent excess sludge generation. This study has the potential to be scaled up. Whereas, under another project ***Swachh Neer***, the research group was able to conclude that use of composite membranes, nano-filtration techniques, absorbents and cellulose based materials could address the water related issues in the selected region to remove personal care chemicals/emerging pollutants from water. Membrane and adsorbent-based hybrid technique can further be developed for desalination.

In order to strengthen human resource development under the existing **Raman-Charpak Fellowship-2018**, twenty six students (25 Indian and one French) were facilitated to work in French and Indian laboratories respectively. In addition, eight Indian doctoral students were trained at the European School on Nano-Sciences and Nanotechnologies (ESONN) through **CEFIPRA-ESONN Fellowship** - 2018.

To promote Innovation through a PPP model of funding, one project from IIT Madras in the area of sustainable habitat was completed under the **Saint Gobain Research, India (SGRI)-CEFIPRA Programme**. As a facilitator, under the DBT's Biotechnology Industrial Research Assistance Council (BIRAC)-French Embassy Programme, two scientific projects were completed in the area of Cardiovascular Diseases and one is on-going within the research domain of Alzheimer's disease. A cost-effective, easy-to-use sensor platform has also been developed for the detection of amyloid beta in biological fluids of Alzheimer's patient at CIIRC, Jyothy Institute of Technology, Bangalore.

Further, under the Indo-French Health Technology Programme in association with BIRAC and Bpifrance in the area of Digital Healthcare and Individualized Medicine, one project is being implemented. Under, Indo-French Programme between Technology Development Board (TDB)-CEFIPRA-Bpifrance, one project is continuing in the area of medical devices. CEFIPRA conducted an outreach session at Business-to-Business Summit (B2B) for disseminating the goals and vision of IARDP programme for Bangalore based Industries, Startups and SMEs on 14 September 2018.

The 3rd **Standard Expert Panel (SEP)** meeting was organized on 17 May 2018 in Grenoble, France along with SC/IRC meetings, wherein 12 French PIs took part. The agenda of the meeting was to mentor and monitor the PIs on the IP related issues and encourage them to file more patents, if any patentable outcome is available under their research project.

The first **Indo-French Joint S&T Committee Meeting** was organized by DST on 25 June 2018 at New Delhi. The meeting was attended by H.E. Mr. Alexandre Ziegler, Ambassador of France in India. The proceedings were Co-Chaired by Prof. Ashutosh Sharma, Secretary, DST and Prof. Alain Beretz, the then Director-General for Research and Innovation, Ministry of Higher Education and Research, France. Representatives of various departments from India viz. DST, DBT, ICMR, CSIR, MoES & JNU and from France viz. CNRS, MEAE, Naval School, IMT, SCRD and French Embassy in New Delhi took part in the meeting. Director, CEFIPRA presented the programmes and activities implemented by the Centre at the Joint S&T Committee Meeting.

CEFIPRA also organized the 2nd Indo-French seminar on **"Women in Science"** during 24-25 September 2018 at CNRS headquarters, Paris, France. This seminar was attended by 60 participants from both countries. Suggestions on how to attract young women to scientific careers & to eliminate gender inequality in the scientific profession were emanated and shared with Indian & French institutes associated with CEFIPRA. During the event, Mme. Laurence AUER, French Co-chair, CEFIPRA also released a CEFIPRA's publication on "Women in Science".

CEFIPRA

2. Governance & Guidance

32nd Meeting of Governing Body (GB)

at Paris, France 8 March, 2019

The 32nd Governing Body meeting of CEFIPRA was organized in Paris, France on 8 March 2019.This meeting was Co-Chaired by Mme. Laurence AUER, the French Co-Chair, Directrice de la culture, de l'enseignement, de la recherche et du réseau, Ministère de l'Europe et des affaires étrangères Paris, Government of France and Prof. Ashutosh Sharma, Secretary, Department of Science and Technology, Government of India.

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 2017-18 along with compilation of three volumes of scientific publications emanated from CEFIPRA supported projects during the year 2018 under Collaborative Scientific Research Programme (CSRP).

A bibliometric analysis of research paper emanated in year 2017 under Collaborative Scientific Research Programme was also released by the Co-Chairs. The Co-Chairs placed on record their satisfaction on the functioning of CEFIPRA and its contribution to the dynamism of long-lasting cooperation between France and India. However, emphasis was given on finding new avenues of growth, working together in sustainable technologies with reduction in carbon emission & cyber-physical system including artificial intelligence and S&T policies as well as bringing in new partners from both the countries, to scale up the already substantial cooperation.

Meetings of the Scientific Council and Industrial Research Committee

The scientific activities of CEFIPRA are guided by its Scientific Council (SC). The SC consists of five members each from India and France. These members are internationally recognized scientists of high calibre nominated by their respective Governments. The SC evaluates proposals for joint research twice a year submitted under Collaborative Scientific Research Programme. These high-quality proposals are from Indo-French research groups from advanced areas of basic and applied sciences. The SC also closely monitors and assesses the progress of collaborative research projects and other programmes of the Centre. During the year two new members, Dr. Catherine Dargemont, Laboratory of Pathology and Molecular Virology, Institut Universitaire d'Hématologie, Paris, and Prof. Tanusri Dasgupta Senior Professor & S N Bose Chair, Head, Centre for Mathematical, Computational and Data Science, Indian Association for the Cultivation of Science, Jadavpur, Kolkata joined the Council in place of Prof. Stephane Noselli, Institut de Biologie Valrose, iBV, Université de Nice Sophia-Antipolis, Nice and Prof. Rohini Godbole, Centre for High Energy Physics, Indian Institute of Science, Bangalore respectively.

In view of Governing Body's suggestions on Vision Group recommendations to focus on high quality scientific thematic research, SC deliberated on changes in the pattern of CSRP Calls in detail. Since CEFIPRA accepts proposals under all identified domains of S & T Areas, SC advised to keep the July 15 deadline as Open to receive proposals, as existed, however for the January 15 deadline; the Call may be in priority on thematic/targeted areas which may be decided by SC from time to time. Excellent proposals outside the themes can thus also be considered if some funding is available after selection of proposals. Subsequently, SC discussed in detail on priority thematic areas and deliberated to improve mechanism for mid-term review of projects and ways for enhancing success rate for funding.

The council ensures scientific excellence and a high-quality selection process for research and innovation projects strictly in accordance with international standards and regulations enforced.

Overlapping meeting on 2 November 2018 at Thiruvananthapuram

The activities under Industry-Academia Research & Development Programme (IARDP) are guided by the members of the Industrial Research. During the year, Mr. Daniel Vellou joined the Committee from French side as a new member. 32nd and 33rd meetings of the Industrial Research Committee (IRC) were held on 18-19 May 2018, Grenoble, France and from 23-24 November 2018, Thiruvananthapuram, India, respectively.

During these two meetings, a total of fourteen proposals were received and considered. The Committee recommended one proposal in the area e-textile to monitor personal health and fitness parameters and selected two seminar proposals on Medical Robotics and Marine Science.

The Committee deliberated on recommendations by Governing Body and the Vision Group. Moreover, the Committee also conversed on analytical assessment of IARDP, measuring its impact in bilateral technological generation during the last four years and to showcase various tangible, as well as intangible outputs and outcomes emerging from IARDP supported projects.

The IRC also discussed and suggested the Electronic Project Proposal Management System (Proposals submission portal) for IARDP and deliberated upon the changes in formats for submission of proposals with emphasis on acronyms and downloadable files of proposals in four parts.

IRC deliberated on various issues on selection and implementation of projects under IARDP and decided as follows:

- Proposals should be industry-centric and clearly list out the deliverables of the project which should be in Technology Readiness Level (TRL) 4-5. The submission guidelines to indicate that the lead should be taken by Industries and the PIs should be from industry.
- It is mandatory for the PIs to submit IP Management Plan/Consortium Agreement before the start of the project, within six months from the date of approval by IRC.
- At least 10% of total budget of the project cost must come from Industry partners, however, this condition may not be applied for MSMEs and Start-ups.

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3. Seminars / Workshops & Outreach

Outreach Activities: Women in Science

The second edition of the "Women in Science" seminar was jointly organized by CEFIPRA and CNRS in Paris during 24-25 September 2018. The seminar was attended by 60 participants from both countries. In addition to the scientific talks delivered by leading female scientists, three panel discussions were also organized.

The primary focus of the seminar was to discuss and deliberate on following issues:

- How to increase the number of women in science careers? How to train the pool? How actions/measures can be taken before the high school education?
- How to bring young girls from minority and disadvantaged social classes to the scientific profession? Can we share common actions, valuable to both countries?
- How to support financial mobility grants specific to the women community? What about entrepreneurship education supports for women? How to stimulate and promote the mobility, and the subsequent reintegration?

Recommendations made are as follows:

At high school level

- Encourage school management bodies to introduce gender mainstreaming in schools. Incorporate into training of the teacher awareness to stereotypes
- Testimonials of women scientists on various social media platforms (online and offline). Publish portraits of pioneering women scientists

At University/Institute level

- Institutions need to valorise time given by Professors, Scientists, Post-doctoral researchers and Doctoral students for engaging in outreach activities
- Equality advisor needs to be inducted in institutions
- Institutions should put into place a code of conduct to install gender neutrality in recruitment committees, for example by excluding questions about marital status or details of family
- The priority should not be given to the quantity of publications. Women tend to publish less papers but with higher quality
- Mentorship and career development programs need to be introduced.
- Steps have to be taken in order to ensure a gender neutral work environment and to exclude all sexual and gender harassment (Gender based violence/harassment is distinct from sexual harassment)

At General level including Funding bodies

- It is important that gender data is available for every institution and committee, for grants and recruitments, in order to create awareness for this grim situation.
- Percentage of women at the candidate level and the success level should always be analyzed in recruitment and grant committees.

To enhance the Indo-French ST&I system and to promote new linkages and collaborations, CEFIPRA, under its Collaborative Scientific Research Programme & Industry - Academia Research and Development Programme has supported the following eight Seminars/Workshops in cutting edge sciences.

Indo-French School on

Magnetism of Molecular Systems

26-30 November 2018 at Indian Institute of Science, Bengaluru, India

Indian Coordinator
Prof. S Ramasesha
Indian Institute of Science, Bengaluru

French Coordinator
Dr. Jean-Pascal Sutter
Laboratoire de Chimie de Coordination (LCC), UPR8241, Toulouse

This School was aimed to encourage young researchers to work in newer area of molecular magnetism. Lectures were delivered on theories, experimental techniques, systems and phenomena & modelling. The young researchers were encouraged to take up research in this newer challenging and technologically important field of molecular magnetism. This school had brought Indian and French researchers together which hopefully will lead to stimulating collaborations under the aegis of CEFIPRA.

The total number of participants was sixty including nine French participants. The school introduced young researchers to the modern concepts of molecular magnetism while the workshop provided insights into current research activities in this field. Many of the Indian and French participants had initiated discussions for possible research collaborations in synthesizing and studying these systems.

Indo-French Seminar on

New Frontiers in Understanding and Treating Liver and Pancreatic Diseases

19-20 January 2019 at Institute of Liver and Biliary Sciences, New Delhi

Indian Coordinator
Prof. Shiv Kumar Sarin
Institute of Liver and Biliary Sciences (ILBS), New Delhi

French Coordinator
Prof. Richard Pierre Moreau
INSERM U1149, CNRS-ERL8252, Paris

This seminar imparted substantial knowledge and helped in identifying various strategies for performance improvement of therapeutic options used in treating liver and pancreatic diseases. The Indo-French groups also conceptualized development of investigative projects on liver and pancreatic regeneration.

The total number of participants was 50 including thirteen from French side. This seminar also helped in establishment of Indo-French collaborating units for development of therapeutic regenerative medicine for liver and pancreatic diseases.

Indo-French Workshop on

Multi-fragmentation, Collective Flow and subthreshold Particle Production in heavy Ion Reactions

4-6 February 2019 at Punjab University, Chandigarh, India

Indian Coordinator
Prof. Rajeev Kumar Puri
Panjab University,
Chandigarh

French Coordinator
Prof. Joerg Aichelin
Subatech Umr 6457,
Nantes

This joint workshop was meant to enhance the communication between Indian Groups and French institutes, working in the field of fragmentation, collective flows, symmetry energy as well as sub threshold particle production both theoretically and experimentally.

Forty Indian and seven French participants attended this workshop. This joint workshop provided a platform for exchange of information pertaining to the comparison of different transport models used to study heavy ion reactions. Participants also had hands on experience in using various software developed by different French groups. These activities will hopefully open up possibilities for joint collaborations.

Franco-Indian workshop in

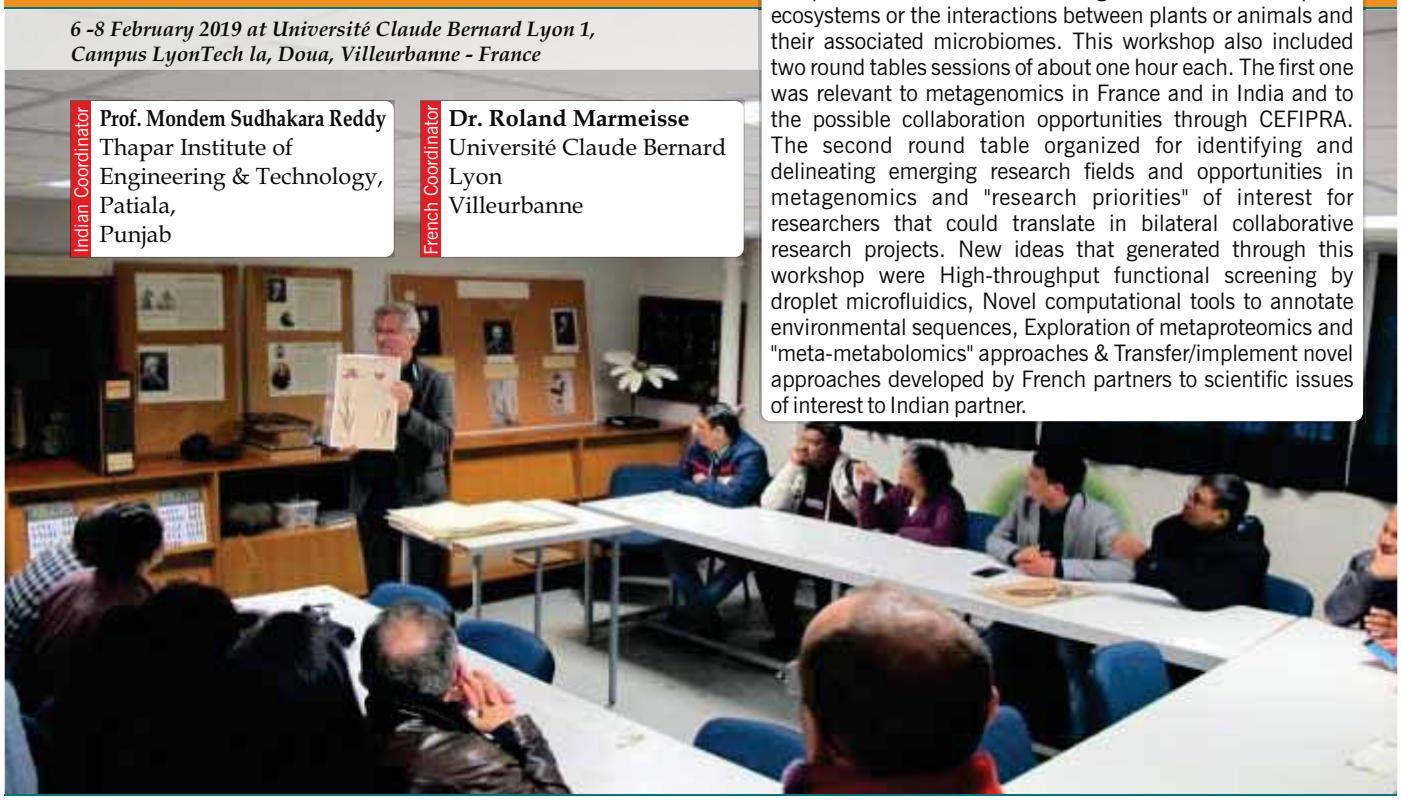
Functional Metagenomics-from Ecosystem Processes to Biotechnology

6 -8 February 2019 at Université Claude Bernard Lyon 1, Campus LyonTech la, Doua, Villeurbanne - France

Indian Coordinator
Prof. Mondem Sudhakara Reddy
Thapar Institute of Engineering & Technology,
Patiala,
Punjab

French Coordinator
Dr. Roland Marmeisse
Université Claude Bernard Lyon
Villeurbanne

This workshop brought together 26 invited researchers from India and France. Presentations were organized in six sessions that covered the main areas of functional metagenomics, from applications in the biotech or human health areas to the comprehension of the functioning of terrestrial or aquatic ecosystems or the interactions between plants or animals and their associated microbiomes. This workshop also included two round tables sessions of about one hour each. The first one was relevant to metagenomics in France and in India and to the possible collaboration opportunities through CEFIPRA. The second round table organized for identifying and delineating emerging research fields and opportunities in metagenomics and "research priorities" of interest for researchers that could translate in bilateral collaborative research projects. New ideas that generated through this workshop were High-throughput functional screening by droplet microfluidics, Novel computational tools to annotate environmental sequences, Exploration of metaproteomics and "meta-metabolomics" approaches & Transfer/implement novel approaches developed by French partners to scientific issues of interest to Indian partner.



Indo-French Seminar on

Radiation Damage in Nuclear Materials

18-20 February 2019 at Amity University, Noida, Uttar Pradesh

Indian Coordinator
Dr. Devesh Kumar Avasthi
Amity University,
Noida,
Uttar Pradesh

French Coordinator
Mr. Gaël Sattonnay
CSNSM - Centre de Sciences Nucléaires et de Sciences de la, Matière,
Orsay

This seminar aimed for nucleating joint research activities in area of radiation damage in materials thus provided a platform for identifying researchers and institutions where the experiments and simulations could be carried out collectively, sharing the responsibilities and research activities. The seminar brought together scientists working in ion matter interactions, understanding the radiation damage process and opened up new collaborative objectives using complementary experimental facilities in India and France.

A total of 120 participants attended the seminar including eight from France. The topics of the specific research of common interest were identified in view of the unique experimental facilities available in two countries. Amity University, IITD, IUAC and CSNSM Orsay agreed to join hands for joint research. The visit to IUAC gave a direct glimpse of various accelerators associated facilities which could be useful for the joint project within the theme of the seminar.

Indo-French Workshop on

Robotics for Rehabilitation (Robo-Rehab-2019)

26-28 February 2019 at CSIR-Central Scientific Instruments Organisation, Chandigarh

Indian Coordinator
Dr. Neelesh Kumar
CSIR-Central Scientific Instruments Organisation,
Chandigarh

French Coordinator
Dr. Ahmed Chemori
LIRMM, CNRS,
Montpellier

This workshop was focused on the Engagement and Networking in the area of medical robotics and their application in rehabilitation. It was organized to provide a platform for bilateral exchange of Prominent Indian and French Institutes (researchers, clinicians & industry) to encourage collaborative work & Translation of research outcomes into affordable healthcare rehabilitation technologies and devices. This workshop provided the platform for exchanging information, ideas and research models in the emerging area of medical robotics and rehabilitation. The workshop attracted and provided opportunities to young researchers, post graduate students, PhD scholars and fellows for bilateral student exchanges, seminars, workshops and international fellowships. A total of 70 participants attended the seminar including eleven from French side.

B2B Summit for the Aeronautics and Aerospace Sector at Bengaluru

Technology Development Board (TDB) and CEFIPRA along with the Federation of Indian Chambers of Commerce & Industry (FICCI) organized the B2B (Business-to-Business) Summit on "Aeronautics and Defense Equipment Sector" on 14 September 2018 at Bengaluru. The Summit had two thematic sessions covering topics on "Innovations and Technologies in Aerospace Input Supply" and "Future Technologies". The discussions were followed by group activity and visit to Aerospace Equipment Industry. The event was organized to have an interactive meeting exploring business opportunities in aeronautics/defense equipment manufacturing and technology transfer. Generation of new projects, build collaborations and file joint applications under TDB's bilateral programme with Bpifrance was also another purpose for organizing this summit.

During this one day interactive event, delegates were from aerospace/aeronautics industries, training institutes, Startups, SMEs and officials from the Government. In the inaugural session, Mr. Anand Sudershan, Chairman, National Startup Committee, FICCI and Founder & Director, Sylvant Advisors welcomed the delegates. Dr. Bindu Dey, Secretary, TDB, Dept. of S&T, Ministry of Science and Technology, Government of India and Dr. Mukesh Kumar, Director, CEFIPRA addressed and highlighted the purpose & expectations from the B2B Summit. The keynote address was delivered by Dr. Bala K. Bharadvaj, Director, Boeing Research & Technology Center, Bangalore. He discussed the activities of Boeing in India and success stories of some small & medium Indian companies associated with Boeing India. The vote of thanks was delivered by Mr. Shaju Mangalam, Additional Director & Head – Karnataka State Council, FICCI.

There were two panel discussions on topics related to aerospace sector. A total of seven eminent speakers from aeronautics/aerospace industry delivered lectures on various aspects and challenges of the aerospace/aeronautics industry in India. Secretary, TDB delivered the lecture on "Funding Opportunities for Technology Ventures" and explained the details of availing funding from Technology Development Board for Industries. CEFIPRA had its identified table to further disseminate more information and clarify doubts to the visitors.

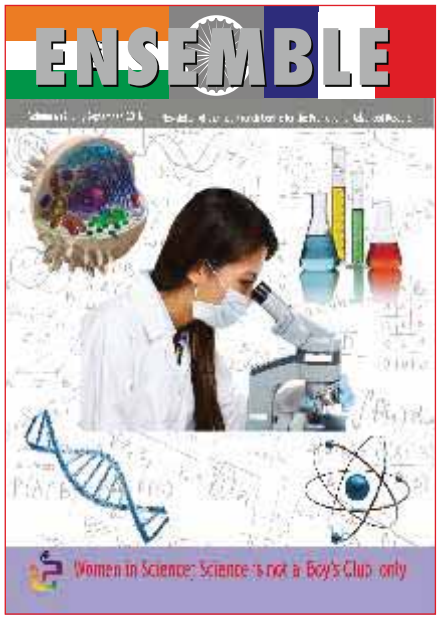
CEFIPRA's Session at B2B (Business-to-Business) Summit at Bengaluru

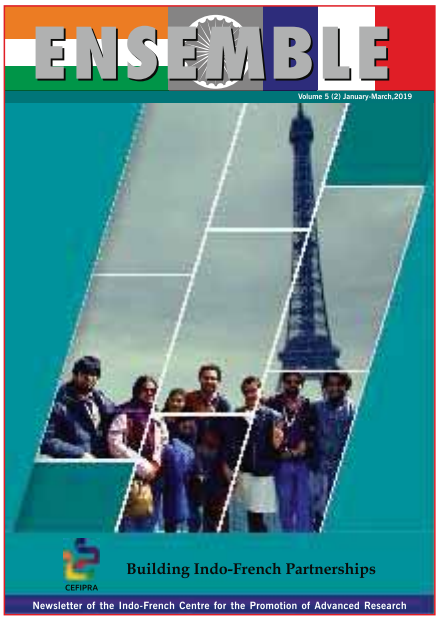
CEFIPRA's session was held in the afternoon of 14 September 2018, at Business-to-Business Summit for dissemination of IARDP to Bangalore based Industries, Startups and SMEs. The event was planned as per the recommendations of last IRC meeting held in May 2018 at Grenoble, France to disseminate information on industrial relevant programmes to industry clusters especially SMEs & Start-ups. Dr. Mukesh Kumar, Director, CEFIPRA coordinated and delivered the welcome address with brief presentation on CEFIPRA's industries oriented programmes. Dr. Jayant Modak, CEFIPRA's IRC member also briefed the gathering about the objectives and mandate of IARDP and PPP programmes of CEFIPRA. He further provided details on the development of industrial proposals and the expectations from industries. Mr. Jerome BOVE, Attaché for Scientific & Academic Collaborations, French Embassy in Bengaluru presented his remarks about the CEFIPRA by quoting its 30 year old successful partnership which has already brought out several significant achievements. He further added that CEFIPRA was showcased during the 'Bonjour India' event & state visit of H.E. the President of France to India in March 2018. This event was a grand success.

Ensemble: The Newsletter of CEFIPRA

CEFIPRA publishes a periodic newsletter called Ensemble. This is one of the important tools to communicate and highlight the research and developmental activities funded by the Centre, and disseminate the information among the research communities and other officials in India and France. In view of the commitments of Indo-French scientific communities and their concern for the environment, CEFIPRA had taken out only e-version of the Ensemble during the year 2018-19.

The three issues, showcased outcomes of few excellent graded projects reflecting deep rooted Indo-French partnership along with snapshots of CEFIPRA's activities. One of the issues of Ensemble was dedicated to the Women Scientists working in various Indo-French collaborative projects, highlighting their scientific contributions & achievements. This special issue also featured the proceedings of Indo-French seminar on "Women in Science" organized during 24-25 september 2018 at CNRS headquarters in Paris.





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4. Dedicated Mobility Support Programmes

Raman-Charpak Fellowship

The "Raman–Charpak Fellowship" scheme was launched during the State visit of the then President of France, H.E Monsieur François Hollande, to India during 14-15 February 2013 with the aim to facilitate 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 of Europe & Foreign Affairs, Government of France. During the five years, 118 fellows were supported & 4 debriefing sessions were organized in India (3) and France (1).

During the reporting period, 229 applications were received against the Call announced in April 2018. Preliminary meeting for selection of candidates held twice on 31 July 2018 and 3 August 2018 in which 67 Indian candidates were shortlisted. The Final Selection meeting was held on 5 September 2018 in which 25 Indian students were awarded. A separate Call for French Master's students was launched in August 2018 with deadline as 31 October 2018, one application received was recommended. The results were declared on 10 January 2019 and visits of the awardees were facilitated. The Debriefing Session for fellows of 2016 & 2017 was held on 14 March 2019 at CEFIPRA, New Delhi.

Raman-Charpak Fellows - 2018

Indian Candidates:

S. No.	Name	Area of Interest	Name of Parent Institution / University	Name of the Host Institution / University
1.	**Ms. Ashwini Ravi**	Biological Sciences, Life and Medical Sciences	**Dr. M. S. Santosh** Affordable Medical Devices (AMD), Centre for Incubation, Innovation, Research and Consultancy/ Visveswaraya Technological University, Bangalore	**Dr. Rabah Boukherroub** Institute of Electronics, Microelectronics and Nanotechnology (IEMN, UMR CNRS 8560), University of Lille, Villeneuve d'Ascq Cedex
2.	**Mr. Balkaran Singh Sran**	Chemical Sciences	**Dr. Geeta Hundal** Department of Chemistry, Guru Nanak Dev University Amritsar Punjab	**Prof. Olivier Cador** Institute of Chemical Sciences of Rennes UMR 6226 CNRS - University Rennes 1 Beaulieu
3.	**Ms. Mandira Majumder**	Physical Sciences	**Prof. R. B. Choudhary** Nanostructured Polymeric Hybrid Materials for Supercapacitor Applications, Indian Institute of Technology (ISM), Dhanbad	**Prof. Sabine Szunerits** Université de Lille Institut d'Electronique, de Microélectronique et de Nanotechnologie Université de Lille - Sciences et Technologies, Villeneuve d'ascq

S. No.	Name	Area of Interest	Name of Parent Institution / University	Name of the Host Institution / University
4.	**Mr. Anurag Kumar**	Materials Science	**Dr. Suman L. Jain** CSIR-Indian Institute of Petroleum Dehradun	**Dr. Rabah Boukherroub** Institute of Electronics, Microelectronics and Nanotechnology (IEMN, UMR CNRS 8560), University of Lille, Villeneuve d'Ascq Cedex
5.	**Mr. Kaustav Chakraborty**	Physical Sciences	**Prof. Srubabati Goswami** Physical Research Laboratory, Ahmedabad/ Indian Institute of Technology Gandhinagar	**Prof. Marcos Dracos** Institut Pluridisciplinaire Hubert Curien, University of Strasbourg. IPHC-IN2P3/CNRS, Universit de Strasbourg, Strasbourg
6.	**Ms. Deepaneeta Sarmah**	Biological Sciences, Life and Medical Sciences	**Dr. Pallab Bhattacharya** Stroke Research and Therapeutic Laboratory, National Institute of Pharmaceutical Education and Research, Ahmedabad (NIPER-A) Gandhinagar	**Prof. Anne-Marie Rodriguez** Institut national de la santé et de la recherche médicale (Inserm), U955-Faculté de Médecine, Créteil Cedex
7.	**Mr. Sourav Biswas**	Materials Science	**Dr. Sujit Sankar Panja** Department of Chemistry, National Institute of Technology Durgapur	**Prof. Philippe Cassagnau** Université Claude Bernard Lyon, Ingénierie des Matériaux Polymères, UMR-CNRS 5223 Villeurbanne
8.	**Mr. Ramprasad Regar**	Chemical Sciences	**Dr. J. Sankar** Indian Institute of Science Education and Research Bhopal	**Prof. Dr. Gilles Ulrich** Institute of Chemistry and Process for Energy, Environment and Health (ICPEES), CNRS, ECPM, University of Strasbourg Strasbourg
9.	**Mr. Arijit Shome**	Biological Sciences, Life and Medical Sciences	**Dr. S. K. Bhure** ICAR-Indian Veteriniary Research Institute (IVRI) Izatnagar	**Dr. Benjamin Ezraty** Institut de Microbiologie de la Méditerranée, C.N.R.S Marseille

S. No.	Name	Area of Interest	Name of Parent Institution / University	Name of the Host Institution / University
10.	**Mr. Rohit Mangla**	Atmospheric Sciences, Earth Sciences and Environmental Sciences	**Dr. J. Indu** Department of Civil Engineering, Indian Institute of Technology Bombay Mumbai	**Dr. Philippe Chambon** CNRM-UMR 3589 Météo-France and CNRS, Toulouse
11.	**Ms. Eva Judy**	Chemical Sciences	**Prof. Nand Kishore** Department of Chemistry, Indian Institute of Technology-Bombay Mumbai	**Dr. Eric Ennifar** IBMC, University of Strasbourg Strasbourg
12.	**Mr. Arijeet Mitra**	Atmospheric Sciences, Earth Sciences and Environmental Sciences	**Dr. Indra Sekhar Sen** Department of Earth Sciences, Indian Institute of Technology-Kanpur Kanpur	**Dr. Laurie Reisberg** CRPG-CRNS-Universite de Lorraine, Vandœuvre-lès-Nancy
13.	**Ms. Divya Goel**	Mathematical and Computational Sciences	**Prof. Konijeti Sreenadh** Indian Institute of Technology-Delhi, New Delhi	**Prof. Jacques Giacomoni** Laboratorty of Mathematics and Applications of Pau (LMAP), UMR-E2S UPPA CNRS 5142, University of Pau and Pays de I'Adour Pau
14.	**Ms. Priya**	Physical Sciences	**Dr. Rajesh V. Nair** Department of Physics Indian Institute of Technology Ropar	**Prof. Pascale Senellart** Centre for Nanoscience and Nanotechnology, UMR 9001-CNRS-C2N, University Paris Saclay Palaiseau
15.	**Mr. Suprakash Biswas**	Chemical Sciences	**Dr. Apurba Lal Koner** Department of Chemistry, Indian Institute of Science Education and Research Bhopal	**Dr. Yann Ferrand** Institute of Chemistry and Biology of Membranes and Nano-objects CBMN UMR 5248, Université de Bordeaux Bordeaux

S. No.	Name	Area of Interest	Name of Parent Institution / University	Name of the Host Institution / University
16.	**Mr. Prathapan Abeesh**	Biological Sciences, Life and Medical Sciences	**Dr. Guruvayoorappan C** Division of Cancer Research, Regional Cancer Centre/ Kerala University Thiruvananthapuram	**Prof. Philippe Bouvet** Cancer Research Centre of Lyon, UMR Inserm 1052 CNRS 5286, Centre Leon Berard Lyon
17.	**Mr. Arun Verma**	Mathematical and Computational Sciences	**Prof. Manjesh K. Hanawal & Prof. N. Hemachandra** Industrial Engineering and Operations Research, Indian Institute of Technology-Bombay Mumbai	**Dr. Odalric-Ambrym Maillar** SequeL Team, Inria Lille Lille
18.	**Mr. Rishi Sharma**	Biological Sciences, Life and Medical Sciences	**Prof. Binaya Kumar Bastia** Department of Forensic Medicine and Toxicology, All India Institute of Medical Science, Rishikesh Uttarakhand	**Prof. Benjamin Rolland** Hospitalier Le Vinatier, Service Universitaire d'Addictologie de Lyon (SUAL), University of Lyon, Bron Lyon
19.	**Mr. Krishanu Roy**	Mathematical and Computational Sciences	**Prof. K N Raghavan** The Institute of Mathematical Sciences Chennai	**Prof. Cedric Lecouvey** University Francois Rabelais, Laboratory of Mathematics and Theoretical Physics Tours
20.	**Mr. Nilutpal Bora**	Atmospheric Sciences, Earth Sciences and Environmental Sciences	**Dr. Rajib Biswas** Department. of Physics, Tezpur University Napam Assam	**Dr. Pierre-Yves BARD** IsTerre/ IFSTTAR, Grenoble-Alpes University Grenoble
21.	**Mr. Arijit Roy**	Engineering Sciences	**Prof. Sudip Misra** Smart Wireless and Networking Laboratory, Indian Institute of Technology Kharagpur	**Prof. Farid Naït-Abdesselam** Laboratoire LIPADE, Paris Descartes University Paris

S. No.	Name	Area of Interest	Name of Parent Institution / University	Name of the Host Institution / University
22.	**Ms. Pragya Gupta**	Engineering Sciences	**Dr. Pradip K Maji** Advanced Materials Research Laboratory, Department of Polymer and Process Engineering, Indian Institute of Technology Roorkee	**Dr. Yves GROHENS** Institut de Recherche Dupuy De Lôme (iRDL), Université de Bretagne-Sud Lorient
23.	**Mr. Jnana Ranjan Khuntia**	Engineering Sciences	**Prof. Kishanjit K Khatua & Prof. Somesh Jena** Department of Civil Engineering, National Institute of Technology Rourkela	**Dr. Sébastien Proust** Institut National de Recherche en Sciences et Technologies pour l'Environnement et l'Agriculture (Irstea) Villeurbanne
24.	**Mr. Arpit Mishra**	Engineering Sciences	**Dr. Parthasarathi Ghosh & Dr. Arnab Roy** Process Equipment and Design Laboratory, Cryogenic Engineering Centre, Indian Institute of Technology Kharagpur	**Prof. Frederic Ayela** Laboratoire des Écoulements Géophysiques et Industriels, (LEGI - UMR 5519), Université Grenoble Alpes Grenoble

French Master Student:

S. No.	Name	Area of Interest	Masters' Registered Institute/University	Name of the Host Institution / University
25.	**Mr. Anthony Hurier**	Physical Sciences	Institute de Physique Nucleaire, Université Pierre et Marie Curie Paris	**Prof. B. Ananthanarayan** Centre for High Energy Physics, Indian Institute of Science Bangalore

Debriefing of the Raman-Charpak Fellows 2016 & 2017

at CEFIPRA Office, New Delhi on 14 March, 2019

Ten students (7 Indian & 3 French), three experts along with representatives of funding agencies and CEFIPRA officials attended the session

During the Debriefing session organized by Centre, the Fellows made presentations on their feedback on availing the Raman-Charpak Fellowship and highlighted the research work carried out at their host institution. The research experience significantly enhanced their experimental, technical & analytical skills and was a life changing experience. They were extremely happy to be called as Raman-Charpak laureates. This programme enriched their lives in forging new bonds of International S&T collaborations. They also appreciated the quick response & support received from CEFIPRA, in managing and providing logistics arrangement during the implementation of this programme. Suggestions in bringing more improvement in programme were also discussed among the stakeholders.

DST - CEFIPRA Fellowship for ESONN Programme

CEFIPRA with Université Grenoble Alpes, Grenoble, France, is supporting the participation of Indian doctoral students in the European School on Nanosciences and Nanotechnologies (ESONN) session since 2013. ESONN is a three-week course conducted by Université Grenoble Alpes aimed at providing training for graduate students, postdoctoral and junior scientists from universities and laboratories in the field of nanosciences and nanotechnologies in Physics, Biology and Chemistry. Since year 2013 to 2017, CEFIPRA supported the participation of 38 Indian doctoral students. In order to expand the scope of this programme, the Revised Vision Group in its meeting held on 2 September 2016 at CEFIPRA office, New Delhi suggested contacting National Funding Agencies. Accordingly, CEFIPRA had submitted a proposal/scheme document to DST in January 2017. The programme was relaunched as DST-CEFIPRA-ESONN Fellowship Programme in February 2017. The 30th GB accorded its approval for this programme, subsequently, the financial sanction was received in Oct. 2017 from DST. The Call was launched on 9 March 2018 with deadline as 20 May 2018. The Expert Committee met on 15 June 2018 and recommended 16 candidates to ESONN and finally selected eight candidates for the award in consultation with ESONN. All 8 candidates completed their fellowship and returned to India in Sept. 2018.

Mr. Chandan Kumar
Indian Institute of Technology
(BHU), Varanasi

Mr. Monu Mishra
CSIR- National Physical Laboratory
New Delhi

Ms. Nishta Arora
Indian Institute of Science
Bengaluru

Ms. Debalina Deb
University of Kalyani
Kalyani

Ms. Maithri Tharmavaram
Gujarat Forensic Sciences University
Gandhinagar

Mr. Bhaskar Das
National Institute of Technology
Rourkela

Ms. Prajakta Vilas Tambe
Agharkar Research Institute, Pune
Savitribai Phule, Pune Univessity

Ms. Pranjita Ganesh Zantye
Birla Institute of Technology and
Sciences, Pilani, Goa

CEFIPRA-SOLEIL Synchrotron Programme

In an effort to utilize large scale scientific facilities located in India & France for the scientists/researchers of both the countries, CEFIPRA signed an MoU on 14 October 2014 with SOLEIL Synchrotron to facilitate the use of this facility in France by Indian Scientists. Under this programme, CEFIPRA has supported visits of 29 scientists/researchers/students to SOLEIL till date.

The Scientific Council of CEFIPRA, in its 58th meeting held in Nov. 2016, at Varanasi, India, suggested measuring the impact & outcome of the visits under the CEFIPRA-SOLEIL Synchrotron programme and sharing it with DST to consider the programme for support. SC had further recommended that next two cycles prior to completion of MoU in October 2017 may be supported by CEFIPRA as scheduled. Accordingly, the Centre developed a questionnaire which was sent to the students and scientists who had visited under this programme. The information received in the questionnaire, was utilized for analyzing the outcome of the visits under the programme.

A report on Outcome Analysis of CEFIPRA-SOLEIL Synchrotron Programme (2014 to 2017) was prepared.

Facility in Saint-Aubin, France

CEFIPRA

CEFIPRA

5. Brief Reports of Research Projects

A. Collaborative Scientific Research Programme

Pure & Applied Physics

ADVANCED COMPUTATIONAL MODELS TO FACILITATE SOLAR ACTIVITY AND SPACE WEATHER PREDICTIONS

Project No. 5004-1 | **Jan. 2015 to Dec. 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, telecommuni-cations and air-traffic on polar routes. Slow-long term solar activity variation also influences the global climate. Studies of the Sun-Earth-System 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 PI's, 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 tubedynamics 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

- Development of the model for the decay and dispersal of sunspot magnetic fields on the Sun's surface
- Development of the 3D global flux transport dynamo model incorporating the buoyant emerge
- Development of the model for the decay and dispersal of sunspot magnetic fields on the Sun's surface
- Development of the 3D global flux transport dynamo model incorporating the buoyant emergence of sunspot-forming magnetic flux tubes
- Coupling of 2D solar surface flux transport model with the 3D global dynamo model was initiated and a few test case simulations were carried out
- Interactions under the project resulted in plans for a more large-scale future collaboration between the solar and stellar magnetism and space weather groups at IRAP, University of Toulouse and CESSI, IISER Kolkata

Principal Collaborators

Dibyendu Nandi
Indian Institute of Science Education and Research Kolkata

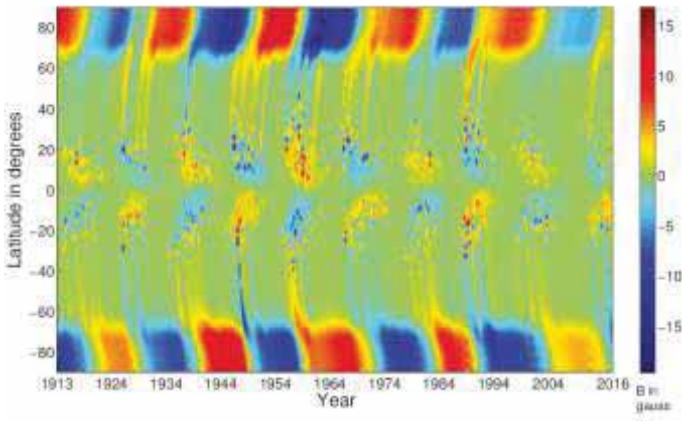
Laurène Jouve
Institut de Recherche en Astrophysique et Planétologie, Université Paul Sabatier Toulouse

Publications

- No. of publications in SCI journals: 6
- No. of papers presented in conferences: 3

Mobility Support

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



Century-Scale Global Solar Surface Field Evolution

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 auto-immunity 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

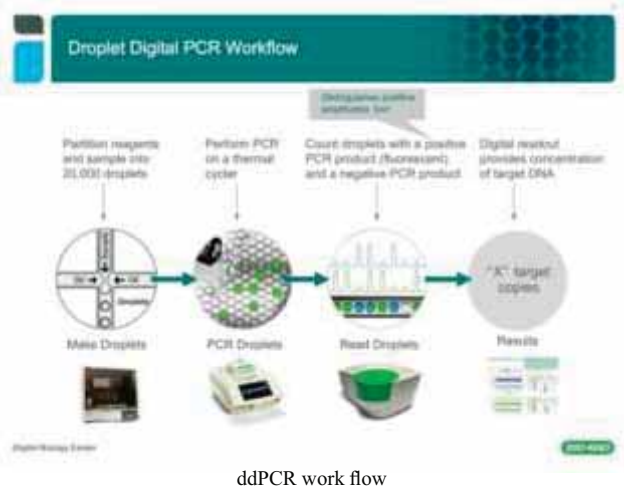
i. Toll like Receptor (TLR) genes:
   - Two SNPs in the TLR 10 gene have been studied in Schizophrenia and Bipolar Disorder cases and Super Normal Control
   - Six SNPs in the TLR 4 gene have been studied in Schizophrenia and Bipolar Disorder cases and Super Normal Control
   - Four SNPs in the TLR 2 gene have been studied in Schizophrenia and Bipolar Disorder cases and Super Normal Control

ii. HERV based classification: completed

iii. Neuropsychiatric lupus as disease control group: enrolled and immune profiling and proteomic analysis carried out

iv. Controls for C4 null homozygous (HLA) state was obtained after screening large number of families in the context of transplantation

v. C4 A, B, L, S copy numbers profiled for all study groups



ddPCR work flow

Principal Collaborators

Vir Singh Negi
Jawaharlal Institute of Postgraduate Medical Education and Research Puducherry

Ryad Tamouza
INSERM U1160, Saint Louis Hospital Paris-Diderot (P7) Universit'e de Paris Paris

Publications

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

Mobility Support

- India to France: 2
- France to India: 6

Life & Health Sciences

OLFACTORY MODULATION OF INSECT FLIGHT

Project No. 5103-2 | **Apr. 2014 to Apr. 2016**

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 chemo-orientated 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: 5
- No. of papers presented in conferences: 3

Mobility Support

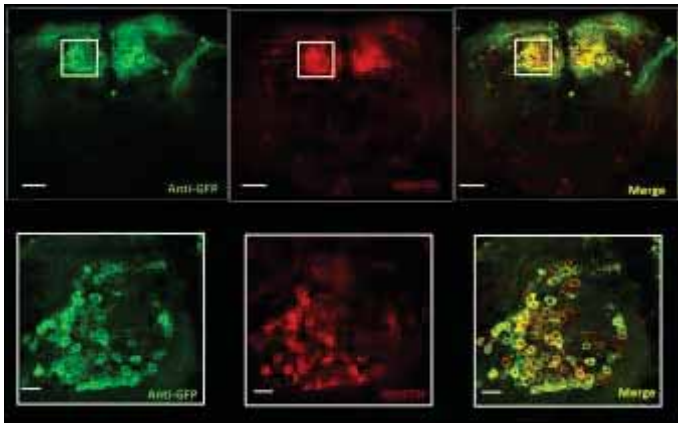
- India to France: 4
- France to India: 4

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

- Completed response in the wind tunnel to a single odorant stimulus (food) and to a dual choice between food and pheromones
- Identified a set of central dopaminergic neurons (PAM neurons) required during free flight for normal response to an odor-stimulus in the wind tunnel. PC also identified an Octopamine receptor on the dopaminergic neurons as required for successful landing on the odor source in the wind tunnel
- Identified the precise developmental stage(s) during which olfactory modulated free flight depends most on the newly identified central dopaminergic neurons and has also characterized some of the molecular mechanisms involved in the maintenance of dopaminergic neuron function during aging
- Developed techniques to film and auto-track the 3D trajectories of flies as they track the sources of odor within a windtunnel
- Develop tools extensively to study the function of the dopaminergic PAM neurons in freely flying flies during odor tracking
- Characterized subtle variations of the flight of a pheromonal mutant (desat1) to a choice between two food sources added, or not, with adult pheromones
- The imaging tools were developed to auto-trigger high-speed cameras to film at high resolution the landing and take-off behavior in flies. The conditions for auto-triggering can be user-specified which enables them to specify the conditions for filming and observation of such behavior



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

Life & Health Sciences

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

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.

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

Knowledge Generated/Products Developed

- Systematic insertion experiments with reference promoters and localization by sequencing of both populations and single clones
- Characterization of gene expression levels and noise of the inserted promoters
- Complex role of H-NS in determining the gene expression levels of exogenous promoters
- Different noise properties of (frequent) insertions close to ribosomal genes
- Phenotypic switching of high-noise inserted promoter, without specific regulation

Principal Collaborators

Aswin Sai Narain Seshasayee
Tata Institute of Fundamental Research
Bangalore

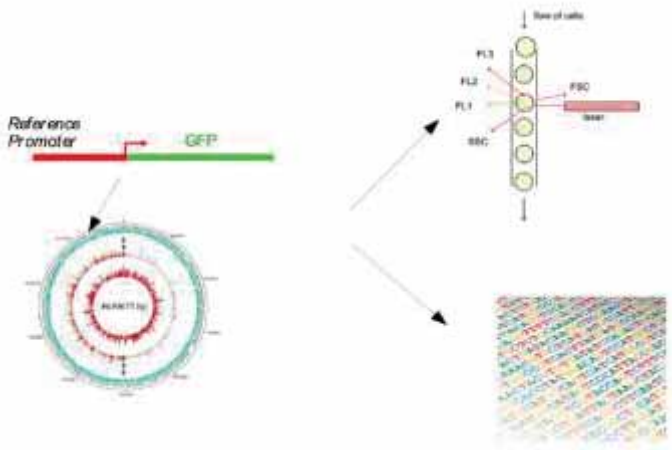
Marco Cosentino Lagomarsino
UMR 7238 CNRS
University Pierre and Marie Curie
Paris

Publications

- No. of publications in SCI journals: 4
- No. of papers presented in conferences: 5

Mobility Support

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



Sketch of the experimental pipeline

Pure & Applied Physics

SELF-SIMILAR OPTICAL PATTERNS IN NONLINEAR MEDIA

Project No. 5104-2 | **May 2014 to Apr. 2018**

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

- 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

Knowledge Generated/Products Developed

- Real-Time Observation of Internal Motion within Ultrafast Dissipative Optical Soliton Molecules: Krupa PRL 2017
- Pulse breaking through spectral filtering in dispersion-managed fiber lasers: Alsaleh JOSA B 2018)
- Construction of the Rogue wave solutions of complex optical systems (high-order terms, coupled systems): He PRE 2016, Chen JPhysA 2017
- Numerical investigation on the effect of Temperature on Supercontinuum Generation in Water-core Photonic Crystal Fiber: Joshva Raj PTL 2016
- Construction of new soliton solutions with nonlinear chirping to include higher-order dispersion and nonlinear effects: Triki J.Opt 2016

Principal Collaborators

K. Porsezian (Late)
Pondicherry University
Pondicherry

Ph. Grelu
UMR 6303 CNRS- Universite'.
Bourgogne Franche-Comté
Dijon

Publications

- No. of publications in SCI journals: 59
- No. of papers presented in conferences: 11

Mobility Support

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

Ultrafast optical characterization platform, which is the background of the experimental investigations in fiber laser dynamics performed in the French lab (ICB Dijon)

Life & Health Sciences

INSIGHTS ON PROTEIN STRUCTURAL AND EVOLUTIONARY DYNAMICS

Project No. 5203-2 | **Mar. 2015 to Dec. 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

Knowledge Generated/Products Developed

- 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

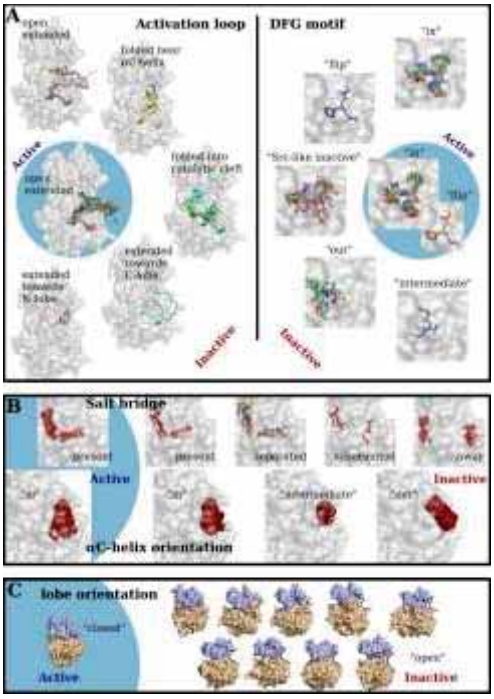


Figure representing a fine analyse of the protein kinases in active and inactive form

Principal Collaborators

Narayanaswamy Srinivasan
Indian Institute of Science
Bangalore

G Alexandre de Brevern
INSERM UMR-S 665
DSIMB
Univ Paris Diderot
Paris

Publications

- No. of publications in SCI journals: 29
- No. of papers presented in conferences: 1

Mobility Support

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

Life & Health Sciences

HOST-VIRUS INTERACTIONS AND ANTIBODY THERAPY FOR *JAPANESE ENCEPHALITIS*

Project No. 5203-3 | **Mar. 2015 to Mar. 2019**

Background

The central theme of the project concerns the molecular and biochemical dissection of the immune evasion mechanism of J*apanese 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 effcacy. 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.

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, and fibroblasts and viral envelope protein(s) responsible for binding to the PRRs and mediating viral internalization

Knowledge Generated/Products Developed

- Identification of GRP78 as a crucial host factor for virus entry and replication in multiple cell types
- Characterization of JEV interactions with dendritic cells and impact on immune responses
- Establishment of technology to clone V regions of immunoglobulins at single B-cell level, and express them as recombinant IgG
- Biochemical and functional characterization of in vitro generated acquired JEV-reactive human monoclonal antibodies
- Attempts for passive therapy for *Japanese encephalitis* using acquired JEV-reactive monoclonal antibodies

Principal Collaborators

Manjula Kalia
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Sebastien Lacroix-Desmazes
Institut National de la Sante et de la Recherche Medicale (INSERM)
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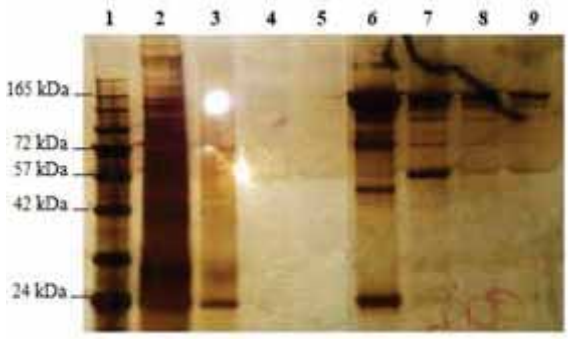
Publications

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

Mobility Support

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



Purification profile of mAb72 from HEK293 cell supernatant on reducing 10% SDS-PAGE gel

Life & Health Sciences

NOVEL INHIBITORS OF NHEJ AGAINST RESISTANT TUMOUR CELLS

Project No. 5203-4 | **Mar. 2015 to Nov. 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 including SCR inhibitors
- 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
- Characterisation of novel Diazepine based novel inhibitors and implications in cancer therapeutics
- Derivatisation of SCR7: Identification and characterisation ofnovel Ligase IV inhibitors

Principal Collaborators

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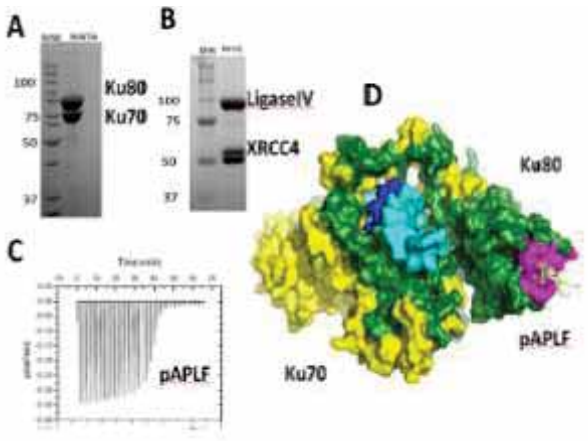
Publications

- No. of publications in SCI journals: 7
- No. of papers presented in conferences: 10

Mobility Support

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



Expression in insect cells and purification of Ku70/Ku80 heterordimer (A) and XRCC4/LigaseIIV complex (B) by the French Partner for biochemical studies (India Partner), affinity measurements by microcalorimetry (C) and crystal structures (D) (French Partner). (C) Interaction between Ku70/Ku80 heterordimer and a petide of APLF (D) Crystal strucure of Ku70 (yellow) Ku80 (green) with a DNA (light and dark blue) and with a peptide of APLF (yellow) in a Ku80 site (magenta) (CEFIPRA citedin Nemoz C et al, *Nat Struct Mol Biol, 2018*)

Life & Health Sciences

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

Project No. 5203-5 | **Mar. 2015 to Dec. 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

- In depth characterisation of the MutS2 protein: identification of new nuclease site and analysis of nucleotide binding and hydrolysis activities
- Development of cell biology tools to follow natural transformation and their application
- First evidence for a role of m4C methylation as a global epigenetic regulator and transformation control
- Structural characterisation of transformation proteins NucT and DprA (2 publications)
- Characterisation of a novel active site in the four Zn-finger domain of *Hp* Topoisomerase I
- Identification of the periplasmic DNA receptor for transformation

Principal Collaborators

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J. Pablo Radicella
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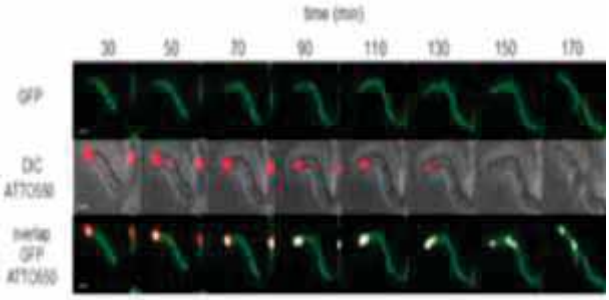
Publications

- No. of publications in SCI journals: 10
- No. of papers presented in conferences: 9

Mobility Support

- India to France: 4
- France to India: 6



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

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.

Principal Collaborators

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Lyon

Publications

- No. of publications in SCI journals: 5
- No. of papers presented in conferences: 9

Mobility Support

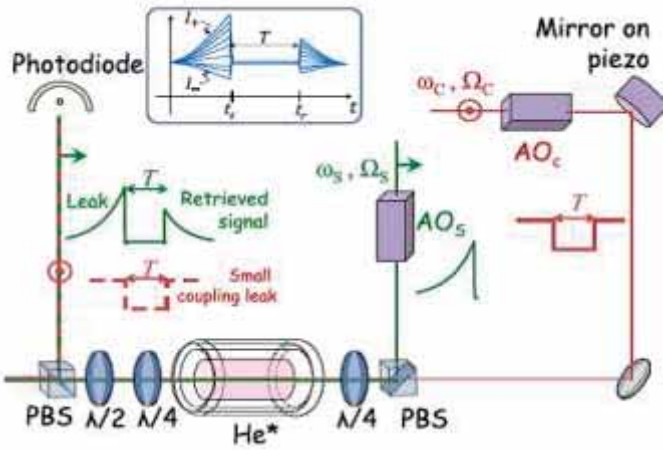
- India to France: 2
- France to India: 5

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;T o 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

- The first architecture (1 pump) was implemented and PIs have experimentally investigated the evolution of the noise figure of the noise figure as a function of the relative phase between the three waves. These results open interesting perspectives in cascading noiseless optical taps as demonstrated for χ2 PSAs. Theoretical simulations were performed to optimize the second configuration (2 pumps), including applications to all optical regeneration
- **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. A theoretical model was developed which demonstrated that this phenomenon occurs through an original scheme involving superpositions of atomic states. The squeezing detection was implemented,but the laser used so far was shown to have a phase noise, which is too large and a new one was ordered. Simulations of CPO were achieved and a model using a newly introduced "popularitон" quasiparticle was developed



Experimental set-up for light storage

Pure & Applied Physics

RADIO PROPERTIES OF CLUSTERS AND GALAXY LENSES

Project No. 5204-2 | **Mar. 2015 to Sept. 2018**

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 collabortors 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).

Principal Collaborators

Joydeep Bagchi
Inter University Centre for Astronomy and Astrophysics, Pune

Bruno Guiderdoni
Centre de Recherche Astrophysique de Lyon
Observatoire de Lyon
Lyon

Publications

- No. of publications in SCI journals: 5
- No. of papers presented in conferences: 17

Mobility Support

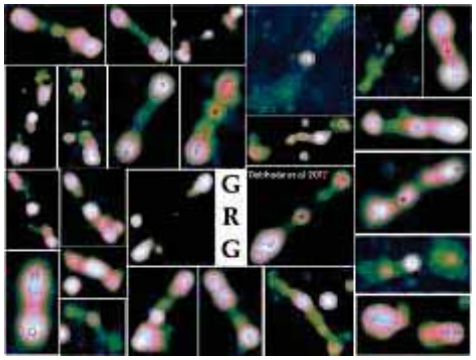
- India to France: 6
- France to India: 4

Objectives

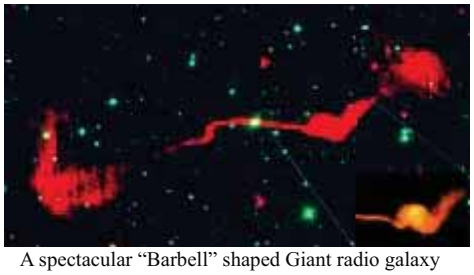
- Studying diffuse non-thermal emission and magnetic field in 25 Lensing clusters of galaxies ($0 < z < 1$) from the CLASH catalog and studying the SFR and emission line properties of faint galaxies ($0 < z < 5$) in the distant Universe using gravitational lensing technique. Studying the nature of lensing 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

Knowledge Generated/Products Developed

- Discovery of about 300 new Giant Radio Galaxies and Quasars of >1 Mpc in radio size, for the first time in this area of research. Their detailed study undertaken
- Discovery of an extremely large and massive supercluster named "Saraswati", first time from the Indian soil. A path breaking find
- Discovery of 4C 35.06, an extremely unusual radio galaxy associated with multiple (9) galactic black-hole mergers in the centre of galaxy cluster Abell 407 (named Zwicky's Nonet by us)
- Discovery of an extraordinary rare, massive spiral galaxy ejecting 1.6 Mpc scale radio jets and its follow up studies with Chandra, XMM, HST, IRAM-30m and GMRT
- Non-thermal emission in many lensing galaxy clusters from our sample have been studied and new radio mini-haloes have been discovered in cool-core clusters
- Multi-wavelength study on 14 lens systems have been carried out in order to study the interplay between dark and normal baryonic matter



A Montage showing Radio image from 1.4 GHz NVSS radio survey of all new GRGs (Giant Radio galaxies) reported by Dabhade et al 2017 discovery paper in international MNRAS Journal (Discovery of Giant Radio Galaxies from NVSS: Radio & Infrared Properties" Dabhade et al. (2017)MNRAS, vol 469, page 2886)



A spectacular "Barbell" shaped Giant radio galaxy

Pure & Applied Physics

HOLOGRAPHY AND IT APPLICATIONS

Project No. 5204-4 | **Jan. 2016 to Dec. 2018**

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

- Developed models for probes in approximately AdS spacetimes through the study of novel tensor models
- Developed the study of quantum chaos through holography, in particular how super-maximal chaos is related to instabilities in the holographic model
- Found supporting evidence for the fact that black hole micro states carry zero angular momentum. This was done in context of IIA string theory on a six torus
- Gave a systematic study of 1/N correction in SYK-like models
- The visit to India by Erbin gave rise directly to a review of closed superstring field theory with Sen

Principal Collaborators

Sandip Trivedi
Tata Institute of Fundamental Research
Mumbai

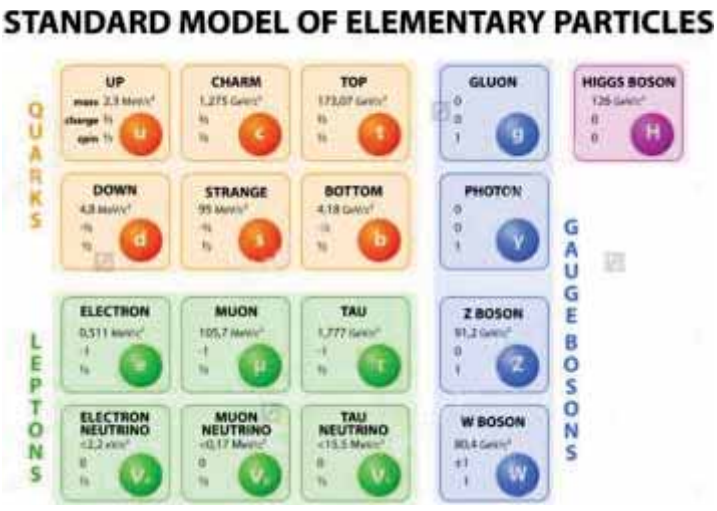
Nick Halmagyi
Université SorbonneLPTHE-UPMC
Paris

Publications

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

Mobility Support

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



Materials Science

NOVEL NANOCATALYSTS SYNTHESIS GUIDED BY DNP NMR

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 (CO_2 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 nitridiated KCC-1 and reagents or intermediates for chemical reactions catalyzed by nitridiated KCC-1

Knowledge Generated/Products Developed

- Size and Fiber Density Controlled Synthesis of KCC-1 is achieved
- Novel NMR techniques for the indirect observation of quadrupolar nuclei via protons at the surface of nanomaterials
- Various active sites of nitridated silica was achieved
- Design of CO_2 sorbents using functionalized KCC-1 and insights into the efect of the silica morphology was achieved
- Solution phase synthesis and photocatalysis of KCC-1/TiO_2 is achieved
- Probing the interfaces in nanosilica supported TiO_2 photocatalysts by solid-state NMR and in-situ FTIR

Principal Collaborators

Vivek Polshettiwar
Tata Institute of Fundamental Research (TIFR)
Mumbai

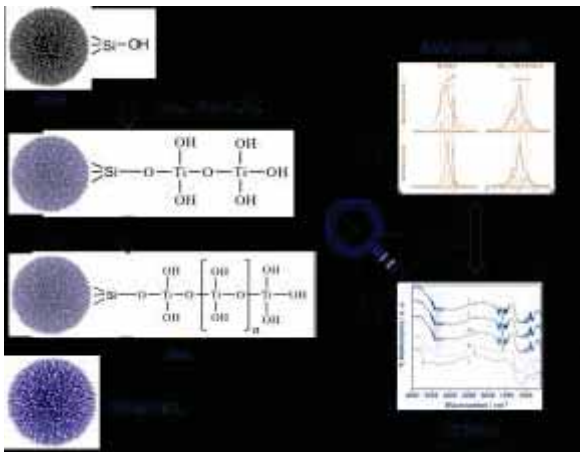
Olivier Lafon
Unite de Catalyse et de Chimie du Solide (UCCS)
CNRS UMR 8181, Université of Lille
Lille

Publications

- No. of publications in SCI journals: 13
- No. of papers presented in conferences: 27

Mobility Support

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



Mechanistic insight of TiO_2 coating on DFNS using ssNMR and FTIR

Biotechnology

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

Project No. 5300-B1 | **Jul. 2015 to Jun. 2018**

Background

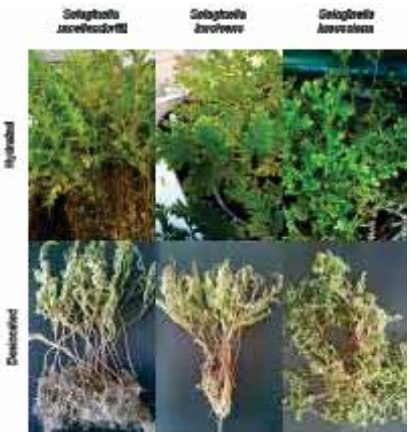
Water supplies for agriculture are a major factor in limiting crop and livestock production. The project proposes to undertake comparative systems biology based evaluation of a new selection of grass species that have the ability to thrive under air dried conditions, for fresh and dry biomass production. For this purpose grasses of genera *Eragrostiella*, *Oropetium* arrd *Tripogon* that can survive total drying of its vegetative tissues, and produce suffcient quantity of (biomass) under three different water stress regimes will be used. These grasses will be compared with mosses llke *Selaginella* that incorporates a constitutive mechanism of desiccation tolerance. Also, proven models of Desication 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 kraqussiana, bryopteris and martensii from sub-tropical forests of lndia 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 resurection 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

- Cell wall profiling methods have been able to provide significant and unique insights into complex remodeling of polymers required for desiccation stress
- First structural characterization of the leaf cell wall of the desiccation-tolerant species *S. involvens* and two desiccationsensitive species, namely *S. kraussiana* and *S. moellendorffii*
- New Hypothesis on the mechanism of tolerance to desiccation has been proposed based on the results obtained from multiple profiling methods
- Several new desiccation tolerant phenotypes of Pteridophytes namely species of *Selaginella*, non *Selaginella pteriidophyte* species namely *Chelianthes*, bryophyte *Hyophilia* and grass *Ergograstis* have been established and their physiology has been deciphered
- Cell wall profiling methods have been able to provide significant and unique insights into complex remodeling of polymers required for mitigation of desiccation stress
- Comparative proteomic analysis has shown that significant differences in physiological states during water gain and water loss. The result provides tremendous insight into anti-oxidant physiology and has the potential to be taken u as a separate study
- Significant capacity enhancement in terms of infrastructure, technical and scientific training for M.Sc and Ph.D students



Principal Collaborators

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IRIB-PRIMACEN-IBiSA
Université de Rouen
Mont- Saint Aignan

Publications

- No. of publications in SCI journals: 5
- No. of papers presented in conferences: 7

Mobility Support

- India to France: 5
- France to India: 3

Life & Health Sciences

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

Project No. 5303-1 | **Apr. 2015 to Apr. 2018**

Background

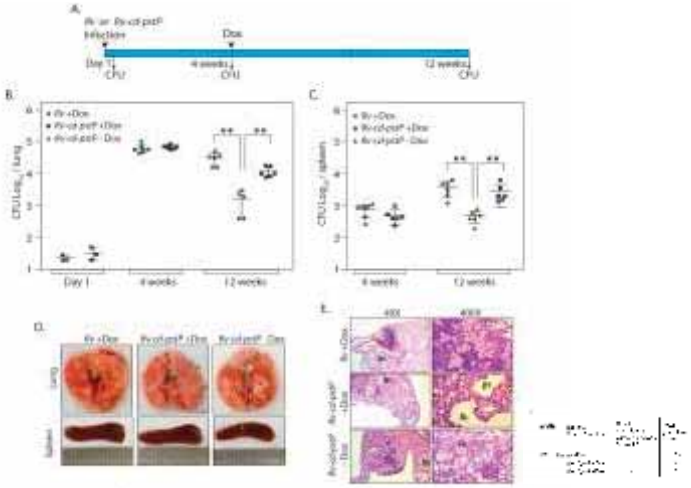
M. tuberculosis encodes for 11 serine/threonine protein kinases, one tyrosine kinase (PtkA), one serine/threonine phosphatase (PstP) and two tyrosine phosphatases (PtpA, PtpB). All the phosphatases have been biochemically characterized and the structures have been determined. PstP dephosphorylates PknA 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

- Our data suggests an important role for PstP in establishing and maintaining infection, possibly via the modulation of cell division events
- PstP depletion results in elongated multiseptate cells, suggesting a role for PstP in regulating cell division events, eventually leading to cell death
- Mice infection experiments establish a definitive role for PstP in pathogen survival within the host. Depletion of PstP from established infections causes pathogen clearance, indicating the continued presence of PstP is necessary for pathogen survival
- 153 proteins were identified as PstPinteracting partners and 38 are also phosphorylated. We are currently in the process of validating some of the candidates that are found in both the phosphoproteome and interactome in order to decipher the role of PstP mediated dephosphorylation and/or interaction in modulating their functionality



Depletion of PstP decreases the bacillary load even in an established infection. A. Schematic outline depicting the experiment. B & C. BALB/c mice groups were infected with Rv and Rv-cd-pst.Three mice each from Rv and Rv-cd-pstP infected groups were sacrificed one day post infection, and CFUs were determined. 6 mice each from Rv and Rv-cd-pstP infected groups were sacrificed four weeks post infection, and the bacillary load in the lungs and spleen were determined. Log10 CFUs for Rv and Rv-cd-pstP in the lungs were 4.8 and 4.84 and in the spleen were 2.66 and 2.56, respectively. Rv-cd-pstP infected mice were divided into two groups (n= 6) four weeks post infection, and one group was provided Dox (1 mg/kg) for 8 weeks. CFUs were enumerated in lungs and spleen twelve weeks post-infection.The bacillary load (log10 CFUs) in the lungs for Rv + Dox, Rv-cd-pstP +Dox and Rv-cd-pstP —Dox were 4.49, 3.14 & 4.08, and in the spleen were 3.57, 2.54 and 3.45, respectively. Error bars: S.E.M.**P<0.001, two tailed non parametric t-test. D. Representative images of lungs and spleen after 12 weeks of infection. Prominent granulomas are indicated by arrowheads. E. 40X and 400X histopathology images of of lung sections at 12 weeks post infection. G: granuloma; FC: foamy cells; AS: alveolar space; E: epithelioid cells. BL: bronchial lumen. F. Granuloma Score of the histopathology sections of E

Principal Collaborators

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Virginie Molle
CNRS UMR5235- DIMNP (Dynamique des Interactions
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Universite Montpellier II, Montpellier

Publications

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

Mobility Support

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

Pure & Applied Physics

SYMMETRIES AND DYNAMICS: WORLD SHEET 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.

Objectives

- 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

Knowledge Generated/Products Developed

- 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 flux compactifications
- Study of discretised holographic adS-CFT, also in Mellin space
- Developed matrix model for the Riemann zeta function. Symmetry enhancement of wavelets on p-adic space

Principal Collaborators

Debashis Ghoshal
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Ruben Minasian
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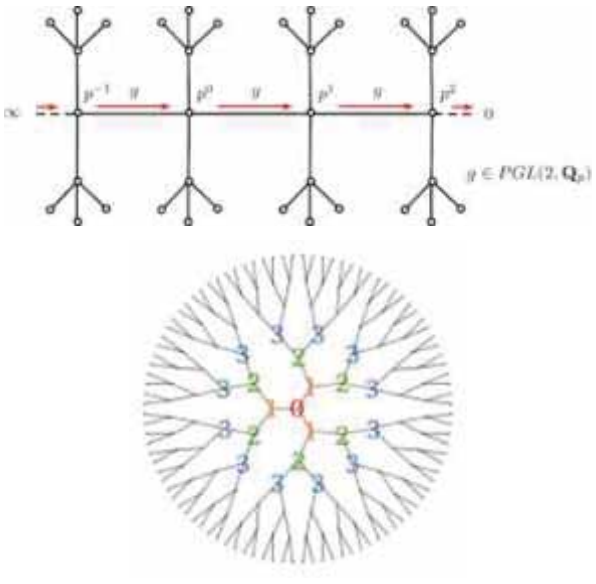
CEA – Saclay
Paris

Publications

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

Mobility Support

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



Symmetries and Dynamics: Worldsheet and Spacetime

Pure & Applied Physics

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

Project No. 5304-3 | **Apr. 2015 to Oct. 2018**

Background

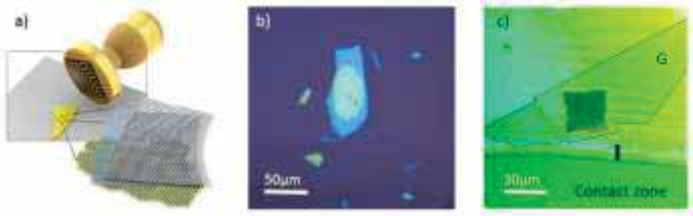
The project centred on the production and study of quantum electron transport properties of Graphene devices for which the carbon monolayer is encapsulated by Van-der-Waals interactions in between two layers of hexagonal Boromn Nitride, side-contacted with lateral electrodes and gated with set of top electrodes. These sandwiches allow to prepare 2D electron/hole gases with very long mean free paths and high electronic mobilties 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

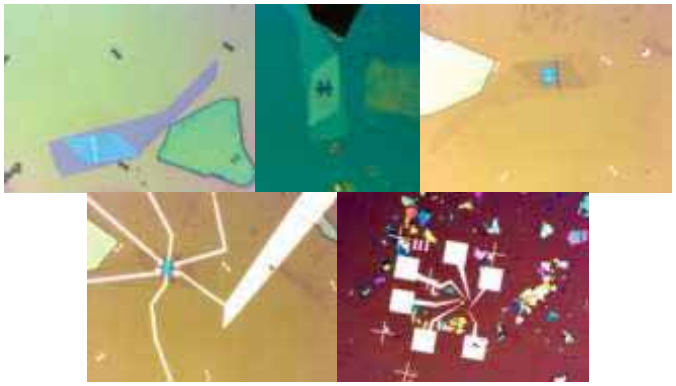
- Fabricate layered heterostructures by stacking graphene (single or bilayer) with other layered materials, such as boron nitride (BN), to achieve a new class of composite materials
- Study quantum transport in high mobility graphene/BN heterostructures and interplay of quantum Hall effect and superconductivity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

Knowledge Generated/Products Developed

- Successful measurement of side-contacted Graphene/h-BN heterostructures of high electronic mobility
- Fractional Quantum Hall Effect observed in side-contacted Graphene/h-BN heterostructures
- Fabrication of dichalcogenide / hBN heterostructures
- Cathodoluminescence of dichalcogenide / hBN heterostructures.
- Evolution of inter-layer coupling strength in twisted TMDCs layers



Principles of a van der waals stacking by successive stamping



Principles of a van der waals stacking by successive stamping
(a) BN-G-BN Stack with align markers (b) Hall Bar shaped HSQ mask on the stack (c) Quantum Hall Bar structure after etching (d) Hall Bar with metal contacts (e) BN-G-BN Hall bar device with metal pads

Principal Collaborators

Aveek Bid
Indian Institute of Science
Bangalore

Vincent Bouchiat
NEEL, CNRS-Grenoble
Grenoble

Publications

- No. of publications in SCI journals: 3
- No. of papers presented in conferences: 8

Mobility Support

- India to France: 4
- France to India: 5

Pure & Applied Chemistry

AXIALLY CHIRAL BIARYLS FROM C-H ACTIVATION & RADICALS

Project No. 5305-1 | **Jun. 2015 to Feb. 2019**

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 straight forward 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
- Cross coupling of axially chiral phenols with di-alkyl phosphites were achieved
- A moderate success in diastereoselectivity in the reaction between axially chiral phenols with racemic ethyl phenylphosphinate was achieved
- Application of couplings between phenol derivatives and H-Phosphonates towards the organophosphates based fluorecent BODIPY derivatives
- TBAI/TBHP mediated oxidative cross coupling of ketones with phenols and carboxylic acids: Direct access to benzofurans
- Iron Catalyzed Minisci Type Acetylation of N-Heteroarenes Mediated by CH(OEt)3/TBHP

Principal Collaborators

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CSIR- Indian Institute of Chemical Technology
Hyderabad

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25 Rue Becquerel 67087
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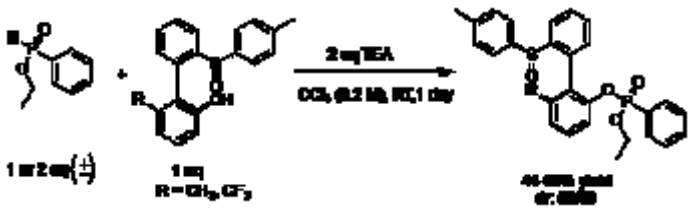
Publications

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

Mobility Support

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



Phosphorylation of *p-tolylsulfoxidebiaryl* phenol under Atherton-Todd reaction conditions

Pure & Applied Mathematics

SUMS OF INTEGERS: FOURIER, COMBINATORICS, COMPUTATION

Project No. 5401-1 | **Feb. 2016 to Jan. 2019**

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 Z/pZ such that A+A and A are disjoint. Characterize A
- Theme 2. Large subsets of integer sequences. How they retain the additive proprerties 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 Z/pZ (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+ε) . (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 τ be the Ramanujan function. Under the standard conjecture that τ does not vanish, there are infinitely many integers n for which the change of size of the values of τ(n), τ(n+1),…,τ(n+k) can be arbitrarily prescribed

Principal Collaborators

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Chennai

Jean-Marc Deshouillers
Institut Mathématique de Bordeaux
Université de Bordeaux-CNRS
Bordeaux

Publications

- No. of publications in SCI journals: 12
- No. of papers presented in conferences: 25

Mobility Support

- India to France: 6
- France to India: 3

Pure and Applied Chemistry

H_2 EVOLUTION: CHEAP CATALYSTS FOR NOBLE TASK

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

Background

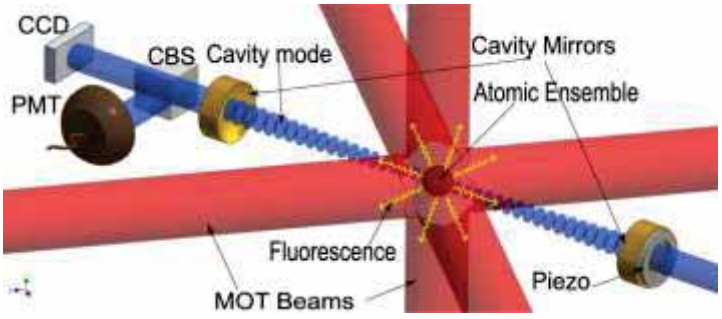
The two applicant groups have already reported a set of biomimetic Fe-Fe, Ni-Fe, Ni-Mn and Mo based effcient H_2 producing catalyst with potential to replace noble metals in water-splitting electrolyzers. This project has two major goals. First, the mechanism of these HER catalysts will be studied in 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 O_2. 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 H_2 evolution mechanism catalyzed by bio-inspired compounds
- Enhancing catalytic performances for H_2 evolution

Knowledge Generated/Products Developed

- [NiFe]-hydrogenase enzymes are efficient catalysts for H_2 evolution but their synthetic models have not been reported to be active under aqueous conditions, so far. We showed that a close model of the [NiFe]-hydrogenase active site can work as a very active and stable heterogeneous H2 evolution catalyst under mildly acid aqueous conditions. Entry in catalysis is a NiIFeII complex, with electronic structure analogous to the Ni-L state of the enzyme, validating the mechanism modification recently proposed for [NiFe]-hydrogenases
- A new Cp*- derivative of a NiFe mimic has been synthesized and its catalytic activity as well as tolerance to CO has been demonstrated. A catalytic mechanism distinct from the parent Cp complex has been demonstrated (*ACS Catal.* 2018). Other derivatives with Co and Zn metal ions instead of Ni have been prepared and assessed for H_2 evolution catalytic acticity
- The Cp-based NiFe mimic has been immobilized in a MOF and was shown to retain its activity
- A new FeFe mimic has been developed that shows bidirectional activity for both H_2 evolution and oxidation
- The same FeFe mimic has been interfaced with carbon electrodes and implemented in H_2/O_2 fuel cell setups. This is the first time a FeFe mimics is shown to be active for H_2 oxidation under electrochemical conditions



Principal Collaborators

Abhishek Dey
Indian Association for the Cultivation of Science
Kolkata

Vincent Artero
Laboratoire de Chimie et Biologie des Métaux
CEA-Grenoble
Grenoble

Publications

- No. of publications in SCI journals: 9
- No. of papers presented in conferences: 17

Mobility Support

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

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

Knowledge Generated/Products Developed

Modelling of Rayleigh-Taylor (RT) and Resistive Instabilities with focus on dust

- study of growth of RT & resistive instabilities and Frequency band under the effect of ionization
- discovery of an unexpected stream instability due to dusts (ion beam-dust interaction)
- explanation for the electron mean axial velocity (thanks to the Hamiltonian description and analysis of trajectories)
- anisotropic electron heating

Principal Collaborators

Hitendra Kumar Malik
Indian Institute of Technology Delhi
New Delhi

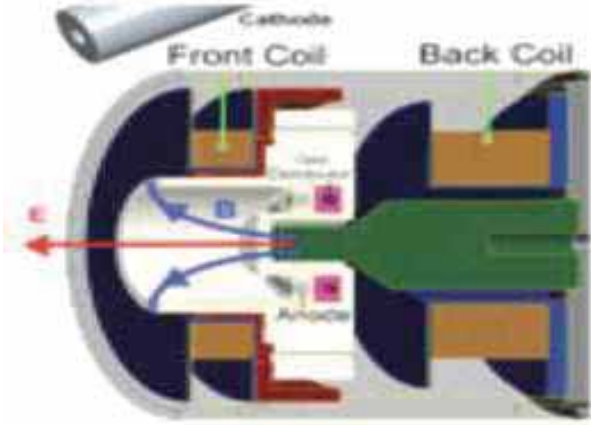
Yves Elskens
UMR 7345 du CNRS /
Aix Marseille Université
Marseille

Publications

- No. of publications in SCI journals: 6
- No. of papers presented in conferences: 10

Mobility Support

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



Cross-section view of a cylindrical Hall thruster. Electrons are magnetized and are confined by a combination of the magnetic and electric fields. Segmented anode is shown

Computational Science

LARGE SCLAE LOSS BASED LEARNING VIA ENERGY MINIMIZATION

Project No. 5302-1 **Apr. 2016 to Sept. 2019**

Background

The aim of our research plan 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 selfpaced 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

Knowledge Generated/Products Developed

- Journal paper on energy minimization for document analysis (joint)
- Papers on incremental learning and evaluation of cost function based models at ECCV 2018, and on a novel generative model at NeurIPS 2019, premier conferences in computer vision and machine learning (French team)
- Conference paper at CVPR 2017 (Indian team)
- Journal paper on weakly-supervised learning (French team)
- Results on self supervised feature learning for face recognition (India team)

Principal Collaborators

C V Jawahar
International Institute of Information Technology Hyderabad

Cordelia Schmid
INRIA, Montbonnot

Publications

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

Mobility Support

- India to France: 5
- France to India: 4

Life & Health Sciences

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

Project No. 5303-2 | **Sept. 2015 to Sept. 2019**

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.

Principal Collaborators

Kishore K Srivastva
AcSIR
CSIR-Central Drug Research Institute
Lucknow

Anne-Marie Caminade
Laboratoire de Chimie de Coordination du CNRS
Délégation Midi-Pyrenees
Toulouse

Publications

- No. of publications in SCI journals: 12
- No. of papers presented in conferences: 2
- No. of patent: 2

Mobility Support

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

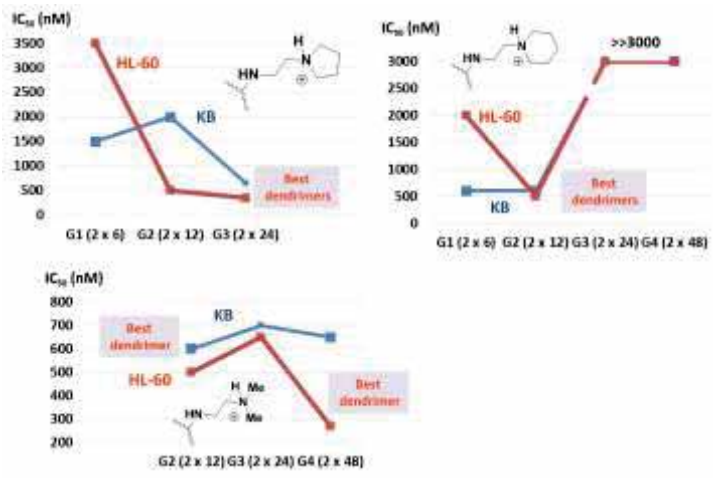
Objectives

- 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

Successed to combine talents, backgrounds and knowledge for a common objective through India and France to get one team spirit

- about 98 original phosphorus dendrimers prepared (different generations and various surface modifications) and tested as anti-mycobacterial, but also for many of them as anti-bacterial, anti-fungal, and anti-cancer agents
- Within, more than 98 original dendrimers prepared, more than 15 first-in-class phosphorus dendrimers are active against three different tuberculosis strains. The one dendrimer 16/CEF/280 showed more than 10 fold (50 mg/kg) maximum tolerated dose in Balb/C Mice
- More than 20 first-in-class phosphorus dendrimers are active against Gram+ and Gram- microbes, including several multi-drug resistant strains. Two of them 16/CEF/062 and 17/CEF/360 were selected for detailed study due to their high selective index
- More than 10 original phosphorus dendrimers are active against solid and/or liquid tumours, for cytotoxicity evaluation (see revised objectives) and safety evaluation against normal cell line.
- Two patents were completed: First dedicated to the development of anti-TB dendrimers, and the second in the oncology domain
- PIs planned to publish at least five papers in good journal. The first one about original anti-TB dendrimers was completed and will be sent once after the first patent be filed



Dendritic effects of polycationic phosphorus dendrimers

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 land marks 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.

Principal Collaborators

Rejish Nath
Indian Institute of Science Education and Research Pune

Paolo Pedri
Laboratoire de Physique des Lasers - CNRS - UMR7538
Université Paris 13 - Institut Galilée - 99 Villetaneuse

Publications

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

Mobility Support

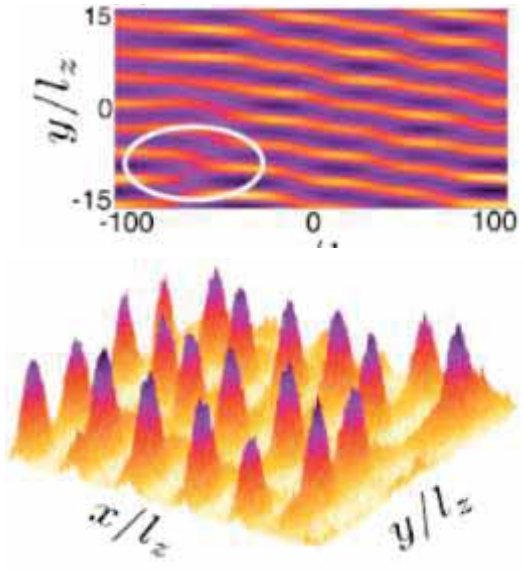
- India to France: 2
- France to India: 4

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

- Estimated the Hubbard parameters for Rydberg-admixed atoms in a one-dimensional optical lattice
- A new cooling scheme was demonstrated for dipolar chromium condensates
- Novel parameter regime for two-dimensional bright solitons were identified and studied as a function of tilting angle of dipoles. A two dimensional condensate self-trapped in one direction was proposed
- Anisotropic roton quasi-particles with highly tunable roton momentum were 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 was studied using chromium atoms
- Rydberg array under periodic modulation was analyzed
- Quantum fluctuations and droplets in quasi-1D dipolar Bose-Einstein condensates were analyzed
- The effect of Rabi offset on the dynamics of two Rydberg atoms was analyzed
- In PIs analyzed the effect of periodic modulation and quantum quenches in spinor condensates



The stripe pattern and soliton gas formed

Earth & Planetary Sciences

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

Project No. 5307-1 | **Sept. 2015 to Jun. 2019**

Background

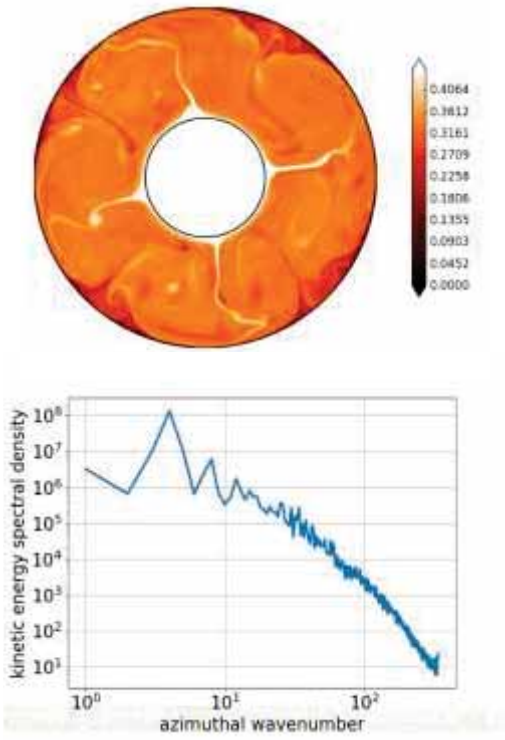
Over the past two decades, our understanding of Earth and planetary core dynamics, and magnetic field generation within planetary interiors, has greatly benefited from numerical simulations. The temporal discretization used in these simulations has surprisingly received little attention. However, if 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 cylindrical annulus
- Development of a complementary experimental facility to investigate the dynamics of thermal core-mantle interaction in the Earth.
- Connecting the patterns of convection obtained in a cylindrical annulus to those in the equatorial region of the Earth's outer core; understanding the implications for the geomagnetic field
- Proposal of a plausible mechanism for inner core heterogeneity in Earth
- Development of a theory for the selection of the axial dipole in planetary magnetic fields



Top: A snapshot of the temperature field in a turbulent two-dimensional convection simulation. Bottom: the associated kinetic energy power spectrum, showing an inverse energy cascade peaking at azimuthal wavenumber $m = 4$

Principal Collaborators

Binod Sreenivasan
Indian Institute of Science
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Alexandre Fournier
Institut de physique du globe de paris (IPGP)
Paris

Publications

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

Mobility Support

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

Materials Science

MAGNETISM OF SELF-ORGANIZED STRUCTURES AT SURFACES

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.

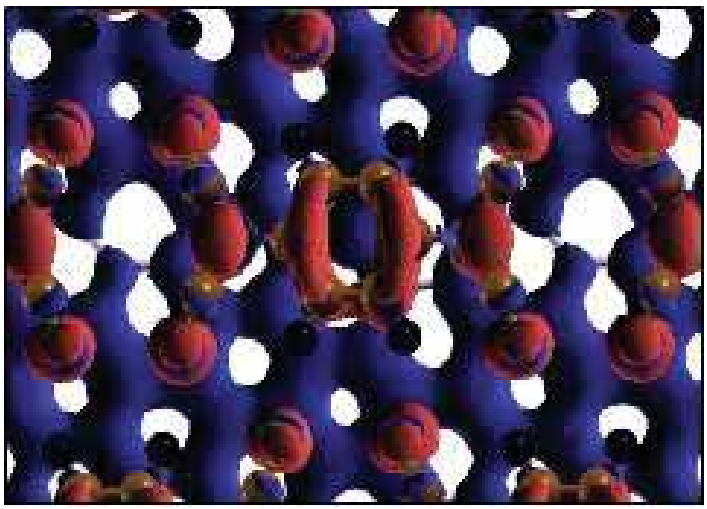
Objectives

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

Knowledge Generated/Products Developed

- The change in magnetic anisotropy energy of Co surfaces on depositing a monolayer of thiols was measured experimentally and calculated theoretically
- Single molecules of TCNQ on N-doped graphene were selectively charged by an STM tip, and this process has been studied theoretically
- Experimental data on a long-range ordered structure observed with STM on depositing a spin-crossover molecule on Au(111) was shown, conclusively, by theoretical calculations to be a mixed spin phase consisting of 2:1 ratio of high spin and low spin molecules, with the transition triggered by epitaxial strain imposed by the substrate
- Various features seen commonly in experimental STM images of the surface of black phosphorene were correlated with different types of point defects, using theoretical simulations
- Molecular structure, dynamics and doping of F4-TCNQ on black phosphorene were studied by STM and DFT. These results were contrasted with F4TCNQ on multilayer graphene



Computed charge redistribution when a monolayer of TCNQ molecules is deposited on N-doped graphene

Principal Collaborators

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Publications

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

Mobility Support

- India to France: 7
- France to India: 6

Life & Health Sciences

PATHOGENIC ASPERGILLUS: INTERACTION WITH INNATE IMMUNE CELLS

Project No. 5403-1 | **Jan. 2016 to Dec. 2019**

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* 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

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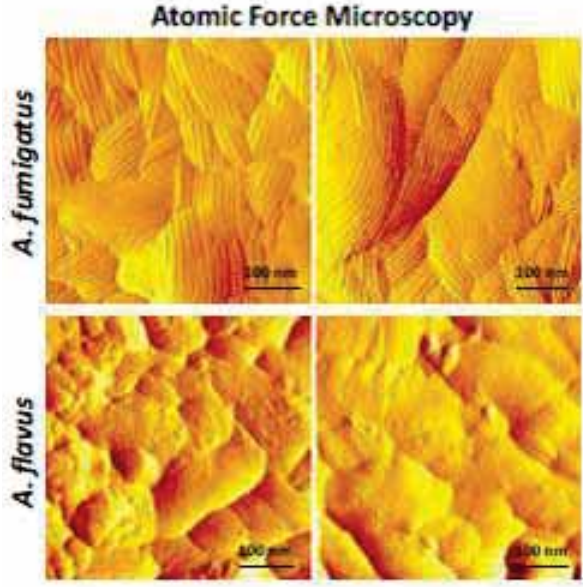
Publications

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

Mobility Support

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



Atomic force microscopic images of the A. fumigatus and A. flavus conidial surfaces

Pure and Applied Physics

LORIC: LONG-RANGE INTERACTIONS IN ULTRA COLD GASES

Project No. 5404-1 | **Mar. 2016 to Dec. 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 manybody 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 traping, 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

- 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 homonuclearand hetero-nuclear (with a dipole moment) molecules
- Cooling molecules : innovative deceleration method for polar molecules, basedon electron attachment, deceleration and trapping

Knowledge Generated/Products Developed

- Discovered universal dissociation mechanism for trapped alkali dimer molecular ions
- Demonstration of cold atoms lasing into cavity mode
- New cooling mechanism for trapped ions was 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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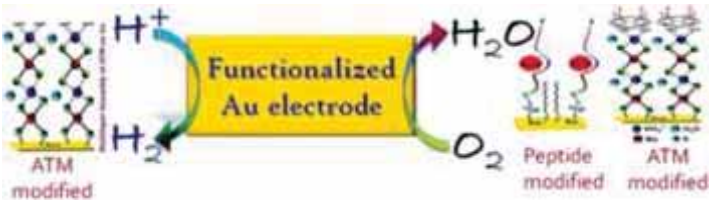
Laboratoire Aimé Cotton, CNRS
Université Paris-Sud
Orsay

Publications

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

Mobility Support

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



Pure and Applied Physics

GLIMPSES OF NEW PHYSICS

Project No. 5404-2 | **Feb. 2016 to Dec. 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. Searchesat 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 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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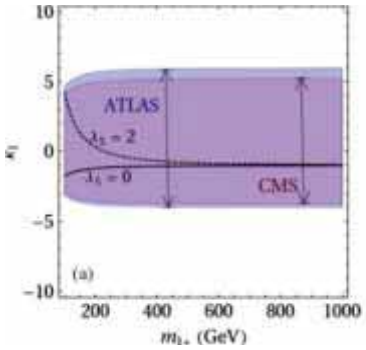
Palaiseau

Publications

- No. of publications in SCI journals: 4
- No. of papers presented in conferences: 1

Mobility Support

- India to France: 7
- France to India: 2



Computational Science

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

Project No. 5408-1 | **Nov. 2015 to Oct. 2019**

Background

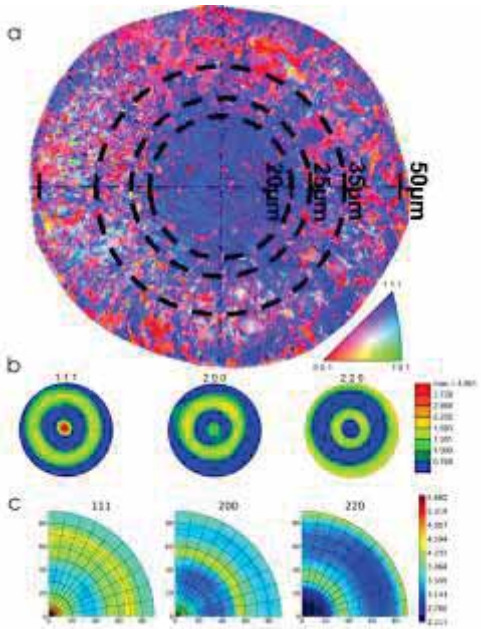
The project aims at a comprehensive investigation on size effects in microwires, involving (a) microstructural control during the wire drawing process, (b) conventional mechanical testing, (c) in-situ mechanical testing in an SEM, (d) in-situ testing in synchrotron, (e) relevant microstructural studies 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 were performed on microwires with different diameters
- Two series of microwires were produced by electropoloshing or cold drawing, allowing for the assessment of microstructure impact on mechanical properties
- In-situ tensile tests under synchrotron x-ray beam were successfully performed with specifically adapted micro-deformation machine
- Microstructure analysis provided relevant parameters for the implementation of modelling
- Internal microstructure and architecture identified as explanations for the observed size effects, with the fundamental understanding providing a preliminary means for tailoring microstructures and architectures for required properties



Texture analysis of 100 µm Ni microwire. (a): Cross-sectional EBSD map (IPF relative to the wire axis); the black dashed circles correspond to the different diameters obtained by electropolishing. (b): (111), (200), (220) pole figures from cross-sectional EBSD. (c): (111), (200), (220) pole figures along wire axis from high-energy X-Ray diffraction

Principal Collaborators

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Ludovic Thilly
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Futuroscope

Publications

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

Mobility Support

- India to France: 3
- France to India: 5

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 Nov 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 overburden 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-bioremediation (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 Crisotopic signatures

Knowledge Generated/Products Developed

Two field trip missions were performed for sample collection (monsoon and dry seasons):

- Water samples chemistry was fully characterized
- Several bacterial species were isolated and identified from the water samples collected from the mine site
- Rock, sediment and soil samples were analyzed for total content and mineralogy partially characterized
- The process parameters controlling the bioremediation of chromium were optimised
- Strong interactions with the mining company

Principal Collaborators

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Dr. Yann Sivry
Institut de Physique du Globe de Paris
Paris

Publications

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

Mobility Support

- India to France: 7
- France to India: 8

Field photographs of sample location, a) Chromite band in peridotitic dunitic rock. (b) insitu chromite band in dunite. (c) Dolorite dyke (d) Chromite rich rocks inside mine region. (e) pyroxenite, (f) weathered websterite

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.

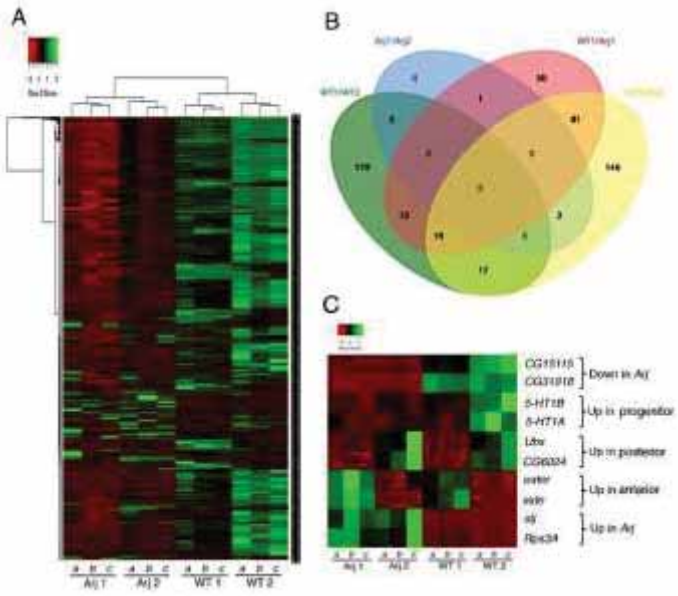
The project will give unprecedented insights into the molecular nature of *Drosophila* blood cell progenitor populations. It will also provide deeper insights into how a key regulator of the endocytic transport machinery modulates developmental signals and affects stemness, hematopoiesis and leukemia.

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*

Knowledge Generated/Products Developed

- Identification of new larval blood cell markers and tools
- Demonstration that the *Drosophila* larva lymph gland comprises molecularly and functionally distinct populations of blood cell progenitors
- Characterization of new regulators of *Drosophila* blood cell progenitor maintenance
- Identification of conserved genes regulated by Asrij in mouse and *Drosophila* blood cell progenitors
- Demonstration that Asrij/OCIAD1 is a tumor suppressor in mouse blood cells



(A) Heat map of gene expression among 960 differentially expressed genes ($p<0.001$) between control and asrij mutant lymph glands. Hierarchical clustering of the samples and gene expression values were performed using R-Bioconductor. (B) Venn diagram showing the overlap of differentially expressed genes between different combinations of samples. (C) Heat map showing examples of differentially expressed genes for blood cell progenitors, posterior lymph gland lobes and asrij mutant. (A,C) gene expression profiles from biological triplicates (a,b,c) of control (WT) or arj mutant (Arj) anterior (1) or posterior (2) lobes

Principal Collaborators

Maneesha Inamdar
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Publications

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

Mobility Support

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

Life & Health Sciences

MOLECULAR ANANLYSIS OF A CAPACITOR HOX PROTEIN MOTIF

Project No. 5503-2 | **May 2016 to Jul. 2019**

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

Knowledge Generated/Products Developed

All constructs for doing experiments were generated (Merabet lab)

- Functional assays were realised in *Drosophila* with Ubx constructs from different insect species (Merabet lab and Shashidhara Lab)
- Interaction tests started in *Drosophila*, with the identification of several candidate cofactors (Merabet lab)
- Bioinformatics analysis of transcriptome data in different insect species were realised to identify putative cofactors of Ubx (Shashidhara lab)
- Chip-seq experiments were performed for Ubx in the *Drosophila* haltere to identify more precisely target enhancers with upstream regulators (Shashidhara lab)

Principal Collaborators

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Publications

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

Mobility Support

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

Pure & Applied Physics

WAVELET GRAPHS FOR GRAVITATIONAL WAVE SEARCHES

Project No. 5504-1 | **Apr. 2016 to Apr. 2020**

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

Knowledge Generated/Products Developed

- Design and Development of new clustering scheme (wavelet graph) to enhance the detection of gravitational wave searches with LIGO and Virgo interferometers
- Development of the signal-based chi-square veto scheme for rejecting the noise transients
- The wavelet graph scheme was tested for simulated set-up and showed enhanced performance
- Porting of chi-squared scheme was completed in the coherent wave burst platform
- The combined scheme was tested for real LIGO noise which showed improved performance for low mass black-hole binaries

Principal Collaborators

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Eric Chassande-Mottin
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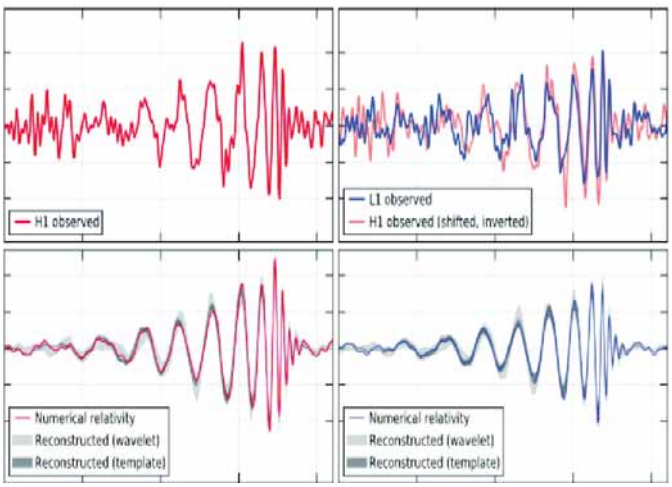
University Paris Diderot
Paris

Publications

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

Mobility Support

- India to France: 4
- France to India: 1



Pure & Applied Physics

COSMOLOGICAL EVOLUTION OF COLD GAS FROM QUASAR ABSORPTION LINES

Project No. 5504-2 | **May 2016 to Oct. 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

Knowledge Generated/Products Developed

- Design of the MeerKAT Absorption Line Survey (MALS): the survey footprint and selection function (MALS will be the most sensitive and dust-unbiased survey to trace cold gas in galaxies using absorption lines; https://mals.iucaa.in/)
- MALS data processing pipeline: prototyping the big data challenge posed by MALS (the prototype is already released; all the solutions and the advanced version will be publicly released later next year; a limited release is planned this year)
- First unbiased exploration of cold atomic gas at high redshifts using the newly commissioned capabilities of the upgraded Giant Metrewave Radio Telescope in India
- Complete surveys of molecular and high column density gas at high redshift using Very Large Telescope (VLT) in Chile (access through European Southern Observatory)
- Detailed understanding of physical and chemical conditions based on microphysics.

Principal Collaborators

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Inter University Center for Astronomy & Astrophysics (IUCAA), Pune

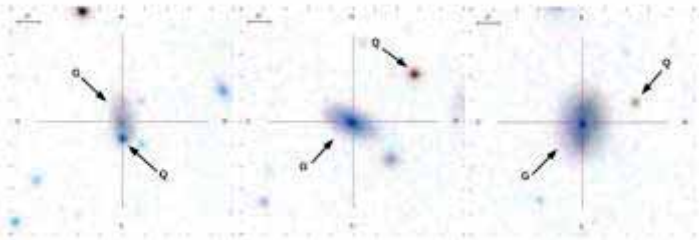
Pasquier Noterdaeme
Institut d'Astrophysique de Paris Paris

Publications

- No. of publications in SCI journals: 12
- No. of papers presented in conferences: 6

Mobility Support

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



Showing a few of the quasar sight lines and the foreground galaxies at z<0.4 probed by Hi 21-cm absorption

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

Knowledge Generated/Products Developed

- Preparation of plasmonic individual and coupled Ag and Au nanowires and their electrical connections
- Linear and nonlinear characteristics of the surface plasmon propagation in nanowires
- Confirmed the essential role of the surface plasmon polariton modes to explain the longitudinal extension of the nonlinear responses observed in plasmonic nanowires
- Electrical modulation of the nonlinear response of coupled nanowire devices
- Exchange of personals

Principal Collaborators

Pawan Kumar
Indian Institute of Science Education and Research, Pune

Alexandre Bouhelier
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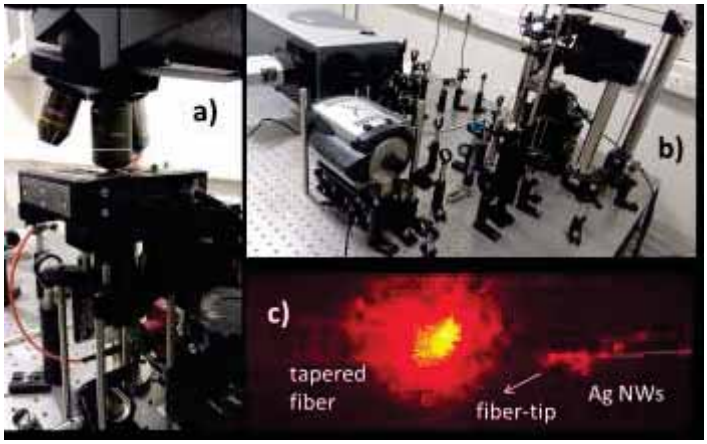
Publications

- No. of publications in SCI journals: 7
- No. of papers presented in conferences: 8

Mobility Support

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



a) Microscopy system with piezo-stage; b) Layout of the optics, with microscope coupled to EM-CCD and a spectrometer; c) Optical image showing a tapered fiber that can optically excite and manipulate Ag NWs

Pure & Applied Chemistry

N-HETROCYCLIC CARBENE (NHC)-PRGANOCATALYZED ENATIOSELECTIVE TRIFLUOROMEN-THYLATION AND TRIFLUOROMETHYLTHIOLATION OF UNACTIVATED C-H BONDS

Project No. 5505-1 | **May 2016 to May 2019**

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 poposed to develop an efficient and new protocol to achieve unprecedented trans-formations 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 trifluoro-methylation and trifluoromethy lthiolation 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_3)-CF_3 and C(sp_3)-SCF_3 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 (CF_3, SCF_3) 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_3)-CF_3 and C(sp_3)-SCF_3 bond formation at the a-, b- and g-position of carbonyl compounds

Knowledge Generated/Products Developed

- NHC-catalyzed synthesis of 4-difluoromethylquinoline derivatives
- *N*-Heterocyclic Carbene-Catalyzed Synthesis of α-Trifluoromethyl esters
- Enantioselective *N*-Heterocyclic Carbene-Catalyzed Cascade Reaction for the Synthesis of Pyrroloquinolines
- Development of the Trifluoromethylthiolation of α-Chloroaldehydes leading to an Access to Quaternary SCF_3-Containing Centers
- Proofs of concept for the β- trifluoromethylation of aldehydes.

Principal Collaborators

Akkattu T Biju
Indian Institute of Science
Bangalore

Tatiana Besset
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Mont St Aignan

Publications

- No. of publications in SCI journals: 5
- No. of papers presented in conferences: 23

Mobility Support

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

Pure & Applied Chemistry

CHIRAL PHOSPHAHELICENES IN GOLD (I) ENANTIOSELECTIVE CATALYSIS

Project No. 5505-2 | **Apr. 2016 to Mar. 2019**

Background

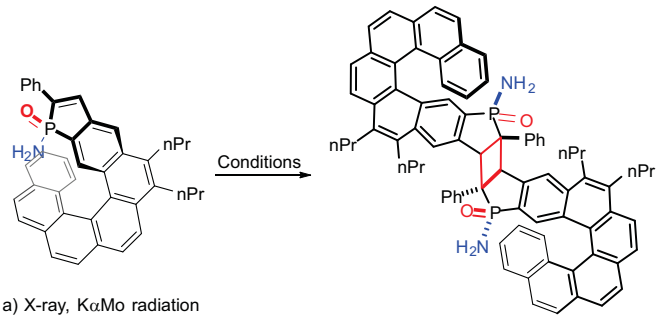
Aim of this project is the parallel development of new gold (I) catalyzed processes, and the design and synthesis of new series of helically chiral ligands. The targeted catalytic processes are either intermolecular reactions or skeletal rearrangements of polyunsaturated substrates which involve electrophilic 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

Knowledge Generated/Products Developed

- The first enantioselective variant of the gold(I)-catalyzed hydrative cyclizations of ynamides was implemented by using bis-gold(I) complexes of chiral diphosphines.
- A convenient access to a new family of phosphahelicenes which display phosphinamide functions was established. Under irradiation, an unusual dimerization process takes place with these compounds, both in solution and in the solid state
- The chemistry of phosphahelicenes was expanded to: enantioselective organocatalyzed cyclisations, new organometallic complexes, synthetic approaches to thiophosphinic acids, new synthetic approaches involving metal-promoted triynes cyclotrimerizations and other cyclisation reactions
- The first example of regioselective sulfonyl/sufinyl migration cycloisomerization cascade of alkyne tethered ynamides was developed in the presence of Xphos gold catalyst
- The unprecedented Gold(I)-catalyzed syn-1,2-difunctionalization of ynamides and intramolecular Tetradehydro-Diels-Alder (TDDA) reaction of alkyne-tethered-ynamides also been demonstrated



a) X-ray, KαMo radiation
b) sunlight, solid state (powder), 2h, 95% conversion
c) sunlight, 0.017 M solution in $CDCl_3$, 4h, 40% conversion
d) hν, 150 watt, pyrex photoreactor, 0.017 M solution in $CDCl_3$, 9h, 53% conversion

[2+2] photocyclization of the helical phosphinamide

Principal Collaborators

Akhila Kumar Sahoo
University of Hyderabad
Hyderabad

Angela Marinetti
Institut de Chimie des Substances Naturelles (ICSN), UPR2301
Gif Sur Yvette

Publications

- No. of publications in SCI journals: 17
- No. of papers presented in conferences: 8

Mobility Support

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

Pure & Applied Mathematics

p-ADIC ASPECTS OF AUTOMORPHIC FORMS AND THEIR L-FUNCTIONS

Project No. 5601-1 | **Nov. 2016 to Oct. 2019**

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

Knowledge Generated/Products Developed

- Several conferences were given by both Indian and French collaborator on the results obtained
- A preliminary preprint available on the archives. The URL is: http://arxiv.org/abs/1802.10064
- By construction, our p-adic L-functions are distributions on the Galois group of the maximal abelian extension of F unramified outside p∞. Moreover, we prove the so-called Manin relations between the p-adic L-functions at all critical points. This has the striking consequence that, given a unitary Π whose standard L-function admits at least two critical points, and given a prime p such that Πp is ordinary, the central critical value $L(_{12},\Pi\otimes\chi)$ is non-zero for all except finitely many Dirichlet characters χ of p-power conductor

Principal Collaborators

Anantharam Raghuram
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Mladen Dimitrov
CNRS / Laboratoire Paul Painlevé University of Lille
Lille

Publications

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

Mobility Support

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

Life & Health Sciences

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

Project No. 5603-1 | **Nov. 2016 to Oct. 2019**

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.

Principal Collaborators

Kumaravel Somasundaram
Indian Institute of Science
Bangalore

Philippe Marin
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Montpellier

Publications

- No. of publications in SCI journals: 20
- No. of papers presented in conferences: 3

Mobility Support

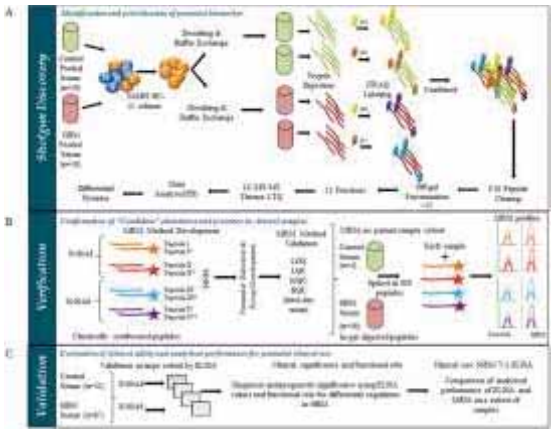
- India to France: 2
- France to India: 1

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

Knowledge Generated/Products Developed

- Quantitative proteomic analysis of Glioma Cancer Stem Cells (GSC) and Differentiated Glioma Cells (DGC) secretome and proteome
- All three proteins - AGT (Angiotensinogen), TF (Transferrin; Siderophilin) and FMOD (Fibromodulin)-showed significant differentially abundance in the secretome of GSCs vs DGCs as per mass-spec data. While FMOD and AGT showed high abundance in DGC secretome, TF showed high abundance in GSC secretome. The TF protein also showed high abundance in the GSC intracellular proteome as well.
- FMOD is essential for glioma tumor formation
- Secreted FMOD induced glioma angiogenesis
- RPPA analysis of recombinant human FMOD treated endothelial cells identified showed increase in HS1 and phosphoFAK
- FMOD induced angiogenesis by activation Notch signaling
- FMOD activated integrin signaling which was found to be important for Notch signaling activation and induction of angiogenesis
- A model was proposed integrating activation of integrin signaling and Notch signaling in the process of FMOD induced angiogenesis
- FMOD is not needed for GSC and DGC growth as well as DGC reprogramming 3
- A model was proposed which reiterates the importance of differentiation during tumor formation even though tumor initiating capacity lies with GSCs only



Pure & Applied Physics

MODELING SOFT GLASSY FLOW FROM MICRO TO MACRO SCALE

Project No. 5604-1 **Dec. 2016 to May 2019**

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

Knowledge Generated/Products Developed

The main achievements obtained in the first half of the project duration can be summarised as follows:

- Setting up a numerical scheme to study the shear-response of a unbounded amorphous material to applied stress, using microscopic simulation, allowing to explore finite size effects in creep response under thermal conditions. Same scheme is now being used to study athermal systems, for which the mesoscopic model has been developed and studied
- Study of the residual stress in athermal amorphous solids, and confirming the validity of scaling relation between stress of flowing body and the eventual residual stress, when the shear is switched-off, exploring a wide range of shear-rates, strain, and preparation history. Currently, the microscopic signatures of residual stress are being investigated. Concurrently, the corresponding mesoscale investigations are ongoing
- Using microscopic and mesoscopic simulations for the superposition of shear with vibrations in amorphous materials to semi-quantitatively reproduce the fluidisation induced by external vibrations. This is interesting in the context of spontaneous formation of shear bands that can be prevented through these external perturbations

Principal Collaborators

Pinaki Chaudhuri
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Chennai

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Laboratoire Interdisciplinaire
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Grenoble

Publications

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

Mobility Support

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

Pure & Applied Physics

EXTREME EVENTS AND LARGE DEVIATIONS IN STRONGLY CORRELATED MANY BODY SYSTEMS

Project No. 5604-2 | **Nov. 2016 to Oct. 2019**

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

Knowledge Generated/Products Developed

- Exact results for the extreme statistics in the 1d Coulomb gas
- Exact computation of first-passage properties for the one-dimensional run-and-thumble model
- Study of large deviations and first passage properties for two dimensional active particles in a harmonic trap
- Analytical results for the time gaps between avalanches in the one dimensional random field Ising model
- Study of the out-of-time ordered correlator in classical spin chain and connection with growth models

Principal Collaborators

Abhishek Dhar
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Gregory Schehr
LPTMS, Université Paris-Sud Orsay

Publications

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

Mobility Support

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

Pure & Applied Physics

INTERPLAY BETWEEN MgO OXYGEN VACANCIES AND TUNNELLING SPIN TRANSFER TORQUE

Project No. 5604-3 | **Oct. 2016 to Jan. 2019**

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 would 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

Knowledge Generated/Products Developed

- Devices with different barrier quality were analyzed
- Fabricated MgO based MTJs
- bias dependence of spin transfer torque in the MgO-based magnetic tunnel junction
- Improvement to the picture of localized states due to oxygen vacancies in MgO: experiment+ DFT calculations revealed that hole tunnelling is taking place -> expected impact on STT picture
- Maturing the nanobead process: on-going results

Principal Collaborators

Pranaba Kishor Muduli
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New Delhi

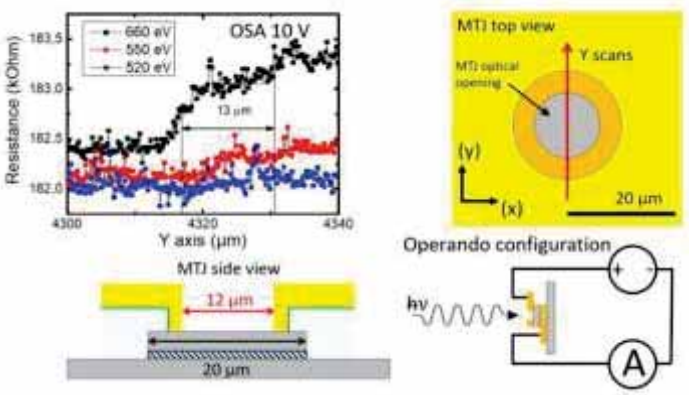
Martin Oliver Bowen
Institut of Physics and Chemistry of Strasbourg
Strasbourg

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



Line scan in Operando conditions of a MTJ optical opening. The MTJ resistance is determined using ±10mv of biases in order to suppress any offset effects. The measurements set-up is in floating mode (*i.e.* not grounded.)

Pure & Applied Physics

NUCLEAR STRUCTURE AT THE EXTREME OF ISOSPIN AND SPIN

Project No. 5604-4 | **May 2017 to Apr. 2020**

Background

The project addresses an open question,viz., how do the internal properties of the complex many-body quantum system, the nucleus, evolve when there is animbalance of neutron to protons (compared stable nuclei) AND simultaneously undergoing fast rotation. Studies have shown the presence of new phenomena like new shapes, change of shell structure etc. occur in exotic short lived nuclei. The present project will explore the presence of new phenomena as a function of isospin (neutron-proton asymmetry, N/Z) AND spin in particular around doubly magic 13282Sn126. A part of the work will use the VAMOS++ magnetic spectrometer and the Advance Gamma Tracking Array (AGATA) to study the prompt gamma rays emitted from the isotopically identified fission fragments produced in inverse kinematic reactions at energies around the Coulomb barrier (in France)increasing the selectivity and sensitivity by at least an order of magnitude over other methods.

Objectives

- The evolution of nuclear structure will be characterized in the most neutron rich nuclei produced in fission for various elements ranging from Sr to Pm. In particular, the position of i13/2 single particle state and the octupole vibrations in 133Sn will be identified. The signature for chiral structures and evolution of triaxiality in Rh isotopes will be investigated
- The interplay of single particle and collective excitations will be investigated in nuclei with a few particles and holes in doubly magic Z=50 and N=82 shell closure by the spectroscopy of neutron rich Te and Xe isotopes

Knowledge Generated/Products Developed

- Identification of isotopes (A,Z) has been done from data of experiment with VAMOS++ coupled to AGATA at GANIL
- Analysis on spectroscopy of Sb and In isotopes from AGATA data has been completed. Manuscript is under preparation
- Analysis of Pm isotopes from VAMOS++ coupled to EXOGAM
- One experiment at VECC has been performed to study the single particle and collective structures of 131Xe, using Indian National Gamma Array (INGA) setup and alpha beam from K-130 cyclotron at VECC, Kolkata

Principal Collaborators

Sarmishtha Bhattacharyya
Variable Energy Cyclotron Center, Kolkata

Navin Alahari
Grand Accelerateur National d'Ions Lourds(GANIL), Caen

Publications

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

Mobility Support

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

Picture of the K-130 cyclotron and the associated beam lines at VECC. The beam line at 36_ was used in the present experiment.

Pure & Applied Chemistry

METAL CHELATORS DERIVED FROM IMIDAZOLE THIONES AND SELONES FOR DETOXIFICATION

Project No. 5605-1 | **Jan. 2017 to Dec. 2019**

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

Knowledge Generated/Products Developed

- Synthesized many imidazole-based thiones and selones in last 15 months
- Synthesized many benzimidazole-based thiones and selones (mentioned Section II, Work Report). This part we had done additionally to understand the nature of imidazole and benzimidazole-based thiones and selones
- In the process of synthesizing many tripodal ligands in a multi-step synthetic procedure. Already synthesized two N,N'-disubstituted imidazole-based tripodal ligands (7b and 7c) and in the final step of synthesizing one N-substituted imidazole-based tripodal ligand 15b (mentioned Section II, Work Report)
- Found that N-substituted imidazole or benzimidazole-based thiones bind strongly with Cu(I) in comparison to the N,N'-disubstituted imidazole or benzimidazole-based thiones

Principal Collaborators

Gouriprasanna Roy
Shiv Nadar University,
Uttar Pradesh

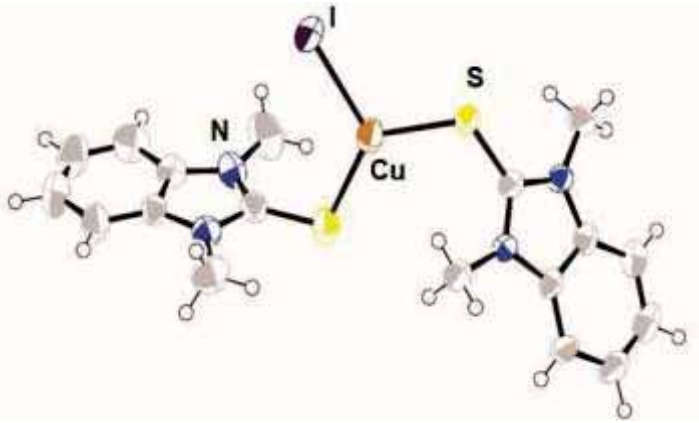
Pascale Delangle
CEA Centre de Grenobles
Grenoble

Publications

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

Mobility Support

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



Crystal structure of compound

Earth and Planetary Sciences

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

Project No. 5607-1 | **Nov. 2016 to Oct. 2019**

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.

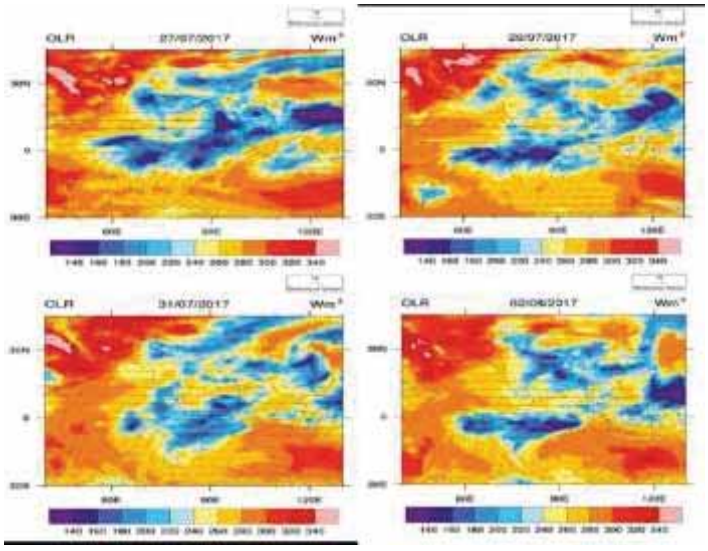
The project will use Lagrangian modelling to explore the paths of air within the TTL, with an emphasis on the role of small-scale dynamics and a meso-scale model with chemistry to map the intensity of the sources and the generation of ice clouds and aerosols. The satellite observations will be used to characterize the distribution and the physical properties of the cirrus and will be linked to the sources by Lagrangian transport.

Objectives

- To study the process governing the composition of TTL and the path of air parcel going through it
- Characterisation of high clouds from recent and historical satellite datasets

Knowledge Generated/Products Developed

- The historical satellite (ISCCP-B1) dataset since 1980 has been archived and processed..The climatology of high cloud fraction from satellite brightness temperature was derived over the Asian summer monsoon region
- The data from INSAT-3D satellite was analysed to identify the deep convective areas over the Asian summer monsoon region during Strato-clim flight campaign period
- Trajectory calculations have been performed using most advanced reanalysis dataset for summer 2017. Campaign data are used to test and improve the methods and validate large-scale study over the whole Asian monsoon region
- Satellite data from passive geostationary instruments and active instruments (radar + lidar), compared with model data, have been used to investigate the distribution of very high clouds over the Asian monsoon region



Satellite data analysis

Principal Collaborators

Kesavapillai Mohanakumar
Cochin University of Science & Technology
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Bernard Legras
École Normale Supérieure
Paris

Publications

- No. of publications in SCI journals: 2
- No. of papers presented in conferences: 8

Mobility Support

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

Materials Science

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

Project No. 5608-1 | **Nov. 2016 to Aug. 2019**

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

Knowledge Generated/Products Developed

- Collagen extracted and purified were used for the fabrication of native fibrillar collagen based scaffolds
- Development of dual anticancer drug loaded polycaprolactone (PCL) electrospun fibers
- Fabrication of Porosity engineered 3-D printed scaffolds:
  - Sacrificial mold assisted tunable porous gelatin scaffolds
  - Antibacterial PCL scaffolds comprising *in-situ* synthesized silver nanoparticles
  - Silver doped biphasic calcium phosphate (synthetic bone mineral) incorporated antibacterial PCL scaffolds

Principal Collaborators

Narayana S Kalkura
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Mikhael Bechelany
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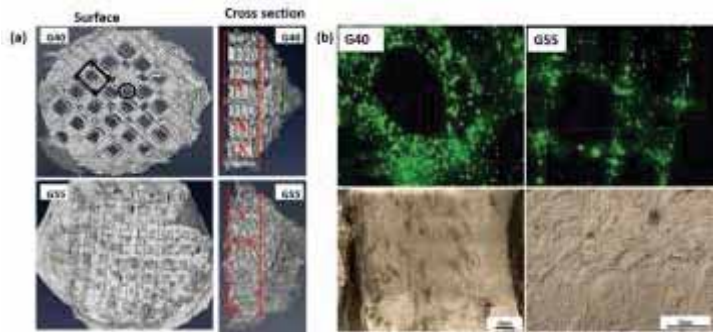
Montpellier

Publications

- No. of publications in SCI journals: 3
- No. of papers presented in conferences: 11

Mobility Support

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



Tomography of gelatin scaffolds and (b) Fluorescent and SEM images of the cells attached on the gelatin scaffolds

Materials Science

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

Project No 5608-2 | **Jan. 2017 to Mar. 2020**

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 pohoto 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

Knowledge Generated/Products Developed

- Heavy metal based chalcogenide TI compounds are thoroughly studied
- Through a clear literature reports, we have selected few interesting TI compounds for synthesis and probing surface conducting states
- $TlBiS_2$, Cu_2Te&Ag_2Te, Bi_2S_3, Sb_2Te_2Se, Bi_2Te_2Se, Bi_2Te_2S TI's were prepared using direct heating method
- Basic structural and transport studies using XRD and ARS closed-cycle refrigerator has been performed

Principal Collaborators

Sebastian Chirambatte Peter
Jawaharlal Nehru Centre
For Advanced Scientific Research
Bangalore

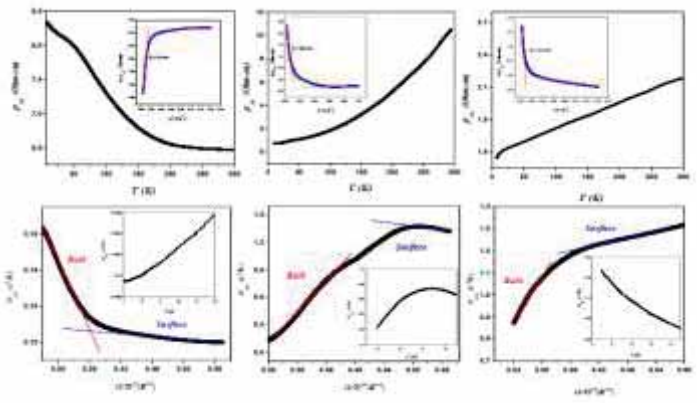
Marie-Aude Measson
NEEL Institute
Grenoble

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



Temperature dependent DC resistance as function of temperature for Sb_2Te_2Se, Bi_2Te_2Se and Bi_2Te_2S with 3D VRH model fitting to understand the metal and insulator region

Computational Science

THE ECONOMICS OF NETWORKS AND QUEUES

Project No. 5702-1 | **May 2017 to Oct. 2020**

Background

The project aims to study various issues in the telecommunication networks that have been recently considered by the telecom authorities in several countries for regulation. Specifically, it will be focussed on the differential pricing in the Internet and the Spectrum sharing between the telecom operators, and study the impact of the current rulings on the interests of the various players. Several of current rulings are based on public consultations and are subjected to revision in the near future. The goal is to systematically validate the claims of the various stakeholders and develop policy guidelines that lead to efficient utilization of network resources, and can be adapted as amendments to the current rulings. In this project, scheduling schemes that improve quality of service for all types of packets when the traffic consists of multiple class of packets will be studied. In the process, it is aimed to develop techniques that the regulators can use to identify type of scheduling schemes employed by the service providers.

Objectives

- Differential Pricing in the Internet Ecosystem: To understand the impact of such schemes on society, new models will be developed and studied effect of zero-rating schemes; Analyse the effect of new schemes on the pricing strategies of the content providers and quality of service experienced by the end users in the zero-rated platforms
- Neutrality of Scheduling Schemes: This work will a) evaluate the performance of new type of schedulers that are non-dominant service disciplines. b) develop methods to determine automatically, only by observing partial information about the queue like the arrival rate and departure rate of packets, which type of scheduler or service discipline is currently used in the queue. Then, a non-neutral behavior from the queuing manager could be identified and denounced

Knowledge Generated/Products Developed

- All objectives met on topic 'Economics of Internet Ecosystem'. A conference paper is presented on this and journal version is under review
- Significant progress made on topic 'Spectrum Sharing'. A technical report has been prepared
- Two PhD students- one in France and one in India, are hired under the project
- Several visits are undertaken and collaborators from both countries visited each other
- 5 conference papers authored jointly by Indian and French collaborators are presented in various international conferences and several others are under preparation

Principal Collaborators

Manjesh Kumar Hanawal
Indian Institute of Technology, Bombay, Mumbai

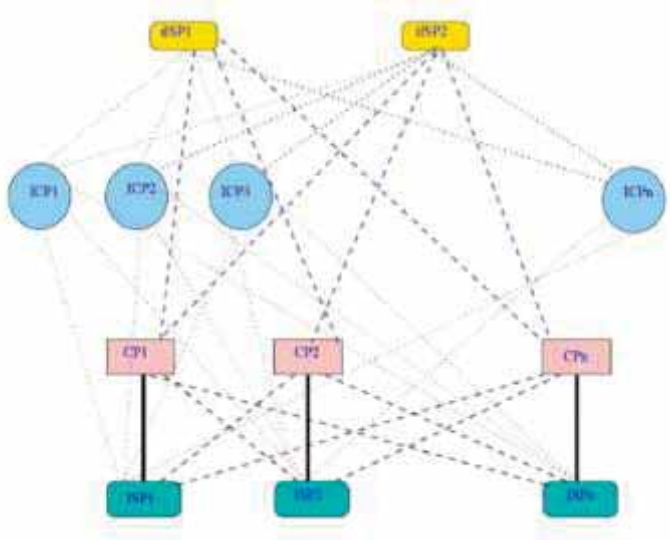
Yezekael Hayel
Université d'Avignon, Avignon

Publications

- No. of publications in SCI journals: 4
- No. of papers presented in conferences: 5

Mobility Support

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



Life and Health Sciences

CONTROL OF MICROTUBULE DYNAMIC INSTABILITY BY THE TUBULIN CODE

Project No. 5703-1 | **May 2017 to Apr. 2020**

Background

Microtubules (MTs) are key elements of the cytoskeleton, and as such involved in virtually every function of the cell. MTs are assembled from highly conserved alpha/beta-tubulin heterodimer, which are expressed from multiple tubulin genes across metazoans. While the core structural elements of tubulin, which are directly involved in the MT assembly, are highly conserved across eukaryotes, the unstructured carboxy-terminal tails (CTTs) are divergent between different tubulin gene products. Additionally, the CTTs are also hotspot for unique posttranslational modifications (PTMs) such as detyrosination, polyglutamylation and polyglycylation. The high degree of variablity in the CTTs led to the project of a tubulin code that modulates interactions between MTs and their multiple associated proteins, thus controlling key cellular functions. This is strongly supported by recent studies showing that kinesin and dynein motors show motility preferences towards particular tubulin code elements, in particular to PTMs. However it is still not clear whether the tubulin variations control MT dynamic instability, a key MT property. In this project this question is addressed by engineering tubulin isotypes and PTMs into fission yeast, and characterizing MT dynamics *in vivo*.

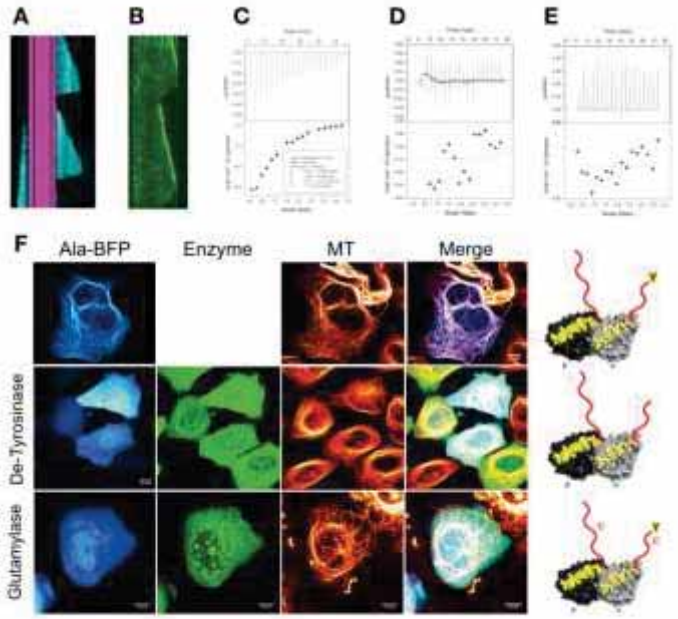
Objectives

To understand the contribution of tubulin diversity in microtubule growth and dynamics, the objectives are as follows:

- Comparative analysis of tubulin variations in microtubule growth and dynamics
- Engineering fission yeast to measure the impact of the tubulin code on microtubule dynamics *in vivo*

Knowledge Generated/Products Developed

- Cloning and expression of tubulin genes using insect cells
- Establishing the in vitro microtubule polymerization assay
- Screening binders and identifying the sequence of binder proteins
- Determining biochemicalproperties of binders against tubulin PTMs
- Validating the binders as live cell sensors of tubulin PTMs



A; Kymograph of typical microtubule dynamic assay of labelled tubulin growing (cyan) from a stable GMPPCP microtubule seed (magenta). Average growth rate: 13nm/sec ± 2.6, n=52

Principal Collaborators

Minhaj Sirajuddin
Institute for Stem Cell Biology and Regenerative Medicine
Bangalore

Carsten Janke
Institut Curie
Orsay

Publications

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

Mobility Support

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

Life and Health Sciences

A GENOME-WIDE STUDY TO IDENTIFY NOVEL REGULATORS OF CHROMOSOME STABILITY USING A HUMAN PATHOGENIC YEAST CANDIDA ALBICANS AS THE MODEL SYSTEM

Project No. 5703-2 | **May 2017 to Apr. 2021**

Background

In this project, it is proposed to identify novel regulators and their role in maintaining genome integrity in C. *albicans*. To this aim, first a collection of C. *albicans* over-expression strains will be generated by transforming an existing collection of over-expression plasmids for ~5000 C. albicans genes into a C. albicans reporter strain that allows monitoring loss-of-heterozygosity (LOH) events at the single cell level thanks to three fluorescent markers (BFP, GFP, mCherry) whose genes have been conveniently positioned on the two arms of the two homologues of C. *albicans* chromosome 4. In a second step, the ~5000 over-expression strains will be individually monitored for the effect of over-expression on gross ploidy change, or whole chromosome loss (WCL). Ploidy changes will be determined by propidium iodide staining and subsequent analysis by flow cytometry. WCL events will be identified by analysing loss of both BFP and mCherry signals (that are genetically unlinked) but maintenance of the GFP signal using high-throughput confocal microscopy.

Principal Collaborators

Kaustuv Sanyal
Jawaharlal Nehru Centre for Advanced Scientific Research
Bangalore

Christophe d'Enfert
Institut Pasteur
Paris

Publications

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

Mobility Support

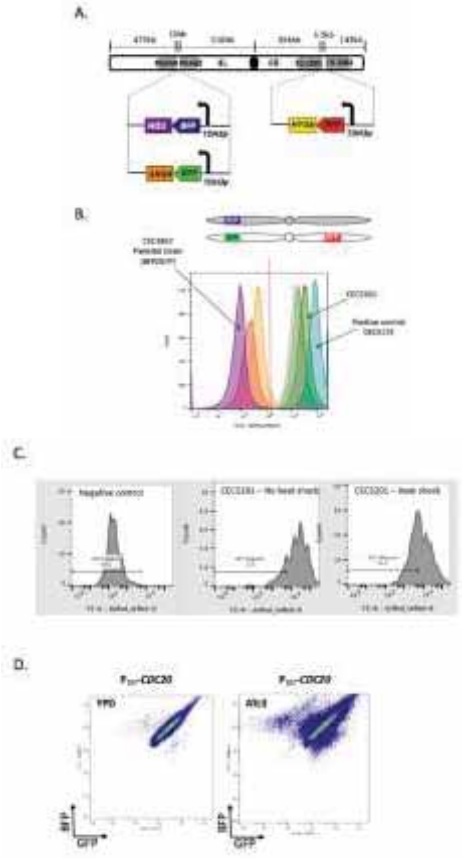
- India to France: 1
- France to India: 1

Objectives

- Construction of a strain collection for the identification of genes whose over-expression alters chromosome stability and ploidy
- Identification of C. *albicans* genes whose over-expression triggers gross ploidy changes or chromosome loss: the impact of a gene's over-expression on ploidy variation will be determined after staining the transformants obtained in objective 1 with propidium iodide followed by flow cytometry
- Functional characterization of C. *albicans* genes whose over-expression affects chromosome stability and ploidy
- Molecular and biochemical characterization of selected genes

Knowledge Generated/Products Developed

- The reporter strain for screening the genes of genome stability in *C. albicans* has been constructed and validated using several assays that promote chromosome loss
- DNA preparation for ~2,522 overexpressing plasmids has been carried out by the Indian and French partners in a 96 well plate format (in the French lab). These plasmids are currently being transformed in the abovementioned reporter strain
- The reporter strain for functional characterization of the identified genes has been constructed and validated by microscopy. This strain will be used for the secondary screen



Construction of a reporter strain for monitoring whole chromosome loss

Pure & Applied Physics

YIELDING IN GLASSES AND COLLOIDAL SYSTEMS UNDER CYCLIC DEFORMATION

Project No. 5704-1 | **Jun. 2017 to May 2020**

Background

The study of the non-linear response of glassy systems to periodic perturbations is proposed in the project. Disordered and glassy systems under the effect of an external constant driving often present a discontinuous response that goes, according to the context, under the names of crackling noise, stick-slip motion, earthquakes or avalanches and is characterized by power-law scaling and critical behavior. A lot of these systems show a yielding behavior; since they start to present plastic rearrangements that will ultimately make them flow.

In recent times, a new phenomenon has been uncovered for glassy systems undergoing cyclic deformations, namely a transition from a localized phase where particles go back to their positions after a cycle to a diffusive one as a function of the amplitude of the deformation. The nature of plastic rearrangements in the localized phase, and the manner in which they change as the amplitude of strain increases hold a key to understanding the nature of the yielding behaviour of amorphous solids.

In this project, it is planned to perform extensive computer simulations to explore the role of cyclic deformation on glasses.

Objectives

- To understand the physical mechanisms that underlaying plastic rearrangements during cyclic deformation on amorphous materials and to link them to the nature of yielding behaviour
- To investigate the mechanical response and the memory effects in colloidal glasses under cyclic mechanical deformations

Knowledge Generated/Products Developed

- Investigation of the existence hyperuniform states in cyclically deformed glass former
- Observation of loss of hyperuniformity upon yielding
- Investigation of the yielding transition in amorphous silica, a network forming glass
- Characterisation of plastic deformation events using a new method
- Plasticity and yielding of 2D systems under cyclical deformation

Principal Collaborators

Srikanth Sastry
Jawaharlal Nehru Centre for Advanced Scientific Research Bangalore

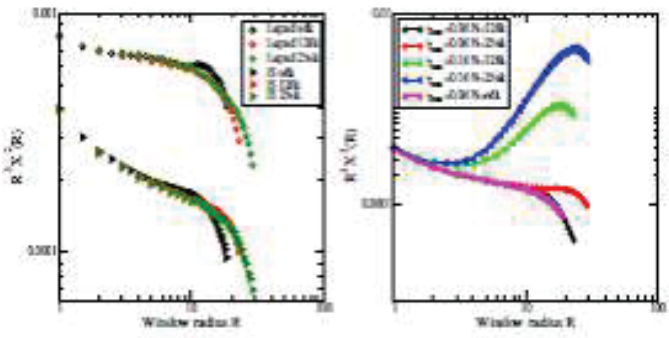
Giuseppe Foffi
Université Paris sud - Paris XI Orsay

Publications

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

Mobility Support

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



The weighted volume fraction variance X (R) times R^3 is plotted for different system size.

Pure & Applied Chemistry

BIFUNCTIONAL CATALYSTS FOR COOPERATIVE C-H BOND CLEAVAGE VIA INTRAMOLECULAR DEPROTONATION TOWARD DIRECT FUNCTIONALIZATIONS OF ALKANESS

Project No. 5705-1 | **May 2017 to Apr. 2020**

Background

This project seeks to examine inner sphere C-H activation by Brønsted base covalently attached to ligand framework. Milsteins bifunctional Ir-PNP system exploits aromatization/dearomatization motif to activate C-H bond of benzene. The C-H bond activation mechanism in this project is based on deprotonation/protonation principle. At the beginning, ligand scaffolds (bipyridine, NHC, phosphine) with pendent Brønsted bases, e.g., -OH, $-CO_2$-, -NTf, -NTs, $-SO_3$-, $-PO_3$-; etc, will be synthesized in Kanpur. The catalytic utility for metal-complexes bearing these ligands for direct arylation of (hetero)arenes will be evaluated in Rennes. The design scheme allows easy variations in the ligand system, 1. pKa of the base unit, 2. length and identity of the linker group, 3. the metal ion, 4. the ligand scaffold, that would permit the screening a wide range of catalyst systems. Applications of these catalysts for direct functionalization of inert and non-acidic $C(sp^3)$-H bond (alkanes) will constitute a major part of this work. Substrates without directing group will be employed. Kinetic experiments, isolation and characterization of intermediates, deuterated studies and DFT calculations will be undertaken to gain insight on the mechanism.

Objectives

The central aim of this project is to examine Intramolecular Pendent-Base Assisted Concerted Metalation Deprotonation (IPB-CMD) protocol for direct C-H functionalization. Towards this goal, the present project will seek to achieve the following objectives:

- Design and synthesis of ligand (scaffold = bipyridine, phosphine and NHC) with pendent Brønsted bases, e.g., -OH, $-CO_2$-, -NTf, -NTs, $-SO_3$-, $-PO_3$-; etc.
- Catalytic evaluation of newly synthesized metal-complexes bearing these ligands for direct arylation and alkylation of (hetero)arenes
- Application and screening of a wide range of catalysts with different ligand systems- obtained by varying pKa of the base unit, length and identity of the linker group, the metal ion and the ancillary ligands around the metal

Knowledge Generated/Products Developed

- Synthesis of ligand and Pd and Ni complexes with pendent Brønsted bases
- Discovery of chemoselective $C(sp^2)$–H bond sulfonylation

Principal Collaborators

Jitendra Kumar Bera
Department of Chemistry, IIT Kanpur, Kanpur

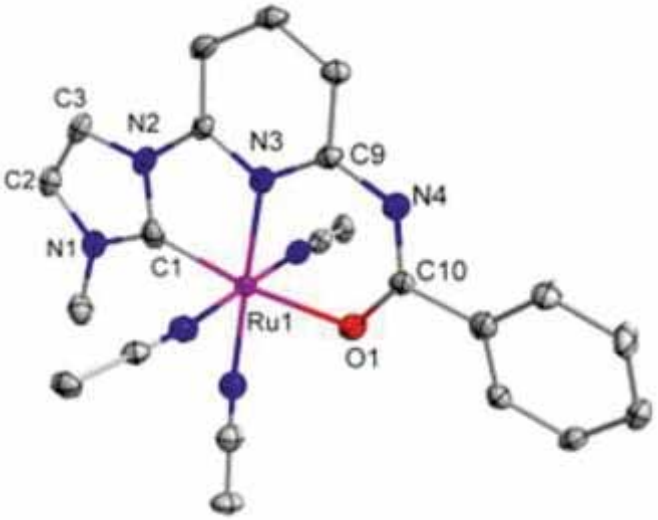
Henri Doucet
Université de rennes 1 Rennes

Publications

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

Mobility Support

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



X-ray structure of 2 with selective atmos labelled. Dispiacement ellipsoids are set at 30% probability and hydrogen atoms omitted for clarity. selected nond distances (A) and angles (°): Ru1-C1 1.973(3), Ru1-N3 2.029(3), Ru1-O1 2.092(2), C1-Ru1-N3 79.82(11), N3-Ir1-CI1 93.64(8), C5-N3-C9 118.8(3)

Materials Science

DURABLE FUEL CELLS BASED ON POLYMER COATED NANOCARBON COMPOSITES (DUPONT)

Project No. 5708-1 | **May 2017 to May 2020**

Background

The aim of the project is to reduce the use of Pt and at the same time improving the activity and durability of the catalyst in hydrogen fuel cells. Reducing the cost of hydrogen fuel cell electrodes and increasing the life cycle are two main challenges of fuel cell technology to be competitive with conventional technologies. It is proposed to disperse Pt alloy nanoparticles (NPs) on highly active and stable heteroatoms incorporated ionomer coated polymer wrapped CNT/graphene based catalyst support. This will improve the substrate-catalyst interaction, lead to a higher electrochemical surface area of the catalyst and enhance the ionic conductivity. The mechanism of degradation such as degradation due to detachment of Pt alloy NPs from the support material at different temperatures and the change in the morphology of the Pt alloy NPs during cycling will be studied using state of the art characterization techniques including HRTEM (with hot stage), EELS, WAXS and RAMAN (temperature controlled) mapping. The experimental investigation will be supported by modelling studies. Based on the results a road map will be established for low cost high durability fuel cells taking into consideration, process up scaling, cost estimation and life cycle analysis.

Objectives

The objective of the project addresses two key challenges by reducing the use of Pt and at the same time improving the activity and durability of the catalyst

- To disperse Pt alloy nanoparticles (NPs) on highly active and stable heteroatoms incorporated ionomer coated polymer wrapped CNT/graphene based catalyst support
- To study the durability of our catalyst by an in-depth study of the mechanism of degradation of the electro-catalyst using a combination of state of the art characterization techniques including HRTEM (with hot stage), EELS, WAXS and RAMAN (temperature controlled) mapping

Knowledge Generated/Products Developed

- In depth study of structural properties of doped and surface modified carbon nanotubes and reduced oxide graphene (Raman, TEM, EDX, XPS)
- Promising uniform distribution of dopants and metal nanoparticles on nanotube surface
- Poster presentation of result at international carbon conference (Madrid, 2018)
- Preparation of first manuscript for scientific publication
- First round of visits in India and France

Principal Collaborators

Sundara Ramaprabhu
Indian Institute of Technology Madras, Chennai

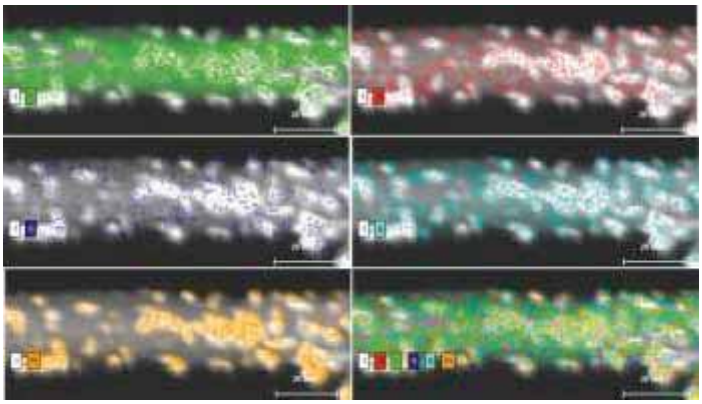
Wolfgang S Bacsa
Centre d'élaboration de matériaux et d'études structurales (CEMES) UPR8011, Toulouse

Publications

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

Mobility Support

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



Elemental mapping of Pt/NS-PECNT depicts the carbon, oxygen, nitrogen, sulphur and platinum distribution over partially exfoliated MWCNT

Pure & Applied Mathematics

INTERACTIONS BETWEEN DYNAMICAL SYSTEMS, GEOMETRY AND NUMBER THEORY

Project No. 5801-1 | **Jan 2018 to Jan 2021**

Background

The project will study central problems in the ergodic theory and geometry of group actions and related number theory. Recent years have seen dramatic advances in the ergodic theory of group actions and Diophantine analysis. The focus of the team will be the study of group actions on homogeneous spaces and applications, using a variety of tools from ergodic theory and geometry. Let G be a Lie group and Gamma a discrete subgroup of G. On the geometric side, we are interested in the dynamics of discrete group actions on homogeneous varieties of G, and dually, the action of subgroups H of G on G/Gamma. In the case that Gamma is a lattice subgroup, namely when G/Gamma carries a finite G-invariant measure, this is a well studied topic and includes the famous theorems of M. Ratner. However, the case when Gamma is not a lattice but a 'thin' group is a rapidly emerging subject which is witnessing intense development right now. This work is likely to have many applications in number theory and geometry.

Objectives

- The objective of the project is to investigate interactions between dynamical systems on homogeneous spaces, the geometry of discrete groups and number theory, especially Diophantine analysis and to develop new techniques to address outstanding problems in these subjectsand g-position of carbonyl compounds

Knowledge Generated/Products Developed

- Progress was made on the main objectives. On the ergodic front, several results were obtained by Nogueira, Laurent, Maucourant and Ghosh
- On the number theoretic front, by Nogueira, Bugeaud and Ghosh; and on the geometric front, by Mj, Dahmani and Maucourant
- Several papers have been written by the PI's and co-PI's and submitted to top journals and made available on the arxiv
- Talks have been given in national and international conferences on the advances made
- A postdoctoral scholar has been appointed on the Indian side and is making good progress

Principal Collaborators

Anish Ghosh
Tata Institute of Fundamental Research
Mumbai

Arnaldo Nogueira
Aix Marseille University
Marseille

Publications

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

Mobility Support

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

Life & Health Sciences

MECHANISM OF POLARITY REVERSALS IN MYXOCOCCUS XANTHUS

Project No. 5803-1 | **Jan 2018 to Jan 2021**

Background

Frequent reversals of cell polarity facilitate motility and organization into fruiting bodies in the soil bacterium *Myxococcus xanthus*. Studying the molecular basis of polarity reversals in *M. xanthus* contributes towards understanding fundamental principles in cell motility, polarity determination and spatial localization in biology. Roles of a small Ras-like GTPase MglA and regulatory proteins that act as switch, the bacterial cytoskeleton MreB that forms part of the motility complex, and a novel signal sensing mechanism, involving FrzCD as receptor, that drives oscillations in response to external stimuli, are some of the features that make the spatial oscillatory mechanism in *M. xanthus* very interesting.

The study has implications in understanding spatial positioning in bacteria, regulation of bacterial motility, novel roles of bacterial cytoskeleton, and characterization of a cytoplasmic chemosensory signal sensing mechanism. Detailed characterization of the mechanism will help identifying analogous systems in pathogenic bacteria and eukaryotes by bringing out the conserved features.

Principal Collaborators

Gayathri Pananghat
Indian Institute Science Education and Research
Pune

Tam Mignot
Laboratoire de chimie bactérienne
CNRS
Marseille

Publications

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

Mobility Support

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

Objectives

To understand the mechanism of polarity reversals in *Myxococcus xanthus* by studying:

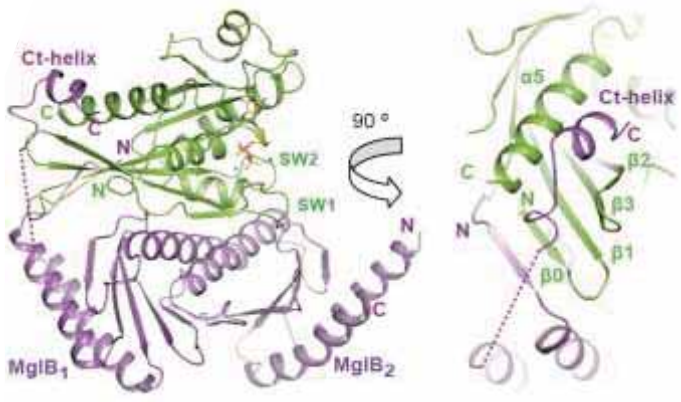
- the role of the GTPase MglA and MglB in driving the oscillations
- the role of the bacterial cytoskeleton MreB in positioning the motility complexes
- how FrzCD senses the signal that modulates the frequency of oscillation

Revised objectives, if any

- Interaction studies of MglA and MglB with RomR and FrzX have been initiated since this was found to be important based on our results from objective 1.

Knowledge Generated/Products Developed

- Structure determination of the different nucleotide-bound states of MglA in complex with MglB, Biochemical studies of MglA and MglB and their mutants, and corroborative in vivo experiments, genetic construction of mutants and cell biology measurements have been carried out. Manuscript related to this work is under communication to *PloS Biology*
- Overexpression of *Myxococcus xanthus* MreB in E. coli and large scale purification of homogenous protein sample suitable for electron microscopy studies was achieved. Stability assays for purified MreB are in progress. Efforts to improve stability are ongoing
- Overexpression of *Myxococcus xanthus* FrzCD and domain-wise constructs in *E. coli* and large scale purification of homogenous protein sample suitable for structural studies have been achieved. Oligomeric studies are ongoing. Construction of domain deletion mutants for corroborative analysis is ongoing. Super-resolution analyses of DNAreceptor-bound complexes has been achieved
- Analysis of MglA and B oscillations in multicellular contexts and their role in 2 the formation of multicellular patterns is ongoing



Crystal structure of MglAB complex highlighting the Cterminal helix of MglB bound to MglA

Life & Health Sciences

DIRECTING THE BALLET OF MEIOTIC CHROMOSOMES: REGULATION OF SEPARASE AND CONTROL OF MONOPOLAR KINETOCHORE ORIENTATION

Project No. 5803-2 | **Jan. 2018 to Dec. 2020**

Background

Proper distribution of chromosome at mitosis and meiosis is crucial to preserve genome integrity, prevent aneuploidy and carcinogenesis. Control of chromosome segregation during cell division requires precise temporal control of the activity of Separase the protein that cleaves Cohesin, the protein complex that holds sister chromatids together at metaphase. In fungi and animals, Separase activity is controlled by Securin, a direct inhibitor that binds Separase. However, in plants Securin has not been yet identified, leaving regulation of separase elusive in this clade of eukaryotes.

Objectives

- Identify and characterize factors that regulate separase activity at meiosis and mitosis in Arabidopsis
- Identify and characterize factors that ensure monpolar orientation of kinetochores at meiosis I

Knowledge Generated/Products Developed

Screens for the separase interactant achieved

- Identification of the Securin
- Genetic screen for monopolar orientation completed
- Identification of a series of mutants and corresponding genes for monopolar orientation

Principal Collaborators

Imran Siddiqi
CSIR - Centre For Cellular & Molecular Biology Hyderabad

Raphael Mercier
INRA, Plant Biology and Breeding Versailles

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

Pure & Applied Physics

THE ASSEMBLY HISTORY OF DISK GALAXIES OVER THE LAST 8 BILLION YEARS

Project No. 5804-1 **Jan. 2018 to Dec. 2020**

Background

This project aims to uncover the history of disk galaxy assembly over the last 8 billion years (which is more than half the age of the universe) using state-of-the-art observing facilities and numerical simulations. More specifically, the collaborators would like to decode how and when different structural components of a disk galaxy, e.g., bulge, disk, non-axisymmetric structures such as bars, spirals that are abundant in present-day disk galaxies, have assembled as it evolved over time. Both star formation and a number of physical processes such as minor mergers, accretion of cold gas, secular evolution identified as potentially important; contribute to the assembly of disk galaxies. In order to have a better planning, the project is divided into two broad sections - observations, data analysis and numerical simulations.

Principal Collaborators

Kanak Saha
Inter University Center for Astronomy & Astrophysics (IUCAA)
Pune

Francoise Combes
Observatories de Paris
Paris

Publications

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

Mobility Support

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

Objectives

- To derive star-formation rate, stellar mass using multi-wavelength Spectral Energy Distribution constructed from UVIT/ASTROSAT (FUV, NUV), HST (Optical, IR), and IRAM NOEMA interferometry (Millimetre) for a sample of disk galaxies in the GOODS-South/North field as a function of redshift z, starting from z~1 to z~0
- Get different structural components using multi-component decomposition techniques and quantify (by analysing imaging data from HST) the strength of non-axisymmetric features in the disk galaxies. Carry out this analysis at the same redshift bins from z~1 to z~0
- Run and analyse zoom-in cosmological simulations of disk galaxies with minor mergers and cold gas accretion. Estimate time scales for the formation and assembly of different structural components

Knowledge Generated/Products Developed

- Ultra-Violet (UV) imaging observation of the GOODS-North field has been completed by the Ultra-Violet Imaging Telescope on-board AstroSat
- A preliminary reduction of the Level1 data has been carried out and astrometric corrections are completed now. Then we have created a catalog of galaxies in far and near-ultra-violet band. Currently, we are in the process of preparing multiwavelength SEDs using archival data from HST and Spitzer space telescope. We have identified a set of galaxies with CO observation from IRAM NOEMA interferometry to investigate recent starformation activity as planned
- A set of cosmological zoom-in simulations are being carried out by the French side. We are analyzing some of these simulations to understand growth of bulges and change in the peripheral size of disks
- A set of isolated galaxy simulations with off-centered dark halo has been performed to study the formation of Lensed S0 galaxies in the local universe. Two papers are ready to be submitted
- An initiative to utilize GALMER simulation database to understand the effect of minor mergers on S0 galaxies

Pure & Applied Physics

MICRO-SQUID MAGNETOMETRY OF NANO-SCALE MAGNETIC STRUCTURES

Project No. 5804-2 **Jan. 2018 to Dec. 2020**

Background

The collaborators propose a μ -SQUID magnetometry setup using non-hysteretic μ-SQUIDs, to investigate the magnetism in nanoparticles. The set up with 1.3K base temperature will be developed in IIT Kanpur and it will use the non-hysteretic μ -SQUIDs fabricated in Institut Néel in Grenoble. The previous results of our collaboration in getting hysteresis-free - μ-SQUIDs will be essential here.

After testing the setup using sub μ-m size permalloy thin film structures, the PIs purposed to measure the switching field distribution and magnetization relaxation times in single domain ferromagnetic and hybrid nano-particlesIt is proposed to investigate the coupled dynamics of nano-particle magnetization and the SQUID's phase to observe the predicted Shapiro steps and magnetization reversal. This could also provide further insights into the magnetization dynamics. After achieving spin sensitivity below 100μB/√Hz in our setup with further optimization of electronics and SQUID design. Investigate the antiferromagnetic and spin-frustrated nanoparticles. To understand the physics of different magnetic phases and associated dynamics in different magnetic nanoparticles.

Principal Collaborators

Anjan Kumar Gupta
Indian Institute Of Technology Kanpur

Hervé Courtois
CNRS et Université Grenoble Alpes Grenoble

Publications

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

Mobility Support

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

Objectives

- Development of a micro-SQUID magnetometry setup with temperatures down to 1.3 K and vector magnetic fields up to 1 T using non-hysteretic micro-SQUIDs
- Investigating the switching fields and magnetization dynamics in individual magnetic nano-structures, for instance some of the correlated oxide nano-structures with ferromagnetic ordering and hybrid nano-particles with core-shell structure
- Further optimizing the setup to obtain magnetic moment sensitivity better than 100&'61549;B/&'8730;Hz so as to investigate the nano-structures with non-ferromagnetic ordering

Knowledge Generated/Products Developed

- μ-SQUIDs with some having permalloy nano-structures were fabricated in Institut Neel (France)
- A setup for magnetometry with up to 1 T field and 1.3 K cryostat base temperature has been successfully made in IITK (India)
- Some earlier fabricated μ-SQUIDs were tested by a senior Indian student Sourav Biswas for the existence of phase dynamic regime. These results were published in Phys. Rev. B
- A novel technique for eliminating hysteresis by using an inductive shunt was also found. This work is under review in Phys. Rev. Lett
- The magnetometry setup has been successfully tested on permalloy nano-structures using both hysteretic and non-hysteretic SQUIDs. Thus Objective-1 has been successfully achieved

shows the 1.3 K cryostat with the vector magnet at bottom

Pure & Applied Physics

PHASE TRANSITIONS IN SUB-SATURATION NUCLEAR MATTER AND APPLICATIONS TO CORE-COLLAPSE SUPERNOVA AND NUCLEAR EXPERIMENTS

Project No. 5804-3 | **Mar. 2018 to Mar. 2021**

Background

Nuclear clusters are abundantly formed in heavy ion collisions and believed to compose the dense matter in the universe that characterizes the cores of supernovae and the inner crust of neutron stars. Both aspects are the manifestation of the same physical phenomenon, namely the liquid-gas phase transition of nuclear matter. A realistic description of such clusters interacting inside the medium composed by their continuum states is important for both fields. Specifically, nuclear experiments can provide constraints to the parameters of the theory that cannot be fixed by ab-initio considerations, and in turn these constraints can be translated into confidence levels for astrophysical observables such as, among others, neutron star radii. The effective interaction among nucleons and the in-medium binding energy shift of the clusters due to the nucleons can be both described through Density Functional Theory. A model independent energy functional will be used which only depends on empirical parameters.

Objectives

- Clarify the confidence interval on empirical equation of state parameters through heavy-ion collision data, and measure its impact on neutron star observables
- Improve the description of nuclear clustering, both for multifragmentation and core collapse evolution, including in the best available models the missing in-medium binding energy shifts
- Analyze the impact of sophisticated ab-initio treatments of hyper-nuclear matter on the possibility of multi-strange cluster production, and on the evaluation of the complete hyper-nuclear matter phase diagram at low density

Knowledge Generated/Products Developed

- PIs developed a HI transport code with a mean-field treatment (meta-modeling) that can interpolate between EoS models
- PIs had shown in a paper that was accepted for publication in Physical Review, that the mass and charge of the evaporation residue in intermediate energy Ni+Ni collisions is a sensitive probe of the symmetry energy
- PIs introduced the metamodeling in a sub-saturation equilibrium EoS model that fully accounts for the nuclear distribution at finite temperature
- PIs have replaced the simplified liquid-drop approximation of the canonical multi-fragmentation model with an improved functional with surface properties optimized on experimental masses
- PIs have shown in a paper in preparation, that the fractionation property of the liquid-gas phase transition leads to very different isotopic ratios in equilibrium multi fragmentation, with respect to the predictions of the spinodal instability

Principal Collaborators

Gargi Chaudhuri
Variable Energy Cyclotron Center
Kolkata

Francesca Gulminelli
LPC / ENSICAEN
Caen

Publications

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

Mobility Support

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

Pure & Applied Chemistry

NOVEL CHIRAL FIRST ROW TRANSITION COMPLEXES FOR ASYMMETRIC CATALYSIS VIA ACTIVATION OF INERT C-H AND C-HETEROATOM BONDS

Project No. 5805-1 **Oct. 2017 to Sept. 2020**

Background

The aim of the project is to develop new efficient catalytic systems based on inexpensive first row transition metals for asymmetric transformations of unreactive substrates via activation by dehydrogenation. For this purpose, various chiral ferrocene-based metal complexes will be used with cobalt, iron and manganese. A large variety of ligands with various coordination pattern and different elements of chirality (planar chirality, central chirality) will be prepared in few steps in diastereoisomerically and enantiomerically pure form. The redox properties of the new complexes will be exploited for unknown or underdeveloped catalytic transformations, in particular for the asymmetric version of dehydrogenation/ hydrogenation, C-N bond formation and C-H bond activation/functionalization reactions. The best catalytic systems will be grafted on polymeric or inorganic supports and mechanistically studied.

Objectives

- To develop new efficient catalytic systems based on cheap first row late transition metals (cobalt, iron and manganese) for asymmetric transformations of unreactive substrates via activation by dehydrogenation. Chiral complexes of the selected metals with different chiral ferrocene-based ligands will be in particular tested in asymmetric C-N bond formation from unreactive alcohols by dehydrogenation/ hydrogenation sequence and in the asymmetric functionalization of alkanes through C-H bond activation (dehydrogenation)/ functionalization (hydrosilylation, hydroboration) sequence

Knowledge Generated/Products Developed

- Synthesis and characterization of 3 chiral PNP ligands, 1 chiral PNN, 1 chiral PSP
- Structural determination by X-ray diffraction analysis of 3 synthetic intermediates
- A non-noble metal-based catalytic system, specifically with a high-valent cobalt complex, for C-C and C- N bond formation through activation of secondary alcohols was developed for the first time
- Catalytic reductive alkylation of amines with oxidized hydrocarbons such as carboxylic acids was developed using Co/PP_3 catalytic system
- New Cp*Co(III)-complexes were isolated and applied in transferhydrogenation of carbonyl derivatives under mild conditions

Principal Collaborators

Basker Sundararaju
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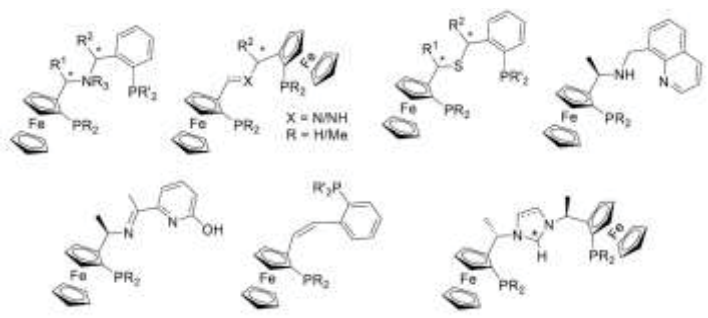
Publications

- No. of publications in SCI journals: 4
- No. of papers presented in conferences: 1

Mobility Support

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



Schematic representation of some targeted planar-chiral ligands

Materials Science

TUNING THE INTERFACIAL DZYALOSHINSKII-MORIYA INTERACTION IN ULTRATHIN MAGNETIC FILMS:TOWARD THE STABILIZATION OF SKYRMIONS IN SPINTRONICS DEVICES

Project No. 5808-1 | **Jan. 2018 to Dec. 2020**

Background

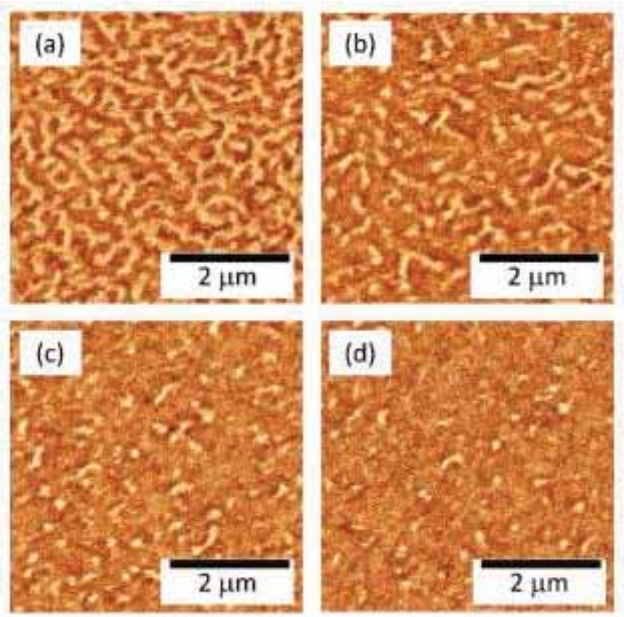
The project aims to develop an experimental project towards fabrication of ultrathin magnetic films and nanostructures where interfacial Dzyaloshinskii-Moriya interaction (iDMI) plays an important role in determining the domain wall chirality and dynamics. iDMI has drawn intense research attention over the last decade because of their potential in applications as well as in fundamental research. One of the most fascinating issue of iDMI is the stabilization of skyrmions (a novel chiral texture characterized by a topology different from the ferromagnetic uniform state), which drives an intense worldwide research. Using combined magneto-optical Kerr effect (MOKE) based microscopy and magnetic force microscopy (MFM) it is planned to investigate the current driven motion of skyrmions in ultrathin films with structural absence of inversion symmetry. The challenge is to tailor the chirality and energy of the domain walls in such a way that the skyrmions remain stable at room temperature, in a structure where they can be efficiently driven via spin transport torque, in particular induced by the spin Hall effect (SHE). Controlling the skyrmion size by tuning the DMI strength and magnetic anisotropy by varying the deposition conditions is a first challenge in view to produce ultrasmall skyrmions for spintronics application. Another important aspect is to produce films with low damping and pinning, in order to enable efficient nucleation and motion in devices.

Objectives

- Preparation of ultrathin ferromagnetic film with perpendicular magnetic anisotropy with the structure of heavy metal (HM)/ ferromagnet (FM)/ oxide (O)
- Micro/nanofabrication on the as prepared thin films with iDMI using photolithography and electron beam lithography to connect the ferromagnetic nanostructures for transport measurements
- Structural characterization of the films will be performed using atomic force microscope (AFM), small angle x-ray reflectivity (XRR) and scanning electron microscopy (SEM)
- Determination of iDMI of the films and its variation as a function of the deposition parameters
- Characterization of domain wall pinning under the pulsed magnetic field and/or current
- Investigation of skyrmions (size) using magneto optic Kerr effect (MOKE) based microscope and magnetic force microscope (MFM) depending on the size of the skyrmions
- Study of skyrmion nucleation and motion using current pulse et optimization of the spin Hall effect torque

Knowledge Generated/Products Developed

- PIs have successfully prepared the ultrathin films as per the sample geometry promised in the proposal
- The sample morphology has been checked by atomic force microscopy
- Thicknesses of the layers has been tuned to optimize the perpendicular magnetic anisotropy, a prerequisite for skyrmion observation in such ultrathin films
- The skyrmion observation has been successfully performed via magnetic force microscopy
- PIs have made their plans for the device fabrication which was one of the major goal of this project



(a) Domain structure obtained using MFM on Si (100)/Ta (5 nm)/Pt (6.0 nm)/Co (1.5 nm)/Ta (5.0 nm) sample in remanence state. (b)-(d) Formation of skyrmions under applied magnetic field of 9.6 mT, 14.3 mT and 17.2 mT respectively. The bright and dark contrasts represent repulsive and attractive forces, respectivel

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: 1
- France to India: 1

Computational Sciences

NOVIS60: NON-CONTACT VITAL SIGN ESTIMATION WITH 60 GHZ RADAR TECHNOLOGY

Project No. 5902-1 **Jul. 2018 to Jul. 2021**

Background

NOVIS60 aims to develop an innovative electronic system capable of detecting people's vital signs (namely, respiration and heartbeat rate) in a remote and contactless way.

NOVIS60's solution will be based on a Doppler radar operating in the license-free 60 GHz band. A radio-frequency wave will selectively illuminate a person, whose vital signatures will be responsible for micro-movements of the body. These movements will affect in turn the reflected wave, which will be received and processed by the system in order to extract vital signs information. Due to the directive illumination of the system, it will be possible to monitor several people simultaneously, and to recognize possible situations of stress/danger. A first proof of concept has been obtained within the consortium and NOVIS60 aims to develop a demonstrator to assess such radar in real situations. This demonstrator will include a novel beam-scanning antenna and its dedicated 60 GHz transceiver and will enable drawing the fundamental limitations of this approach while better highlighting its potential.

Principal Collaborators

Jayanta Mukherjee
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IIT Bombay
Mumbai

Julien Sarrazin
L2E
Sorbonne Université
UPMC – University Pierre and Marie Curie
Paris

Objectives

- To design smart radar at 60 GHz to wirelessly monitor heartbeat and respiratory rate of people, without the need for them to wear any types of devices

Life And Health Sciences

HEMATOPOIESIS AND METABOLISM

Project No. 5903-1 **Aug. 2018 to Jul. 2021**

Background

This research proposal aims to conduct a cohesive understanding of hematopoiesis with specific emphasis on their origin and associated functions allied to metabolic homeostasis in animal physiology. Being a question of broader relevance, but given the nature of complexity it may not be easily addressed in a vertebrate system. The PIs plan to utilize the Drosophila hematopoietic model to establish a genetically tractable platform to explore this in detail.

A conclusive understanding of hematopoiesis and metabolic homeostasis in animal physiology will be obtained by employing metabolic approaches along side developing genetic tools to precisely modulate embryonic and definitive hematopoietic cells. Finally, it is proposed to investigate the relevance of myeloid origin in defining susceptibility to dietary and metabolic stresses. The overarching goal of this effort is to decipher conserved molecular mechanisms underlying myeloid development and homeostasis in global metabolic physiology and to truly understand the cross talk between immune cells and the organism.

Principal Collaborators

Tina Mukherjee
Institute for Stem Cell Biology and Regenerative Medicine
Bengaluru

Angela Giangrande
Institut de Génétique et de Biologie Moléculaire et Cellulaire
Strasbourg

Objectives

- A comprehensive understanding of myeloid-cell metabolic and transcriptional states during hematopoietic development
- The influence of immune cell origins in systemic metabolic homeostasis
- Correlating altered innate immune states from the different phases of their development in the onset of metabolic disorders

Pure & Applied Physics

MODELLING AND OBSERVING PULSARS: FROM HIGH ENERGY TO RADIO EMISSION

Project No. 5904-1 **Jun. 2018 to Jun. 2021**

Background

Studying radio pulse profiles and polarization helps to get unprecedented insight into the emission physics of pulsar and constraints on the magnetic topology. Only recently, theoreticians went beyond the dipole paradigm, trying to constrain multipolar components from joint radio and X-ray observations. The goal is to determine the role of multipoles on pulsar emission physics. Observationally the existence of such fields is still being probed and future space and ground based telescopes are being designed to assert the magnetic topology. Probing multipolar fields requires observing neutron stars close to their surface. There are primarily two ways of probing the region below 10% of the light cylinder, namely the coherent radio emission and the emission of thermal X-rays from hot polar caps.

The radio pulse shape, its polarization and spectral properties suggest that pulsar emission arises from regions of open dipolar field lines. Pulsar radio emission is highly linearly polarized and in several pulsars the linear polarization position angle exhibits a S-shaped traverse.

Principal Collaborators

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Pune

Jérôme Petri
Université de Strasbourg
Observatoire astronomique de Strasbourg, CNRS
Strasbourg

Objectives

- Analysing existing radio and X-ray data
- Computing equilibrium configurations of the pulsar magnetosphere
- Interpreting results in the light of multipolar fields within the magnetosphere

Pure & Applied Physics

COMPOSITE MODELS AT THE INTERFACE OF THEORY AND PHENOMENOLOGY

Project No. 5904-2 **Jun. 2018 to May 2021**

Background

The major physics goal of high-energy physics is to understand the structure of matter in terms of its most elementary constituents. One possible approach to knowing what lies beyond the present theoretical paradigm of high-energy physics, known as the Standard Model, is to ask whether the particles of the Standard Model are composite. Experiments tell us that some of the particles are elementary, to a large extent at least, but for others we do not have the comfort of this knowledge. These particles could well be composite objects arising from an underlying more-fundamental theory. The questions sought here to address in this proposal are then:

i) What theoretical models of compositeness can be written down in a mathematically consistent way?
ii) Do these models stand the test of current experiments?
iii) What new predictions do composite models have that can be searched for in experiments?

Principal Collaborators

K Sridhar
Department of Theoretical Physics
Tata Institute of Fundamental Research
Mumbai

Giacomo Cacciapaglia
CNRS/IN2P3 Researcher,
Institut de Physique Nucléaire de Lyon
Université Lyon 1
Lyon

Objectives

- Investigation of specific models of compositeness and their viability from a theoretical point of view
- Issues of UV-completion and the inputs to model-building from perspectives of duality
- Using existing collider information and precision electroweak measurements to constrain the parameter space of the models
- Examine the role of flavour physics and cosmology in understanding such scenarios
- Predicting new effects from the models and suggesting suitable search strategies at present and future experiments for these effects

Multi Disci (Physics, Chemistry, Biology)

PRE-EVOLUTIONARY PROCESSES IN AUTOCATALYTIC RNA NETWORKS

Project No. 5904-3 | **May 2018 to Apr. 2021**

Background

Building artificial systems able to evolve by natural selection would allow to better understand the origins of life and conceive novel strategies to screen for chemical reactions. Here, it is proposed to explore how ensembles of RNA molecules that replicate collectively - or CAS for Collectively Autocatalytic Sets - could have started to evolve according to the laws of natural selection when compartmentalized in protocells. This requires to implement several pre-evolutionary properties in autocatalytic systems: heredity, variation and selection. The Indian partners have pioneered the study of CAS evolution, recently showing reaction structures for robust reproduction and memory effect. The French partners have pioneered the droplet microfluidics technology for biochemical applications, and have recently coupled it with molecular bar-coding and Next Generation Sequencing to study catalytic RNA networks. It is proposed to use RNA system, derived from a ribozyme from the Azoarcus bacterium, which allows to design and build a huge diversity of CAS connectivities. It is proposed to implement pre-evolutionary properties in this system in a stepwise manner.

Principal Collaborators

Sandeep Krishna
National Centre for Biological Sciences
TIFR
Mumbai

Philippe NGHE
Laboratoire de Biochimie
Ecole Supérieure de Physique et de Chimie Industrielle (ESPCI)

Objectives

- Demonstrate compositional heritability in autocatalytic RNA networks.
- Screen environmental perturbations that allow transitions between heritable growth states
- Implement a protocell cycle with selection to achieve evolution by natural selection in collectively autocatalytic sets

Pure & Applied Chemistry

BORON-CONTROLLED CO_2 REDUCTION

Project No. 5905-1 | **May 2018 to Apr. 2021**

Background

Due to the increasing level of CO_2 in the atmosphere, its use as a carbon source has attracted considerable interest in recent years. Borane compounds have played a key role thanks to a dual character of Lewis acidity and of hydride donor ability. On one hand, hydroborane, with a catalyst, and hydroborate, without, are able to reduce CO_2 by transferring hydride(s) to the electrophilic central carbon atom of CO_2. On another hand, the Lewis acidity of the borane moiety has been used in ambiphilic compounds to activate CO_2. In this proposal, it is proposed to combine both properties and propose to design and synthesize hydroborane/borate compounds featuring pendant Lewis bases, in a FLP-inspired strategy. The compounds will then be coordinated to prepare the corresponding metal complexes containing M-H, B-H and/or M-H-B moieties. The ability of these compounds and of the complexes to activate/reduce CO_2 will be investigated in detail.

Principal Collaborators

Sundargopal Ghosh
Department of Chemistry, Office 317
Indian Institute of Technology-Madras
Chennai

Sebastien Bontemps
Chargé de Recherche
Laboratoire de chimie de coordination du CNRS
Narbonne

Objectives

- To get benefited from both the Lewis acid and the hydride donor ability of boron-based reagent to activate and transform CO_2
- Designing and synthesizing boron-based compounds with a pendant Lewis base moiety
- To study the reactivity of these compounds and of the related complexes toward CO_2 and to get deeper insights about mechanistic pathways and to disclose new transformations

Earth & Planetary Sciences

NUTRIENT TRANSFERS THROUGH GROUNDWATER IN INDIA (NUNDERGROUND)

Project No. 5907-1 **Aug. 2018 to Jul. 2021**

Background

There are a limited number of studies of GW biogeochemical processes and contribution to chemical budgets of Indian Ocean. NUNDERGROUND proposes to gather on-going complementary surveys from different labs in France and India adding advanced isotopic tools and expertise on C, N, Si, Ca, Sr, H_2O to help identifying the external sources (natural and anthropogenic) of macronutrients and carbon in Indian ground will take advantage from on-going efforts by Indo-French teams to combine expertise on GW processes from continental hydrogeologists and geochemists (IISc, GET, IEES) with biogeochemical expertise on estuaries (NIO and LOCEAN). To achieve this, it is proposed to apply an advanced isotopic toolbox common to the studied systems that should provide the added value needed to unlock gaps in our current understanding on nutrient sources and processes in GW as well as their potential contribution to estuaries and coast.

Principal Collaborators

V.V.S.S. Sarma
CSIR-National Institute of Oceanography
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Damien Cardinal
LOCEAN
Laboratoire d'Océanographie et du Climat - Expérimentations et Approches Numériques
Sorbonne Université, Paris

Objectives

NUNDERGROUND, Nutrients transfer through groundwater in India, will focus on C, N, Si cycles in groundwater along the Indian land-to-ocean continuum with the following objectives:

- Identify the external SOURCES of macronutrients in Indian groundwater
- Characterize groundwater PROCESSES that contribute to and modify their macronutrient contents
- Characterize the FATE of GW macronutrients
- Estimate and understand the seasonal and regional CONTROLS of these transfers

Material Sciences

A NOVEL HIGH TEMPERATURE SELECTIVE COATING ON SUPERALLOY SUBSTRATES STABLE UP TO 600 DEG. C IN AIR FOR SOLAR THERMAL ELECTRICITY RECEIVERS: STUDIES ON IMPROVED EFFICIENCY AND ACCELERATED AGING TESTS

Project No. 5908-1 **Sept. 2018 to Sept. 2020**

Background

The proposal addresses the challenges in developing new optically efficient solar selective coatings which are stable in air for temperatures greater than 580 deg. C. For this purpose, thermally stable nitrides, carbides, oxynitrides and oxides of W, Si and Ti will be synthesized by sputtering processes. Their composition and thicknesses will be tailored to develop a novel spectrally selective coating on superalloy substrates with a gradient of refractive indices, leading to very high spectral selectivity (absorptance above 94%, emittance below 15%), and high temperature stability in air (up to 600 deg. C). The coating design will be optimized using optical simulation tools and fine tuning of process parameters, and its thermo-optical performance will be experimentally validated using a large number of characterization techniques available with the collaborators, including UV-VIS-NIR and IR spectrophotometry. In addition, solar absorptance will be measured under natural solar irradiation (DISCO) and thermal emittance will be evaluated at high temperature up to 500 deg. C, to assess the solar-to-electric efficiency of the coating system. Accelerated aging tests with various atmospheres and thermal cycling, in electrical (ALTHAIA) and solar (SAAF) furnaces, will be applied to evaluate the coatings service life for high temperature CSP applications.

Principal Collaborators

Harish Bharsilia
Surface Engineering Division
CSIR-National Aerospace Laboratories
Bangalore

Audrey Soum-Glaude
Laboratoire Procédés, Matériaux et Énergie Solaire (PROMES)
Font Romeu Odeillo

Objectives

- Develop a novel metal carbide, oxide, oxynitride and oxide based spectrally selective high temperature solar absorber coating
- Achieve coating high selectivity (absorptance above 94%, emittance below 15% at 82 deg. C) and thermal stability (600 deg. C in air under cyclic conditions) on superalloy substrates
- Optimize the coating structure by optical simulation and experimental validation of optical properties, substrate pre-treatment and fine tuning of process parameters
- Accurately evaluate the coating thermo-optical properties, including with unique solar facilities and equipment, and estimate the solar-to-heat efficiency of thus coated solar receiver
- Qualify the coating thermal stability, investigate its aging behavior and predict its service life in solar thermal applications

Material Sciences

2D MATERIALS FOR NOVEL NANO ELECTRONIC DEVICE APPLICATIONS

Project No. 5908-2 **Aug. 2018 to Jul 2021**

Background

Materials including graphene, TMDCs, and III-VI semiconductors. These are easily transferable to other substrates and this is the technique of choice for making nanolayers in our laboratory from any layered material. Standard techniques for the fabrication of heterostructures of 2D materials have been perfected, and making devices of these using e-beam or physical mask lithography. These developments will be needed for the development of solar cells based on layered heterostructures. Developed a very efficient method of electrostatic doping which is compatible with eventually large scale device fabrication. This development will be useful for fabricating transparent conductors which are integral parts of solar cells, but also for creating bipolar junction devices.

At the SPPU facilities exist for thin film fabrication for solar cell devices (sputtering, e-beam evaportation and CVD) and characterization. Since a couple of years layered perovskites are being investigated for solar applications. The three year work plan will be based around the following objectives:

Principal Collaborators

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Savitribai Phule Pune University
Pune

Abhay Shukla
Institut de minéralogie, Physique des Matériaux et de Cosmochimie (IMPMC)
UPMC Sorbonne Université
Paris

Objectives

- To fabricate and characterize efficient hybrid photoconductors based on the principle of combining 2D materials targeted for their specific properties of light-matter interaction or transport and to build efficient geometries to maximise light matter interaction
- To investigate the specific properties of monolayer dichalcogenides which could reveal topological phenomena like the spin or the valley Hall effect
- A secondary objective would be to use the expertise of the Indian team to explore the possibilities of the use of 2D materials in photovoltaic solar cells. Solar-cell studies which have received a new impetus since the advent of perovskite materials

Pure & Applied Mathematics

HIGH PERFORMANCE FORMATION CONTROL IN THE PRESENCE OF UNCERTAINTIES AND COMMUNICATION CONSTRAINTS

Project No. 6001-1 **Feb. 2019 to Jan. 2022**

Background

To comprehensively study formation control under a variety of uncertainties, such as in sensor measurement (bias or noise) or in the interaction graph (communication). Investigators proposed not only look to evaluate precise asymptotic consensus errors but also to identify scenarios under which these errors are rejected and exact consensus/formation achieved. As an outcome of this work, PIs will deliver formation control (or consensus) algorithms that are more robust and amenable to actual hardware implementation where sensor and communication errors are recurrent.

Secondly, they consider topologies in which the interconnections are not perennial but may be established and be lost over non-negligible intervals of time. This calls for an analysis of cooperative laws with time-varying interconnections. In addition to that, on a different scale of time, one needs to consider the case in which the interconnection topology is time-varying that is, some interconnections are completely lost and new ones appear. Finally, it must be considered that such intermittence both of the interconnections and the topology, may be state dependent and even dynamical.

Principal Collaborators

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Indian Institute of Technology-Bombay
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Irinel Constantin Morarescu
Centre de Recherche en Automatique de Nancy (CRAN), UMR7039
Université de Lorraine
Vandoeuvre-Lès-Nancy

Objectives

- To comprehensively study formation control under a variety of uncertainties, such as in sensor measurement (bias or noise) or in the interaction graph (communication)
- To analysis of cooperative laws with time-varying interconnections
- In the context of consensus and formation control, event-triggered laws have been proposed for static graphs in which has been improved upon for intermittent trigger function monitoring and for general linear system agent models

Computational Sciences

COMPUTING ON ENCRYPTED DATA: NEW PARADIGMS IN FUNCTIONAL ENCRYPTION

Project No. 6002-1 **Feb. 2019 to Jan. 2022**

Background

This proposal addresses one of the fundamental and most powerful tools in the setting of computing on encrypted data: functional encryption (FE). This primitive allows utmost control of the data being disclosed to the users of the system. In functional encryption, each user can be provided with a key that corresponds to a circuit C, which we denote by SK(C). The user can apply this key to any ciphertext CT(X), to obtain C(x) and nothing else. The flexibility and fine-grained access control afforded by Functional Encryption makes it a very attractive tool for modern day encryption needs. As an example, consider the case of a mail gateway which must route incoming emails according to the characteristics of each email. If email is encrypted, then the gateway cannot perform spam filtering directly, while giving the gateway access to the user's secret key might be dangerous. However, if the email is encrypted using a functional encryption scheme, then the gateway can be given a key that lets it check whether the email is spam, but nothing more. The study of functional encryption is a new and exciting field, which has displayed tremendous progress in a short time, and shows even more potential for the future.

Principal Collaborators

Shweta Agrawal
Computer Science and Engineering
Indian Institute of Technology-Madras
Chennai

Benoit Libert
Ecole Normale Superieure de Lyon
Lyon

Objectives

- Supporting the Turing machine and RAM model of computation
- Improving hardness assumptions underlying constructions of functional encryption
- Efficient constructions for specific functionalities. To provide efficient constructions for specific functionalities of practical relevance
- Studying new lattice-based hardness assumptions and applications

Pure & Applied Physics

DESIGN AND CONTROL OF MANY-BODY STATES IN HYBRID QUANTUM SYSTEMS

Project No. 6004-1 **Feb. 2019 to Jan. 2022**

Background

Nonequilibrium conditions are emerging as a new way of controlling quantum matter. The most spectacular applications are expected in systems of strongly-interacting particles, and studying their nonequilibrium dynamics has become a pressing theoretical challenge. This proposal consists of concrete routes to realize interesting nonequilibrium many-body states in strongly-coupled light-matter systems. A nonequilibrium scheme is proposed to generate the long-sought long-lived multipartite quantum entanglement, by bringing ideas from driven-dissipative systems and from solid-state physics to design the interactions between distant qubits and their direct nonequilibrium photonic environment. The concrete scheme will be geared towards the rapidly maturating cavity quantum electrodynamics architectures in both 1D and 2D.

This objective relies on the parallel development of theoretical and numerical tools much needed to advance the understanding of nonequilibrium states of open quantum interacting systems. We propose to mostly focus on advancing steady-state methods which can bypass the compute-intensive transient dynamics.

Principal Collaborators

Manas Shreekanth Kulkarni
International Centre for Theoretical Sciences (TIFR)
Bengaluru

Camille Aron
Ecole Normale Supérieure (CNRS)
Paris

Objectives

- Propose a driven-dissipative scheme to generate indefinitely long-lived multipartite quantum entanglement in lattices (both 1D and 2D) of qubits, by bringing ideas from quantum-bath design and from condensed-matter physics. The concrete scheme will be geared towards the rapidly maturating cavity quantum electrodynamics architectures
- To investigate the strongly-correlated properties of the photons forming the qubit environment
- Develop a set of analytical and numerical tools to compute the nonequilibrium dynamics of extended light-matter systems by brute-force integration, as well as to access their non-equilibrium steady states with methods bypassing the transient dynamics

Pure & Applied Chemistry

ENHANCED CO_2 ADSORPTION AND ITS PHOTO-ELECTROCHEMICAL CONVERSION USING SEMICONDUCTOR-METAL COMPLEX HYBRIDS

Project No. 6005-1 **Mar. 2019 to Mar. 2022**

Background

The prime objective of the research proposal is to develop semiconductor-metal complex hybrids particularly, using polyoxometalates (POM), silicon nanowires (SiNW), SiNW/TiO_2, MoS_2 or SiNW/TiO_2/MoS_2 composites as semiconductors support for grafting of metal complexes for enhanced CO_2 adsorption and its simultaneous conversion to high value chemicals such as formic acid, formates, methanol via photo-electrochemical conversion route using visible light. CO_2 adsorption is of highest concern during the CO_2 reduction process because CO_2 reduction kinetics is highly correlated to the CO_2 concentration. Thus it is targeted to design an adsorptive photo-electrochemical interface by combining inorganic-organic hybrid consisting of mono- or multi-nuclear transition metal complexes/ metallic clusters which can bind CO_2 through CO_2-M bond and thus can enhance the adsorption of CO_2 on its surface. In our concept, visible light will be harvested by semiconductor and an enzyme mimicking molecular complex mainly of ruthenium as well as low cost metals such as Co, Cu will be immobilized to POM to accelerate and regulate the electron transfer for CO_2 reduction.

Principal Collaborators

Suman Lata Jain
CSIR-Indian Institute of Petroleum
Haridwar Road, Mohkampur
Dehradun

Rabah Boukherroub
Institute of Electronics,
Microelectronics and Nanotechnology
Villeneuve d'Ascq

Objectives

- Design and synthesis of semiconductor supports such as, transition metal substituted polyoxometalates (POMs) having MOx basic units, silicon nanowires (SiNW), MoS_2 and composites of SiNW with TiO_2 and MoS_2
- Synthesis of mono or polymerized molecular complexes/clusters of ruthenium and low cost metals such as Cu, Co
- Covalent attachment of metal complexes/clusters with POM or other semiconductor supports through in situ or post grafting methods
- CO_2 adsorption study and simultaneous solar photo-electrochemical reduction to high value chemicals under visible light irradiation
- The catalytic yield, selectivity and efficiency of the prepared photo-electrocatalysts will be investigated
- Best selected photoelectrocatalyst will be targeted to explore

Pure & Applied Chemistry

FROM MOLECULES TO AEROSOLS AND DUST PARTICLES: APPLICATIONS TO THE PHYSICS AND CHEMISTRY OF PLANETARY ATMOSPHERES AND THE INTERSTELLAR MEDIUM

Project No. 6005-2 **Mar. 2019 to Mar. 2022**

Background

The project aims to uncover the detailed nucleation mechanisms and the associated rates through the exploration of elementary reaction steps. The investigation will be carried out with the help of supersonic flow reactors associated with mass and optical spectrometers and with free jets combined to a FTWM spectrometer. The focus will be put on the nucleation enhancement of prototype molecules (e.g. H2O) by polar species which play the role of rainmakers. It is proposed to explore the hypothetic link between hydrogenated amorphous carbons and polycyclic aromatic hydrocarbons, the role of olivine grains as catalyst for the generation of singular forms of carbons, and the decomposition products of silicate grains in an effort to identify additional tracers of shock regions. Dust analogs processing will be studied using shock tubes and a variety of ex-situ analytical methods. In a second phase, in-situ real-time optical and mass-spectrometry techniques will be implemented. Complementary, the formation of carbon particles in hypersonic flow from the pyrolysis of light hydrocarbons will be explored in an effort to identify key molecular intermediates.

Principal Collaborators

E. Arunan
Department of Inorganic and Physical Chemistry
Indian Institute of Science
Bengaluru

Ludovic Biennier
Institut de Physique de Rennes
(UMR UR1-CNRS 6251)
Université de Rennes 1
Rennes

Objectives

- The main scientific objectives are
  - to uncover nucleation mechanisms and kinetics at the molecular level, and
  - investigate the evolution of dust analogues at high temperatures of a few thousands of K

Earth & Planetary Sciences

PETROLOGIC, OS ISOTOPIC AND PLATINUM-GROUP ELEMENT (PGE) GEOCHEMICAL STUDIES OF THE ARCHEAN KOMATIITES FROM THE SINGHBHUM CRATON (EASTERN INDIA): IMPLICATIONS FOR CHEMICAL DIFFERENTIATION OF THE EARTH AND PROSPECTS FOR NI-CU-(PGE) SULFIDE MINERALIZATION

Project No. 6007-1 **Feb. 2019 to Jan. 2022**

Background

It is proposed to conduct collaborative research on Archean komatiites from the Singhbhum craton, India (1) to evaluate their origin and implications for chemical differentiation of the early Earth and (2) to search for Ni-Cu-(PGE) sulfide deposits in these rocks. Komatiites are >2.5 billion-year-old high-Mg lavas usually attributed to plumes from the lower mantle that inform about our planet's earliest history and the chemistry of the deep Earth. Platinum-group elements (PGE) show extreme preference for liquid metal relative to silicate melt (experimental D values >105) and thus should have strongly partitioned into the metallic core, leaving the mantle almost devoid of these elements. However, PGE contents of planetary mantles are much higher than predicted from these partition coefficients. We will assess the processes proposed to explain this discrepancy using PGE abundances and Re-Pt-Os isotope systematics of Singhbhum komatiites. Ni-Cu-(PGE) sulfide deposits are rare and economically valuable. Preliminary exploratory work and geology similar to that hosting Ni-Cu-(PGE) sulfide mineralization elsewhere suggest that such deposits, though not yet found, may exist in India. Field geology, petrography, petrology, geochemistry, PGE abundances and Os isotopes will be used to characterize komatiitic rocks from the Archean Gorumahishani-Badampahar greenstone belt of Orissa and Jharkhand and to understand the nature and origin of their mantle source. We will also find and study areas with visible Ni-Cu-(PGE) sulfide mineralization, using geochemical data to identify sulfide saturation of the magma. The project includes fieldwork to collect samples and laboratory work engaging MSc, PhD and postdoctoral students under the supervision of Laurie Reisberg and Sisir Mondal. Mondal?s students will receive analytical training at the CRPG, and all involved will conduct fieldwork together in India. Mondal will organize workshop-seminars during visits of Reisberg and members of her group.

Principal Collaborators

Sisir Kanti Mondal
Department of Geological Studies
Jadavpur University
Kolkata

Laurie Reisberg
Centre de Recherches
Pétrographiques et Géochimiques (CRPG)
Vandoeuvre-Lès-Nancy

Objectives

- To understand the chemical differentiation of the early Earth, and the more specific goal of searching for Ni-Cu-(PGE) sulfide deposits
- To determine (1) PGE and Os isotopic characteristics of these rocks and their mantle sources, and the processes responsible for creating these characteristics, including the timing of these processes; (2) the implications of the observed PGE and Os isotope signatures for the evolution of the Earth's mantle; and (3) whether these komatiites contain any Ni-Cu-(PGE) sulfide mineralization, and if so, the nature and origin of this mineralization

CEFIPRA

CEFIPRA

5. Brief Reports of Research Projects

B. High Impact Scientific Research Network Programme

High Impact Scientific Research Network Programme

CEFIPRA has been traditionally associated bridging individual scientists of the 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 the first call on High Impact Scientific Research Network Programme in all the focus areas of interest in Science & Technology between India and France. The following two proposals were selected for support under this programme:

INTERNATIONAL STUDY ON A TYPICAL HEMOLYTIC UREMIC SYNDROME

Project No. Network-1 AHUS | **Apr. 2016 to Mar. 2019**

Principal Collaborators

MA Dragon-Durey
Université Paris Descartes, Paris
Ali Si Mohammad, *Dijon*
Regis Daneil, *Evry*

Arvind Bagga, *All India Institute of Medical Sciences*
Satyajit Rath, *National Institute of Immunology*
M Mukherjee, M Faruq, *IGIB, New Delhi*
Neelam Taneja, *PGI Chandigarh*
Arvind Sahu, *NCCS Pune*

St. Johns Medical College, Bangalore
Armed Forces Medical College
BJ Wadia Hospital, Mumbai
BL Kapoor Hospital, New Delhi
Christain Medical College, Vellore
Chacha Nehru Bal Chikitsalaya, New Delhi
Fortis Hospital, New Delhi
JIPMER, Puducherry
Max Action Balaji Hospital, New Delhi
Mehta Children's Hospital, Chennai
Pediatric Nephrology, Ahmedabad
PGIMER, Chandigarh
Rainbow Children's Hospital, Hyderabad
SGPFI, Lucknow
Sir Gangaram Hospital, New Delhi

Aarti Gupta, RW Thergaonkar, Savita Saini, Ashima Gulati, Himanshi Saini Bahadur Singh Gurjar, Mamta Purasawani, Divya Bhatia, Shambhuprasad Aditi Sinha, Uma Kanga, Pankaj Hari, Amit K Dinda, Priyanka Khandelwal Debasis Dash

Network

French laboratories
PH dans le service Laboratoire de Serologie-Virologie Dijon and Laboratoire Analyse et Modélisation 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
The Network enabled integration of work across multiple centers, enhancing individual capacities, ensuring utilization of resources and standardization of study protocols. The Network has continued work on multiple projects aiming to understand the pathogenesis and pathophysiology of anti-FH associated HUS. Collaboration involved many research labs on HUS in France and efforts were made to involve complement biologists, immunologists and geneticists across laboratories in India. Evidence based consensus guidelines on management of HUS in India that are relevant to many developing countries, have been developed with experts from across the country.

INDO-FRENCH HIGH ENERGY PHYSICS NETWORK

Project No. Network-2 INFRE-HEPNET | **Jan. 2016 to Dec. 2018**

Principal Collaborators

Sudhir Kumar Vempati
Indian Institute of Science
Bangalore

Biswarup Mukhopadhyaya
HRI
Allahabad

Gautam Bhattacharya
Saha Institute
Kolkata

Sourendu Gupta
TIFR
Mumbai

Fawzi Boudjema
LAPTh
Annecy

Aldo Deandrea
IPN
Lyon

Emilian Dudas
Saclay
LPTO

Fawzi Boudjema
LAPTh
Annecy

Jean-Yves Ollitrault
IPhT
Saclay

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 7-8TeV 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
1) Synergy of Experimentalists and Theorists: For the first time, HEP experimentalists of India and France had a framework to collaborate with each other as well as with theorists from both sides. 2) World Class Research Work and long lasting ties: The network largely focused on two main areas of HEP (a) QGP and (b) BSM (Beyond the Standard Model) physics. A permanent website (and wiki) is in place which keeps track of the various working group activity and the projects.3) The research output has been significant with about 28 published papers and about 15 more in pipeline. 4) Emphasis on younger researchers: From the beginning, a conscious effort was put to involve as many junior members as possible. 5) Two major Network meetings and two spin Offs meetings on a) string theory & mathematical physics and their possible exploitation in the domain of amplitudes and b) Gravitational waves and dark matter distribution with the astrophysics community were organized. From the success of the projects implemented under the high impact network programme was graded excellent.

GROUP FARMING AND COLLECTIVE ACTION

Sept. 2015 to Sept. 2019

Principal Collaborators

Indian PI
Bina Agarwal
University of Delhi
Delhi

French PI
Birgit Müller
IIAC-LAIOS
EHESS
75006 Paris

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 Agricolesd'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 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. We believe ours is the first systematic indepth survey 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. Hence we see this as an achievement
2. Bina Agarwal and Bruno Dorin completed a publishable paper explaining regional variations in GAECs across France
3. (a) Capacity building in France of 6 French scholars of whom 5 had earlier only done fieldwork for their MA/MSc theses in developing countries, and had never done research on French farming. Their feedback on their learning experience was very positive, even though they found the fieldwork challenging and difficult at times
   (b) Capacity building in India of 10 young researchers. Many of them were interns who had never handled primary data before. They learnt to code and enter the data on the computer for analysis from survey questionnaires. In addition senior research analysts oversaw the coding and data entry and contributed to the ongoing analysis
4. As PIs, we learnt a great deal about the functioning of GAECs, and more generally French farming, and the kinds of challenges it is facing
5. We also found it a learning experience to understand the legal aspects of EU policies as they impinge on French farmers, and how rural institutions such as SAFER intervene to mediate land access among farmers

CEFIPRA

5. Brief Reports of Research Projects

C. Industry Academia Research & Development Programme

Ongoing Projects

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

Domain: Aerospace | **Apr. 2014 to Jan. 2020**

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.

Indian Partners

Krishnan Balasubramaniam
Indian Institute of Technology Madras
Chennai

Prabhu Rajagopal
Indian Institute of Technology Madras
Chennai

S. Gopalakrishnan
Indian Institute of Science
Bangalore

Sujatha Chakravarthy
Dhvani Research &
Development Solutions Pvt Ltd
Taramani
Chennai

French Partners

Michel Castaings
Universite de Bordeaux
Talence

Oudea Coumar
Ariane Group SAS
Pessac

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

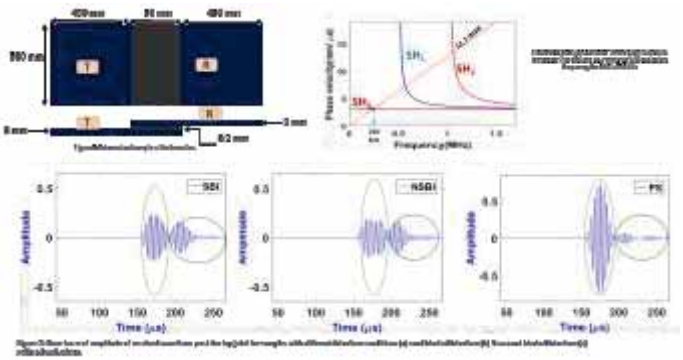
Knowledge Generated/Products Developed

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



Ongoing Projects

INDIRA_B: INDICATORS OF RELIABILITY AND VARIABILITY OF BRT

Domain: Urban Transportation | **Jan. 2016 to Jul. 2019**

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.

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
GRETTIA
COSYS I
IFSTTAR
Marne la Vallée

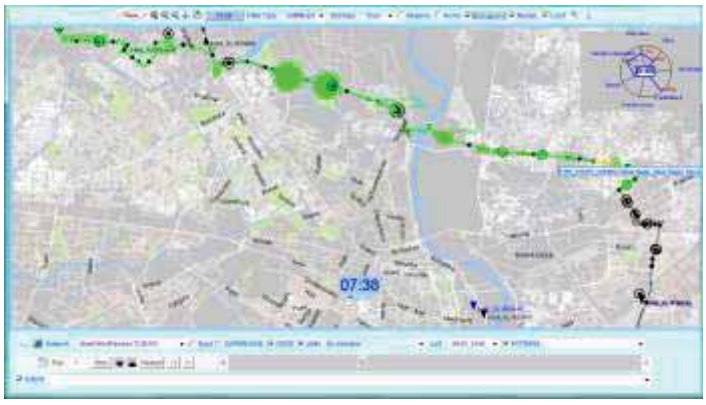
Objectives

- 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 Clarie-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 alterates have to be used



Cockpit replay Demo

Ongoing Projects

INNOVATIVE WHEEL DRIVE TO ENABLE WIDESPREAD ELECTRIC BIYCLCLE TRANSPORTATION

Domain: Automobile | **Jan. 2016 to Jul. 2019**

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 contuse go 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 25 kmph 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

Indian Partners

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

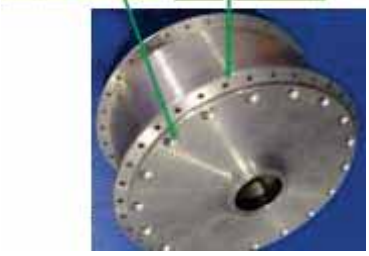
Chandan Bhattacharjee
M/s. Turnpoint Technologies Private Limited
New-Delhi

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

French Partners

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

Francois Bernot
FranceCol Technology.
ZA Grande Noue, 37230,
Luynes



Ongoing Projects

DEVELOPMENT OF LOOP HEAT PIPE FOR AVIONICS AND TERRESTRIAL APPLICATIONS

Domain: Avionics | **Apr. 2017 to Mar. 2020**

Background

Passive thermal management of aero-space vehicles, Loop Heat Pipe (LHP), Phase-change thermo-physics, Mechanical engineering, fundamentals of evaporation in porous media (LHP wick structures), flow condensation, wick development via powder metallurgy, thermal/configuration design, testing, characterization, manufacturing of thermo-mechanical demonstrator prototype

Loop heat pipes (LHPs) are advanced passive thermal management systems that can ensure highly efficient transport of heat from source (for example an electronic platform for avionics or a concentrated solar collector, in terrestrial application). The heart of successful LHP operation is a specialized wick structure, wherein efficient evaporation of working fluid is achieved which transports heat in the form of latent heat to a condenser.

Indian Partners

Sameer Khandekhar
Dept. of Mechanical Engineering
IIT, Kanpur

Siddharth Y. Paralikar
Chief Executive Officer (CEO)
Golden Star Technical Services Pvt. Ltd.
Pune

French Partners

Jocelyn Bonjour
CETHIL, INSA Lyon,
Villeurbanne

Claude Sarno
Thermal Systems Packaging
Thales Avionics (THALES)
Valence

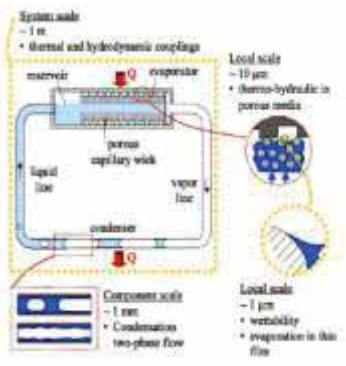
Objectives

- Industrial capability build-up for manufacturing specialized LHP wicks, as per design guidelines and specifications of avionics industry
- Characterization of the developed wick structures, in terms of relevant porous media and thermal-hydraulic properties
- Development of a high performance thermo-mechanical LHP demonstrator with specified wick structure (Typically Cu/Ni/Ceramic) to handle up to 100 W thermal power at all orientations
- Research output on convective condensation, local evaporator dry-out and system level thermal-hydraulics via the development of a transparent LHP system

Knowledge Generated/Products Developed

- IITK had conducted a detailed literature review, focusing on the design and fabrication aspects of LHP wicks
- Making use of dimensional analysis, preliminary LHP design and methodology has been frozen. Mathematical model for predicting the performance has been developed
- Various copper wick samples have been prepared (initial samples are mono-porous) by varying the powder morphology (spherical, dendritic and irregular)
- Single effect experiments have commenced on understanding the effect of powder morphology on transport parameters (permeability, porosity, thermal conductivity, pore radius, etc.)
- Capillary rise experiments were conducted for three wick samples (made of smooth, irregular and dendritic powder)

Conventional Heat



Loop Heat Pipe

Ongoing Projects

DEVELOPMENT OF NEW ANTI COUNTERFEIT PRINTING TECHNIQUES FOR MEDICINAL PACKAGING

Domain: Printing | **Aug. 2017 to Jul. 2020**

Background

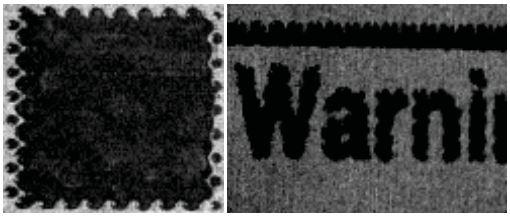
In today's world counterfeiting and piracy are increasing hugely. It affects a variety of goods and the worst affected area is pharmaceuticals and healthcare. Counterfeit drugs may include products without active ingredients, with incorrect quantities of active ingredients, wrong ingredients, and incorrect quantities of active ingredients with fake packaging. Counterfeited medicines may lead to death in severe cases such as heart attack, epilepsy etc. Counterfeit pharmaceuticals product is a product that is deliberately and fraudulently mislabeled with respect to identity. Sometimes expire dates are manipulated in order to clear the stock. In counterfeit packaging the batch number are copied from the original batch number. It is very difficult to identify counterfeit products from genuine products. Hence, anti-counterfeiting is needed urgently for the brand protection.

Objectives

- To develop a generic watermark method for printed aluminium foils
- Enhance the printed surface coverage of watermarks
- To develop an adaptive watermark method taking into account the spatial information to be printed
- Study the temporal stability of watermarks against light exposition, humidity rate
- To develop a solution to protect packaging against expiry date changes. Objectives were revised to add a third security level to the barcode:
  - Level 1: Classical barcode. It will enable customers to have access to additional info about the pharmaceutical product using their smartphone
  - Level 2: Low security mark. It will enable customers to check using their smartphone if the pharmaceutical product was produced or not by the right pharmaceutical company. We will use for that a solution similar to this solution: https://github.com/jeromeetienne/AR.js/blob/master/README.md
    This new security level will be implemented and tested during Task 3c
  - Level 3: High security mark. It will enable authorized people to authenticate the product and to check if the pharmaceutical packaging has been counterfeit (i.e. the security pattern has been scan and printed in an illegal way)

Knowledge Generated/Products Developed

- The binary watermark is stored into 16-bit buffer. Each of the 16-bits will be embedded into different positions of the host image respectively. The first printed watermarked images were scanned and reprinted to study the distortion effects from a perceptual and mathematical point of views. Also comparisons between host images, printed watermarked images and reprinted scanned watermarked images, have been done
- First experimental results showed that the proposed scheme successfully makes the watermark perceptually invisible and robust for print and Scan attacks. The light-fastness and water-fastness of printed watermarks have been studied with weather variations under different humidity and temperature variations. It is needed to check the fastness properties under controlled conditions. It has been observed that lightness decreases with time
- The spectrum of one magenta ink printed on aluminium foil with its image taken by one mobile device and two scanners are compared. One graph is given as an example for 124 lpi. It is observed that the printed magenta ink has upward trend in the range of 600 to 700 nm whereas the scanners and mobile do not have that trend. This shows that the ink may be difficult to scan and reprint



Example of serrated edges on a) the edges of a block pattern and b) letters observed by ZEISS microscope with 5xmagnification.

Indian Partners

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Mr. Ashish Bhattachariya
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French Partner

Tremeau Alain Anne
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Ongoing Projects

PIEZOELECTRIC ACTUATOR SYSTEMS FOR AUTOMOTIVE TRANSLATION SYSTEMS (PASATS)

Domain: Automotive | **Feb. 2017 to May 2020**

Background

Piezoelectric actuation is a promising candidate for this actuation system but some challenges remains to be unlocked. A main challenge is to design a piezo actuating device able to provide the required power to lift up a standard tailboard. This has to be done with the minimum amount of motion transformation from the motor to the tailboard, and keeping the cutting edge advantages of piezoelectric actuation devices. However, several non linearities tend to hinder the precision positioning applications of piezo actuators viz hysteresis, creep, vibration, etc. Besides, several errors related to parameter uncertainties and external disturbances need to be compensated by proper robust control system design. Another main feature of such a device, for safety purpose, is to remain locked if the electrical power is cut off. The operation of the system under dysfunctional conditions has also to be included in the project so as to ensure a fault tolerant behaviour and control. This has significant implications in the chosen design. The present proposal aims at including all these constraints to design a full tailboard actuation system based on the latest development of piezoelectric system design.

Objectives

Demonstration of automatic slider actuation system for automatic seating using piezoelectric actuators

Knowledge Generated/Products Developed

- Finalization of specification of the automotive seat motion
- Choice of an actuation principle: Inchworm motor
- Literature survey for simulation and design of control system, design of driver/amplifier for piezo actuator
- Proposition of 3 motor designs based on piezoelectric actuators, which meet the required specifications in terms of dimension and performance
- Geometrical modelling along with the necessary mechanical system design for automotive seat motion

Indian Partners

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West Bengal

French Partners

Laurent Daniel
Faurecia / CentraleSupelec / Esigelec
GeePs, Gif-sur-Yvette

Yves Bernard
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New Projects

REACTIVE PROGRAMMING AND COMPILATION FOR THE REDEFINE MANYCORE

Domain: Computational Sciences | **Feb. 2018 to Jan. 2021**

Background

This project addresses certain important, pertinent and topical challenges in the realization of a FADEC, consolidating computationally intensive control and health monitoring components on a single hardware platform. Synchronous reactive programming of sequential, periodically scheduled real-time control systems is routinely used in avionics. But moving to parallel architectures is a huge challenge, both scientifically (in terms of efficiency, accountability, isolation, timing analysis) and in terms of industrial practice and certification according to safety standards.

Indian Partners

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Morphing Machines
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French Partners

Dumitru Potop-Butucaru
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François Neumann
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Massy Cedex

Marc Pouzet
École Normale Supérieure,
Département d'Informatique
Paris

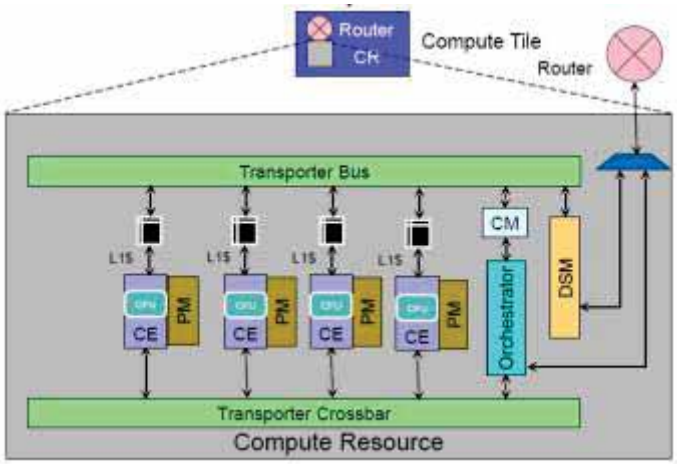
Objectives

The objective of the project is to realize a FADEC on REDEFINE, a massively parallel, reconfigurable manycore system for safety criticality. To provide the expected levels of safety, by design, the project will rely on synchronous reactive programming, and extend it to enable automatic parallelization and mapping of the FADEC to the REDEFINE architecture. The certification of the code generator and parallelization tools is out of the scope of such a ressearch project; but we will validate the safety requirements from a realistic FADEC model on the model and generated code using formal methods and extensive tests. We will also demonstrate performance levels of automatically generated code on par with manually written, low-level REDEFINE programming

Knowledge Generated/Products Developed

- Design of an OpenCL-based programming flow and runtime for subsystem programming
- Communication of a design document that describes the REDEFINE execution model, the OpenCL- based REDEFINE programming model, a description of the APIs for writing kernels using the C-with-HyperOps specification
- Development of a prototype REDEFINE Compiler based on LLVM, that accepts kernel code written in C-with-HyperOps and compiles it for the REDEFINE target
- Development of a Functional Simulator and an ISA simulator for REDEFINE

REDEFINE COMPUTE RESOURCE



CE : Compute Element; CFI: Custom Function Unit; DSM: Distributed Memory; PM: Private Memory; CM: Context Memory.

New Projects

COST-EFFECTIVE STRATEGY FOR THE INDUCTION OF IMMUNE TOLERANCE TO THE THERAPEUTIC FACTOR VIII IN HEMOPHILIA A

Domain: Immunology | **May 2018 to Apr. 2021**

Background

Development of anti-factor VIII (FVIII) antibodies (FVIII inhibitors) is a major concern during FVIII replacement therapy for patients with hemophilia A. Mucosal administration of recombinant FVIII fragments produced from plants blocks the production of FVIII inhibitors. However, this technology may have limitations in terms of cost and efficiency in preventing or eradicating FVIII inhibitors. This project proposal aims to produce recombinant FVIII fragments in large amounts in a relatively short amount of time using a *Pichia pastoris* expression system. PIs produce and purify recombinant FVIII fragments (Heavy and Light Chain) using proprietary technologies. The safety and capacity of the FVIII fragments to confer oral tolerance to FVIII will be pre-clinically tested in hemophilia A mice. This technology could be industrially integrated to produce recombinant FVIII fragments in large amounts in a cost effective manner and could be made clinically available for hemophilia A patients.

Indian Partners

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Centre for BioSeparation Technology (CBST), Vellore Institute of Technology (VIT) Vellore

Murali Tummuru
M/s Virchow Biotech Private Limited, Hyderabad

French Partners

Sebastien Lacroix-Desmazes
Equipe 16 INSERM UMRS 1138 Centre de Recherche des Cordeliers Paris

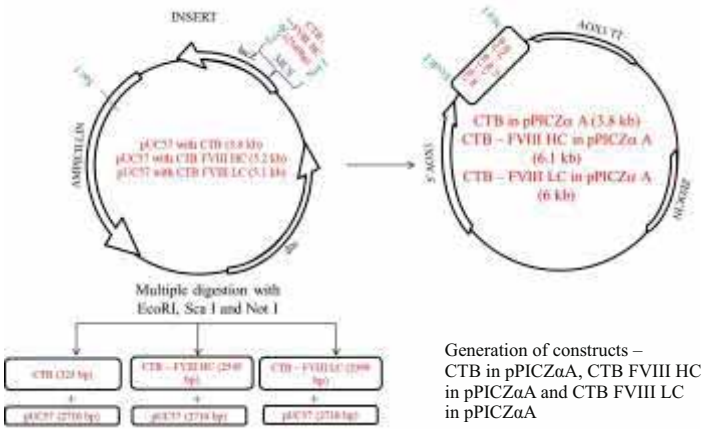
Daniela Balvay
R&D Director, SPAN Diagnostics S.A.R.L. Parc Technologique des Rives de l'Oise, 60280 Venette

Objectives

- Cloning and optimization of production by *Pichia pastoris* of recombinant FVIII heavy and light chains alone or fused to CTB
- Process optimization for scale up at the 2L fermentor level in a cost effective manner (CBST team and Virchow Biotech team)
- Scale up and the optimization of production of various constructs of FVIII in *Pichia pastoris* expressing FVIIIHC, FVIIILC, CTB-Fused FVIIIHC and CTB-fused FVIIILC in 15L or 30L
- *In vivo* animal model studies to validate the efficacy of Factor VIII molecules in the inhibition of antibody development against FVIII

Knowledge Generated/Products Developed

- Exchange of material has been done: cDNA encoding FVIII and CTB, protocols for detection of FVIII by ELISA
- Codon optimization of Factor (F)VIII was done for expression in Pichia pastoris
  (a) Cholera Toxin B-CTB
  (b) Factor VIII Heavy Chain (FVIIIHC)
  (c) Factor VIII Light Chain (FVIIILC)
- Custom made cDNA clones in pUC57 were procured from Genscript, NJ USA
  (a) CTB
  (b) CTB fused with FVIIIHC with a flexible linker and a Furin cleavage site
  (c) CTB fused with FVIII LC with a flexible linker and a Furin Clevage site
  (d) Factor VIII LC
  (e) Factor VIII HC
- Successfully cloned following cDNA clones into Pichia pastoris expression vector pPICZ-alpha
  (a) pPICZ-alpha containing CTB
  (b) pPICZ alpha containing CTB-FVIIIHC
  (c) pPICZ alpha containig CTB-FVIIILC



Generation of constructs – CTB in pPICZαA, CTB FVIII HC in pPICZαA and CTB FVIII LC in pPICZαA

New Projects

TO DEVELOP AN EFFECTIVE EXTRACTION AND SEPARATION TECHNOLOGY TO SELECTIVELY EXTRACT RARE EARTH ELEMENTS – ERBIUM (ER), TERBIUM (TB), EUROPIUM (EU), PRASEODYMIUM (PR), NEODYMIUM (ND) AND DYSPROSIUM (DY) FROM WEEE (WASTE ELECTRICAL AND ELECTRONICS EQUIPMENTS)

Domain: E-Waste | **May 2018 to May 2021**

Background

The current project proposal is focused on the development of suitable process scheme for the utilization of waste for the recovery of valuable rare earth metal ions. "Selective Leaching" has been targeted in the current proposal, so that rare earth ions (Nd, Dy, Pr) or (Er, Tb, Eu, Y) present in the magnet or lamps respectively comes in the aqueous solution. For the individual separation of rare earth ions from aqueous solution, suitable solvent extractant combination will be designed with the help of molecular modelling techniques. To compare the performance of developed combination of extractant, separation studies will also be carried out by using commercially available extractants. Therefore, the idea of the proposal is to give complete "Extraction" and "Separation" scheme for the recovery of rare earths from scrap magnets and fluorescent lamps, so that it can be tried on the larger scale.

Indian Partners

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Beena Rai
Tata Research Development and Design Centre
TCS
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French Partners

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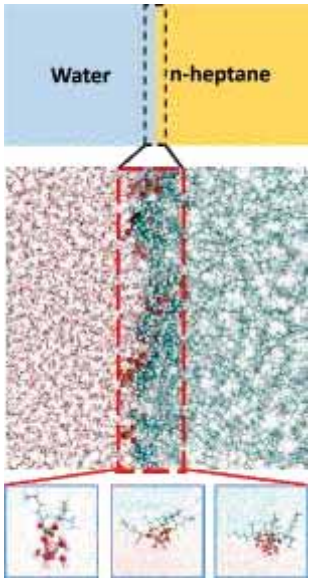
Christian Louis Thomas
Terra Nova Development
Lille

Objectives

- Development of process parameters for selective leaching of rare earths metals from WEEE (Waste Electrical and Electronic Equipments - NdFeB magnet and fluorescent lamps)
- Design of suitable solvent-extractant combination (e.g. task specific ionic liquids) using molecular modelling techniques
- Synthesis and characterization of recommended solvent-extractant combination or task specific ionic liquids for separating rare earth ions (Nd, Pr, Dy) or (Y, Eu, Tb, Er)
- Optimization of process parameters for the separation of rare earth ions (Nd, Pr, Dy) or (Eu, Tb, Er) by solvent extraction using commercially available extractants
- Conduct large scale trial of the complete process developed for scrap magnets and fluorescent lamps

Knowledge Generated/Products Developed

- Spent NdFeB magnet was characterized by chemical analysis, XRD, SEM etc. followed by optimization of oxidative roasting conditions for selective leaching of REEs
- Roasted magnets were leached using mineral acid followed by separation of REEs via solvent extraction using aliquat nitrate as the extractant
- Suitable atomic potentials to model solvent extraction processes using Molecular Dynamics were identified after extensive literature search and in house benchmarking
- We have shown that D2EHPA in n-heptane solvent is highly selecitve for Dy over Nd. Efficient separation of Dy/Nd from a mixture of the two ions in ratios similar to those found permanent magnets can be obtained by extracting Dy at lower pH and starving doses of D2EPHA, followed by extraction of Nd at higher pH
- Molecular dynamics simulations were used to explain the origin of the selectivity of D2EHPA towards heavier REEs. IT was shown that the origin of the selectivity lies in the differential stabilization of the metal-ligand complex between the organic and aqueous phases



MD studies of the interfacial structure during SX of REEs by acidic ligands and the extraction mechanism

New Projects

CUSTOMER BEHAVIOUR ON TRAVEL MARKETPLACES (FOR E-COMMERCE): MODELLING AND DECISION SUPPORT

Domain: E-Commerce | **Jan. 2018 to Jan. 2020**

Background

This project aims at building models and tools that could reveal buyers profiles or any patterns to help the decisions of travel agencies. These models and tools should improve the lead conversion of agencies and reinforce the insert of the platform for agencies. Two main problems will be addressed during this project, mixing customer behaviour modelling, data analysis, preference modelling and machine learning. Customer behaviour analysis and modelling should provide useful inputs for the data analysis part, which in turn will lead to the tuning of machine learning algorithms modelling the preferences of the customers, and thus providing recommendations for the travel agencies. The resulting models and algorithms will be integrated by Planet Ride and Pandora in the marketplace. The data analysis (or data mining) algorithms will extract useful information from the customer behaviors on the existing platform or marketplace and identify discriminant features of the customers. This will be used as an input for machine learning algorithms taking into account customer preferences (or preference learning), and provide recommendations for new customers. Further, this may assist in dynamically segmenting customers into small groups and addressing individual customers based on actual behaviors and how they move over time to help predict some of the future behaviour of customers.

Indian Partners

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Lata Dyaram
Indian Institute of Technology (IIT)
Madras

French Partners

Christine Balagué
Institut Mines -
Télécom Business School of Management
Evry

Pierre-Alexandre Chiron
Planet Ride
Paris

Objectives

- Data analysis and mining
- Extraction of influencing features of customers
- Development of candidate preference learning algorithms
- Implementation, validation, tuning, testing of the algorithms
- Recommendation of the algorithm to integrate in the platform
- Elicit customer preference data from experimental manipulation of trip package parameters.
- Unlike drawing business implications from conventional reliance on past customer behaviour, the party anticipates to generate key insights and sound indicators allowing more accurate customer behaviour predictions with support from objective metrics and machine learning technologies
- Develop connectors and extractors to make available data required for the project
- Develop functionalities in Planet Ride applications to prepare the integration of the experimentation
- Integrate result of the experimentation in Planet Ride tools in staging environment

Knowledge Generated/Products Developed

- Realization of a literature review about: a) users' modeling techniques and the evolution of their interests over time; b) methods allowing to predict future actions of users given the model carried out
- Pre-processing and transformation of data provided by Planet Ride
- Development of two machine learning models for predicting quote requests, following the analysis of user behavior on the Planet Ride website
- Implementation of the algorithms, definition of the experimental protocol, testing the algorithms on a dataset of 2 months and a half. Other tests are in progress
- Writing an article is in progress
  - New experiments and tests on a larger dataset (one year of navigation on Planet Ride) and on an open source dataset
  - Definition of a product recommendation protocol based on our predictive model
  - Analysis of purchasing data to propose a solution that increases lead conversion of agencies
  - Organization of a seminar on recommendation systems Finalizing the writing of an article to submit to a top ranked journal and starting the drafting of a second paper
  - Development of a machine learning models for predicting quote requests, following the analysis of user behaviour on the Planet Ride website by IMT

CEFIPRA

CEFIPRA

5. Brief Reports of Research Projects

D. Targeted Programmes

Department of Science and Technology (DST) - Institut national de recherche en informatique et en automatique (Inria) - Centre national de la recherche scientifique (CNRS)

This programme was initiated in 2013 and focused on areas such as 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. During the year, two projects were completed, nine are ongoing and four new projects were initiated. Further, the 6th Call for proposals of 2018 was launched in areas of Big Data, Computer science for Biology and Life Sciences, Artificial Intelligence, Cyber Physical Systems, ICT and Applied Mathematics. The meeting of the Expert Committee for evaluation of proposals was held on 3 January, 2019 at CEFIPRA office, New Delhi. This was followed by the progress review of completed & ongoing projects on 4 January 2019 at CEFIPRA office, New Delhi. The Joint Selection Committee meeting between DST, Inria and CNRS was held on 18 January 2019 wherein two projects were recommended for support.

Completed Projects

AUTOMATED VERIFICATION OF CONCURRENT SOFTWARE (AVECSO)

Oct. 2015 to Sept. 2018

Background

The goal of this project is to design algorithmic methods for the automated verification of concurrent software systems. The focus is on models and verification algorithms for concurrent programs, verification of concurrently shared data structures and verification of distributed, geo-replicated data structures.

Principal Collaborators

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Chennai

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Paris

Publications

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

Mobility Support

- India to France: 8
- France to India: 7

Objectives

To design algorithmic methods for the automated verification of concurrent software systems

- Models and verification algorithms for concurrent programs
- 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
- Specification and verification of quantitative properties of concurrent programs
- Languate theoretic properties of well-structured transition systems
- Verification of asynchronous programs with unbounded channels
- Formalizing distributed data structures with multiple levels of consistency
- Formal verification of web services
- Specification and verification of quantitative properties of concurrent programs
- Grammar controlled vector addition systems
- Formal properties of counter systems

A BIG DATA PERSPECTIVE FOR ENERGY MANAGEMENT IN SMART 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 main objective of this work at the building level is the estimation and adaptation of human activity to grid requirements. To this end, we approached a problem of energy management in smart buildings centred on the occupant. In this a multiobjective optimization problem with a differential evolution optimizer was set up where the obtained schedule of actions is one where the comfort of the occupant is closest to the comfort at the ideal solution — which in turn is formulated with respect to a minimal thermal dissatisfaction and CO_2 based air quality dissatisfaction. The data used here was a set of sensor data collected over a year sampled at every hour of every day regarding the physical state of the room as well as the opening of doors and windows and movement of the occupants.

Principal Collaborators

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Sangmitra Bandhopadya
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Publications

- No. of publications in SCI journals : 11
- No. of papers presented in conferences: 8

Mobility Support

- India to France: 5
- France to India: 3

Objectives

- At building scale, the objective is to estimate the human activities and meet them with the collective ability of the grids to satisfy the needs of end users
- At grid scale, the objective is to study the strategic interactions (both unilateral and collaborative) between the micro-grids as a result to minimize the instantaneous or long term cost and reduce the dependencies on non-renewable energy resources

Knowledge Generated/Products Developed

- A game theoretic model for Demand Side Management has been developed where Stackelberg Games was utilized to reduce Peak-to-Average demand ratio. Experiments carried out on simulated data showed the effectiveness of the models in incentivizing users into offloading consumption onto non-peak hours
- A framework for optimal energy management in a micro-grid has been developed and studied. We also demonstrated different types of behaviour and interactions among heterogeneous producers and consumers in a global energy network
- Demand Side Management has been integrated with distributed energy generation and storage. A day-ahead optimization process has been 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
- Considering the Demand Side Management in smart buildings, we have worked on data-driven appliance usage prediction framework. Also, to handle larger datasets, we have defined a data parallel distributed architecture for our machine learning models. Significantly lower training times are demonstrated by our models as compared to the non-distributed framework
- Optimal Power Flow under Competitive Bidders was also studied where an electricity market model is formulated and analyzed under various real-life scenarios using Game Theory and Optimization Tools
- A Simulated Annealing based discrete time model was studied for the optimal generation schedule for the Distributed Energy Resources by minimizing the operational cost [C1]. The experimental results showed economic feasibility of the method in an energy market
- PIs have studied the change in power consumption of a building during the different segments of the day depending on demographic information of the house. PIs have used different clustering techniques to obtain the clusters based on day segment power and predict the aggregated power consumption in the clusters
- Estimation of occupancy and adaptation of human activities have been performed. Sensors were used in this work to record the human activities and its impact in terms of factors like thermal discomfort, indoor CO_2 concentration and heater related expenditure Multi-objective optimization has been used to provide an equi-best compromised set of actions which optimizes the comfort of the occupant in a building
- While an equi-best compromised routine is suitable for a general group of occupants, often multiple occupants have subjective preferences in regard to multiple comfort criteria. A time-constrained bargaining approach is proposed leading to a consensus solution. Such an approach with flexible control on the definition and type of fairness presents a robust alternative for decision-making which can aid the controller design for building automation and hence, the energy policy-makers in the long run
- For motivating the occupants of smart buildings for adopting energy-saving practices, causality analysis is performed through generation of contextual explanations and causal graphs. Such explanations are later integrated with human-computer interface (recommender system) to provide an overall cause-and-effect picture to the occupants

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

Jul. 2016 to Jun. 2019

Background

Machine learning is a recent scientific discipline involving Applied Mathematics, Statistics and Computer Science. Its goals are the optimization, control, and modeling complex systems from observations generated by the system. It applies to data from numerous engineering and scienti c domains (e.g., vision, bioinformatics, neuroscience, audio processing, text processing, E-Commerce, nance, 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 speci c structure is often present and hard to take into account with current algorithms. Learning from Big Data create new challenges both algorithmic (need to perform inference efficiently) and theoretical (what can be learned with large amounts of noisy data?).

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.

Principal Collaborators

Chiranjib Bhattacharyya
Indian Institue of Science (IISc), Bangalore

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

Publications

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

Mobility Support

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

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

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

Knowledge Generated/Products Developed

- Proposed Exact Penalty based framework for optimization over intersection of sets nsures approximate solutions are always accompanied with a guarantee on their in-feasibility
- For the general nonsmooth class we showed that an adaptation of the standard subgradient method requires only $O(1/\varepsilon^2)$ calls to the projection oracles of the simple sets. This improves over the existing requirement of $O(1/\varepsilon^3)$. For strongly convex functions we further improve it to $O(1/\varepsilon)$
- For the class of nonsmooth objectives with smooth saddle-point structure we present primal-dual algorithms which achieves $O(1/\varepsilon)$ complexity. This is further improved to $O(1/\sqrt{\varepsilon})$ for strongly convex objectives. These complexities are improvement over existing ones
- The paper got accepted to the proceedings of AISTATS 2018, a leading venue in Machine Learning research

REFLECTION AWARE ICC ANALYSIS FRAMEWORK FOR ANDROID APPS

Jul. 2016 to Jun. 2019

Background

The main objective 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 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

- 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

Knowledge Generated/Products Developed

- Handling of Network Reflection APIs
- Representation of solution using Formalism for all classes of Reflection i.e. Class, Method, Constructor and Field
- Slice based traversal of app (Work in Progress)

Principal Collaborators

Vijaylaxmi
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CNRS
Bordeaux

Publications

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

Mobility Support

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

MODELLING AND CONTROL OF MOBILE CO-OPERATING BIONIC ARMS

Jul. 2016 to Jun. 2019

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, o Communications and coordination among the robots to realize the global mission of system of systems

Knowledge Generated/Products Developed

- Dynamic modelling for planar cooperative bionic manipulator has been achieved and published in a conference iNaCoMM 2017, held in Mumbai
- Kinematic model has been done
- A model based controller has been designed for cooperative planar bionic manipulator. This work has been published in International Conference on Bond Graph Modelling and Simulation (ICBGM 2018), held in France

Principal Collaborators

Pushparaj Mani Pathak
Indian Institute of Technology, Roorkee

Rochdi MERZOUKI
Ecole Polytechnique Universitaire de Lille, Villeneuve d'Ascq.

Publications

- No. of publications in SCI journals : 1
- No. of papers presented in conferences: 4

Mobility Support

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

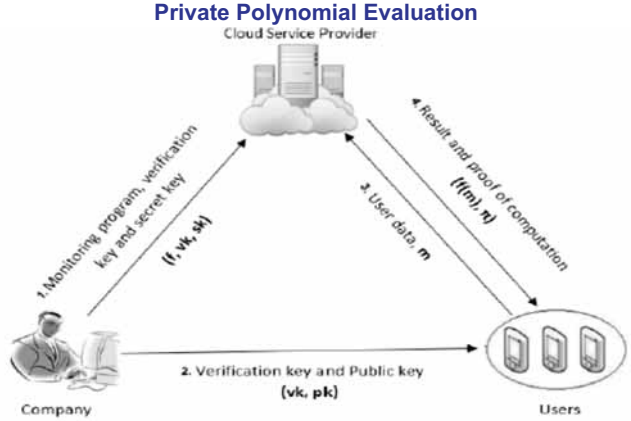
STUDY OF PRIVACY ACCOUNTING AND OWNERSHIP IN IoT

Jul. 2016 to Jun. 2019

Background

The Internet facilitates enormous opportunities to modern computing world where not only humans but also machines even tiny sensing devices can communicate and collaborate with each other. An innovative Internet infrastructure referred as the Internet of Things (IoT) is emerging as a promising infrastructure, which will be able to integrate information related to the real world (from objects) and the virtual world (computer applications). In simple terms, IoT scenarios require integration of several complimentary technologies, where information related to the real world and the virtual world will be retrieved, combined, processed, analysed, and distributed anywhere and anytime, providing new and exciting applications, challenges and opportunities.

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

- Research on secure network connectivity mechanisms and protocols that assure the confidentiality, integrity, authentication and accountability properties in IoT applications
- 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
- 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
- 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
- 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
- Development of a proof-of-concept or prototype to demonstrate the research outcomes with smart devices/phones, NFC protocols, sensors and RFID tags

Knowledge Generated/Products Developed

Both first year and second year exchange visits by both teams have been carried out. Through the exchange visits, both sides have shared domain knowledge and research outcomes as per activity plan of the project

Principal Collaborators

Manik Lal Das
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Pascal Lafourcade
University of Clermont Auvergne Clermont-Ferrand

Publications

- No. of publications in SCI journals : 5
- No. of papers presented in conferences: 9

Mobility Support

- India to France: 1
- France to India: 0

POLYHEDRAL COMPILATION AND OPTIMIZATION FOR DATAFLOW PROGRAMMING LANGUAGES

Jun. 2016 to Jun. 2019

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

Revised Objectives

PIs have discovered key scalability issues in prior art for polyhedral compilation. PIs are thus starting with a focus on scalability, which will have a significant impact both on compilation of dataflow as well as generalpurpose and domain-specific programming languages

Knowledge Generated/Products Developed

- A publication containing a major result from our collaboration was recently accepted and published at the premier venue for programming language research: ACM SIGPLAN conference on programming language design and implementation (PLDI) in Jun 2018. CEFIPRA and its DST-INRIA program was acknowledged as the funding source in the paper.
- Significant progress has been made overall, and a second paper is being prepared for submission.
- Results from the joint work have been integrated into the open-source polyhedral parallelizer Pluto http://pluto-compiler-sourceforge.net

Principal Collaborators

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Albert Cohen
PARKAS project team Inria Paris and Ecole Normale Superieure (ENS) Paris

Publications

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

Mobility Support

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

Ongoing Projects

IoT SOFTWARE TESTING USING TIMED AUTOMATA

Nov. 2017 to Nov. 2020

Background

The main scientific goal of the project is to design rigorous development and testing methods for IoT applications. A peculiar feature of IoT applications is their high degree of parallelism, soft time constraints, and absence of a global clock synchronizing all the components. PIs plan to find variants of networks of timed automata suitable to model IoT systems. The challenge here lies in incorporating the peculiarities of such systems without losing the efficient algorithmic properties of the model. PIs will also propose new verification algorithms and implement it as a part of a verification tool for timed systems. Our starting point will be the existing industrial cooperation with the Indian industry, and the verification tool for timed systems (called T-Checker) developed by the Bordeaux group. Recently, the Verification and Validation (V & V) group at Tata Research Development and Design Centre (TRDDC) in Pune (India) have developed a formalism called Expressive Decision Tables (EDT) that can be used to specify requirements of a system. This formalism has gained wide popularity among system engineers and has an increasing user base, especially in the automotive industry.

Objectives

The aim of this project is to build on this fruitful collaboration, base our work on the existing accepted EDT formalism, construct verification algorithms, and implement a tool that will be used in testing and verification of IoT systems specified in EDT. More specifically, the objectives are as follows:

- Construct a corpus of representative examples of IoT systems using EDT formalism
- Improve timed automata technology to efficiently handle EDT benchmarks
- Develop automated test generation for EDT using timed automata technology
- Develop a tool-chain for testing IoT applications

Knowledge Generated/Products Developed

- Formal semantics for EDT
- Improvements in timed automata technology (Liveness verification, Safety verification)

Principal Collaborators

B. Srivathsan
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Chennai

Igor Walukiewicz
LaBRI (Bordeaux)
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Bordeaux

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

LOOKING BEYOND BACKPROPAGATION IN DEEP LEARNING

Nov. 2017 to Oct. 2020

Background

Deep Learning has gained immense momentum since its onset about a decade back. However the concepts of deep learning were not new; they were known to the early proponents of neural networks. However it did not become a reality for two reasons:

1. Deeper networks meant more parameters (network weights) to learn; in turn this required more training data. In the early days of neural networks 90s, such humongous amount of data was not available. Big Data was a distant dream.
2. Even if large volumes of data were available for some specific problems, in early days of neural networks, computers were not powerful enough to store and manipulate such volumes.

Currently, there are two major focus in deep learning research: (1) new application areas (speech, vision, NLP etc.), and (2) new hardware architectures tailored for deep learning – in this context Nvidia's GPGPU for deep learning is well known.

Objectives

- Leveraging acceleration techniques for gradient-like methods, such as majorization-minimization approaches or generalized projectors to replace backpropagation so as to improve its convergence speed
- Instead of going for the traditional pre-training and fine-tuning phases of deep learning, resorting to parallel / distributed techniques to optimally solve deep architectures in one go
- Starting from recent works on proximal algorithms for non-convex optimization taking into account non smooth penalization terms in order to improve the performance in terms of learning accuracy while conserving high estimation speed

Knowledge Generated/Products Developed

- Preconditioning strategies relying on MM formulations
- Subspace strategies (memory gradient / L-BFGS)
- Block alternating proximal algorithms

Principal Collaborators

Angshul Majumdar
Indraprastha Institute of Information Technology New Delhi

Emilie Chouzenoux
LIGM UMR CNRS 8049, Université de Paris-Est Marne-la-Vallée Marne-la-Vallée

Publications

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

Mobility Support

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

MODELLING OF HUMAN INTENTION DURING GAIT REHABILITATION

Nov. 2017 to Oct. 2020

Background

Human cognitive and functional augmentation was a science fiction in the recent past, these are gaining a foothold in the real world, thanks to the advances in frontiers of science & technology. Exoskeleton is an enabling technology that augment the human body and its capabilities. From a military soldier to a spinal injured patient, are expected to be hugely benefitted from the advent of this technology. Correlating electrical activity in the muscles to motor intentions is essential for developing new generation of prosthetic systems. Despite significant progress, the available techniques cannot yet master the control of prosthetic devices, thus not clinically viable. The big challenge is programming it to be pliable for human anticipation with a more natural, co-operative, adaptive, bi-directional and multi degree of freedom control. This predilection motivated the research community to think in the direction to accommodate sensors for acquiring myoelectric and nerve signals to detect the wearer's intention to move before applying the assistive force.

Objectives

- Human Biomechanics for design of novel robotic aids for rehabilitation using machine learning
- Design, Modeling and virtual prototyping of device for augmenting gait assistance
- Machine learning techniques using hybridized bio-signal and gait sensor data for event and intent identification

Knowledge Generated/Products Developed

Modelling, Simulation and Design of experiments for intent based control of Exoskeleton for Ankle therapy

Principal Collaborators

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Principal Scientist,
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CSIR-CSIO
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Ahmed Chemori
CNRS Research Scientist,
LIRMM CNRS /
University of Montpellier 2
Montpellier

Publications

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

Mobility Support

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

MACHINE LEARNING FOR NETWORK ANALYTICS

Dec. 2017 to Nov. 2020

Background

In the past couple of decades network science has seen an explosive growth, enough to be identified as a discipline of its own, overlapping with engineering, physics, biology, economics and social sciences (see, e.g., the recent monographs). Much effort has gone into modelling, performance measures, classification of emergent features and phenomena, etc, particularly in natural and social sciences. The algorithmic side, all important to engineers, has been recognised as a thrust area (e.g., two recent Nevanlinna Prize (J. Kleinberg 2006 and D. Spielman 2010) went to prominent researchers in the area of network analytics). Still, in our opinion the area is yet to mature and has a lot of uncharted territory. This is because networks provide a highly varied landscape, each flavour demanding different considerations (e.g., sparse vs dense graphs, Erdos-Renyi vs planted partition graphs, standard graphs vs hypergraphs, etc). Even adopting existing methodologies to these novel situations is often a nontrivial exercise, not to mention many problems that cry out for entirely new algorithmic paradigms. It is in this context that we propose this project of developing algorithmic tools, drawing not only upon established as well as novel methodologies in machine learning and big data analytics, but going well beyond, e.g., into statistical physics tools.

Objectives

- **Network inference:** Estimating network characteristics such as diameter, edge conductances, average occurrence of specified motifs, testing hypotheses regarding graph structure, rumor source detection, network tomography, etc., furthering ongoing work in some of these as well as some new directions
- **Network algorithms:** This includes distributed algorithms on networks such as gossip based, distributed learning and optimization, and also algorithms for networks such as ranking, approximate computation of centrality measures, clustering etc.
- **Dynamic and strategic issues:** This will cover graph dynamics, dynamics on the graphs and related optimisation and estimation issues, strategic behaviour on networks, e.g., resource allocation, network based games, belief propagation, etc.

Knowledge Generated/Products Developed

- Random walk based algorithms for averaging, PageRank computation, rumour source detection, distributed optimization (ADMM)
- Resource allocation using index policies
- Analysis of content caching and delivery schemes under various settings
- Evolutionary algorithms, learning algorithms in general and for specific applications such as recommendation systems
- Persistence of the Jordan centre in randomly growing graphs

Principal Collaborators

Vivek S. Borkar
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Konstantin Avrachenkov
Inria
Sophia Antipolis

Publications

- No. of publications in SCI journals : 6
- No. of papers presented in conferences: 12

Mobility Support

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

New Projects

FORMAL VERIFICATION OF AUTOPILOT SOFTWARE FOR UAVs

Nov. 2018 to Oct. 2021

Background

Unmanned Aerial Vehicles (UAVs), commonly known as drones, are a class of cyber-physical systems that are being popular in many application domains, for example, mail and good delivery, monitoring and surveillance, search and rescue, law enforcement etc.. Any autonomous system is driven by a piece of intelligent software called autopilot. For UAVs, the state-of-the-art autopilot is Px4 [Px4], developed as part of the Pixhawk project at ETH Zurich [Pixhawk]. After its initial development, several researchers and developers have contributed to the autopilot software in various ways. The community contributing to and using Px4 autopilot is growing, and Px4 has been established as a de facto autopilot for UAVs.

As UAVs are expected to be used in safety-critical applications, the reliability of the autopilot is of prime importance. The modules of the autopilot software are currently tested manually and through extensive flight testing. As testing cannot be done exhaustively, flight testing often reveals shortcomings in the autopilot that may lead to accident causing financial loss and sometimes loss of properties or even life. For autopilot development, formal verification techniques could be employed at the early stage of development of autopilot software so that the bugs in the software can be found in the initial stage when fixing them is not expensive.

As the end-to-end behavior of a UAV under the action of an autopilot depends on the characteristics of both the vehicle and the autopilot software, verification technique needs to model both the continuous dynamics of the vehicle and the discrete dynamics of the software. Hybrid automaton [ACH+95] is a popular model for verifying systems having both the continuous and the discrete dynamics. However, generating a hybrid automaton for a complex system like UAVs and its autopilot is utterly challenging. Moreover, even though we are able to model and verify the closed-loop system successfully, it will be difficult to confirm that no bug is introduced during the implementation of the autopilot and the system in operation is free from any error.

In this project, PIs aim to create a model based development (MBD) process for the autopilot of an UAV. In this process, model for the vehicle and the autopilot software will be developed, the model will be converted to hybrid automata automatically, the hybrid automata will be verified using a state-of-the-art verifier and finally the code of the autopilot will be generated automatically from the model. Further, the verification process will be used to debug the autopilot software and to synthesize different parameters automatically.

Verification tools like Astree [BCC+03] and Fluctuat [GPBG07] have been successful in proving various safety properties of controller programs, such as the absence of arithmetic or buffer overflows. However, the absence of a plant model makes it hard to verify properties of the entire feedback control system that depend on the interaction between the plant and the controller. The need of analyzing both the plant and the controller code has been expressed before [Cou05,GMP06,AMST10,Fer10], and some tools to perform closed-loop simulation of feedback control systems have been developed (cf. [AKRS08, LKM+08, MSSZ12, ZSDX16]).

Principal Collaborators

Indranil Saha
Indian Institute of Technology Kanpur

Goran Frehse
Laboratoire Verimag
Université Grenoble Alpes
Grenoble

Objectives

In this project, objectives is to establish an end-to-end model-based development for software for autonomous systems, which is governed by the verification of closed loop control systems modeled as hybrid automata

- Modelling an autonomous vehicle in Simulink
- Modelling of an Autopilot in Simulink
- Translating the closed-loop Simulink model to Hybrid Automata using Sl2SX Tool
- Verification of the Hybrid System
- Automatic Debugging of Simulink Model of the Autopilot
- Parameter Synthesis for Simulink Model of the Autopilot

EFFICIENT QUANTITATIVE VERIFICATION

Sep. 2018 to Aug. 2021

Background

Formal modeling and verification is a well-established approach for analyzing hardware and software systems that has gained acceptance both in academia and the industry over the last 30-40 years. A lot of effort has been devoted to Boolean verification of discrete systems, i.e., formal analysis of systems that check whether a given property is true or false. However, this has proved insufficient when trying to analyze so-called cyber-physical systems that combine some discrete features with the physical environment that is neither Boolean nor discrete and instead is highly quantitative and imprecise. Indeed in such cyber physical systems, a Boolean verdict is not sufficient. Notions of interest are for instance the amount of confidential information leaked by a system, the proportion of some protein after a duration in some experiment in a biological system, or the correct protocol to reach this proportion, whether a distributed protocol satisfies some property only for a bounded number of participants, the time needed by a metro rail to catch up with an expected schedule after a delay, and so on. These real-life examples can be addressed only in a quantitative, stochastic and timed setting, in which one expects verification algorithms to compute a value such as the probability for a property to hold, the mean cost of runs satisfying it or the time needed to achieve a complex workflow. Quantitative verification of cyber-physical systems hence brings new difficult challenges that cannot be addressed with the same techniques as in the Boolean context. Further, this quantitative aspect brings an additional dimension for verification, as infinity does not only come from the non-deterministic control choices, but also from the unbounded number of values that may appear in the system. To have a practical impact, verification algorithms also have to be efficient. Solutions to quantitative problems should belong to tractable complexity classes, even at the cost of some approximation. Verification questions are often PSPACE complete or worse, but some classes of models allow polynomial time (Boolean) verification [Esparza95]. Similarly, some questions related to costs in timed models have polynomial solutions [BouyerFLMS08]. Nevertheless, the current state-of-the art of knowledge about efficient classes in a quantitative setting is highly limited and this forms the context of our project. The main objective of this project is to study efficient techniques for quantitative verification of cyber-physical systems, and develop efficient algorithms for models of such systems that involve time and/or randomness. A first and immediate challenge is to have good models for such systems that would capture the necessary features while remaining tractable. In this project, we plan to focus on classical as well as new models including stochastic timed games, Markov decision processes, and different variants of timed and concurrent systems. Indeed one objective of the project is to classify the problems and models of cyber-physical systems in terms of tractability. The project is organized along three main research directions: The first direction is dedicated to timed systems, with an emphasis on efficiency of algorithms for the verification of timed properties of concurrent systems. The second line of research will consider the control of stochastic models.

Principal Collaborators

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Indian Institute of Technology Bombay
Mumbai

Loïc Hélouët
SUMO Team, INRIA CR1
Rennes

Objectives

- Efficient Algorithms for Timed and Concurrent Models
- Efficient Control of Stochastic Systems
- Timed & stochastic games

GAMES AND OPTIMIZATION FOR ENERGY MANAGEMENT WITH STOCHASTICITY (GOEMS)

Sep. 2018 to Aug. 2021

Background

The theory of copula is known for years in probability theory and mathematical statistics to describe the dependency structure of a random vector. PIs will use this notion to characterize the dependence between constraint rows of the probabilistic optimization and game problems, and also between random variables in multistage/dynamic framework. At the best of PIs knowledge, copulae have been scarcely used in stochastic optimization and game theory. The copulae theory is a powerful dependence modelling tool for various types of problems. It allows to model the dependence between different random variables in a unified setting and to develop new and powerful solution methods 4 based on this formulation. The French applicant is one of the leading experts in this field. Using the copulae approach for stochastic problems has been started by Henrion and Strugarek . PIs would like to go beyond their work and explore new areas where the modelling tool of nonexplored copulae can add new insight and provide improved solution methods to stochastic optimization problems and games. PIs emphasis on risk under conditions of both exogenous and endogenous uncertainty in combination with copulae theory represents the principal novelty of this project. This calls for development of novel numerical approaches which will be the core of our study. This will enable us to address the novel applications to industry and services that the available techniques were not able to tackle. Multistage stochastic programs and dynamic games bring computational complexity which may increase exponentially with the number of decision stages and the size of the scenario tree, representing a discretization of the underlying random process. Dynamic games arise between players when the strategic interactions among them recur over time. Decision makers change strategies over a period of time, and they are interested in strategies that maximizes the expected payoff over time horizon (finite or infinite). The players' payoffs for finite horizon problem can be defined as total expected payoff criterion, whereas the infinite horizon payoffs can be modelled using expected discounted payoff or limiting average payoff. In more practical problems, players also face certain constraints at every decision epoch. Such constraints could be of budget type constraints or resource constraints. The constraints are stochastic in nature due to presence of hidden random demands and underlying costs. The random constraints of each player are also dynamic in nature which can be modeled as "Dynamic chance constraints". Then, in this case each player is interested in maximizing the expected payoff collected over the horizon subject to his dynamic chance constraints. This game theoretic problem involves the integration of game theory, stochastic dynamics programming and dynamic chance constraints. French and Indian teams have a large experience in management optimization problems using either deterministic or stochastic optimization. French teams ran projects with EDF, the national energy company, on different energy optimization problems. The French PI had already supervised a PhD thesis on energy management problems. The Indian team has also a large experience in stochastic games. Usually, these problems are NP-hard (meaning there is no hope to design polynomial time exact algorithms for them), and we focus on designing fast, efficient approximation algorithms for them with proved performance guarantee. The Indian PI is currently working on stochastic Nash games under chance constrains & its equivalent formulations as mathematical programs, complementarity problems and variational inequality problems.

Principal Collaborators

Vikas Vikram Singh
Indian Institute of Technology Delhi

Abdel Lisser
Laboratoire de Recherche en Informatique (LRI) Université Paris Sud Paris

Objectives

The objective in this project is to put together experiences both in energy management problems and in stochastic optimization and games in order to solve more challenging real-life energy problems

- Study of stochastic Nash game problem with dependent stochastic constraints using copulae
- Study of multistage stochastic optimization as well as dynamic game problems under time variant stochastic constraints
- Applications to renewable energy management problems

FOGCITY: QOS-AWARE RESOURCE MANAGEMENT FOR SMART CITIES

Aug. 2018 to Jul. 2021

Background

The modern era of technology is witnessing the emergence and evolution of the Internet of Things (IoT), which encompasses billions of smart devices connected over the Internet. These devices generate a high volume of data, which are currently managed within cloud data centers. However, many IoT applications are latency-sensitive and need faster turnaround than what can be provided by cloud [1]. Fog computing has emerged as a means of providing computation near the data sources (IoT devices) to serve these latency sensitive applications and reduce the burden on the cloud infrastructure. Therefore, fog computing is the appropriate computing paradigm to support the specific requirements of smart, IoT-based eco-systems, especially smart city applications. Nonetheless, serving smart city applications using fog data centers induces many challenges. Fog platforms are essentially tiny and resource-constrained data center clusters that are geographically distributed. Therefore, it is important to select node(s) in a data center suitable to serve an incoming application by meeting its Quality of Service (QoS). In this regard, the existing cloud-based solutions (honey bee approach, biased random sampling, and active clustering) for data center scheduling are inappropriate because they involve migrating applications between data centers which affects the turnaround time of latency-sensitive applications (such as applications involving vehicular communications, drones, flight control, and traffic monitoring). To address this issue, we propose data center scheduling strategies for smart city applications exclusively in a fog environment.

Principal Collaborators

Sudip Misra
Indian Institute of Technology Kharagpur

Christine Morin
Research Director at Inria Rennes

Objectives

- Selection of a data center to ensure the QoS of applications in terms of the service latency
- Selection of the computing node(s) for optimal resource utilization within the data center and subsequent load management of the nodes

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 Department of Science & Technology (DST), Govt. of India and the French Embassy in India joined hands for Indo-French Scientific Networking Programme in the field of Water. This networking programme is being implemented by CEFIPRA. The areas of interest are particularly (a) Waste water treatment (Industrial/ Domestic); (b) Natural water treatment systems. Two projects were supported for implementation under this programme. As on September 2018, both the projects were completed. Decision for the next Call is awaited from the stakeholders.

SWACHH NEER - UNE VIE MEILLEURE: COMBATING WATER ISSUES THROUGH INDO-FRENCH NETWORKING

May 2016 to May 2018

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.

Dr. Julie Mendret
Associate Professor, Institute Européen des Membranes (IEM), UMR Université Montpellier

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

Principal Collaborators India

Jitendra K Pandey
University of Petroleum and Energy Studies

Parsenjit Mondal
Indian Institute of Technology (IIT), Roorkee

Sukdeb Pal
National Environmental Engineering Research Institute (NEERI), Nagpur

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(Industrial Partner)

Principal Collaborators France

Benoit Teychene
Université de Poitiers Poitiers Cedex

Patrick Loulergue
Université de Rennes 1, Rennes

Szymczyk Anthony
Université de Rennes 1, Rennes

Julie Mendret
Université Montpellier, Montpellier

Jean Milidakis
WASTE & WATER SARL, Villers -les-Nancy
(Industrial Partner)

Knowledge Generated/Products Developed

- The thematic school and workshop were organized (In India & France) for students, educators, researchers, scientists, engineers, and industrialists, engaged in a wide range of water related research & applications invoving Indian & French partners of various universities and industries
- Development of jointly comprehensive review on desalination technologies Journal of Organic Chemistry (2018 Submitted) & Collaborative Editor of Thematic Issue of Journal of Organic Chemistry on the theme Polymer nano-composites and membranes for water treatment (2017)
- **Collaboration for Erasmus+:** *The Erasmus Programme is an EU exchange student programme that has been in existence since the late 1980. Its purpose is to provide foreign exchange options for students from within the European Union and it involves many of the best universities and seats of learning on the continent. Application process is completed between University of Poitiers and University of Petroleum and Energy Studies*
- Based on evaluation matrix that has been developed to screen the various alternative technologies for water treatment, it was concluded that use of composite membranes, nano-filtration techniques, absorbents and cellulose based materials could address the water related issues in the selected region to remove personal care chemicals/emerging pollutants from water. Membrane and adsorbent-based hybrid technique can be developed for desalination

Indo-French Thematic School & Workshop on Water Treatment and Management
University of Petroleum and Energy Studies, Dehradun
28-29 March, 2018

GREYWATNET: NETWORK ON DECENTRALIZED GREY / WASTE WATER TREATMENT & RECYCLE

Jun. 2016 to Sept. 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).

Principal Collaborators India

H N Chanakya
Indian Institute of Science
Bangalore

M. M. Ghangrekar
Indian Institute of Technology,
Kharagpur

Srikanth Mutnuri
Birla Institute of Technology and Science,
Goa Campus

Arun Kumar Thalla
National Institute of Technology Karnataka (NITK),
Mangalore

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)

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-H_2O_2 reagent based treatment to maximize bacterial removal and assess their utility for purified greywater

Knowledge Generated/Products Developed

- The network was organized around 4 meetings, under the project in India (Bangalore and Goa) and in France (Nantes) that structured the collaboration. The meeting in Nantes was very important because it was coupled with the IWA specialized conference on "small water treatment systems" and a special session was dedicated to grey water with a presentation of the GreyWatNet network and brought the attention of worldwide professionals to the challenges and emerging scientific results
- A major outcome of this project is the IMPRINT project, which the Indian partners of the GreyWatNet network have succeeded in obtaining funding on the theme of greywater treatment. This made it possible to fund the research on this topic at pilot scale and evolve prototypes that are now being field tested. As typical Indian households have begun to use a lot more household chemicals products (HCP) in daily life and these have been shown to thwart serious efforts to biologically treat wastewater efficiently and economically. This project has designed a 4 stage greywater treatment plant that can treat greywater to levels < 10 COD, < 2 NTU even in the presence of 10-15 ppm of surfactants and ~3-5 ppm of antimicrobial substances at costs ₹10/m^3 of treated greywater with >3 years between maintenance. The process is completely automated and IOT enabled to allow constant monitoring. Early stage production costs range around ₹40,000 for a setup using market available HDPE containers while it costs about ₹80,000 for an MS & FRP based unit. Mass production costs are expected to reduce the production
- As part of the GreyWatNet project, 3-month internship was carried out at INRA in France by an Indian doctoral student on greywater treatment using a new aerobic process whose originality lies in the fact that activated sludge is replaced by phototrophic granules that produce oxygen *in-situ*, which should considerably reduce the environmental impact of existing stations or even achieve a positive energy balance in the station

DESIGN AND DEVELOPMENT OF AN ELECTROCHEMICAL IMMUNOSENSOR FOR THE DETECTION OF AMYLOID BETA IN BIOLOGICAL FLUIDS OF ALZHEIMER'S PATIENTS COLLECTED ON DRIED MATRIX SPOTS

Jul. 2017 to Jun. 2019

Background

The global, progressive and irreversible deterioration of many cognitive functions associated with AD are hampering the daily life of patients. Current diagnostic procedures of AD are difficult and are made in an advanced stage of the disease. Therefore, it is clinically important to find accurate markers for AD by new non-invasive methods that may facilitate the diagnostic process, identify patients at an earlier stage and monitor biochemical effects of the treatments. The continuing demand to develop fast, simple and inexpensive analytical methods for the determination of many clinical and biochemical parameters has motivated us to propose the development of a novel and innovative solution for the detection of AD biomarker, Aβ peptides, using a combination of preanalytical approaches and sensitive label free immunosensor to facilitate and enable early AD diagnosis. To achieve this, we have tested (i) dried matrix spot (DMS) in combination with classical immunodetection of Aβ peptides and (ii) several self assembled monolayers (SAM) and optimized experimental conditions to promote the best immobilization on the gold surface. Further, gold nanoparticles will be electrodeposited and the antibody will be immobilized on modified SAM/gold electrode. The electroanalytical behavior of the developed biosensor will be characterized in terms of calibration data and will be successfully applied to synthetic solutions of Aβ recovered from DMS. The developed preanalytical and analytical process biosensor will be IP protected.

Objectives

- The immunosensor construction which comprises three main steps:
  - (i) Formation of a self-assembled monolayer on the gold surface in order to control the electrode interface. Several self-assembled monolayers (SAMs) were tested and experimental conditions have been optimized in order to promote the best immobilization on the gold surface
  - (ii) Electrodeposition of gold nanoparticles on the modified SAM/gold electrode. Gold nanoparticles are believed to enhance the biosensor response and allow antibody immobilization. Different methods for gold nanoparticles synthesis will be tested and compared
  - (iii) Immobilization of the antibody on the gold nanoparticles/ SAM/gold electrode. Concentration of the antibody and time of incubation will be optimized in order to promote the desired immobilization
    - The validation and the optimization of the DMS use for amyloid peptides
    - The validation of the immunosensor detection for amyloid peptides

Knowledge Generated/Products Developed

- Formation of self- assembled monolayer with good surface area
- Optimized protocol for a robust and efficient detection of Aβ from DMS
- Final protocol for clinical validation study
- Obtain permission to start clinical validation studies

Principal Collaborators

Shushil Choubey
Transintegra Healthcare Pvt. Ltd.
Bhubaneswar

Bruno Filoche
Director of Development,
Spot-To-Lab, Cap Oméga
Montpellier

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Laboratory of Biochemistry and Clinical Proteomics,
IRMB Hôpital St Eloi
Montpellier

Publications

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

Mobility Support

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

CEFIPRA

5. Brief Reports of Research Projects

E. Innovation Programme Through Public Private Partnerships

BIRAC-CEFIPRA Programmes through Public Private Partnerships (PPPs): Biotechnology Industry Research Assistance Council (BIRAC) and CEFIPRA signed an MoU for improving the competitiveness of Indian Industries through French collaboration. Under this MoU, BIRAC supports Indian Industries & CEFIPRA's role as facilitator is to bring the homologous organizations from France for supporting French industries. In August 2017, the MoU between BIRAC & CEFIPRA was extended for a period of 2 years till February 2019. The following two programmes were developed under this MoU:

BIRAC-CEFIPRA-Banque publique d'investissement France (Bpifrance) Programme

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 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 that lead to the development of sensitive, specific and affordable diagnostic tests, new therapeutic options in terms of therapeutic proteins or drugs and affordable process development for existing therapeutics. The second call for proposals 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.). One proposal started in October 2017 is ongoing.

MEDEO-INDIA

Oct. 2017 to Oct. 2020

Background

Medeo-India is a collaborative project between the French startup Medeo and the Indian group Vishwakarma International, part of the Bhuwalka Premier Group. This project is focused on developing, innovative solution in the digital health industry, in order to improve health in India, by monitoring post-surgery patients or the ones that suffers from chronic disease or NCDs (non-communicable disease).

Nowadays, there are several means to facilitate telemedicine in India, in particular with the set-up and emergence of many telemedicine centers. However, many of those centers are very dependent on government support and does not sustain when the help is withdrawn. That's why, PIs are also looking at a collaborative business model approach for the project's longevity.

Principal Collaborators

Kamal Kumar Bhuwalka
Managing Director
Vishwakarma International Private Limited
Bangalore

Rémi Jean Berger
CEO, Medeo SAS
Lyon

Objectives

- PIs plan to develop a smartphone application and a web modular application that can be customized according to the user needs
- The basic account will have a free therapeutic educational program that will inform and teach patients how to live in a better way with their disease with some lifestyle advice and recommendation made by specialists
- For more options, a subscription system allows users to improve their experience with the application and add more functionalities to suit their needs, such as use of the connected device interface and the data collection visualization platform for both practitioners and patients' family

Knowledge Generated/Products Developed

- Mobile application developed for IOS and Android
- Integration of 60 medical devices with Medeo platform
- Medical software with configurable care plans

BIRAC-CEFIPRA-French Embassy Programme

BIRAC, CEFIPRA and French Embassy in India 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 from the area of Cardiovascular Diseases were completed under the 1st Call.

The second call was launched in October 2015, from the identified areas of Molecular Diagnostics for Prediction of Alzheimer's and Other Dementia, New Assisting Technologies for mobility of physically challenged (including prosthesis and robotics applications), Biomaterials and Cell Engineering for health applications. One project under this Call was completed in June 2019.

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Objectives

- The immunosensor construction which comprises three main steps: (i) Formation of a self-assembled monolayer on the gold surface in order to control the electrode interface. (ii) Electrodeposition of gold nanoparticles on the modified SAM/gold electrode. (iii) Immobilization of the antibody on the gold nanoparticles/SAM/gold electrode. Concentration of the antibody and time of incubation will be optimized in order to promote the desired immobilization
- The validation and the optimization of the DMS use for amyloid peptides
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Knowledge Generated/Products Developed

- Formation of self-assembled monolayer with good surface area
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- Final protocol for clinical validation study
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Bruno Filoche
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Sylvain Lehmann
Laboratory of Biochemistry and Clinical Proteomics, IRMB Hôpital St Eloi, Montpellier

SGRI Project

MULTI-OBJECTIVE OPTIMIZATION OF DAY LIGHTING SYSTEMS

CEFI/PPP/SGRI/2014/2 **Jan 2015 to Oct 2018**

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 were developed
- Existing solutions for static and rotatable light shelves were 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 was achieved without much infra-red transmission

Principal Collaborators

Benny Raphael
IIT Madras, Chennai

Arunvel T
SGRI Chennai

Publications

- No. of publications in Journals: 01
- No. of papers presented in conferences: Nil

Photographs from the project work

The arrangement of second order pulley system as shown in the figure

TDB-CEFIPRA-Bpifrance Programme

Technology Development Board (TDB), a statutory body of the DST, GoI with a mandate to promote development and commercialization of indigenous technology and adaptation of imported technology for wider application in domestic market. Bpifrance is a public investment bank which finances business from the seed phase to transfer to stock exchange listing through loans, guarantees and equity. TDB and Bpifrance have signed an MoU in April 2016 to invest in Indian and French companies respectively. Subsequently, CEFIPRA, TDB and Bpifrance signed LoI and Procedure Document on 10 May 2016 at New Delhi.

Under this programme, each project shall have at least one company from India and one from France each as 'Joint applicants' (1+1 model). Proposal submission is open during the entire duration of MoU, i.e. till 10 April, 2021. Call for Proposal(s) are for Indian and French companies/Industries/SMEs from the areas of Aeronautics, Automotive & Biotechnology.

Under, Technology Development Board (TDB)'s bilateral programme with Bpifrance managed by CEFIPRA, one project entitled "Development and Commercialization of IMRT/IGRT based Treatment Planning System (TPS) for 6MV Medical LINAC" in the area of medical devices submitted by Panacea Medical Technologies Pvt Ltd, Bangalore (Indian partner) and DOSIsoft SA, Cachan, France (French Partner) was implemented. The project envisages the development of IMRT/IGRT based Treatment Planning System (TPS) for 6 MV Medical LINAC and its commercialisation for making the cancer treatment cost effective. The software being developed works as assisting system for beam delivery device with unique contouring solution to improve the productivity and streamline the process of planning and treatment. The project was sanctioned and exchange of loan agreement was carried out by TDB with the Indian partner in March 2018. After following the TDB's funding guidelines, the first instalment of the loan amount was disbursed by TDB to the Indian company Panacea Medical Technologies Pvt Ltd., Bangaluru in March 2018.

Active dissemination of information of this programme through emails has been done by Centre by contacting CII, IFCCI, IamSMEofIndia and various Indian (>300) industries. TDB, CEFIPRA in association with Federation of Indian Chambers of Commerce and Industry (FICCI) and Indo French Chambers of Commerce & Industry (IFCCI) organized an one day B2B Summit and Industry in Aeronautics and Aerospace sector on 14 September 2018 at Bengaluru. The principle aim of the event was interactive meeting among industries to explore as well as develop business opportunities in aeronautic/defense equipment manufacturing and technology transfer. Over 90 delegates from big and small aerospace/aeronautics industries including start-ups and Indian government sectors like research laboratory CSIR NAL, representatives from Indian Navy and Airforce participated in the meeting.

Exchange of loan agreement between TDB and Indian partner Panacea Medical Technologies Pvt. Ltd., Bengaluru

Interactions with Industries at B2B Summit for Aeronautics and Aerospace sector on 14 September, 2018 at Bengaluru

CEFIPRA

CEFIPRA

6. Analysis of Scientific Activitites

CEFIPRA is committed to aligning its scientific programmes with trends in the research world and the priorities of stakeholders.

The Core Programmes of the Centre including Collaborative Scientific Research Programme (CSRP), Industry-Academia Research & Development Programme (IARDP) and Seminars are funded by the nodal agencies from Indian side viz the Ministry of Science and Technology and Ministry for Europe and Foreign Affairs from the French side, for quality collaborative research in advanced areas of S&T.

The Non-Core Programmes are funded by National Funding agencies of India and France with the aim to foster the Indo-French collaboration in scientific research for targeted areas. In these programmes, CEFIPRA's role is as a catalyst, facilitator and enabler to reach out to the scientific communities with emphasis on developing systematic linkages to support and implement research activities.

These Indo-French collaborative projects facilitated the scientific institutions & scientists via providing opportunity for transfer of technologies/products/processes/publications/patents/ joint PhDs /joint labs. CEFIPRA over a period of three decades has been playing an active role between the two scientific communities in promoting the emergence of collaboration and mobility in both directions.

The supported Seminars/Workshops during the year enabled more than three hundred participants from Indian and French institutes for knowledge-sharing on science and technology in the areas of current relevance. Moreover, these interactions among the scientists and technologists of the two nations developed close links, enhanced student & faculty exchanges and conceptualized collaborative research. The Centre has achieved its mandate through its core activities for societal benefits, which reciprocates into knowledge generation in priority research areas.

Core Programmes

Every year CEFIPRA supported projects have been making a great impact through their compelling outcomes. During the reported period, these programmes enhanced the institutional linkages to more than thirty five. The key to the success of these core programmes is the importance of a bottoming up approach and productive collaboration of scientists, inclusion of industries and R&D labs in their programs has further added value to their competitiveness and creating awareness for both countries.

Collaborative Scientific Research Programme

In the year 2018-19, eighteen new projects were initiated under the Collaborative Scientific Research Programme (CSRP) of CEFIPRA while forty two projects were ongoing from the previous years, out of which fourteen were completed during the reported period. During two calls in the year 2018-19, CEFIPRA had received 185 new proposals. The Centre reviewed 83 and 102 new proposals in its 61st and 62nd Scientific Council (SC) meetings respectively. Out of these proposals, eighteen were recommended for support. A total of seventeen ongoing projects were reviewed during mid-term of the project cycle in the areas of Computational Science (1), Life & Health Sciences (3), Materials Science (3), Pure & Applied Chemistry (3), Pure & Applied Physics (5), Pure & Applied Mathematics (1), Earth & Planetary Sciences (1), Figure 1, depicts the status of total number of CEFIPRA projects implemented w.e.f. from 1 April 2018 to 31 March 2019.

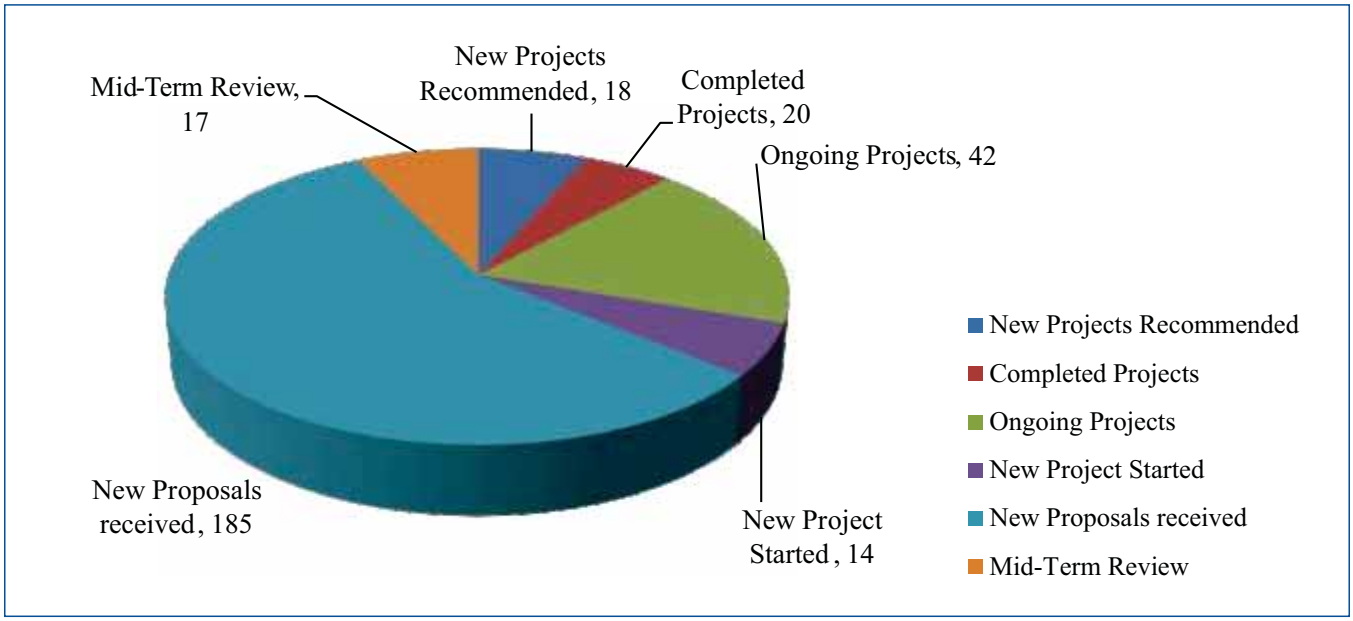


Figure 1- Status of CEFIPRA Projects handled w.e.f. 1 April 2018 - 31 March 2019 under Collaborative Scientific Research Programme

New Projects Commenced:

The Council evaluated the scientific merit of the 185 new proposals on the basis of comments received from the referees and discussions amongst the members. As a result, the Scientific Council in its 61st and 62nd meetings recommended 18 proposals for support. The thrust area-wise distribution of the proposals received and recommended for support during the year 2018-19 is shown in figures 2 and 3. From the figures 2, 3 and 4, it is evident that the area of Life & Health Sciences, Pure & Applied Chemistry and Pure & Applied Physics continues to have a higher share of the proposals recommended whereas, Life & Health Sciences have a higher share of the proposals received.

Thrust Area-wise Distribution of Proposals considered and recommended for support in 61st and 62nd SC

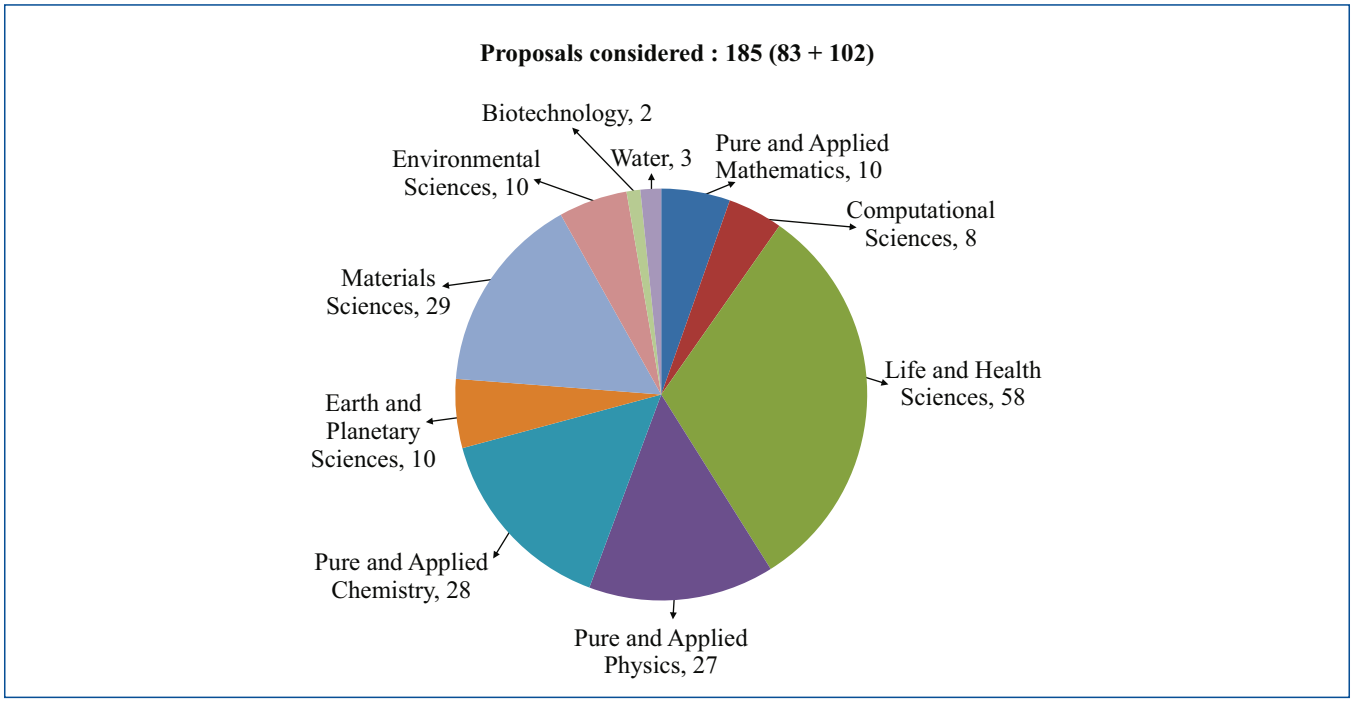


Figure 2- Area-wise Distributions of New Proposals Considered during the year 2018-19

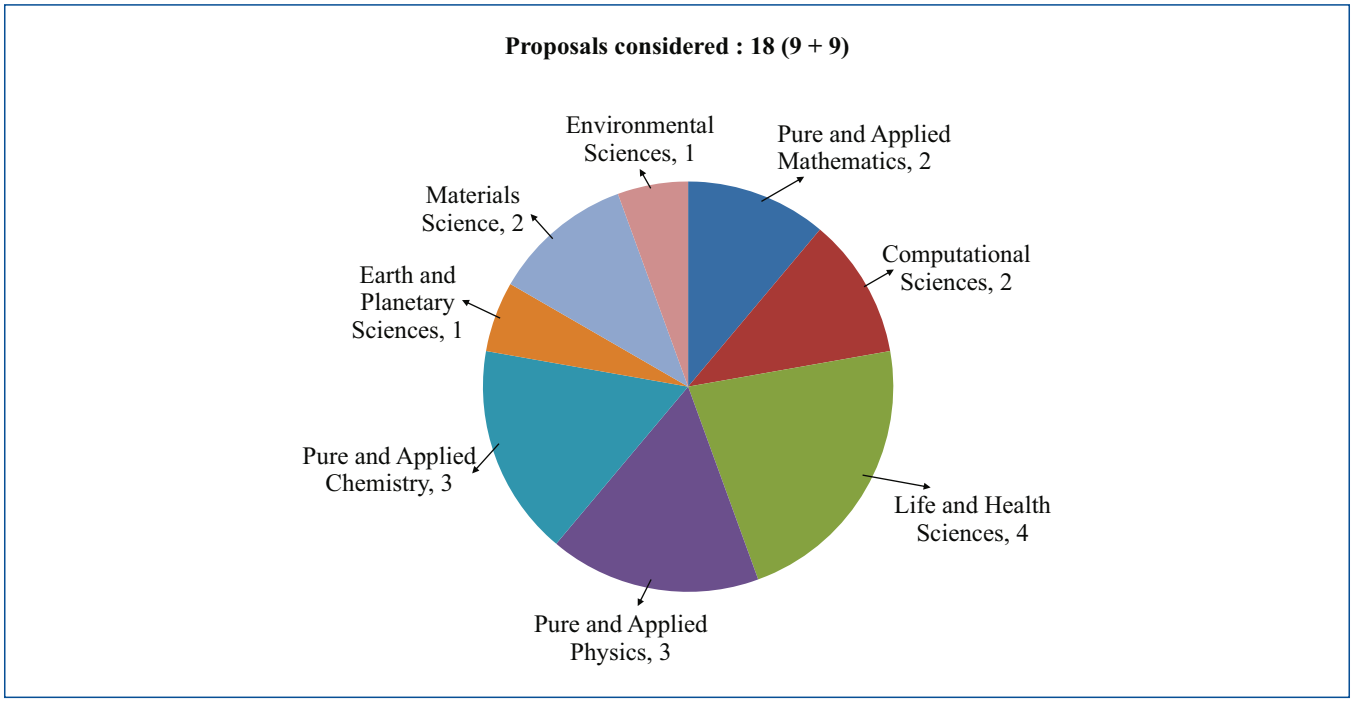


Figure 3- Area-wise Distributions of Projects Recommended in 61st and 62nd meetings of Scientific Council (SC)

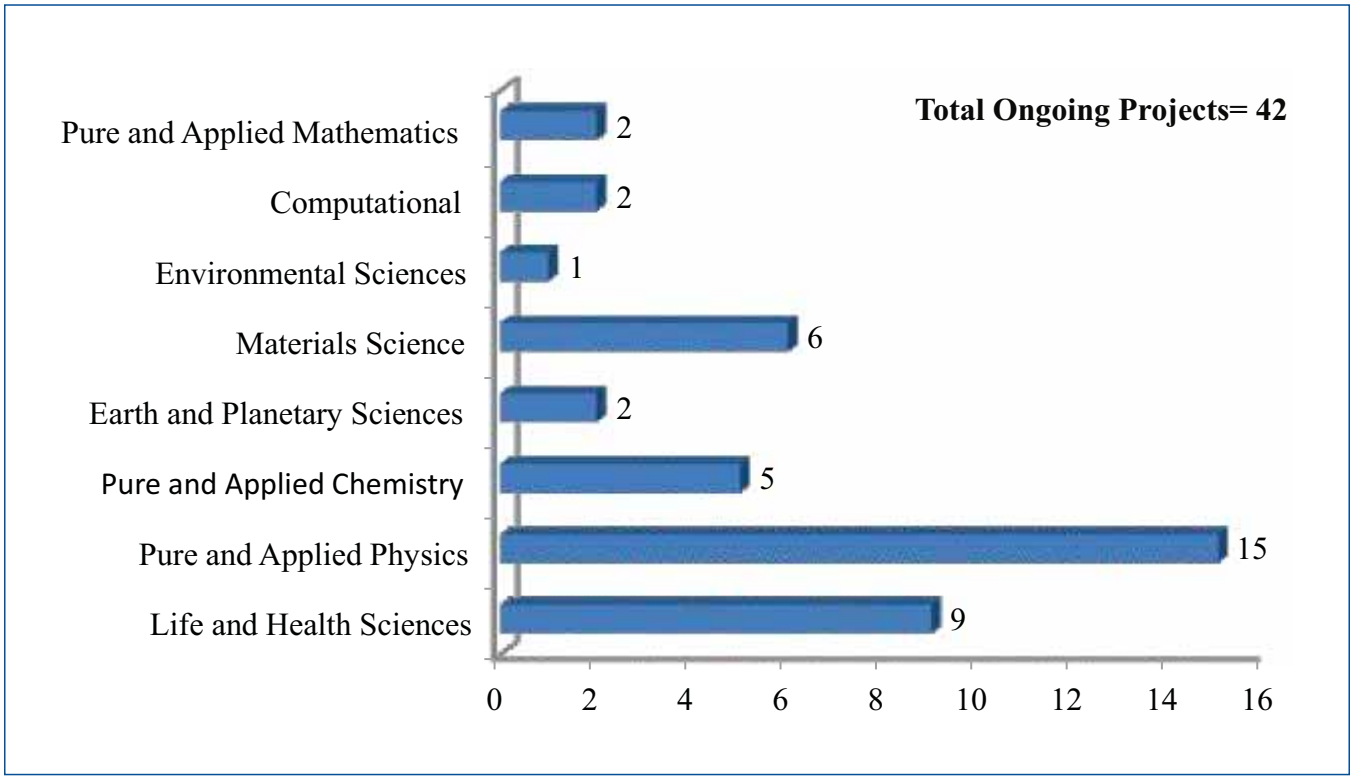


Figure 4- Area-wise Distrubution of Ongoing Projects

Ongoing Projects:

As on 31 March 2019, forty two projects (excluding 14 new projects started) were under implementation at various Indian and French research Institutes. During the two Scientific Council meetings, the members carefully monitored the midterm progress of 17 ongoing projects and suggested corrective measures for smooth operation of projects. In figure 4, an area-wise distribution of these ongoing projects is depicted.

Completed Projects:

During the reported year, Scientific Council reviewed the completed projects (Figure 5). The Council 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 and collaboration between the research teams. As per the grading given by Scientific Council to the eighteen completed project, performance index shows that 10 were Excellent, 5 as very Good and 3 as Good. The ten projects graded as "Excellent" were from the areas of Physics (4), Life & Health Sciences (2) and one each from Chemistry, Biotechnology, Maths and Material Sciences (1). Additionally, 5 projects graded as "Very Good" were from the area of Life & Health Sciences.

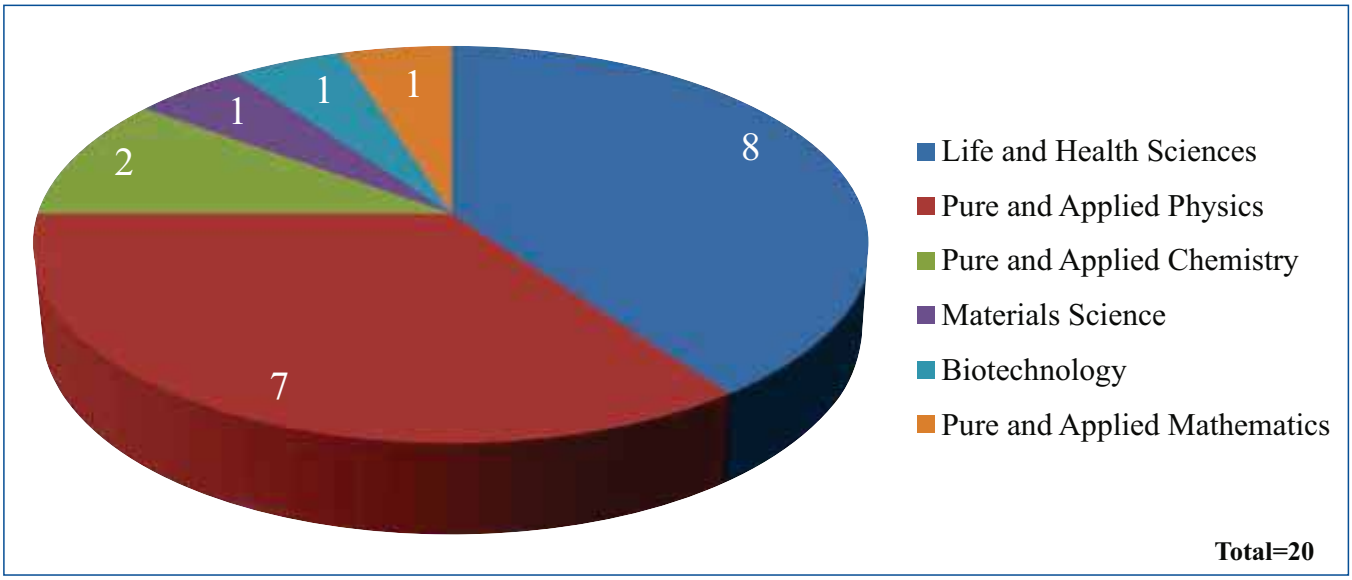


Figure 5- Area-wise Distribution of Completed Projects

Under these twenty completed projects this year, a total of 64 doctoral and post-doctoral students (39 in India & 25 in France) were supported in various labs in India and France. 122 mobility/exchange visits (62 from India to France and 60 from France to India) were facilitated (Figure 6) under these completed projects.

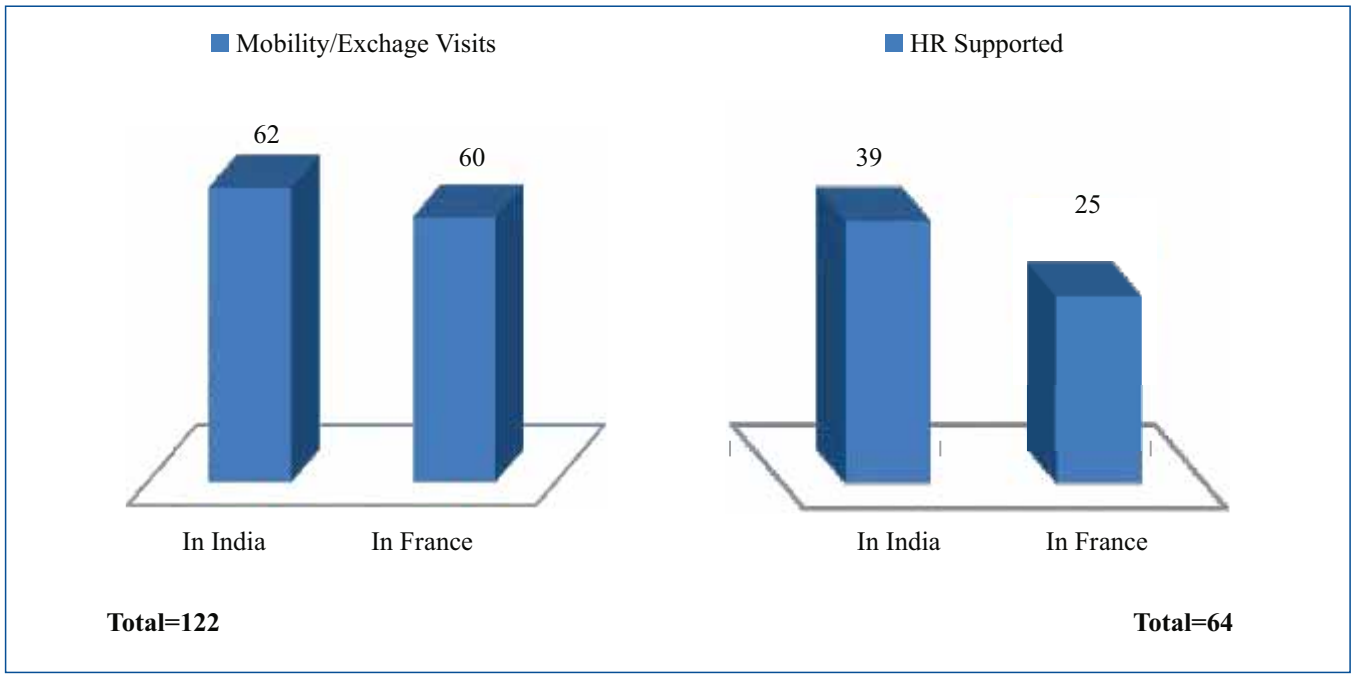


Figure 6- Outcomes in terms Exchange Visits and HR supported under completed projects.

Publications Emanated from Completed Projects

The twenty completed projects resulted in 193 publications. The areas of Pure & Applied Physics, Life & Health Sciences, Pure & Applied Chemistry and Materials Sciences (Figure 7) are having the 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 Scientific Reports*.

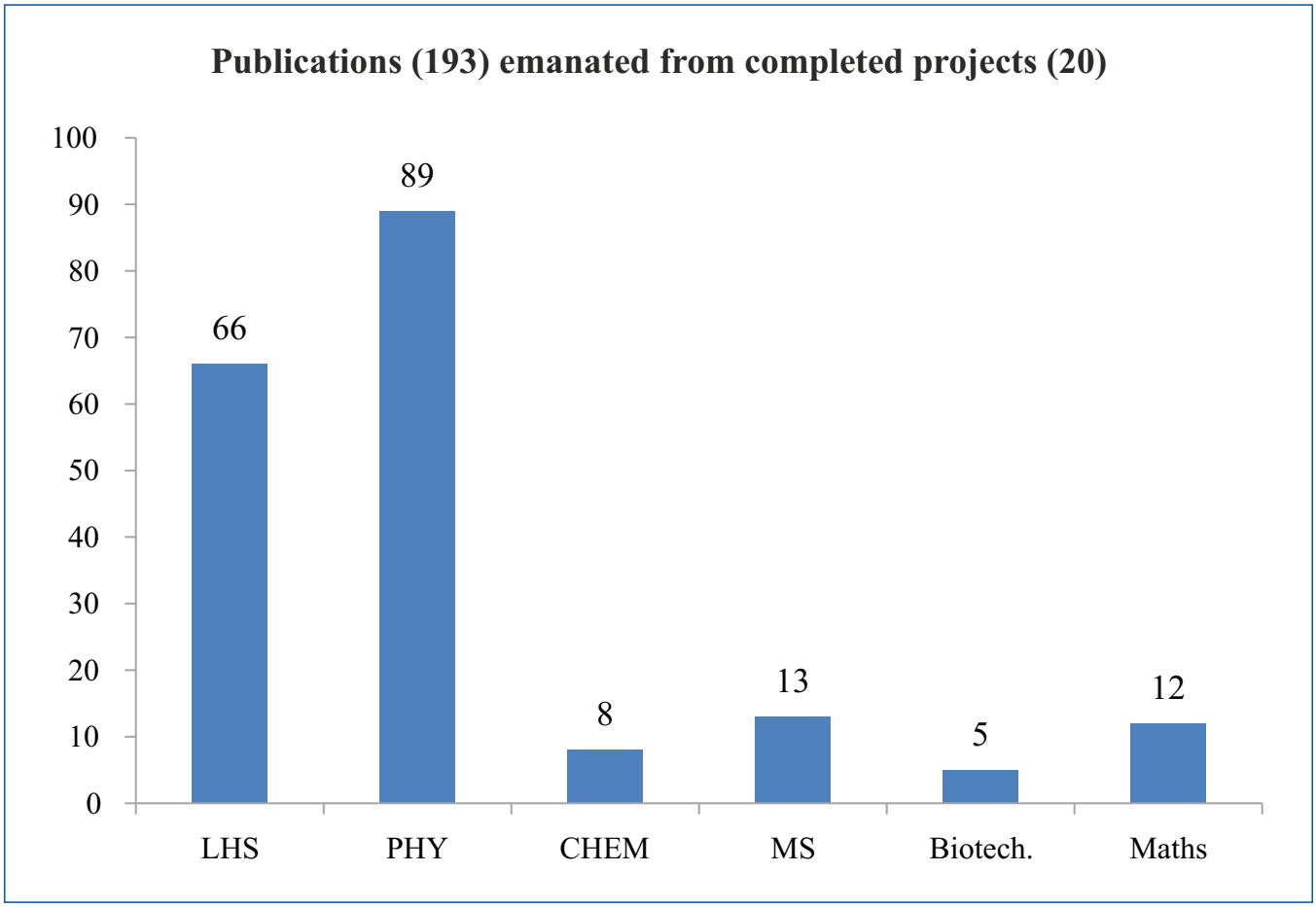


Figure 7- Thrust Area-wise Number of Publications Emanated from Completed Projects

The number of papers emanating from a project depends on several factors such as the nature of the project, the subject area, number of scientists and researchers working in the project, number of collaborators in the project and so on. It is seen that on an average, 2.24 research papers resulted from each of the 20 CEFIPRA projects. The project, "Self-similar optical patterns in nonlinear media" (Project code 5104-2) produced the maximum number of publications -59 (Web of Science, NISCAIR study-31 papers in 2018 & 2019) and one of this projects publications -Krupa, K; Nithyanandan, K; Andral, U; TchofoDinda, P; Grelu, P, Real-Time Observation of Internal Motion within Ultrafast Dissipative Optical Soliton Molecules, *Physical Review Letters*, 2017, 118(24) 243901- paper received maximum citations (36).

The most number of six CEFIPRA papers were published in the Journal of High Energy Physics (Impact Factor: 5.833). These 6 papers were published from 3 projects. The Impact Factors of journals represent the quality of the journals. The Average Impact Factor of the journals in which CEFIPRA Papers were published in 2018 is 4.431.

The paper, "Hydrogen Evolution from Aqueous Solutions Mediated by a Heterogenized [NiFe]-Hydrogenase Model: Low pH Enables Catalysis through an Enzyme-Relevant Mechanism, *ANGEWANDTE CHEMIE-INTERNATIONAL EDITION*, 2018, 57(49), 16001-16004" has already received more than 20 citations.

Some of the completed projects based on sum of impact factor as per NISCAIR (CSIR) study are given as follows:

Projects Title/Number	Papers	Sum-IF	Avg. IF
Genome-scale analysis of differential propensities of different chromosomal domains for horizontal gene insertion in *Escherichia coli* (5103-3)	1	11.561	11.561
Radio properties of clusters and galaxy lenses (5204-2)	4	21.133	5.283
Symmetries and dynamics: worldsheet and spacetime (5304-2)	2	9.795	4.898
H_2 evolution: cheap catalysts for noble task (5405-1)	3	39.173	13.058
Host-Virus Interactions and Antibody Therapy for *Japanese Encephalitis* (5203-3)	1	4.368	4.368
Olfactory Modulation of Insect Flight (5103-2)	1	14.797	14.797
Insights on protein structural and evolutionary dynamics (5203-2)	7	25.600	3.65
Sums of integers: Fourier, combinatorics, computation (5404-1)	4	11.628	2.907
Characterisation of factors that determine the balance between genomic integrity and diversity in *Helicobacter pylori* (5203-5)	2	11.147	11.147
Self-similar Optical Patterns in Nonlinear Media (5104-2)	16	48.961	3.060
Sums of integers: Fourier, combinatorics, computation (5401-1)	4	3.330	0.833

Table 1: Some of the Completed Projects Based on Sum of Impact Factors [Source; CEFIPRA-NISCAIR (CSIR) Study Feb 2019]

Significant Process Developed under the Completed Projects and its Potential for Knowledge Forward Chain

Biotechnology

- A new hypothesis for pteridophyte desiccation tolerance has been proposed which needs to be further validated using multiple-omic approaches and can be taken up as a completely new project.
- The results on identification of *xyloglucans, mannans* and *arabionoxylans* need further investigation in order to understand complete reprogramming of cell wall during moderate recovery processes in pteridophytes.
- Another, important aspect that further needs knowledge chain investigation is to understand the effects of microclimatic conditions on DT in *Selaginella* under climate change scenario and to know how the knowledge generated on *Xylogucans* and *xylans* during desiccation could be used for cell wall remodelling studies in food/forage grasses. (Project No.-5300B1)

Life and Health Sciences

- The results highlighted interesting properties of newly acquired genes within a bacterial genome. These results now open a set of new questions given what we know about the environmental factors that are known to influence the activity of the H-NS protein for example. Further work will, therefore, compare the insertion frequency pattern for cells growing in different conditions. At a different level, the results in the variability of gene expression in a time of a subset of the insertions have shown a possible role of transcription interference in regulating gene expression noise. Further work will allow collecting more data that is required to test the hypothesis that has emerged from these results (Project No.-5103-3).
- Project results provided insights into the role of PstP in modulating survival and in cell division processes. 150 novel interacting proteins of PstP were Identified; Overlayed this on phosphoproteomic data and are pursuing multiple essential and non-essential candidates to delineate the role of PstP in mycobacteria (Project No.- 5303-1)
- Knowledge process/product developed:
  - DNA Ligase IV inhibitors SCR7, SCR7p, DZ11, DZ12, DZ14, SCR116, SCR132
  - DNA Ligase I inhibitors (SCR17 and SCR21)

- Inhibitors of XRCC4/Ligase4 interactions
- Identification of new Ku-independent pathway for classical NHEJ
- Atomic structures deposited to Protein Data bank (6ERF, 6ERG, ERH)

(5203-4)

- For the first time, it has been shown that inactive forms of protein kinases are characterized by higher dynamics than active forms and that extent of flexibility of protein kinases is correlated to hierarchical organization of kinases (Project No.-5203-2).
- Established a protocol for use of evolutionary conservation information in fitting structural models in cryo-electron microscopy-density maps.
- In-depth characterisation of the MutS2 protein: identification of new nuclease site and analysis of nucleotide binding and hydrolysis activities. Development of cell biology tools to follow natural transformation and their application. The first evidence for a role of m4C methylation as a global epigenetic regulator and transformation control. (Project No.-5203-5).

Pure and Applied Physics

- About 300 new Giant Radio Galaxies and Quasars of >1 Mpc in radio size have been discovered for the first time in India (Project No.-5204-2).
- A computational model has been developed to simulate the solar surface magnetic field evolution. This is the first such computational model within India to explore solar surface magnetism. A self-sustained global 3D solar dynamo model has been developed which simulates the magnetic field evolution in the Sun's interior. This is the first 3D global model that on the one hand captures the buoyant emergence of sunspots, and on the other hand, produces realistic evolution of surface magnetic field resulting in a cyclic reversal of large-scale magnetic field which is crucial for a self-sustained dynamo. Connections with solar corona and wind calculations have been made. A data-driven prediction strategy using the solar surface flux transport model and a dynamo model has been developed. This has been utilized to make the first physics-based prediction of the upcoming sunspot cycle 25 (Project No.-5004-1).

Pure and Applied Chemistry

- A new Cp derivative of a NiFe mimic has been synthesized and its catalytic activity, as well as tolerance to CO has been demonstrated. A catalytic mechanism distinct from the parent Cp complex has also been demonstrated (*ACS Catal*. 2018). Other derivatives with Co and Zn metal ions instead of Ni have been prepared and assessed for H_2 evolution catalytic activity (Project No.-5405-1).

Material Sciences

- Fiber density correlation can be extended for catalytic system as well as for CO_2 sorbent system. A novel way for tuning of Si-O-Ti for better photocatalytic activity has been developed, which can be monitored by ssNMR. The active sites and interfaces of photocatalysts and nanomaterials can also be characterized by (DNP)-ssNMR. Novel (DNP)-ssNMR techniques have been developed to observe insensitive quadrupolar nuclei near surfaces (Project No.-5208-2)

Industry-Academia Research & Development Programme (IARDP)

Ten projects were ongoing during the reported period in the areas of Structural Health Monitoring, Urban Transportation, Avionics, Automotive Design, Printing & Packaging and Computational& Data Sciences and Immunology. During the year, two IRC meetings were organized wherein nine ongoing projects and two completed projects were reviewed.

Out of fourteen new research proposals and three seminar proposals considered, Committee recommended support for the project proposal on e-textile to monitor personal health and fitness parameters and two seminars proposals from the areas of Medical Robotics and Marine Science.

The two completed projects (D2D & Tilling) were evaluated during the reporting period. The performance index of D2D project was graded on the achievements made vis-à-vis aims and objectives, and the technical comprehensive research outcome of D2D of the project which was graded as Very Good. Following are the salient achievements of this project:

Publications: 18+

Conferences (International conferences where the work was presented):

- 5G World Forum 2018, INFOCOM 2018, LATINCOM 2017, INFOCOM 2017, NetEcon 2016
- ICC 2017, SCVT 2016, IEEE Infocom 5G & Beyond Workshop, Proceedings of National Conference on Communications 2017 Balkancom17, PIMRC 2017, published in Elsevier Mob Ad hoc Journal

Career Development and Empowerment for Young Researcher through Collaboration:

- PhD thesis defended (for students supported by CEFIPRA)
- CEFIPRA student/post-doc employed by one of the partner company at the end of the project
- Post doc researcher supported by Inria
- One IISC student funded for postdoctoral research by Nokia and TPT
- Two Students from IIT engaged by Nokia for summer internships for the collaboration with TIFR, IISC and inria.

Patents

- NOKIA Bell Labs and TIFR: one patent disclosed and archived
- Nokia Bell Labs and IMT: One patent disclosed and archived

Events

- Workshop organized in Paris in the year 2016 by all the partners
- IOT and beyond Workshop organized in PIMRC 2017 Montreal, co-chaired by Nokia Bell Labs
- On Accelerating and Securing Cloud Native 5G, Panel discussions organized in WCNC 2018 Barcelona
- Nokia Bell Labs with NGPASS H2020 Project

Linkages

- IISc Bangalore and Telecom Paris Tech: Joint research on D2D discovery and mode selection in progress
- Exchange of faculty & Students -TIFR Mumbai Telecom Paris Tech Nokia, Inria, and IISC
- 2 summer interns from IIT Madras to visit Nokia Bell Labs for joint research on Co-existence protocols for unlicensed spectrum for LTE and massive random access protocols for 5G NR
- Supelec and Orange participated in the D2D Workshop Organized by partners
- Thales appointed CEFIPRA Postdoctoral researcher from Inria
- Nokia Bell Labs funding a student from IISC for postdoctoral research with IMT
- IISC Bangalore Pr.Chandra Murthy and his Ph.D student Mohit Sharma visited Inria and TPT in summer 2017

- Amira Alloum from Nokia Bell Labs visited IISC Bangalore and Nokia Bangalore for 2 weeks
- Cedric Adjih and Hussein Khazaie from Inria visited IISC Bangalore for 1 week
- Nokia Bell Labs funding Inria for 3 years research project on "Massive Random Access Protocols for 5G NR" and advertised the openings among the Indian partners of the project
- Workshops and Panel discussions organized by partners and Nokia Bell Labs opened up the project linkage to external industries and Academics in Telecom and IT industry as well as to European Union projects as Orange, Supelec, Intel, Ericsson, Kings College, Oulu University, IBM, Kings College University, H2020 NGPASS project

Following are the salient achievements under Tilling project:

Publications: 5+

Product/ technology developed:

- Three different LSL melon lines with 20 days LSL
- Gynoecious melon line carrying pure female flowers (Normally melon plants carry male and hermaphrodite flowers which makes hybrid seed production expensive as labour is required for emasculation of hermaphrodite flowers and removal of male flowers on the female parent line)

Testing facilities developed under this project:

Greenhouse, Bidadi, Bangalore Open field, ID Halli, Tumkur

Linkage:

- The project was presented to various seed companies during seed association meetings and it has generated interest for licensing of the LSL line for breeding purposes. PIs plan to do the same for the gynoecious mutant in the future

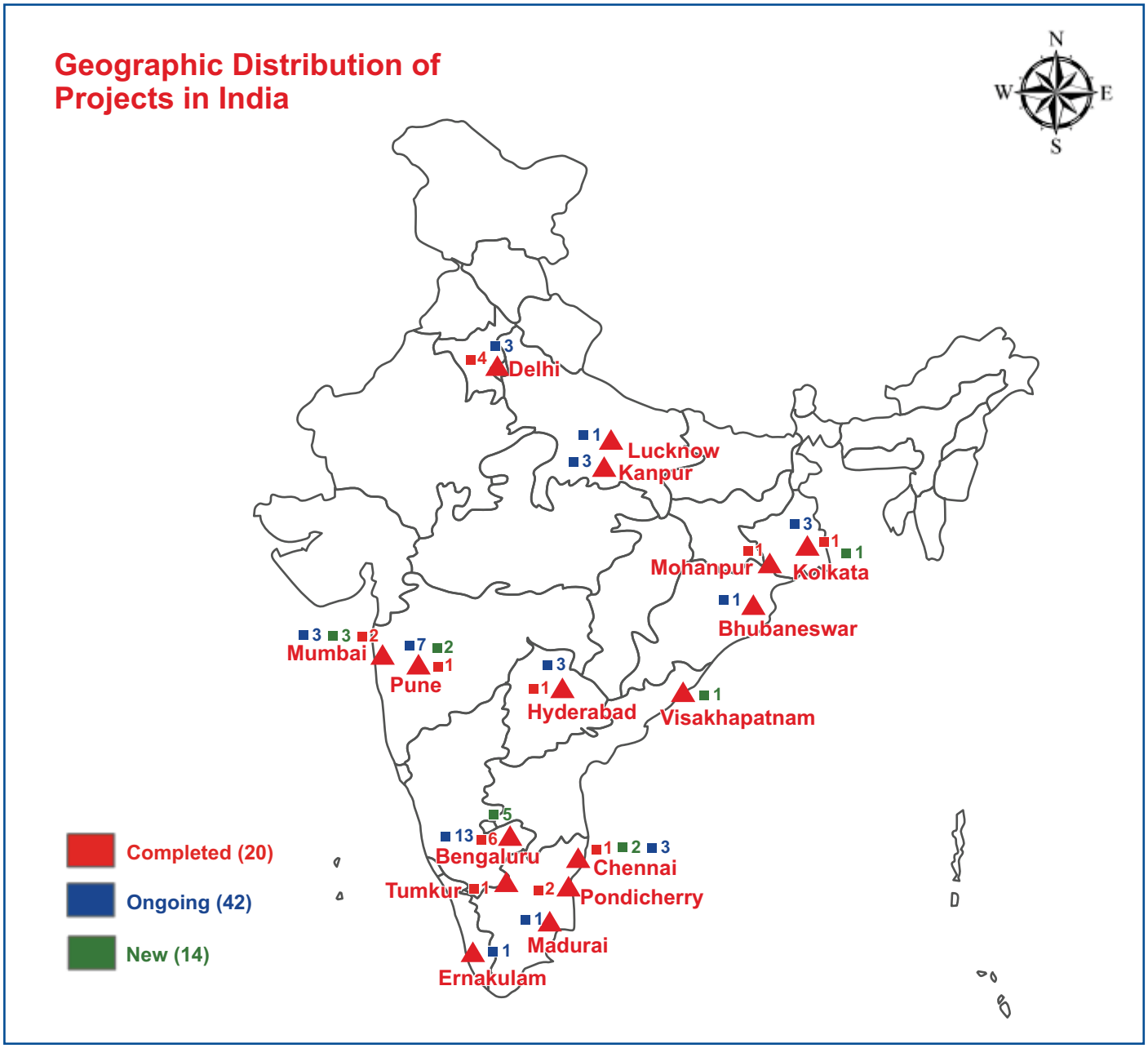
Non-Core Programmes

Under the Non-Core Programmes, CEFIPRA acted as a facilitator for various programmes with Indian national funding agencies like Department of Science and Technology (DST) and Biotechnology Industry Research Assistance Council (BIRAC) with French funding agencies French Institute for Research in Computer Science and Automation (Inria) for collaborative research.

During the reported period, under DST-CNRS-Inria programme two projects were completed in areas of Applied Mathematics and Big Data, resulting in 17 publications. In addition, 13 visits from India to France and 10 from France to India were also undertaken. However, 9 projects are ongoing in the areas of Big Data (1), Cyber Security (1), Internet of Things (2), Distributed and Autonomous Systems (1), Applied Mathematics (1) & Machine Learning (3). Under these ongoing projects, 16 research papers are published and 13 visits from India to France and 12 from France to India are undertaken. Further, 4 new projects are also initiated in the areas of Cyber-Physical Systems (2), Big Data (1) & Stochastic Optimization (1).

Geographic Distribution of Projects in France

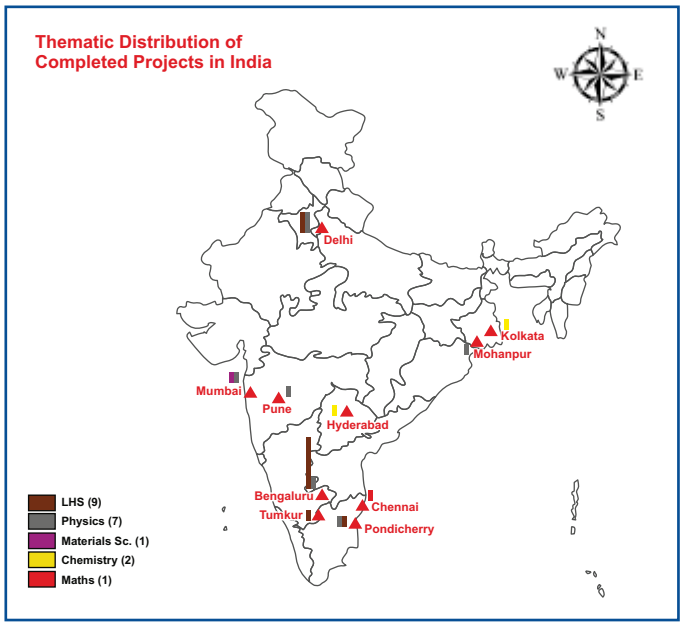
Map 1



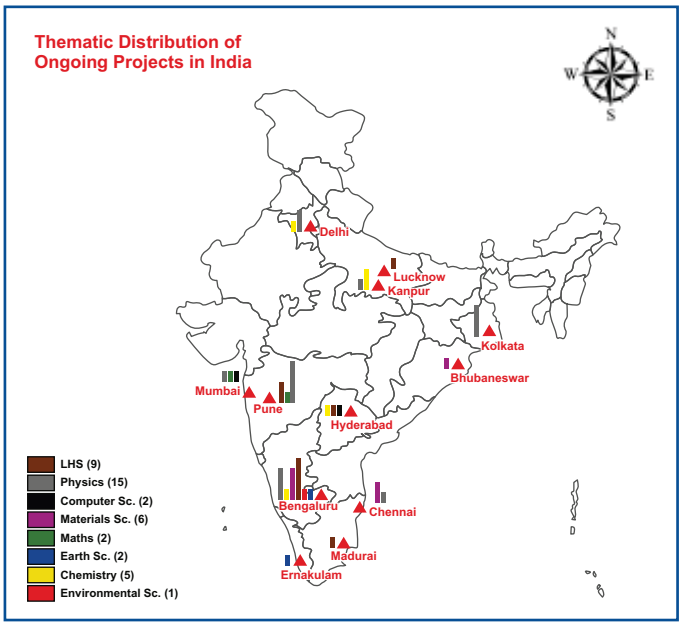
Thematic Distribution of Projects in India

The following three Indian maps are showing the spatial heterogeneity with respect to completed (20) ongoing (42) and new initiated (14) Collaborative Scientific Research Projects of CEFIPRA in different subject domains.

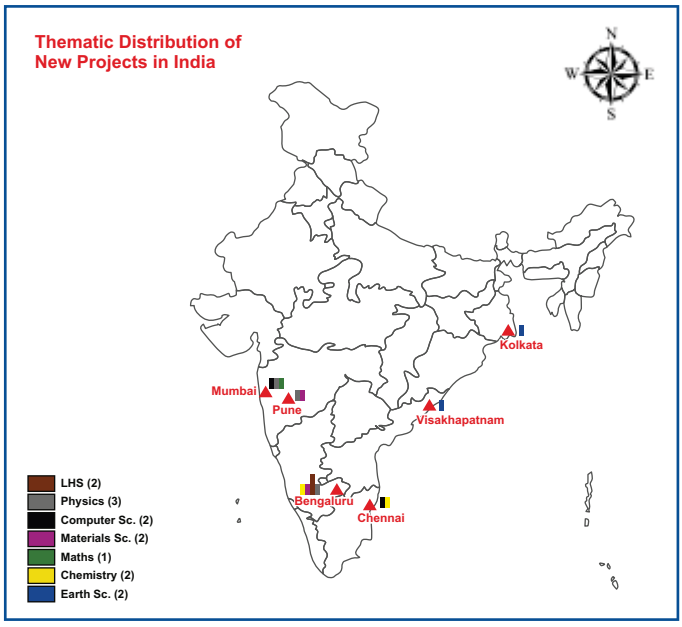
Map 2



Map 3

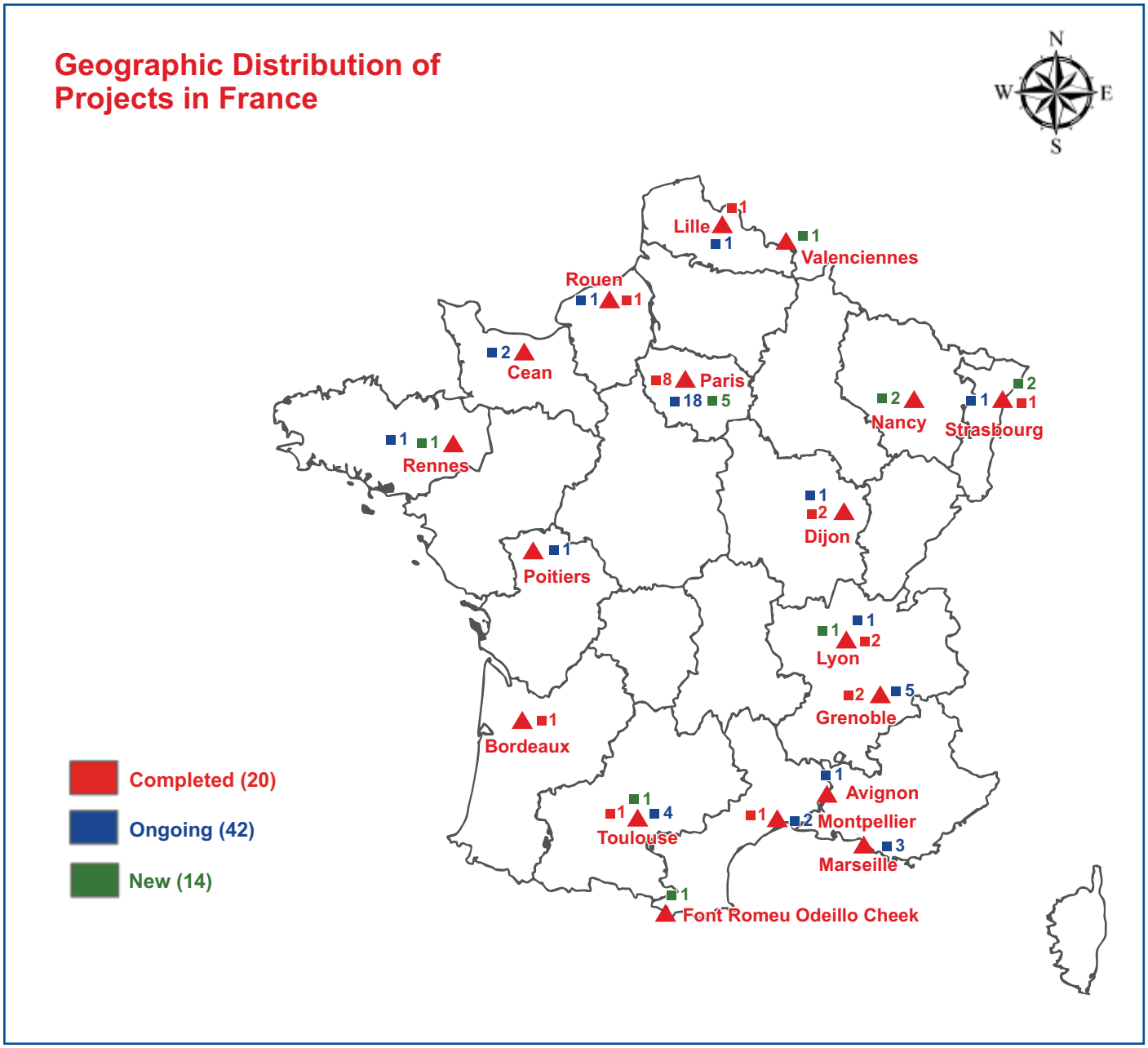


Map 4



Geographic Distribution of Projects in France

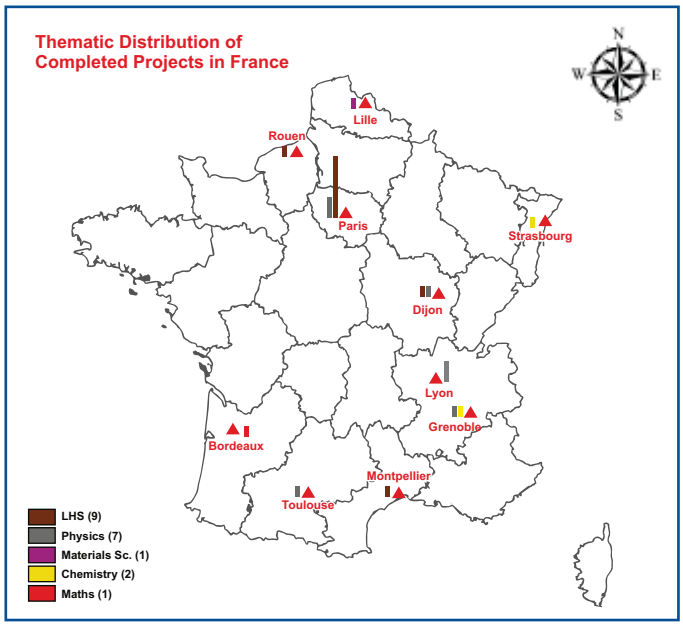
Map 5



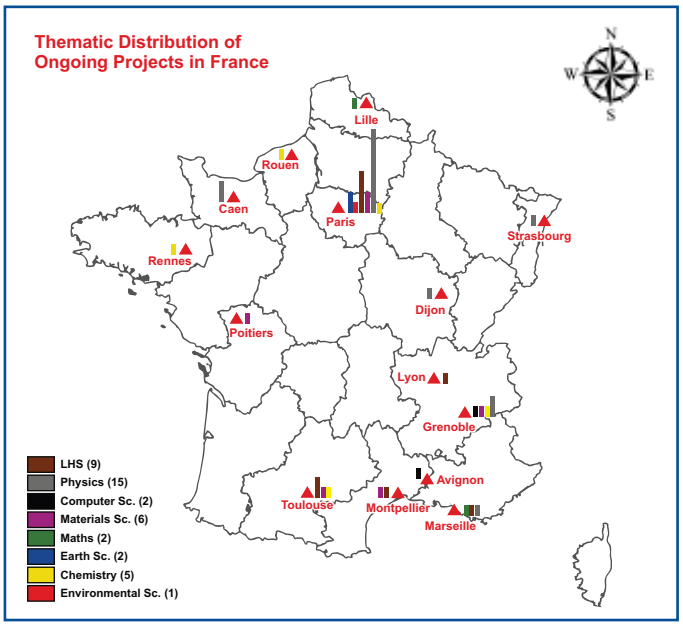
Thematic Distribution of Projects in France

The following three French maps are showing the spatial heterogeneity with respect to completed (20) ongoing (42) and newly initiated (14) Collaborative Scientific Research Projects of CEFIPRA in different subject domains.

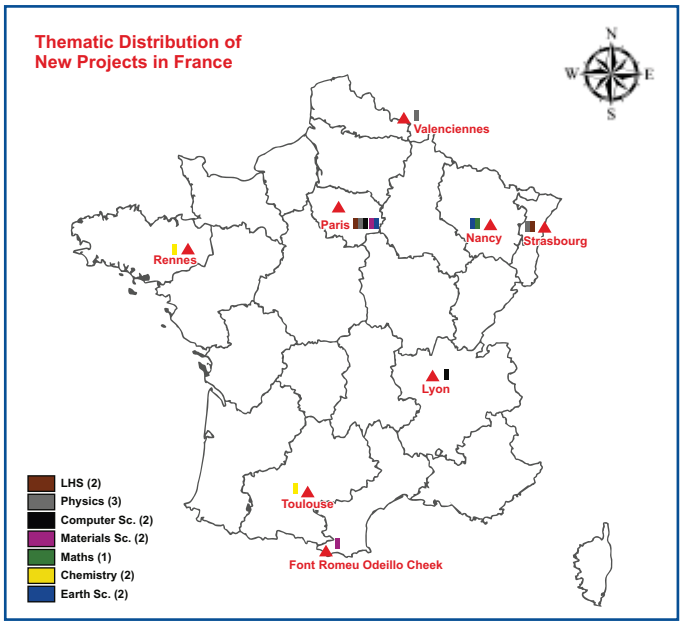
Map 6



Map 7



Map 8



CEFIPRA

7. Human Resource Development Supported under Projects

Mobility of Scientists & Students

CEFIPRA provides support to scientists and students for exchange visits under its core programmes. 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 also enhances international competitiveness. In addition, exchange visits also provide an opportunity for cultural exchanges. The visits undertaken during the year from April 2018 to March 2019 under two core programmes are given below in a tabular form.

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.

Mobility of Scientists/Researchers Supported under CEFIPRA Projects during April 2018 to March 2019

Mobility of Indian Scientists **April - June 2018**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	Glimpses of New Physics	**Dr. Sudhir Kumar Vampati** Centre for High Energy Physics Indian Institute of Science Bangalore	**Dr. Emilian Dudas** Centre de Physique Théorique Ecole Polytechnique, Palaiseau Paris
2.	Deciphering the role of Mycobacterium tuberculosis Serine/Threonine protein phosphatase PstP	**Dr. Vinay Kumar Nandicoori** & **Dr. Divya Arora** National Institute of Immunology New Delhi	**Dr. Virginie Molle** CNRS UMR5235- DIMNP (Dynamique des Interactions Membranaires Normales et Pathologiques), Universite Montpellier II Montpellier
3.	Characterization of factors that determine the balance between genomic integrity and diversity in *Helicobacter pylori*	**Dr. Desirazu Narasimha Rao** Department of Biochemistry Indian Institute of Science Bangalore	**Dr J. Pablo Radicella** Institut de Radiobiologie Cellulaire et Moléculaire Commissariat àl'Energie Atomique (CEA), Fontenay aux Roses Paris
4.	A genome-wide study to identify novel regulators of chromosome stability using a human pathogenic yeast Candida albicans as the model system	**Prof. Kaustuv Sanyal** Jawaharlal Nehru Centre For Advanced Scientific Research Bangalore	**Dr. Christophe d'Enfert** Fungal Biology and Pathogenicity Unit, Institut Pasteur Paris
5.	Insights on protein structural and evolutionary dynamics	**Ms. Ashraya Ravikumar** Indian Institute of Science Bangalore	**G. Alexandre de Brevern** INSERM UMR-S 665 DSIMB, Univ Paris Diderot Paris
6.	Reversals of a large scale field on a turbulent background	**Prof. Mahendra Kumar Verma** Department of Physics Indian Institute of Technology Kanpur	**Stephan Fauve** Ecole Normale Supérieure Laboratoire de Physique Statistique Paris

Mobility of Indian Scientists **April - June 2018**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
7.	Original biocompatible phosphorus dendrimers as a new strategy to tackle pulmonary tuberculosis	**Mr. Rajendra Reddy** Division of Microbiology CSIR-Central Drug Research Institute Lucknow	**Anne-Marie Caminade** Laboratoire de Chimie de Coordination du CNRS Délégation Toulouse
8.	Impact of the Indian Monsoon convection on the Tropical Tropopause Layer abnd climate	**Prof. Kesavapillai Mohanakumar** Cochin University of Science & Technology Kerala	**Dr. Bernard Legras** Directeur de Recherche, Laboratoire de Météorologie Dynamique Ecole Normale Supérieure Paris Cedex 05
9.	Decipher the symbiotic program in tropical legumes	**Dr. Maitrayee Das Gupta** Department of Biochemistry University of Calcutta Kolkata	**Fabienne Cartieaux** Laboratoire des Symbioses Tropicales & Méditerranéennes (IRD) Montpellier
10.	Studies on the Topological Insulator Behaviour in Heavy Metal based Ternary Chalcogenides	**Dr. Sebastian Chirambatte Peter** Jawaharlal Nehru Centre For Advanced Scientific Research Bangalore	**Dr. Marie-Aude Measson** University Paris Diderot Île-de-France Paris
11.	The assembly history of disk galaxies over the last 8 billion years	**Sohali Sachdeva** Inter University Center For Astronomy & Astrophysics Pune	**Prof. Francoise Combes** Observatoire de Paris Paris
12.	CHROmITe: Assessment of CHromium Release from sukinda mining Overburden: an IsoTopic, chemical, physical and microbiological study	**Mr. Amit G. Anil** & **Divyasree C. Prabhakaram** Department of Materials Engineering Indian Institute of Science Bangalore	**Dr. Yann Sivry** University Paris Diderot Sorbonne Paris Cité Institut de Physique du Globe de Paris Paris
13.	A comparative Systems Biology Approach for Understanding Desiccation Tolerance in Forage Grasses and *Selaginella sps*	**Mr. N. S. Yathish** Department of Studies and Research in Environmental Science Centre for Bioinformtionm Tumkur University Tumkur	**Azeddine Driouich** IRIB-PRIMACEN-IBiSA Université de Rouen Mont-Saint Aignan
14.	Controlling for upscaling uncertainity in assessment of Forest aboveground biomass in the Western Ghats of India	**Dr. C.S. Jha** National Remote Sensing Centre (NRSC) (ISRO) Hyderabad	**Pierre Couteron** UMR AMAP Botanique et bioinformatique de l'Architecture des Plantes Montpellier
15.	Bifunctional Catalysts for Cooperative C-H Bond Cleavage via Intramolecular Deprotonation Toward Direct Functionalizations of Alkaness	**Prof. Jitendra Kumar Bera** Indian Institute of Technology Kanpur	**Dr. Henri Doucet** Universitã© De Rennes 1 Rennes
16.	Original biocompatible phosphorus dendrimers as a new strategy to tackle pulmonary tuberculosis	**Prof. Kishore K Srivastva** CSIR-Central Drug Research Institute Lucknow	**Dr. Anne-Marie Caminade** Laboratoire de Chimie de Coordination Toulouse
17.	Sums of integers: Fourier, combinatorics, computation	**Dr. Gyan Prakash** The Institute of Mathematical Sciences Chennai	**Prof. Jean-Marc Deshouillers** Institut Mathématique de Bordeaux Bordeaux

Mobility of Indian Scientists **April - June 2018**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
18.	Modelling Plasma Instabilities and Transport in a Hall Thruster	**Prof. Hitendra Kumar Malik** Indian Institute of Technology Delhi	**Prof. Yves Elskens** Physique des interactions ioniques et moléculaires (PIIM) Marseille
19.	Quantum transport in 2D van der Waals heterostructures based on graphene and Boron Nitride	**Mr. Suman Sarkar** Indian Institute of Science Bangalore	**Dr. Vincent Bouchiat** Neel Institute CNRS-Grenoble
20.	Electrical addressing and control of the plasmonic properties of coupled metal nanowire	**Prof. G.V. Pavan Kumar** Indian Institute of Science Education and Research Pune	**Dr. Alexandre Bouhelier** Universit´e de Bourgogne Bourgogne
21.	Novel Chiral First row Transition Complexes for Asymmetric Catalysis via Activation of inert C-H and C-Heteroatom bonds	**Prof. Basker Sundararaju** Indian Institute of Technology Kanpur	**Prof. Rinaldo Poli** Laboratoire De Chimie de Coordination Toulouse
22.	The Economics of Networks and Queues	**Ms. Fehmina Malik** Indian Institute of Technology Bombay	**Dr. Yezekael Hayel** Université d'Avignon Orsay Cedex

Mobility of Indian Scientists **July - September 2018**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	H_2 evolution: cheap catalysts for noble task	**Prof. Abhishek Dey** Indian Association for the Cultivation of Science Kolkata	**Dr. Vincent Artero** Laboratoire Chimie et Biologie des Métaux, CEA Grenoble
2.	Glimpses of new physics	**Mr. Avik Banerjee** Saha Institute of Nuclear Physics Kolkata	**Dr. Emilian Dudas** Ecole Polytechnique Palaiseau
3.	Modeling soft glassy flow from micro to macro scale	**Dr. Pinaki Chaudhuri** Institute of Mathematical Sciences Chennai	**Dr. Kirsten Martens** Laboratoire Interdisciplinaire de Physique Grenoble
4.	Micro-SQUID magnetometry of nano-scale magnetic structures	**Mr. Sagar Paul** Indian Institute of Technology Kanpur	**Prof. Hervé Courtois** Université Joseph Fourier Grenoble
5.	Cosmological evolution of the cold gas from quasar absorption lines	**Prof. Neeraj Gupta** Inter-University Center for Astronomy and Astrophysics Pune	**Dr. Pasquier Noterdaeme** Institut d'Astrophysique de Paris Paris
6.	Elucidation of conserved molecular signatures and regulators for blood cell progenitor maintenance	**Ms. Diana Rodrigues** Jawaharlal Nehru Centre for Advanced Scientific Research Bangalore	**Dr. Lucas Waltzer** Centre de Biologie du Développement Toulouse

Mobility of Indian Scientists **July - September 2018**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
7.	Characterization of factors that determine the balance between genomic integrity and diversity in *Helicobacter pylori*	**Mr. Gaurav Gunjal** Indian Institute of Science Bangalore	**Dr. J. Pablo Radicella** (PI) Commissariat à l'Energie Atomique et aux énergies alternatives (CEA) Fontenay aux Roses
8.	Electrical addressing and control of the plasmonic properties of coupled metal nanowire	**Mr. Deepak Kumar Sharma** Indian Institute of Science Education and Research Pune	**Dr. Alexandre Bouhelier** Universit´e de Bourgogne Mont St. Aignan
9.	Wavelet graphs for gravitational wave searches	**Dr. Archana Arun Pai** Indian Institute of Technology - Bombay Mumbai	**Dr. Eric Chassande-Mottin** Universit´e Paris Diderot Paris
10.	Control of microtubule dynamic instability by the tubulin code	**Dr. Minhaj Sirajuddin** Institute for Stem Cell Biology and Regenerative Medicine Bangalore	**Mr. Carsten Janke** Institut Curie Paris
11.	A genome-wide study to identify novel regulators of chromosome stability using a human pathogenic yeast *Candida albicans* as the model system	**Ms. Priya Jaitley** Jawaharlal Nehru Centre for Advanced Scientific Research Bangalore	**Dr. Christophe D'Enfert** Institut Pasteur Paris
12.	Tuning the interfacial Dzyaloshinskii-Moriya interaction in ultrathin magnetic films: toward the stabilization of skyrmions in spintronics devices	**Prof. Subhankar Bedanta** National Institute of Science Education and Research Bhubaneswar	**Dr. Stanislas Rohart** Université Paris-Sud Orsay Cedex
13.	Nuclear structure at the extreme of isospin and spin	**Mr. Ranabir Banik** & **Dr. Sarmishtha Bhattacharyya** Variable Energy Cyclotron Centre Kolkata	**Dr. Navin Alahari** Grand Accélérateur National d'Ions Lourds (GANIL) Caen
14.	Extreme events and large deviations in strongly correlated many body systems	**Pr. Anupam Kundu** The International Centre for Theoretical Sciences Bengaluru	**Dr. Gregory Schehr** Laboratoire De Physique Théorique Et Modeles Statistiques (LPTMS) Strasbourg
15.	Radio properties of clusters and galaxy lenses	**Mr. Pratik Dabhade** Inter University Centre for Astronomy and Astrophysics Pune	**Dr. Bruno Guiderdoni** Observatoire de Lyon- CRAL Saint Genis Laval Cedex
16.	Mechanism of polarity reversals in *Myxococcus xanthus*	**Dr. Gayathri Pananghat** Indian Institute of Science Education and Research Pune	**Dr. Tam Mignot** Laboratoire de chimie bactérienne, CNRS Marseille

Mobility of Indian Scientists **October - December 2018**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	Host-Virus Interactions and Antibody Therapy for Japanese Encephalitis	**Dr. Manjula Kalia** Vaccine & Infectious Disease Research Centre, Translational Health Science & Technology Institute Faridabad **Dr. Nimesh Gupta** National Institute of Immunology Aruna Asaf Ali Marg New Delhi	**Dr. Sebastien Lacroix-Desmazes** Institut National de la Sante et de la Recherche Medicale (INSERM) Paris
2.	Interactions between dynamical systems, geometry, and number theory	**Dr. Anish Ghosh** Tata Institute of Fundamental Research Mumbai	**Prof. Arnaldo Nogueira** Aix Marseille University Marseille
3.	Glimpses of New Physics	**Ms. Priyanka Lamba** Saha Institute of Nuclear Physics Kolkata	**Dr. Emilian Dudas** Centre de Physique Théorique, Ecole Polytechnique Palaiseau
4.	Modeling Soft Glassy Flow from Micro to Macro Scale	**Dr. Suman Dutta** The Institute of Mathematical Sciences IMSc, 4th Cross Street, CIT Campus, Taramani Chennai	**Dr. Kirsten Martens** LIPhy, Université Grenoble Alpes & CNRS, 140 Av. de la physique BP 87 F-38402 Saint Martin d'Hères
5.	Understanding mechanical size effects in metallic micro-wires: synergy between experiments and simulation	**Prof. Atul Chokshi** Indian Institute of Science Bangalore	**Prof. Ludovic Thilly** Université de Poitiers, Institut Pprime SP2MI, Futuroscope
6.	Impact of the Indian Monsoon convection on the Tropical Tropopause Layer abnd climate	**Mr. Sivan Chadran** Cochin University of Science and Technology (CUSAT) Kochi	**Dr. Bernard Legras** Laboratorie of Meteorologie Dynamique (LMD) Paris
7.	Metal chelators derived from imidazole thiones and selones for detoxification	**Dr. Gouriprasanna Roy** Shiv Nadar University (SNU) NH-91 Greater Noida	**Dr. Pascale DELANGLE** SyMMES, UMR CEA CNRS UGA CEA Grenoble, 17 rue des martyrs 38054 Grenoble
8.	Cosmological evolution of the cold gas from quasar absorption lines	**Prof. Raghunathan Srianand** IUCAA, Post Bag 4, Ganeshkhind Pune University Campus Pune	**Prof. Pasquier Noterdaeme** Institut d'Astrophysique de Paris 98bis bd Arago, 75014 Paris
9.	Magnetism of self-organized structures at surfaces	**Prof. Shobhana Narasimhan & Mr Sourav Mondal** Theoretical Sciences Unit Jawaharlal Nehru Centre for Advanced Scientific Research Bangalore	**Prof. Sylvie Rousset** Laboratoire Matériaux et phénomènes Quantiques, UMR 7162 CNRS-Université Paris Diderot, 75013 Paris
10.	Functional genomics of glioblastoma: from epigenetics to proteomic investigation of tumor initiating cell secretome	**Dr. Kumaravel Somasundaram** Department of Microbiology and Cell Biology, Indian Institute of Science Bangalore	**Dr. Philippe Marin** Institut de Génomique Fonctionnelle CNRS UMR 5203, INSERM U1191 Université de Montpellier Montpellier Cedex 5

Mobility of Indian Scientists **January-March 2019**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	Glimpses of New Physics	**Prof. Gautam Bhattacharyya** Saha Institute of Nuclear Physics Kolkata	**Dr. Emilian Dudas** Centre de Physique Théorique, Ecole Polytechnique Palaiseau
2.	Yielding in glasses and colloidal systems under cyclic deformation	**Dr. Himanya Bhoumick** Jawaharlal Nehru Centre for Advanced Scientific Research Bangalore	**Prof. Giuseppe Foffi** Université Paris Sud - Paris Xi Ile-De-France Orsay
3.	Mechanism of polarity reversals in *Myxococcus xanthus*	**Ms. Jyoti Baranwal** Indian Institute of Science Education and Research Pune	**Dr. Tam Mignot** Laboratoire de chimie bactérienne CNRS Marseille
4.	Design and Control of many-body states in hybrid quantum systems	**Prof. Manas Shreekanth Kulkarni** International Centre for Theoretical Sciences (TIFR) Bangalore	**Dr. Camille Aron** Ecole Normale Supérieure (CNRS) Paris
5.	High performance formation control in the presence of uncertainties and communication	**Dr. S V Vineet** Indian Institute of Technology Mumbai	**Dr. Irinel Constantin Morarescu** Centre de recherche en automatique de Nancy (CRAN) UMR7039

Mobility of French Scientists **April - June 2018**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	Chiral Phosphahelicenes in Gold(I) Enantioselective Catalysis	**Arnaud Voituriez** Institut de Chimie des Substances Naturelles Gif-sur-Yvette	**Prof. Akhil Kumar Sahoo** School of Chemistry University of Hyderabad Hyderabad
2. 3.	The assembly history of disk galaxies over the last 8 billion years	**Dr. Jonatham Freundlich** Astronome à l'Observatoire de Paris Lerma	**Dr. Kanak Saha** Assistant Professor Inter-University Centre for Astronomy and Astrophysics Pune
4.	H_2 evolution: cheap catalysts for noble task	**Vincent Artero** Laboratoire de Chimie et Biologie des Métaux CEA-Grenoble Grenoble	**Abhishek Dey** Indian Association for the Cultivation of Science Kolkata
5.	The Economics of Networks and Queues	**Dr. Yezekael Hayel** LIA Université d'Avignon Avignon	**Dr. Manjesh Kumar Hanawal** Industrial Engineering and Operations Research IIT Bombay Mumbai
6.	Novel nanocatalysts synthesis guided by DNP NMR	**Dr. Olivier Lafon** Unite de Catalyse et de Chimie du Solide (UCCS) CNRS UMR 8181 Université of Lille Villeneuve d'Ascq Cedex	**Dr. Vivek Polshettiwar** Tata Institute of Fundamental Research (TIFR) Mumbai

Mobility of French Scientists **April - June 2018**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
7.	Bifunctional Catalysts for Cooperative C-H Bond Cleavage via Intramolecular Deprotonation Toward Direct Functionalizations of Alkaness	**Dr. J. F. Soulé** UMR 6226-CNRS-Université de Rennes1 Sciences Chimiques de Rennes Rennes cedex	**Prof. Jitendra Kumar Bera** Department of Chemistry IIT Kanpur Kanpur
8.	Advanced time-domain integration schemes for the simulation of Earth and planetary core dynamics	**Dr. Alexanndre Fournier** Institut de physique du globe de Paris (IPGP) Paris	**Prof. Binod Sreenivasan** Centre for Earth Sciences Indian Institute of Science Bangalore
9.	Durable Fuel Cells Based On Polymer Coated Nanocarbon Composites (Dupont)	**Mr. Guillaume Pillet** Centre d'Élaboration de Matériaux et d'Etudes Structurales (CERMES - CNRS) | CERMES Physics University of Toulouse Toulouse	**Dr. Sundara Ramaprabhu** Department of Physics Indian Institute of Technology Madras
10.	Radio properties of clusters and galaxy lenses	**Dr. Bruno Guiderdoni**, **Prof. Laurence Tressa**, **Dr. David Lagattuta**, **Dr. Mamta Pommier** & **Prof. Wim Van Driel** Centre de Recherche Astrophysique de Lyon Observatoire de Lyon Saint Genis Laval	**Dr. Joydeep Bagchi** Inter University Centre for Astronomy and Astrophysics Pune
11.	Biodegradable core shell electrospun mats and interconnected porous scaffolds for tunable anticancer drug delivery and tissue engineering application	**Dr. Mikhael Bechelany** European Institute Of Membranes de Montpellier Montpellier	**S. Narayana Kalkura** Director and Professor Crystal Growth Centre Anna University Chennai
12.	Original biocompatible phosphorus dendrimers as a new strategy to tackle pulmonary tuberculosis	**Dr. Jean-Pierre Majoral** Laboratoire de Chimie de Coordination du CNRS Délégation Midi-Pyrenees Toulouse	**Dr. Kishore K Srivastva** AcSIR CSIR-Central Drug Research Institute Lucknow
13.	Original biocompatible phosphorus dendrimers as a new strategy to tackle pulmonary tuberculosis	**Dr. Serge Mignani** Laboratoire de Chimie de Coordination du CNRS Délégation Midi-Pyrenees Toulouse	**Dr. Kishore K Srivastva** AcSIR CSIR-Central Drug Research Institute Lucknow
14.	Interactions between dynamical systems, geometry, and number theory	**Prof. Arnaldo Nogue** ira, Institut De Mathématique de Marseille Aix- Marseille University Marseille	**Dr. Anish Ghosh** School of Mathematics Tata Institute of Fundamental Research (TIFR) Mumbai
15.	Metal chelators derived from imidazole thiones and selones for detoxification	**Dr. Pascale Delangle** INAC / SyMMES Team Reconnaissance Ionique et Chimie de Coordination CEA Centre de Grenoble Grenoble	**Dr. Gouriprasanna Roy** Shiv Nadar University Gautam Buddha Nagar

Mobility of French Scientists **April - June 2018**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
16.	Olfactory Modulation of Insect Flight	**Jean-François Ferveur** Centre des Sciences du Goût et de l'Alimentation (CSGA) Dijon	**Gaiti Hasan** Tata Institute of Fundamental Research Bangalore
17.	Magnetism of self-organized structures at surfaces	**Dr. Jerume Lagoute** & **Mr. Rishav Harsh** UMR CNRS 7162 Université Paris Diderot – Paris 7 Paris	**Dr. Shobhana Narasimhan** Jawaharlal Nehru Centre for Advanced Scientific Research Bangalore
18.	Theoretical studies on ultra cold Dipolar Gases	**Prof. Paolo Pedri** & **Mr. Kaci Kechadi** Laboratoire de Physique des Lasers - CNRS - UMR7538, Université Paris 13 - Institut Galilée – 99 Villetaneuse	**Prof. Rejish Nath** Indian Institute of Science Education and Research Pune
19.	Insights on protein structural and evolutionary dynamics	**Prof. G Alexandre de Brevern** INSERM UMR-S 665 DSIMB, Univ Paris Diderot Paris	**Dr. Narayanaswamy Srinivasan** Indian Institute of Science Bangalore
20.	Wavelet Graphs for Gravitational Wave Searches	**Dr. Eric Chassande-Mottin** University Paris Diderot Île-de-France Paris	**Dr. Archana Arun Pai** Indian Institute of Technology Mumbai

Mobility of French Scientists **July-September 2018**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	Biodegradable core shell electrospun mats and interconnected porous scaffolds for tunable anticancer drug delivery and tissue engineering application	**Dr. Sakthivel Nagarajan** European Institute of Membranes Montpellier	**Prof. Narayana S Kalkura** Anna University Chennai
2.	The economics of networks and queues	**Dr. Urtzi Ayesta** & **Dr. Manukumar Gupta** Université d'Avignon Orsay	**Prof. Manjesh Kumar Hanawal** Indian Institute of Technology-Bombay Mumbai
3.	Yielding in glasses and colloidal systems under cyclic deformation	**Prof. Giuseppe Foffi** Université Paris Sud Paris	**Prof. Srikanth Sastry** Jawaharlal Nehru Centre for Advanced Scientific Research Bangalore
4.	Original biocompatible phosphorus dendrimers as a new strategy to tackle pulmonary tuberculosis	**Dr. Anne-Marie Caminade** Laboratoire de Chimie de Coordination Toulouse	**Prof. Kishore K. Srivastva** Central Drug Research Institute Lucknow
5.	LORIC: LOng-Range Interactions in ultraCold gases	**Dr. Olivier Dulieu** Laboratoire Aimé Cotton Paris	**Prof. Sadiqali Abbas Rangwala** Raman Research Institute Bangalore

Mobility of French Scientists **October - December 2018**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	Sums of integers: Fourier, combinatorics, computation	**Prof. Olivier RAMARÉ** Institut Mathématique de Luminy, Marseille	**Prof. R. Balasubramanian** The Institute of Mathematical Sciences Chennai
2.	N-Heterocyclic Carbene (NHC)-Organocatalyzed Enantioselective Trifluoromethylation and Trifluoromethylthiolation of Unactivated C-H Bonds	**Dr. Tatiana Besset** INSA Rouen, UMR 6014, Avenue de l'université, BP 08, 76800 Saint Etienne du Rouvray, Cedex	**Dr. Akkattu T. Biju** Department of Organic Chemistry Indian Institute of Science Bangalore
3.	Molecular analysis of a capacitor Hox protein motif	**Dr. Samir Merabet** IGFL, UMR 5242 CNRS/ENS Lyon 46, Allee d'Italie 69364 Lyon Cedex 07	**Prof. LS Shashidhara** Indian Institute of Science Education and Research (IISER) Pune
4.	Impact of the Indian Monsoon convection on the Tropical Tropopause Layer abnd climate	**Dr. Silvia Bucci** Laboratoire de Météorologie Dynamique, Ecole Normale Supérieure, 24 rue Lhomond, 75005 Paris	**Prof. K. Mohankumar** Advanced Centre for Atmospheric Radar Research, Cochin University of Science and Technology Cochin
5.	The assembly history of disk galaxies over the last 8 billion years	**Prof. Hervé Courtois** CNRS et Université Grenoble Alpes Grenoble	**Dr. Anjan Kumar Gupta** Indian Institute of Technology Kanpur
6.	Modeling Soft Glassy Flow from Micro to Macro Scale	**Dr Vishwas Venkatesh & Ms Magali le Goff** *LIPhy,* Université Grenoble Alpes & CNRS, 140 Av. de la physique BP 87 F-38402 Saint Martin d'Hères	**Dr Pinaki Chaudhuri** The Institute of Mathematical Sciences IMSc, 4th Cross Street, CIT Campus, Taramani, Chennai
7.	Tuning the interfacial Dzyaloshinskii-Moriya interaction in ultrathin magnetic films: toward the stabilization of skyrmions in spintronics devices	**Dr. Stanislas Rohart** Université Paris-SudBatiment 510 91405 Orsay	**Prof. Subhankar Bedanta** National Institute of Science Education and Research, Khordha-Pipili Road, Khordha, Near Jatni Tehsildar Office, Bhubaneswar
8.	A genome-wide study to identify novel regulators of chromosome stability using a human pathogenic yeast *Candida albicans* as the model system	**Dr. Christophe D'Enfert** Institut Pasteur, Paris, Ile-De-France, Paris	**Dr. Kaustuv Sanyal** Jawaharlal Nehru Centre For Advanced Scientific Research, Karnataka, Bangalore Urban District
9.	Characterisation of factors that determine the balance between genomic integrity and diversity in *Helicobacter pylori*	**Prof. J. Pablo Radicella** UMR967 INSERM/CEA, Institut de Radiobiologie Cellulaire et Moléculaire Commissariat à l'Energie Atomique, Fontenay-aux-Roses	**Dr. Narasimha Rao** Department of Biochemistry, Indian Institute of Science Bangalore
10.	p-adic aspects of automorphic forms and their L-functions	**Dr. Mladen Dimitro** University of Lille UMR CNRS 8524	**Dr A Raghuram** Indian Institute of Science Education and Research (IISER) Dr. Homi Bhabha Road, Pashan Pune

Mobility of French Scientists **October - December 2018**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
11.	Cosmological evolution of the cold gas from quasar absorption lines	**Mr Adarsh Ranjan** Institut d'Astrophysique de Paris 98bis bd Arago, 75014 Paris	**Prof. Neeraj Gupta** IUCAA, Post Bag 4, Ganeshkhind, Pune University Campus Pune

Mobility of French Scientists **January - March 2019**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	Interactions between dynamical systems, geometry, and number theory	**Prof. Arnaldo Nogueira** Aix Marseille University Marseille	**Dr. Anish Ghosh** Tata Institute of Fundamental Research Mumbai
2.	Micro-SQUID magnetometry of nano-scale magnetic structures	**Prof. Chemens Ainkelman** CNRS et Université Grenoble Alpes Grenoble	**Dr. Anjan Kumar Gupta** Indian Institute of Technology Kanpur
3.	Extreme events and large deviations in strongly correlated many body systems	**Prof Francois Hennecart** LPTMS, Université Paris-Sud Orsay	**Dr. Abhishek Dhar** International Centre for Theoretical Sciences (TIFR), Bangalore
4.	Sums of integers: Fourier, combinatorics, computation	**Dr. Jean-Marc Deshouillers** Institut Mathématique de Bordeaux Talence	**Dr. R. Balasubramanian** Institute of Mathematical Sciences CIT Campus Chennai
5.	Nuclear structure at the extreme of isospin and spin	**Dr Christelle Schmitt** Grand Accelerateur National D'Ions Lourds (GANIL) CAEN	**Dr. Sarmishtha Bhattacharyya** Variable Energy Cyclotron Centre (VECC), 1/AF Bidhan Nagar Kolkata
6.	Sums of integers: Fourier, combinatorics, computation	**Prof. François HENNECART** Institut Mathématique de Bordeaux Université de Bordeaux-CNRS, Bordeaux	**Dr. R. Balasubramanian** Institute of Mathematical Sciences CIT Campus Chennai
7.	Glimpses of New Physics	**Dr. Debtosh Chowdary** Centre de Physique Théorique Ecole Polytechnique Palaiseau	**Prof. Gautam Bhattacharyya** Saha Institute of Nuclear Physics (SINP) Kolkata
8.	Metal chelators derived from imidazole thiones and selones for detoxification	**Dr. Pascale Delangle** CEA Centre de Grenobles Grenoble	**Dr Gouriprasanna Roy** Shiv Nadar University Uttar Pradesh
9.	Nuclear structure at the extreme of isospin and spin	**Dr. Navin Alahari** Grand Accelerateur National D'Ions Lourds (GANIL) CAEN	**Dr. Sarmishtha Bhattacharyya** Variable Energy Cyclotron Centre (VECC) 1/AF Bidhan Nagar, Kolkata
10.	Composite Models at the Interface of Theory and Phenomenology	**Prof. AldeDeandra** IPNL, Rhône-Alpes Lyon	**Prof. K Sridhar** TIFR Mumbai

Mobility of French Scientists **January - March 2019**

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
11.	Nutrient transfers through groundwater in India (NUNDERGROUND)	**Prof. Damien Cardinal** & **Dr. Veronique Vaury** Université Curie Paris	**Dr. V.V.S.S. Sarma** National Institute of Oceanography, Goa
12.	Interplay between MgO oxygen vacancies and tunnelling spin transfer torque	**Dr. Martin Oliver Bowen** & **Mr. Lalit Kandpal** Institut of Physics and Chemistry of Strasbourg Strasbourg	**Dr. Pranaba Kishor Muduli** Indian Institute of Technology Delhi New Delhi
13.	Original biocompatible phosphorus dendrimers as a new strategy to tackle pulmonary tuberculosis	**Dr. Serge Mignani** Laboratoire de Chimie de Coordination du CNRS Toulouse	**Prof. Kishore K. Srivastava** Division of Microbiology CSIR-Central Drug Research Institute Lucknow

CEFIPRA

8. Indian and French Organizations

Collaborative Scientific Research Projects

INDIAN ORGANIZATIONS

Indian Institute of Technology	
1	Indian Institute of Technology Bombay
2	Indian Institute of Technology Delhi
3	Indian Institute of Technology Kanpur
4	Indian Institute of Technology Madras
Universities	
1.	Anna University
2.	Cochin University of Science & Technology
3.	Jadavpur University
4.	Jawaharlal Nehru University
5.	Pondicherry University
6.	Pune University
7.	Shiv Nadar University
8.	Tumkur University
9.	University of Hyderabad
Other Academic / Research Institutions	
1	CSIR -Central Drug Research Institute
2	CSIR- Centre for Cellular and Molecular Biology
3	CSIR- Indian Institute of Chemical Technology
4	CSIR-National Aerospace Laboratories
5	Indian Association for the Cultivation of Sciences

6	Indian Institute of Information, Hyderabad
7	Indian Institute of Science
8	Indian Institute of Science Education and Research
9	Institute for Stem Cell Biology and Regenerative Medicine
10	Institute of Mathematical Sciences
11	Inter University Centre for Astronomy and Astrophysics
12	International Centre for Theoretical Sciences
13	Jawaharlal Institute of Postgraduate Medical Education and Research
14	Jawaharlal Nehru Centre for Advanced Scientific Research
15	National Geophysical Research Institute
16	National Institute of Immunology
17	National Institute of Oceanography
18	National Institute of Science Education and Research
19	PG Institute of Ophthalmology, Aravind Eye Hospital
20	Raman Research Institute
21	Saha Institute of Nuclear Physics
22	Tata Institute of Fundamental Research
23	Translational Health Science and Technology Institute
24	Variable Energy Cyclotron Centre

Industry Academic Research Projects

INDIAN ORGANIZATIONS / INDUSTRIES

2	CSIR- National Metallurgical Laboratory
3	CSIR-Central Mechanical Engineering Research Institute
4	Delhi Integrated Multi-Modal Transit System Ltd.
5	Dhvani Research & Development Solutions
6	Golden Star Technical Services
7	Indian Institute of Science
8	Indian Institute of Technology Delhi
10	Indian Institute of Technology Madras
11	Jadavpur University

12	M/s. Joshi Electronics & Electricals Pvt Ltd
13	M/s. Turnpoint Technologies Pvt Ltd
14	Morphing Machines Pvt Ltd
17	Pandora Connect LLP
18	Sergusa Solutions Pvt. Limited
19	Tata Consultancy Services
21	Vel Tech Dr. RR & Dr. SR Technical University
22	Vellore Institute of Technology
23	Virchow Biotech Private Limited

Targeted and Innovation Projects

INDIAN ORGANIZATIONS / INDUSTRIES

1	Birla Institute of Technology and Science (Goa Campus)
2	Center for Incubation, Innovation, Research and Consultancy (CIIRC)
3	Chennai Mathematical Institute
4	CSIR-Central Scientific Instruments Organisation
5	Dhirubhai Ambani Institute of Information and Communication Technology, Gandhinagar
6	Indian Institute of Science Bangalore
7	Indian Institute of Technology Bombay
8	Indian Institute of Technology Delhi
9	Indian Institute of Technology Kanpur
10	Indian Institute of Technology Kharagpur
11	Indian Institute of Technology Roorkee
12	Indian Statistical Institute
13	Indraprastha Institute of Information Technology, New Delhi
14	Jadavpur University
15	Jyothy Institute of Technology, Bangalore
16	Malaviya National Institute of Technolog, Jaipur
17	National Environmental Engineering Research Institute
18	National Institute of Technology Karnataka
19	Tata Research & Development Jamshedpur
20	Transintegra Healthcare Pvt. Ltd., Bhubaneswar
21	University of Petroleum and Energy Studies
22	Venza Water Management Solutions
23	Vishwakarma International Private Limited Bangalore
24	Panacea Medical Technologies Pvt. Ltd. Bengaluru

Collaborative Scientific Research Projects

FRENCH ORGANIZATIONS

1	Centre des Sciences du Goût et de l'Alimentation, Dijon
2	Centre national de la recherche scientifique (CNRS)
3	Commissariat à l'énergie atomique (CEA)
4	Institut de Physique du Globe
5	Institut de Recherches en Astrophysique et Planétologie
6	Institut de Recherches en Astrophysique et Planétologie, Toulouse
7	Institut Mathématique de Bordeaux, Bordeaux
8	Institut national de la recherche agronomique(INRA)
9	Institut national de la santé et de la recherchemédicale (INSERM)
10	Institut national de recherche dédié aunumérique (Inria)
11	Institut National des Sciences Appliquées (INSA)
12	Laboratoire de Chimie de Coordination, Toulouse
13	Laboratoire des Symbioses Tropicales & Méditerranéennes (IRD)
14	Observatoire de Lyon- CRAL

Universities	
1	Université de Bordeaux
2	Université de Caen
3	Université de Lyon
4	Université de Nantes
5	Université Paris Diderot
6	University Pierre and Marie Curie
7	Université de Bourgogne
8	Université de Lorraine
9	Universit´ de Lorraine - Metz
10	Université d'Aix-Marseille
11	Université de Lille
12	Université de Luminy
13	Université de Nancy
14	Université de Paul Sabatier
15	Université de Poitiers
16	Université de Reims Champagne-Ardenne
17	Université de Rennes

18	Université de Rouen
19	Université de Rouen
20	Université de Strasbourg
21	Université de Toulouse
22	Université Joseph Fourier, Orsay
23	Universite Montpellier
24	Université Sorbonne

Ecole	
1	Ecole Centrale de Lyon
2	Ecole Nationale Supérieure de Chimie de Paris
3	Ecole Nationale Supérieure de Chimie de Rennes
4	Ecole Polytechnique-Centre de Physique Théorique

Industry Academic Research Projects

FRENCH ORGANIZATIONS / INDUSTRIES

1	Ariane Group,
2	Ariane Group, Les Meureux
3	Centrale Supelec
4	Centrale Supélec, Gif-Sur-Yvette
5	CETHIL, INSA Lyon
6	École Normale Supérieure, Paris
7	Faurecia / CentraleSupelec / Esigelec GeePs, Gif-sur-Yvette
8	Francecol Technology, Luynes

9	IFSTTAR
10	Inria
11	Safran Electronics & Defense SAS
12	Span Diagnostics SAR
13	Telecom Paris Tech, Paris
14	THALES
15	Université de Bordeaux
16	Université Jean Monnet

Targeted and Innovation Projects

FRENCH ORGANIZATIONS / INDUSTRIES

1	Cap Oméga, Montpellier
2	Centre Inter-universitaire de Recherche et d'Ingénierie des Matériaux (CIRIMAT)
3	Centre national de la recherche scientifique (CNRS)
4	Company Jean Voisin
5	Ecole Nationale Supérieure d'Ingénieurs de Poitiers (ENSIP)
6	École Normale Supérieure
7	École Polytechnique
8	Ecoles des Mines de Nantes (EMN), Nantes
9	Institut national de la recherche agronomique (INRA)
10	Institut national de recherche dédié aunumérique (Inria)
11	IRMB Hôpital St Eloi, Montpellier
12	Laboratoire Bordelais de Recherche en Informatique

13	Laboratoire Informatique Gaspard Monge (LIGM)
14	Las – Universite de Lille
15	Medeo SAS , Lyon
16	Paris-Sud University
17	Technopole de Nancy Brabois
18	Université Clermont Auvergne
19	Université de Bordeaux
20	Universite de Clermont
21	Université de Rennes 1
22	Université Grenoble Alpes
23	Université Montpellier 2
24	Université Paris Diderot
25	Univrsité Paul Sabatier

CEFIPRA

9. Financial Reports & Audited Accounts

Financial Report for FY 2018-19

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 (CSRP)
ii) Industry Academia Research and Development Programme (IARDP)
iii) Seminars/Workshops
iv) Others

During the year 2018-19, Rs 145.72 Million (Euro 1.72 million) and Rs.124.24 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- Grants-in-Aid received from Government of India & Government of France for core programmes during FYs 2016-17, 2017-18 & 2018-19

(Rs. in million)

Financial Year	Grant-in-aid received from Govt. of India		Grant-in-aid received from Govt. of France		**Total Funds available**
	C/F from last year	Grant received during the year	C/F from last year	Grant received during the year	
2018-19	67.78	145.72	43.16	124.24	Rs.380.92 (Euro 4.90 million)
2017-18	24.60	105.10	25.55	112.87	Rs. 268.12 (Euro 3.33 million)
2016-17	14.79	119.40	19.71	115.43	Rs.269.33 (Euro 3.88 million)

During the Financial Year 2018-19, one hundred eighty five (185) new collaborative scientific research project proposals (CSRP) and ten (10) Industry Academia Research and Development project proposals (IAR&DP) were received. Out of the, eighteen proposals (18) of CSRP at budgeted cost of Rs. 224.44 million (Euro 2.78 million) and one (01) proposals of IAR&DP at budgeted cost of Rs. 14.95 million (Euro 0.18 million) were recommended. The details of expenditure incurred during the year towards core activities are given below:

i) As on March 31 2019, fifty six (56) projects (including 14 new projects) of CSRP were under implementation. The core expenditure of the Centre towards collaborative scientific research projects is Rs. 136.42 million (Euro 1.75 million).

ii) As on March 31, 2019, six (5 projects of earlier year and 1 new project) projects of IAR&DP were under implementation. Rs. 1.96 million (Euro 0.03 million) was spent on the Industry Academia Research and Development 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, six seminars/ workshops were supported by the Centre at a cost of Rs. 10.52 million (Euro 0.14 million).

iv) Rest of the expenses of Rs. 33.85 million (Euro 0.43 million) are for expense on meetings of Governing Body, Scientific Council and Industrial Research Committee (Rs. 8.72/Euro 0.11 millions) as well as running expenses (Rs. 24.98/Euro 0.32 million).

The details of the expenditure incurred by the Centre during the Financial Year 2018-19 for the core programmes, under various budget heads are given in the *Table 2* and *Figure X*. A comparison with the previous three years has also been provided in **Table 2** and **Figure Y**.

Table 2: Expenditure incurred for the core programmes during the financial years 2016-17, 2017-18 & 2018-19

(Rs./Euro in million)

		2016-17		2017-18		2018-19	
	Budgetary Components	Expenditure Rs.	% of total	Expenditure Rs.	% of total	Expenditure Rs.	% of total
1.	Scientific Research Projects	170.99 (2.47 M Euro)	78.02%	134.73 (1.67 M Euro)	64.82%	136.42 (1.75 M Euro)	67.98%
2.	Industrial Research Projects	3.99 (0.06 M Euro)	1.82%	26.72 (0.33 M Euro)	12.85%	19.62 (0.25 M Euro)	9.79%
3.	Seminars & Workshops	5.21 (0.08 M Euro)	2.38%	14.16 (0.18 M Euro)	6.81%	10.52 0.135 M Euro)	5.24%
4.	PPP Programme (SGRI Projects & Airbus)	1.51 (0.02 M Euro)	0.69%	2.12 (0.03 M Euro)	1.02%	0.00	0.00%
5.	General Scientific Expenses (activities like Publication of research papers, ESONN, SOLEIL Synchrotron Programmes, Lecture Series etc.)	8.43 (0.11 M Euro)	3.85%	4.23 (0.05 M Euro)	2.04%	0.290 (0.003 M Euro)	0.14%
6.	Governing Body, Industrial Research Committee & Scientific Council meetings	9.52 (0.14 M Euro)	4.34%	7.30 (2.47 M Euro)	3.51%	8.87 (Euro 0.114 M)	4.41%
7.	Running expenses of the Centre (Salaries, Office maintenance &Travel)	19.52 (0.27 M Euro)	8.91%	18.60 (0.23 M Euro)	8.95%	24.98* (Euro 0.33 M)	12.44%
	TOTAL	**219.17 (3.15 MEuro) @ 1 Euro = Rs 69.2476**		**207.86 (2.58 M Euro) @ 1 Euro = Rs 80.6222**		**200.7 (2.58 M Euro) @ 1Euro = 77.7024**	

* Increase due to one-time payment of Property Tax Arrears amounting to Rs. 2.7 million and pension contribution of previous Director, Dr. Mukesh Kumar for Rs.2.1 million.

Figure X: Annual Expenditure during last 3 FYs - Core Programmes
(Figures in Rs/Euro in Million)

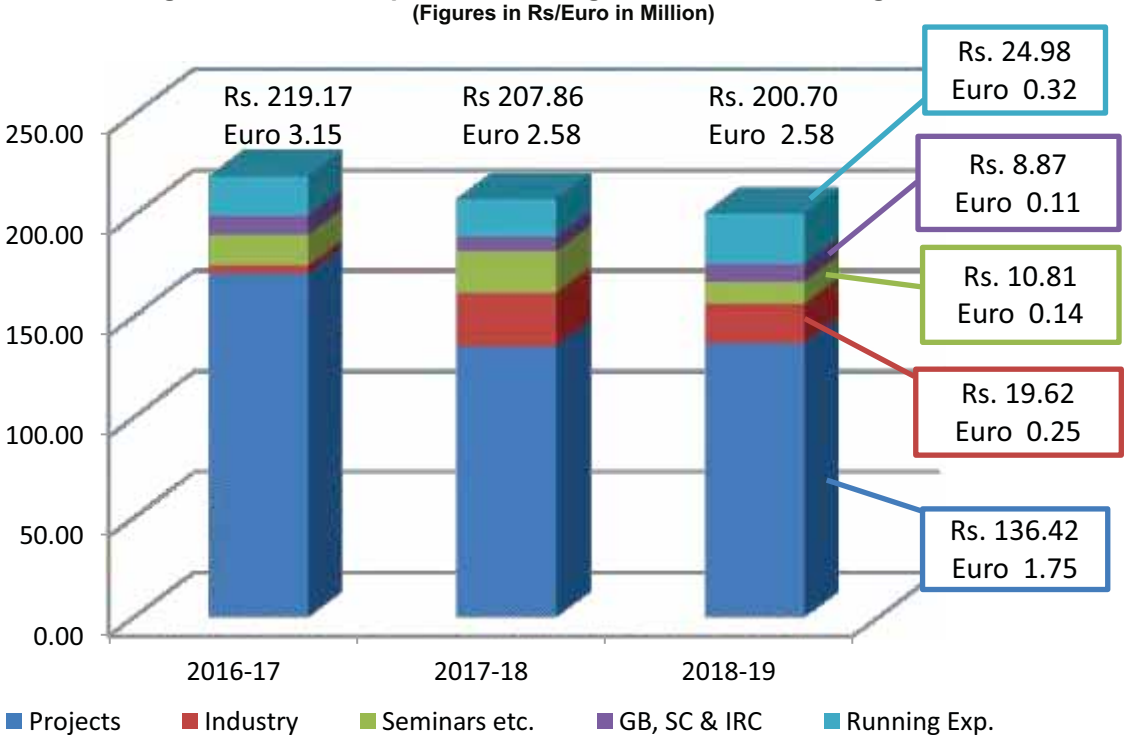
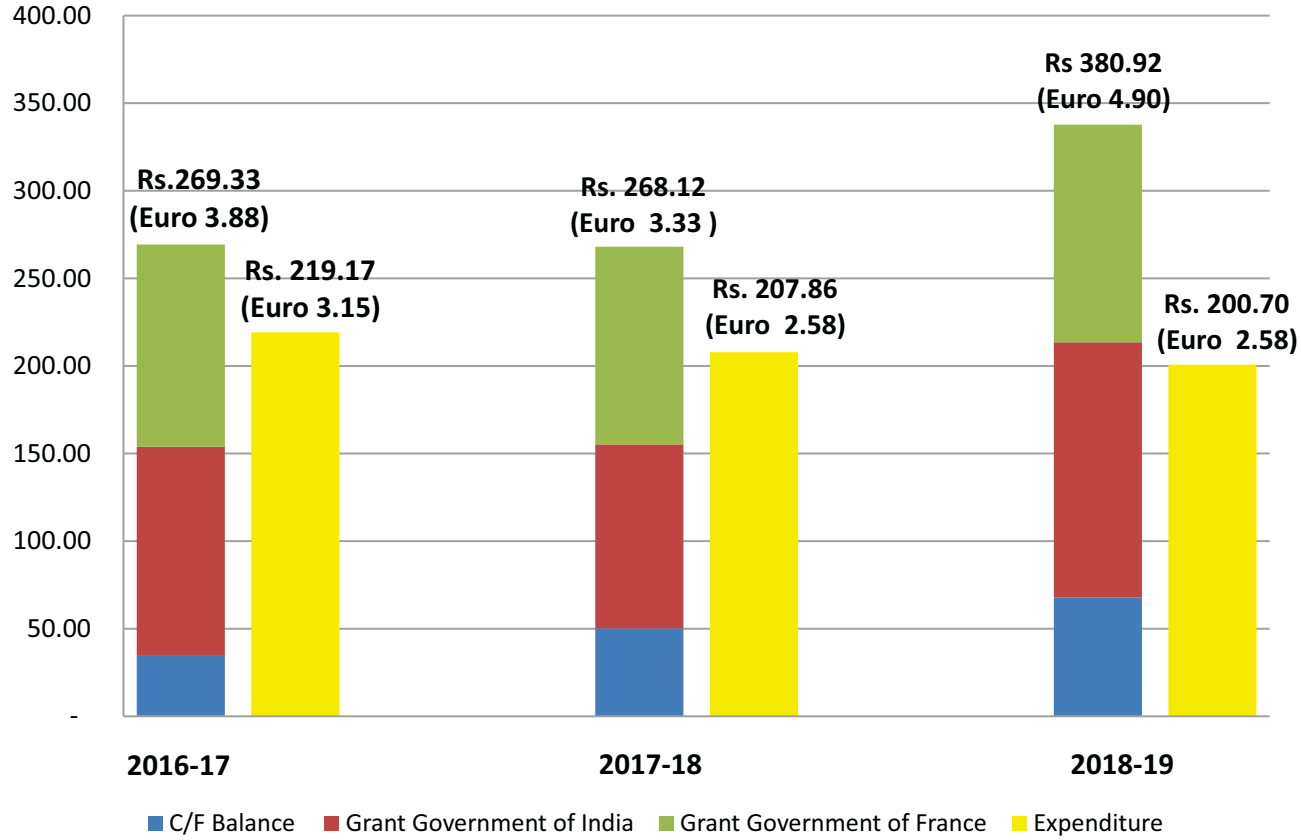


Figure Y: Fund Position v/s Expenditure - Core Programmes
(Figures in Rs/Euro in Million)



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 programme which 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 financial year 2018-19 are given in the **Table 3A** (*Rs in million*), **Table 3B** (*in Euro*)

Table 3A - Non Core Programmes: Fund Position & Expenditure incurred during FY 2018-19

(Rs. in million)

Non- Core Programmes : Fund Position & Expenditure incurred during Financial Year 2018-19												
S.No.	Funds Available		Received during the year			Total funds available during the year (a)	Expenditure during the year		Amount Adjusted during the Year (exchange fluctuation impact)	Amount refunded to DST/ Transferred to Group Farming	Total Expenditure (b)	Balance Available (a-b)
	RECEIPTS	C/F Balance	Indian Side	French Side	Interest Earned on Indian Fund		Indian Side	French Side				
1	IFCAM (DST-CNRS)	9.09	17.30	4.40	0.01	30.80	24.15	-	0.08	-	24.23	6.57
2	RAMAN CHARPAK FELLOWSHIP(DST-Fr.Embassy)	1.64	25.00	11.24	0.29	38.17	8.53	12.05	0.09	0.31	20.98	17.19
3	DST-INRA PROJECTS	3.22	-	-	0.02	3.24	-	-	0.11	2.33	2.44	0.80
4	DST-Inria-CNRS PROJECTS	3.57	10.69	-	0.21	14.47	8.06	-	-	1.67	9.73	4.74
5	DST-ANR PROJECTS	3.49	-	-	0.11	3.60	0.18	-	-	2.30	2.48	1.12
6	BIRAC- FRENCH EMBASSY PROJECTS	12.58	-	-	-	12.58	0.002	1.26	0.31	-	1.57	11.01
7	Indo-French Water Network	11.17	-	-	0.13	11.30	0.24	-	0.35	-	0.59	10.71
8	TDB Programee	0.22	1.10	-	0.02	1.34	1.06	-	-	-	1.06	0.28
9	BIRAC-BPI FRANCE	0.47	2.75	-	-	3.22	0.13	-	-	-	0.13	3.09
10	FRENCH EMBASSY -SST	5.92	-	-	-	5.92	-	-	-	0.18	0.18	5.74
11	DST-ESONN Fellowship	3.03	-	-	0.05	3.08	2.80	-	-	0.28	3.08	-
	TOTAL	**54.400**	**56.840**	**15.640**	**0.843**	**127.723**	**45.151**	**13.310**	**0.941**	**7.070**	**66.472**	**61.251**

NOTE for 2018-19:

(1) The C/F balances includes 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 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) French Embassy, SSt programmes includes Economic Diplomacy programme.

Table 3B - Non Core Programmes: Fund Position & Expenditure incurred during FY 2018-19

(in Euro)

Non- Core Programmes : Fund Position & Expenditure incurred during Financial Year 2018-19												
S.No.	Funds Available		Received during the year			Total funds available during the year (a)	Expenditure during the year		Amount Adjusted during the Year (exchange fluctuation impact)	Amount refunded to DST/ Transferred to Group Farming	Total Expenditure (b)	Balance Available (a-b)
	RECEIPTS	C/F Balance	Indian Side	French Side	Interest Earned on Indian Fund		Indian Side	French Side				
1	IFCAM (DST-CNRS)	1,16,984.80	2,22,644.35	56,626.31	128.70	3,96,384.15	3,10,801.21	-	1,029.57	-	3,11,830.78	84,553.37
2	RAMAN CHARPAK FELLOWSHIP(DST-Fr.Embassy)	21,106.17	3,21,740.38	1,44,654.48	3,732.19	4,91,233.22	1,09,777.82	1,55,078.87	1,158.27	3,989.58	2,70,004.53	2,21,228.69
3	DST-INRA PROJECTS	41,440.16	-	-	257.39	41,697.55	-	-	1,415.66	29,986.20	31,401.86	10,295.69
4	DST-Inria-CNRS PROJECTS	45,944.53	1,37,576.19	-	2,702.62	1,86,223.33	1,03,729.10	-	-	21,492.26	1,25,221.36	61,001.98
5	DST-ANR PROJECTS	44,914.96	43,412.36	-	1,415.66	46,330.62	2,316.53	-	-	29,600.12	31,916.65	14,413.97
6	BIRAC- FRENCH EMBASSY PROJECTS	1,61,899.76	18,605.30	-	-	1,61,899.76	25.74	16,215.72	3,989.58	-	20,231.04	1,41,668.73
7	Indo-French Water Network	1,43,753.60	-	-	1,673.05	1,45,426.65	3,088.71	-	4,504.37	-	7,593.07	1,37,833.58
8	TDB Programee	2,831.32	14,156.58	-	257.39	17,245.28	13,641.79	-	-	-	13,641.79	3,603.49
9	BIRAC-BPI FRANCE	6,048.72	6,048.72	-	-	41,440.16	1,673.05	-	-	-	1,673.05	39,767.11
10	FRENCH EMBASSY -SST	76,188.12	-	-	-	76,188.12	-	-	-	2,316.53	2,316.53	73,871.59
11	DST-ESONN Fellowship	38,994.93	-	-	643.48	39,638.42	36,034.92	-	-	3,603.49	-	-
	TOTAL	**7,00,107.08**	**7,64,183.87**	**2,01,280.78**	**10,810.48**	**16,43,707.27**	**5,81,088.87**	**1,71,294.58**	**12,097.44**	**90,988.18**	**8,15,830.66**	**7,88,238.20**

NOTE for 2018-19:

(1) The C/F balances includes interest earned in the FY 2018-19 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.

Financial Audit

The statutory audit of the accounts of the Centre was carried out by M/s. Nirbhaya & Associates, Sagar Plaza, Vikas Marg, New Delhi-110092. The accounting currencies of the Society are both 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 Receipts and Payments are drawn in respective currencies.

For presentation of INR accounts the grant received in Euro currency for core programme is converted into INR on the exchange rate prevailing on the date of transaction as declared by the Reserve Bank of India (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, on 31st March of each Financial Year.

All INR accounts viz, the Income & Expenditure account, Balance Sheet and Receipt & Payment account of INR are translated to Euro on the basis of rate of exchange prevailing on the date of preparation of the Balance Sheet, as declared by RBI, on 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.

NIRBHAYA & ASSOCIATES
CHARTERED ACCOUNTANT
E-mail: info@canirbhaya..com

203,Sagar Plaza , Radhupalace
Laxminagar, Delhi- 110092
Mob. : 08860988467

INDEPENDENT AUDITOR'S REPORT

To The Governing Body of
Indo French Centre for the Promotion of Advance Research
Lodhi Road, New Delhi

We have audited the accompanying financial statements of **Indo French Centre for the Promotion of Advance Research, New Delhi** (a Society Registered under Societies Registration Act, 1860) which comprise the Balance Sheet as at March 31, 2019, the Income and Expenditure Account and 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, 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.

Auditor's 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 control relevant to the Company's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances. 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.

In our opinion and to the best of our information and according to the explanations given to us, the financial statements give the information required by the Act in the manner so required and give a true and fair view in conformity with the accounting principles generally accepted in India.

For NIRBHAYA & ASSOCIATES
Chartered Accountants
Firm Registration No. 016125N

(KUMAR NISHIKANT)
Partner
Membership No.538686

Place : New Delhi
Date :16th September, 2019

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, 2019

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.

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 rate in foreign currency and rates on which core grants received during the year.

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:

Grant in Aid

1. IFCPRA has received a sum of Rs. 14,57,25,044/- (out of which Rs. 6,86,50,000/- was received on the last day of the financial year) as Grant in Aid from Government of India, Ministry of Science and Technology, Department of Science and Technology during the year for normal core activity.

2. IFCPRA has received a sum of Euro 15,50,000/- as Grant in Aid from Government of France during the year for normal core activity.

3. IFCPRA has received a sum of Euro 1,94,197/- and Rs.5,68,53,907/- as Grant in Aid during the year from Government of France and Government of India respectively during the year for non-core activity.

Foreign Currency Adjustment Account

4. The Non-Core Expenditure of Programme Implementation and Overhead for the current financial year has not been transferred and will be transferred after the finalization of accounts.

5. Exchange Fluctuation Adjustment account liability of Rs.83,80,464/- as on 31st March 2018 has been decreased to Rs.66,23,053/- after translating the bank balance at new closing rate.

6. Contribution was made to LIC of India towards annual premium for Group Gratuity Accumulation Scheme maintained with LIC of India for the FY 2016-17 and FY 2017-18 during the financial year 2018-19 amounting Rs.11,91,621/-. In respect of premium of pension the decision is under consideration of the Governing Body/Finance committee.

7. Provision has not been made for leave encashment liability and the same is accounted for cash basis.

8. The Centre was granted exemption from payment of Income Tax vide notification issued by CBDT dt. 15.11.2018 u/s 11(1) (c) of the Income Tax Act, 1961 valid upto Asst. Year 2018-19.Application for renewal of exemption u/s 11(1)(c) of the Income Tax Act, 1961 for AY 2019-20 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 2018-19.

10. During the year total ongoing projects were 56 and the total liability towards these projects as per sanctioned amounts aggregates to Rs.6,59,27,776/- for the Indian side and Euro 4,33,031/- for the French side at 31st March, 2019.

For NIRBHAYA & ASSOCIATES
Chartered Accountants
Firm Registration No.
016125N

KUMAR NISHKANT
Partner
Membership No.538686
Place : New Delhi
Date :16.09.2019

SIMRANJEET SINGH
Accounts Associate

Dr. PURNIMA RUPAL
Director

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
Balance Sheet as at 31st March 2019

INR Version

	SCH	Amount as on 31.03.2019	Total Amount in INR	Amount as on 31.03.2018	Total Amount in INR
I. Liabilities					
Reserve Fund					
Core Programmes	A	19,66,35,422.69	19,66,35,422.69		13,20,96,137.00
Current Liabilities					
Targeted Programmes	B				
IFCAM Project		32,63,076.81		70,00,955.00	
DST-ANR Projects		11,23,886.00		34,72,606.00	
DST-INRA Projects		8,04,722.54		32,24,543.00	
DST-INRIA Projects		64,20,127.00		35,12,512.00	
Raman Charpak Fellowship		1,74,94,488.26		15,39,863.00	
BIRAC French Embassy		1,10,20,994.22		1,25,62,276.00	
Economic Diplomacy R & D Programme		57,35,739.66		59,18,008.00	
BIRAC BPI France		30,97,889.00		4,60,573.00	
DST- ESSONN Fellowship		3,906.00		29,72,455.00	
Indo French Water Network		1,06,81,415.82		1,11,62,619.00	
			5,96,46,245.30		5,18,26,410.00
Programme Implementation & Overhead	B				
DST-ANR Projects		-		22,956.00	
DST-INRIA Projects		-		56,983.00	
Raman Charpak Fellowship		-		97,287.00	
BIRAC French Embassy				22,518.00	
Indo French Water Network		-		12,124.00	
TDB Programme		2,89,858.00		2,21,733.00	
BIRAC BPI France		-		11,827.00	
DST-ESSONN Fellowship		-		60,000.00	
			2,89,858.00		5,05,428.00
Expenses Payable					
Salaries and Office Expenses Payable	C	1,01,578.00		15,16,512.00	
TDS Payable	C	88,361.00		90,938.00	
Seminar & Workshop	C	39,01,708.00		30,20,629.00	
GB/SC Expenses Payble		2,088.00		3,07,367.00	
Expenses on Publication		7,000.00			
Expenses on 30th Anniversary of CEFIPRA-Payable		-		7,22,252.00	
Scientific expenses payable		6,356.00		62,619.00	
Travel Expenses Payable		5,277.00			
			41,12,368.00		57,20,317.00
BRICS Meeting			-		
Group Farming			8,54,726.40		8,86,844.00
Grant-In Aid-2017-18			-		
Foreign Currency Adjustment Account	D		66,23,853.00		83,80,464.00
Total Liabilities			**26,81,62,473.39**		**19,94,15,600.00**

Accounting policies and notes to accounts are integral part of financial statements.

AUDITOR'S REPORT

As per our report of even date attached.
For NIRBHAYA & ASSOCIATES
Chartered Accountants
Firm Regn. No. [illegible]

(Kumar Nishkarsh)
Partner
Membership No. 538686
Place : New Delhi
Date : 16.09.2019

(Simranjeet Singh)
Accounts Associate

(Dr. Purnima Rupal)
Director

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
Balance Sheet as at 31st March 2019

INR Version

	SCH	Amount as on 31.03.2019	Total Amount in INR	Amount as on 31.03.2018	Total Amount in INR
					INR Version
		Amount as on 31.03.2019		Amount as on 31.03.2018	
			Total Amount in INR		Total Amount in INR
II. Assets					
Fixed Assets	E		45,71,433.00		49,62,701.00
Cash & Cash Equivalents					
Core Bank Balances					
State Bank of Hyderabad Account		6,65,09,909.36		7,80,31,204.04	
Union Bank of India Accumulated Reserve		5,31,95,118.48			
		8		26,80,240.73	
Union Bank of India - DST INRIA Account		70,51,920.64		45,69,094.20	
Union Bank of India - DST INRA Account		6,84,866.00		6,61,411.00	
Union Bank of India - IFCAM Account		1,19,061.82		(44.69)	
Union Bank of India-DST ANR Account		17,04,535.73		38,08,777.93	
Union Bank of India-TDB Programme		7,82,660.16		2,19,452.32	
State Bank of Hyderabad-IFWN		27,59,582.00		28,05,806.00	
State Bank of Hyderabad-BIRAC		26,18,248.50		38,26,933.50	
State Bank Of India- BPI France		30,88,157.00		3,40,858.00	
Union Bank Of India-ESONN		54,556.76		30,05,890.00	
			3,97,72,409.09		2,19,18,418.99
Current Assets					
Seminars & Workshops	F	34,81,415.00		34,81,415.00	
Income Tax & TDS Receivable		3,47,190.00		3,35,684.00	
Other Deposits	F	81,93,743.00		1,58,42,891.00	
Tour Advances- Core		73,92,414.00		54,28,325.00	
Tour Advances-Non Core		1,23,300.00		96,720.00	
Accrued Interest-IFCAM		1,028.00		7,931.00	
Accrued Interest-ESSONN		716.00		26,565.00	
Accrued Interest-ANR		14,710.00		48,572.00	
Accrued Interest-TDB		7,198.00		2,281.00	
Accrued Interest-Raman Charpak		1,25,172.00		38,761.00	
Accrued Interest-INRIA		53,150.00		38,932.00	
Accrued Interest Accumulated Reserve		4,69,402.00			
Accrued Interest- INRA		5,911.00		5,708.00	
Accrued Interest-Core		-		3,643.00	
GB SC/IRC Advance		-		9,67,470.00	
IIC Membership Fee Advance		1,35,700.00		-	
Electonic Project Proposal Management		-		6,22,961.00	
Cash -in-transit		27,080.00		64,49,776.00	
Security Deposit, Campus France, Paris		62,16,192.00		64,49,773.16	
			2,65,94,321.00		3,98,47,408.16
Total Assets			**26,81,62,473.39**		**19,94,15,600.00**
			0.00	(0.00)	

Accounting policies and notes to accounts are integral part of financial statements.

AUDITOR'S REPORT

As per our report of even date attached.

For NIRBHAY & ASSOCIATES
Chartered Accountants
Firm Registration No. 018125N

(Kumar Nishikant)
Partner
Membership No.538686
Place : New Delhi
Date : 16.09.2019

(Simranjeet Singh)
Accounts Associate

(Dr. Purnima Rupal)
Director

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
Schedules forming part of Balance Sheet as At 31st March 2019

	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Transaction in INR	Transaction in Euro	Total Amount in INR	Transaction in INR	Transaction in Euro	Total Amount in INR
Schedule A						
Reserve Fund-Core Programmes						
Opening Balance B/f	6,23,08,568.41	9,24,435.43	13,20,96,137.00	7,71,22,250.00	6,65,435.43	12,02,23,535.00
Balance of Surplus Funds	2,51,13,387.00	4,61,880.74	6,45,39,285.69	(1,32,95,110.59)	2,59,418.92	1,33,91,173.00
Adjustment for Tragetted Programmes	-	-	-	(15,18,571.00)	-	(15,18,571.00)
Balance c/f to next year	**8,74,21,955.41**	**13,86,316.17**	**19,66,35,422.69**	**6,23,08,568.41**	**9,24,854.35**	**13,20,96,137.00**

	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Transaction in INR	Transaction in Euro	Total Amount in INR	Transaction in INR	Transaction in Euro	Total Amount in INR
Schedule D						
Foreign Currency Adjustment Account						
Opening Balance	-	-	83,80,464.00	-	-	23,79,827.00
Current year Adjustment	-	-	(17,56,611.00)	-	-	60,00,637.00
Balance carried forward to next year	**-**	**-**	**66,23,853.00**	**-**	**-**	**83,80,464.00**

NIRBHAYA & ASSOCIATES * DELHI * Chartered Accountants

PRupal

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
SCHEDULES FORMING PART OF THE BALANCE SHEET AS AT 31ST MARCH 2019

Schedule- E Fixed Assets

S.No	Particulars	Rate	GROSS BLOCK				DEPRECIATION				NET BLOCK	
			Opening Balance	Additions during the year upto 30.09.2018	Additions during the year after 30.09.2018	Sold during year	Closing balance	Upto 31.03.2018	Depreciation for the year	Adjustment	Total	Balance as on 31-03-2019	Balance as on 31-03-2018
1	CAR	0.15	6,04,763.00			-	6,04,763.00	4,13,944.00	28,623.00		4,42,567.00	1,62,196.00	1,90,819.00
2	FURNITURE & FIXTURE	0.10	10,92,982.00		43,499.00		11,36,481.00	2,82,264.00	83,247.00		3,65,511.00	7,70,970.00	8,10,718.00
3	OFFICE EQUIPMENT	0.15	41,33,135.00				41,33,135.00	25,48,063.00	2,38,068.00		27,84,141.00	13,48,994.00	15,87,052.00
4	COMPUTER	0.40	20,84,086.00	60,180.00	2,29,170.00		23,53,436.00	19,62,396.00	1,10,582.00		20,72,978.00	2,80,458.00	1,01,690.00
5	LAND & BIUILDING	0.10	1,47,71,284.00				1,47,71,284.00	1,32,26,164.00	1,54,512.00		1,33,80,676.00	13,90,608.00	15,45,120.00
6	PHOTOCOPIER	0.15	1,52,250.00				1,52,250.00	42,250.00	16,500.00		58,750.00	93,500.00	1,10,000.00
7	TELEPHONE SYSTEM	0.15	16,85,958.00				16,85,958.00	10,68,656.00	92,595.00		11,61,251.00	5,24,707.00	6,17,302.00
			2,45,84,458.00	60,180.00	2,72,669.00	-	2,48,37,307.00	1,95,41,757.00	7,24,117.00	-	2,02,65,874.00	45,71,433.00	49,62,701.00
	Previous Year		2,45,81,158.00	3,300.00	-	-	2,45,84,458.00	1,87,79,113.00	7,71,644.00	-	1,87,79,113.00		

NIRBHAYA & ASSOCIATES
DELHI
Chartered Accountants

PRupal

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2019-CORE PROGRAMME

INR Version

	SCH	Amount as on 31.03.2019 Total Amount in INR		Amount as on 31.03.2018 Total Amount in INR	
Income					
Grant-in Aid	G				
From Government of India		14,57,25,044.00		10,51,00,000.00	
From Government of France		12,42,48,000.00		11,28,72,550.00	
			26,99,73,044.00		21,79,72,550.00
Interest From Bank Accounts	H		26,81,837.00		15,04,245.00
Misc. Income			2,68,914.00		3,70,231.00
I. Total Income			**27,29,23,795.00**		**21,98,47,026.00**
Expenditure	I				
Running Expenditure of the Centre					
Salaries and Office Expenses of the Centre		2,42,74,154.00		1,77,28,087.00	
Travel Expense		7,11,901.00		8,67,578.00	
GB/SC/IRC/SEP/Vision Group Expenses		88,72,491.00		72,99,220.00	
Office Expenses-Accumulated Reserve		67,34,933.00		57,29,920.00	
Total Running Expenditure (A)			4,05,93,479.00		3,16,24,805.00
Scientific Expenditure of the Centre					
General Scientific Expenses		2,90,272.00		42,33,143.00	
Research Projects/Seminar and Workshop		16,65,81,176.00		17,56,03,579.00	
SGRI Programmes		-		21,23,799.00	
Airbus project		-		-	
Total Scientific Expenditure (B)			16,68,71,448.00		18,19,60,521.00
II. Total Expenditure(A+B)			**20,74,64,927.00**		**21,35,85,326.00**
Excess of Income over Expenditure(I-II)			**6,54,58,868.00**		**62,61,700.00**
Depreciation	E	(7,24,117.00)		(7,71,644.00)	
Loss on Sale assets		-		-	
Prior period items		(77,198.11)		25,57,568.00	
Exchange Rate Fluctuation(Repatriate Fluctution difference)		(1,18,267.20)		53,43,549.00	
			(9,19,582.31)		**71,29,473.00**
Balance of Surplus Funds			**6,45,39,285.69**		**1,33,91,173.00**

Accounting policies and notes to accounts are integral part of financial statements.

AUDITOR'S REPORT

As per our report of even date attached.

For NIRBHAYA & ASSOCIATES
Chartered Accountants
Firm Registration No. 016125N

(Kumar Nirbhayank)
Partner
Membership No. 538686
Place : New Delhi
Date : 16.09.2019

(Simranjeet Singh)
Accounts Associate

(Dr. Purnima Rupal)
Director

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Income & Expenditure- Core Programme as At 31st March 2019

Schedule -I Expenditure Core Programme	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Transaction (INR)	Transaction (EURO)	Total Amount (INR)	Transaction (INR)	Transaction (EURO)	Total Amount (INR)
I. Running Expenditure of the Centre						
Salaries and Office Expenses of the Centre						
(A) Salaries	1,54,48,512.00	-	1,54,48,512.00	1,40,41,461.00	-	1,40,41,461.00
Less: Salaries for Non Core	- -	-	-	-	-	
Total Salaries(A)	**1,54,48,512.00**	**-**	**1,54,48,512.00**	**1,40,41,461.00**	**-**	**1,40,41,461.00**
(B) Office Expenses						
Communication Expenses	5,61,543.00	-	5,61,543.00	5,65,933.00		5,65,933.00
Conveyance Expenses	25,123.00	-	25,123.00	33,669.00		33,669.00
Entertainment Expenses	- 1,236.00		1,236.00	3,401.00		3,401.00
Repair & Maintenance	53,212.00	-	53,212.00	40,887.00		40,887.00
Electricity Expenses	84,382.00	-	84,382.00	88,593.00		88,593.00
Security Charges	3,37,451.00	-	3,37,451.00	4,35,918.00		4,35,918.00
Other Office Expenses	1,46,695.00	-	1,46,695.00	99,541.00	210.00	1,14,434.00
Bank Charges	973.00	4,224.93	3,29,260.00	18,378.79	4,632.50	3,46,922.00
Electronic Project Proposal Management	18,03,885.00	-	18,03,885.00	7,21,673.00		7,21,673.00
Books & Periodicals	16,814.00	-	16,814.00	15,788.00		15,788.00
Canteen Expenses	44,033.00	-	44,033.00	38,208.00		38,208.00
Festival Expenses	28,542.00	-	28,542.00	29,437.00		29,437.00
Management Service	2,58,637.00	-	2,58,637.00	2,34,585.00		2,34,585.00
Printing and Stationary	1,52,569.00	-	1,52,569.00	2,59,912.00		2,59,912.00
Staff Car Expenses	1,14,585.00	-	1,14,585.00	78,872.00		78,872.00
Professional & Legal Expenses	2,41,555.00	-	2,41,555.00	4,34,616.00		4,34,616.00

NIRBHAYA & ASSOCIATES * DELHI * Chartered Accountants

PRupal

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Income & Expenditure- Core Programme as At 31st March 2019

Schedule -I Expenditure Core Programme	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Transaction (INR)	Transaction (EURO)	Total Amount (INR)	Transaction (INR)	Transaction (EURO)	Total Amount (INR)
Recruitment Expenses	1,69,789.00	-	1,69,789.00	39,901.00		39,901.00
Advertisement Expenses	- 86,420.00		86,420.00	99,084.00		99,084.00
IIC Membership	- -	-		1,04,793.00		1,04,793.00
Website Maintenance	2,95,988.00	-	2,95,988.00	-		-
Gratutity	11,91,621.00		11,91,621.00			
Property tax	28,82,302.00		28,82,302.00			
Office Expenses(B)	**84,97,355.00**	**4,224.93**	**88,25,642.00**	**33,43,189.79**	**4,842.50**	**36,86,626.00**
Total Salaries and Office Expense(A+B)	**2,39,45,867.00**	**4,224.93**	**2,42,74,154.00**	**1,73,84,650.79**	**4,842.50**	**1,77,28,087.00**
(C) Travel Expenses						
Domestic Travel	1,50,362.00	-	1,50,362.00	2,69,480.00		2,69,480.00
International Travel	4,53,191.00	1,394.40	5,61,539.00	4,76,036.80	1,721.08	5,98,098.00
Total Travel Expenses (C')	**6,03,553.00**	**1,394.40**	**7,11,901.00**	**7,45,516.80**	**1,721.08**	**8,67,578.00**
(D) GB/SC/IRC/SEP/Vision Group Expenses						
Governing Body	11,04,341.00	7,268.20	16,69,098.00	7,79,141.00	2,575.00	9,61,764.00
Scientific Council	33,24,059.00	17,768.97	47,04,751.00	24,79,974.00	24,089.79	41,88,456.00
Industrial Research Council	16,09,012.00	8,461.32	22,66,477.00	10,72,168.00	7,418.60	15,98,305.00
Standard Expert Panel	1,23,485.00	1,078.80	2,07,310.00	89,539.00		89,539.00
Finance Sub-Committee	24,855.00		24,855.00	- 10,502.00		10,502.00
Vision Group Meeting			-	3,09,342.00	1,992.51	4,50,654.00
Total GB/SC/IRC/SEP/Vision group Expenses (D)	**61,85,752.00**	**34,577.29**	**88,72,491.00**	**47,40,666.00**	**36,075.90**	**72,99,220.00**

NIRAHAYA & ASSOCIATES DELHI Chartered Accountants

PRupal

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Income & Expenditure- Core Programme as At 31st March 2019

Schedule -I Expenditure Core Programme	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Transaction (INR)	Transaction (EURO)	Total Amount (INR)	Transaction (INR)	Transaction (EURO)	Total Amount (INR)
(E) Office Expenses- Accumulated Reserve						
Maintenance Charges IHC	12,16,443.00	-	12,16,443.00	13,27,051.00		13,27,051.00
Maintenance Charges-Office Premises	5,60,620.00	-	5,60,620.00	5,38,499.00		5,38,499.00
Computer Software	4,720.00	-	4,720.00	4,830.00		4,830.00
Group Farming Projects	3,50,436.00	35,323.00	30,95,118.00	5,85,451.00		5,85,451.00
Employees Insurance Premium	1,48,609.00	-	1,48,609.00	1,68,274.00		1,68,274.00
Expenditure on 30th Anniversary of CEFIPRA			-	7,46,650.00		7,46,650.00
Network Projects	15,51,933.00	2,026.84	17,09,423.00	18,62,500.00	7,003.04	23,59,165.00
Total Office Expenses- Accumulated Reserve (E)	**38,32,761.00**	**37,349.84**	**67,34,933.00**	**52,33,255.00**	**7,003.04**	**57,29,920.00**
II Scientific Expense of the Centre						
(A) General Scientific Expenses						
Expenses on outreach	-	-	-	28,372.00		28,372.00
Scientific Publication	5,98,030.00	-	5,98,030.00	2,11,098.00		2,11,098.00
Expenses in Connection with Esonn	-	-	-	10,22,843.00	19,200.00	23,84,534.00
Cefipra Lecture Series	19,794.00	-	19,794.00	3,65,222.00	10,342.72	10,98,742.00
Region to Region	-	-	-	-		-
Synchroton Meetings	-	-	-	3,53,446.00		3,53,446.00
Other Scientific Expenses	(3,27,552.00)	-	(3,27,552.00)	1,56,951.00		1,56,951.00
Total General Scientific Expenses (A)	**2,90,272.00**	**-**	**2,90,272.00**	**21,37,932.00**	**29,542.72**	**42,33,143.00**

NIRBHAYA & ASSOCIATES DELHI Chartered Accountants

PRupal

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Income & Expenditure- Core Programme as At 31st March 2019

Schedule -I Expenditure Core Programme	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Transaction (INR)	Transaction (EURO)	Total Amount (INR)	Transaction (INR)	Transaction (EURO)	Total Amount (INR)
(B) Research Projects/Seminar and Workshop						
Seminars & Workshops	58,94,160.00	59,588.82	1,05,24,354.00	1,11,05,992.00	43,077.42	1,41,61,103.00
Research Projects	7,09,09,212.00	8,43,203.50	13,64,28,148.00	5,98,51,536.00	10,55,740.50	13,47,26,130.00
Industrial Research Projects	1,11,76,714.00	1,08,773.48	1,96,28,674.00	1,61,74,595.00	1,48,639.92	2,67,16,346.00
Total Research Project/Seminar and workshop (B)	**8,79,80,086.00**	**10,11,565.80**	**16,65,81,176.00**	**8,71,32,123.00**	**12,47,457.84**	**17,56,03,579.00**

NIRBHAYA & ASSOCIATES DELHI Chartered Accountants

PRupal

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
RECEIPT AND PAYMENT FOR THE YEAR ENDED ON 31ST MARCH 2019

	Amount as on 31.03.2019		Amount as on 31.03.2018	
	Transaction in INR	Transaction in Euro	Transaction in INR	Transaction in Euro
I. Receipts				
A. Balance Brought Forward				
Union Bank of India Raman Charpak Account	26,80,240.73		93,41,165.00	-
Union Bank of India DST INRA Account	6,61,411.00		6,43,032.00	-
Union Bank of India DST INRIA Account	45,69,094.20		25,71,733.00	-
Union Bank of India IFCAM Account	(44.69)		38,58,659.00	-
Union Bank of india-DST ANR Account	38,08,777.93		59,14,751.00	-
Union Bank of India- Esson	30,05,890.00			
Union Bank of India-TDB	2,19,452.32		3,16,150.00	
State Bank of Hyderabad Account	7,80,31,204.04		4,89,20,656.00	-
Union Bank of India- CEFIPRA Account	4,22,168.00		4,06,427.00	-
Axis Bank Account	7,89,905.00		7,61,518.00	-
State Bank of Hyderabad (Gratuity Fund) Account	26,16,693.00		25,22,522.00	-
State Bank of Hyderabad-BIRAC	38,26,933.50		58,87,793.00	-
State Bank of Hyderabad-IFWN	28,05,806.00		35,51,900.00	-
State Bnak of India-Birac BPI France	3,40,858.00			
CIC, Paris		6,30,435.56		18,52,039.36
Total Opening Balance(A)	**10,37,78,389.03**	**6,30,435.56**	**8,46,96,306.00**	**18,52,039.36**
B. Grant Received and Interest Earned				
i. Grant-in-aid Core Programmes				
Grant From Govt. of France	-	15,50,000.00	-	7,75,000.00
Grant from Govt. of India	14,57,25,044.00	-	10,51,00,000.00	-
Adavance Grant recived for Financial Year 2017-18	- -	-	-	
ii. Grant-in-aid Non Core Programmes				
Government of France	-	1,94,197.00	-	1,40,000.00
Government of India	5,57,45,640.00	-	2,53,31,609.00	-
TDB-Programme	11,08,267.00	-	4,80,073.00	-
			- -	
iii. Interest from Bank Accounts(Net of TDS)				
			- -	
State Bank of Hyderabad	25,50,395.00	-	13,66,312.00	-
UBI-Bank	14,971.00	-	15,741.00	-
State Bank of Hyderabad-Gratuity account	92,103.00	-	94,171.00	-
Union Bank of India - Raman Charpak Account	2,04,935.00	-	2,62,681.00	-
Union Bank Accumulated Reserve				
Union Bank of India - DST INRIA Account	2,05,106.00	-	1,27,980.00	-
Union Bank of India - DST INRA Account	23,455.00	-	18,379.00	-
Union Bank of India - IFCAM Account	18,125.00	-	1,59,342.00	-
Union Bank of india-DST ANR Account	1,51,422.00	-	2,24,623.00	-
State Bank of Hyderabad Account-IFWN	96,780.00	-	1,27,409.00	-
Union Bank of India-TDB	15,082.00	-	11,917.00	-
State Bank of Hyderabad Account-Birac	1,15,986.00	-	1,19,222.00	-
Axis bank Interest	28,011.00	-	28,387.00	-
Union Bank Of India-ESSONN	76,197.00	-	5,890.00	
Cash in Transit	64,22,696.00			
iv. Misc.Income	3,47,229.00	-	2,75,236.00	-
v. Prior Period Items			-	36,062.00
vi. Repatriation of Funds	2,06,70,089.00	(2,45,509.00)	3,64,71,799.00	(5,50,836.00)
vii. Income Tax Recoverable	- -		44,22,974.00	-
TOTAL (B)	**23,36,11,533.00**	**14,98,688.00**	**17,46,43,745.00**	**4,00,226.00**
TOTAL RECEIPTS(A+B)	**33,73,89,922.03**	**21,29,123.56**	**25,93,40,051.00**	**22,52,265.36**

MIRBHAYA & ASSOCIATES * DELHI * Chartered Accountants

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
RECEIPT AND PAYMENT FOR THE YEAR ENDED ON 31ST MARCH 2019

	Amount as on 31.03.2019		Amount as on 31.03.2018	
	Transaction in INR	ransaction in Euro	Transaction in INR	nsaction in Euro
II. PAYMENTS				
(A) Running Expenses of the Centre				
Salaries and office Expenses of the Centre	2,54,99,078.00	4,224.93	1,58,38,741.25	4,842.50
Travel Expenses	5,98,276.00	1,394.40	7,48,640.80	1,721.08
GB/SC/IRC/SEP/Vision Group Expenses	64,91,031.00	22,577.29	44,05,507.00	19,118.40
Non Shareable Expenses	19,02,369.00	37,349.84	45,11,003.00	7,003.04
Total Running Expenses(A)	**3,44,90,754.00**	**65,546.46**	**2,55,03,892.05**	**32,685.02**
(B) Scientific Expenses of the Centre				
General Scientific Expenses	3,46,535.00	-	23,01,489.00	29,542.72
Research Projects/Seminar and Workshop	8,90,63,096.00	10,43,689.85	8,43,23,605.00	12,42,949.84
SGRI Programmes	-	-	21,23,799.00	-
Airbus programmes	-	-	-	
Total Scientific Expenses (B)	**8,94,09,631.00**	**10,43,689.85**	**8,87,48,893.00**	**12,72,492.56**
(C) Other Payments				
Non Core Programmes	4,65,30,407.56	1,48,386.26	3,69,86,961.33	2,36,440.61
Non Core Programmes Programmed Implementation and Overhead charges	32,81,888.54		36,61,168.68	-
Purchase of Assets Net of sales	4,52,349.00		- 3,300.00	
BRICS Meetings	-		- 51,411.00	
Prior Period Items		993.51		
Interest refunded to DST	13,66,312.00			
Other Deposit	-	(90,450.45)	6,06,035.91	80,211.61
Total Other Payments(C)	**5,16,30,957.10**	**58,929.32**	**4,13,08,876.92**	**3,16,652.22**
TOTAL PAYMENTS(D=A+B+C)	**17,55,31,342.10**	**11,68,165.63**	**15,55,61,661.97**	**16,21,829.80**
III. Cash & Cash Equivalent Balance carried forward				
Union Bank of India Raman Charpak Account	2,09,08,820.48	-	26,80,240.73	-
Union Bank of India DST INRIA Account	70,51,920.64	-	45,69,094.20	-
Union Bank of India DST INRA Account	6,84,866.00	-	6,61,411.00	-
Union Bank of India IFCAM Account	1,19,061.82	-	- (44.69)	
Union Bank of India-DST ANR Account	17,04,535.73	-	38,08,777.93	-
Union Bank of India-TDB	7,82,660.16	-	2,19,452.32	-
Union Bank of India Accumulated Reserve	5,27,25,716.48			
State Bank of Hyderabad Account	6,65,09,909.36	-	7,80,31,204.04	-
Union Bank of India-CEFIPRA Account	4,37,139.00	-	4,22,168.00	-
Union Bank- DST ESONN Fellowship	54,556.76	-	30,05,890.00	-
Axis Bank Account	8,17,916.00	-	7,89,905.00	-
State Bank of Hyderabad (Gratuity Fund) Account	15,17,175.00	-	26,16,693.00	-
State Bank of Hyderabad - BIRAC French Embassy	26,18,248.50	-	38,26,933.50	-
State Bank of Hyderabad -IFWN	27,59,582.00	-	28,05,806.00	-
State Bank of India-BIRAC BPI France	30,88,157.00	-	3,40,858.00	-
CIC Paris		9,60,957.93	-	6,30,435.56
State Bank Of India- GPF Account	78,315.00	-	-	
Exchange Rate Fictuation	-			
TOTAL CLOSING BANK BALANCE (D)	**16,18,58,579.93**	**9,60,957.93**	**10,37,78,389.03**	**6,30,435.56**
TOTAL PAYMENTS (C+D)	**33,73,89,922.03**	**21,29,123.56**	**25,93,40,051.00**	**22,52,265.36**

Accounting policies and notes to accounts are integral part of financial statements.

AUDITOR'S REPORT

As per our report of even date attached.

For NIRMAL & ASSOCIATES
Chartered Accountants
Firm Registration No. 016125N

(Kumar Nishikant)
Partner
Membership No. 538686
Place : New Delhi
Date : 16.09.2019

(Simranjeet Singh)
Accounts Associate

(Dr. Purnima Rupal)
Director

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
RECEIPT AND PAYMENT FOR THE YEAR ENDED ON 31ST MARCH 2019

	Sch	Amount as on 31.03.2019	Total Amount in INR	INR Version Amount as on 31.03.2018	Total Amount in INR
I. Receipts					
A . Balance Brought Forward					
Union Bank of India Raman Charpak Account			26,80,240.73		93,41,165.00
Union Bank of India DST INRA Account			6,61,411.00		6,43,032.00
Union Bank of India DST INRIA Account			45,69,094.20		25,71,733.00
Union Bank of India IFCAM Account			(44.69)		38,58,659.00
Union Bank of India-DST ANR Account			38,08,777.93		59,14,751.00
Union Bank of India- Esson			30,05,890.00		
State Bank of Hyderabad Account			7,80,31,204.04		4,89,20,656.00
Union Bank of India			4,22,168.00		4,06,427.00
Axis Bank Account			7,89,905.00		7,61,518.00
Union Bank Of India-TDB			2,19,452.32		3,16,150.00
State Bank of Hyderabad-BIRAC			38,26,933.50		58,87,793.00
State Bank of India BPI			3,40,858.00		
State Bank of India-IFWN			28,05,806.00		35,51,900.00
State Bank of Hyderabad (Gratuity Fund) Account			26,16,693.00		25,22,522.00
CIC, Paris			5,08,27,101.81		12,82,49,281.00
Exchange Rate Fluctuation					72,56,462.00
Total (A)			**15,46,05,490.84**		**22,02,02,049.00**
(B) Receipts during the Year					
(i) Core Programmes					
Grant From Govt. of France		12,42,48,000.00		5,80,64,085.00	
Grant from Govt. of India		14,57,25,044.00		10,51,00,000.00	
Adavance Grant recived for Financial Year 2017-18				-	
			26,99,73,044.00		**16,31,64,085.00**
(ii) Grant-in-aid Non Core Programmes					
Government of France		1,55,96,757.28		99,28,996.00	
Government of India		5,57,45,640.00		2,53,31,609.00	
TDB-Programme		11,08,267.00		4,80,073.00	
			7,24,50,664.28		**3,57,40,678.00**
(iii) Interest from Bank Accounts(Net of TDS)					
State Bank of Hyderabad		25,50,395.00		13,66,312.00	
UBI-Bank		14,971.00		15,741.00	
State Bank of Hyderabad-Gratuity account		92,103.00		94,171.00	
Union Bank of India - Raman Charpak Account		2,04,935.00		2,62,681.00	
Union Bank of India - DST INRIA Account		2,05,106.00		1,27,980.00	
Union Bank of India - DST INRA Account		23,455.00		18,379.00	
Union Bank of India - IFCAM Account		18,125.00		1,59,342.00	
Union Bank of India-DST ANR Account		1,51,422.00		2,24,623.00	
Union Bank Of India- TDB		15,082.00		11,917.00	
Union Bank Of India-ESSON		76,197.00		5,890.00	
State Bank of Hyderabad Account-IFWN		96,780.00		1,27,409.00	
State Bank of Hyderabad Account-Birac		1,15,986.00		1,19,222.00	
Axis bank Interest		28,011.00		28,387.00	
Misc.Income		3,47,229.00		2,75,236.00	
Income Tax Recoverable		-		44,22,974.00	
Repatriation fumds			-	-	
Prior Period Items		(77,198.11)		-	
			38,62,598.89		**72,60,264.00**
TOTAL (B)			**34,62,86,307.17**		**20,61,65,027.00**
TOTAL RECEIPTS(A+B)			**50,08,91,798.01**		**42,63,67,076.00**

NIRBHAY & ASSOCIATES * DELHI * Chartered Accountants

PRupal

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
RECEIPT AND PAYMENT FOR THE YEAR ENDED ON 31ST MARCH 2019

	Sch	Amount as on 31.03.2019	Total Amount in INR		INR Version Amount as on 31.03.2018	Total Amount in INR
II. PAYMENTS						
(A) Running Expenses of the Centre						
Salaries and office Expenses of the Centre		2,58,27,365.20			1,61,82,178.13	
Travel Expenses		7,06,624.23			8,70,702.20	
GB/SC/IRC/SEP/Vision Group Expenses		82,45,340.62			57,61,410.69	
Non Shareable Expenses		48,04,541.21			50,07,668.40	
Total Running Expenses (A)			**3,95,83,871.25**			**2,78,21,959.43**
(B) Scientific Expenses of the Centre						
General Scientific Expenses		3,46,535.00			43,96,700.06	
Research Projects/Seminar and Workshop		17,01,60,302.20			17,24,75,347.78	
SGRI Programmes		-			21,23,799.00	
Airbus programmes						
Total Scientific Expenses (B)			**17,05,06,837.20**			**17,89,95,846.84**
(C) Other Payments						
Non Core Programmes		5,80,60,376.09			5,37,55,657.63	
Non Core Programmes Programmed						
Implementation and Overhead charges		32,81,888.54			36,61,168.67	
Purchase of Assets Net of sales		4,52,349.00			3,300.00	
Interest Refunded to DST		13,66,312.00				
BRICS Meeting repayment					51,411.00	
Other Deposit		(70,28,217.05)			62,94,755.59	
Total Other Payments(C)			**5,61,32,708.58**			**6,37,66,292.89**
TOTAL PAYMENTS(A+B+C)			**26,62,23,417.04**			**27,05,84,099.16**
III. Cash & Cash Equivalent						
Balance carried forward						
Union Bank of India Raman Charpak Account		2,09,08,820.48			26,80,240.73	
Union Bank of India DST INRIA Account		70,51,920.64			45,69,094.20	
Union Bank of India DST INRA Account		6,84,866.00			6,61,411.00	
Union Bank of India IFCAM Account		1,19,061.82			(44.69)	
Union Bank of India-DST ANR Account		17,04,535.73			38,08,777.93	
Union Bank of India-TDB		7,82,660.16			2,19,452.32	
Union Bank Of India-ESONN		54,556.76			30,05,890.00	
Union Bank of India Accumulated Reserve		5,27,25,716.48				
State Bank of Hyderabad Account		6,65,09,909.36			7,80,31,204.04	
Union Bank of India-CEFIPRA Account		4,37,139.00			4,22,168.00	
Axis Bank Account		8,17,916.00			7,89,905.00	
State Bank of Hyderabad (Gratuity Fund) Account		15,17,175.00			26,16,693.00	
State Bank of Hyderabad - BIRAC		26,18,248.50			38,26,933.50	
State Bank of Hyderabad -IFWN		27,59,582.00			28,05,806.00	
State Bank Of India- BIRAC BPI France		30,88,157.00			3,40,858.00	
State Bank of India Gpf		78,315.00				
CIC Paris		7,46,68,737.46			5,08,27,101.81	
			23,65,27,317.39			**15,46,05,490.84**
Exchange Rate Fictuation			**(18,58,936.42)**			**11,77,486.00**
TOTAL CLOSING BANK BALANCE (D+E)			**23,46,68,380.97**			**15,57,82,976.84**
TOTAL (D+E)			**50,08,91,798.01**			**42,63,67,076.00**

Accounting policies and notes to accounts are integral part of financial statements.

AUDITOR'S REPORT

As per our report of even date attached.

For NIRBHAY & ASSOCIATES
Chartered Accountants
Firm Registration No.016125N

(Kanhar Nishkant)
Partner
Membership No. 538686
Place : New Delhi
Date : 16.09.2019

(Simranjeet Singh)
Accounts Associate

(Dr. Purnima Rupal)
Director

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
Schedules forming part of Balance Sheet as At 31st March 2019

	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Transaction in INR	Transaction in Euro	Total Amount in INR	Transaction in INR	Transaction in Euro	Total Amount in INR
Schdeule C						
1) Salaries & Office Expenses Payable						
Salaries Payable	- -	-		14,83,723.00		14,83,723.00
Other Office expenses	- 39,448.00		39,448.00	3,900.00		3,900.00
Electronic Proposal Mangement Charges	1,38,678.00					
Professional Expenses Payable	- 45,360.00		45,360.00		- -	
Communication Expenses	- 6,501.00		6,501.00	17,223.00	-	17,223.00
Maintenance Charges	- -	-			- -	
Books & Periodicals	- 1,990.00		1,990.00	801.00		801.00
Electricity Expenses	- 8,279.00		8,279.00	10,865.00	-	10,865.00
Total Salaries & Office Expense Payable	**- 2,40,256.00**		**1,01,578.00**	**15,16,512.00**	**-**	**15,16,512.00**
TDS Payable						
On Professional Services	- 60,500.00		60,500.00	71,940.00	-	71,940.00
On Contractors	- 24,700.00		24,700.00	18,998.00	-	18,998.00
On Salary	3,161.00		3,161.00			
Total TDS Payable	**- 88,361.00**		**88,361.00**	**90,938.00**	**-**	**90,938.00**
Seminar & Workshops Liability						
Seminar on Medical Robotics (11-171)	1,08,510.00		1,08,510.00			
Seminar on Radiation Damange(11-173)	2,02,648.00		2,02,648.00			
Seminar on Multifragmentation(11-175)	2,15,753.00		2,15,753.00			
Seminar on New Frontiers	1,23,000.00		1,23,000.00			
Seminar on New Trends in Chemistry (11-138)	- 2,88,000.00		2,88,000.00	2,88,000.00	-	2,88,000.00
Seminar on Organic Semiconductor(11-139)	2,75,400.00	3,820.00	5,72,223.00	2,75,400.00	3,820.00	5,83,377.00
Seminar on Repair Recombination	- 2,12,837.00		2,12,837.00	2,12,837.00		2,12,837.00
Seminar on Green and Sustainable Chemistry	- 1,72,970.00		1,72,970.00	1,72,970.00		1,72,970.00
Seminar on Evolutionary Developmental	-	1,320.00	1,02,567.00		1,320.00	1,06,421.00
Seminar on Metagenomic		3,288.00	2,55,485.00			
Seminar on Airthmetic Geometry	-	3,188.00	2,47,715.00		3,188.00	2,57,024.00
Seminar on ocean Technology	14,00,000.00	-	14,00,000.00	14,00,000.00		14,00,000.00
Total Seminar & Workshop Liability	**29,99,118.00**	**11,616.00**	**39,01,708.00**	**23,49,207.00**	**8,328.00**	**30,20,629.00**

NIRBHAY MAHESHWARI & ASSOCIATES * Chartered Accountants * DELHI

PRupal

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
Schedules forming part of Balance Sheet as At 31st March 2019

	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Transaction in INR	Transaction in Euro	Total Amount in INR	Transaction in INR	Transaction in Euro	Total Amount in INR

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
Schedules forming part of Balance Sheet as At 31st March 2019

Schdeule F- ADVANCES

	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Transaction in INR	Transaction in Euro	Total Amount in INR	Transaction in INR	Transaction in Euro	Total Amount in INR
Seminar & Workshops						
Seminar on Application of Structured Biology	- -	- -		-		-
Seminar on processing	8,05,200.00	-	8,05,200.00	8,05,200.00	-	8,05,200.00
Registrar,Bharistatn University	5,96,000.00	-	5,96,000.00	5,96,000.00	-	5,96,000.00
Tata Institute of Fundamental	- -	--		-		-
Seminar on Catlysis by Design Using NMR	-	13,482.00	10,86,949.00	-	13,482.00	10,86,949.00
Seminar on Plasticity, Rheology and Nonlin	-	12,320.00	9,93,266.00	-	12,320.00	9,93,266.00
Total Seminar & Workshop Advances	**14,01,200.00**	**25,802.00**	**34,81,415.00**	**14,01,200.00**	**25,802.00**	**34,81,415.00**
Other Deposit						
India Habitat Centre	- -	- -				-
Rent-Director Residence	- 21,951.00		21,951.00	21,951.00		21,951.00
Celluar Connection	- 6,515.91		6,516.00	6,515.91		6,516.00
Deposit with Petro Card	- -	- -				-
Internet Charges	74,098.00		74,098.00	1,31,275.00		1,31,275.00
Campus France	-	1,03,996.24	80,80,757.00	-	1,94,446.69	1,56,76,720.00
NPS deduction Recoverable	- -		-	1,230.00		1,230.00
Cash Imprest	- 10,421.00		10,421.00	5,199.00		5,199.00
Total Other Deposit	**1,12,985.91**	**1,03,996.24**	**81,93,743.00**	**1,66,170.91**	**1,94,446.69**	**1,58,42,891.00**

NIRBHAYA & ASSOCIATES * DELHI * Chartered Accountants

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INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Balance Sheet as At 31st March 2019

Schduele B- Targetted Programmes

	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Amount (INR)	Amount (Euro)	Total Amount in INR	Amount (INR)	Amount (Euro)	Total Amount in INR
IFCAM Projects						
Opening Balance-Project Release	37,08,850.85	78,236.00	90,89,476.00	39,35,582.00	98,236.00	1,09,28,651.00
Balance of Surplus Funds	(68,42,272.00)	54,197.00	(23,89,489.00)	(19,39,175.15)	-	(19,39,175.00)
Repatriation of Funds	47,94,238.08	(61,700.00)		16,12,444.00	(20,000.00)	-
Funds In Transit		(43,197.00)	(33,56,510.57)			
Foreign Currency adjustment	- -	-	- -		-	
Adjustment during the year			-	1,00,000.00		1,00,000.00
Total IFCAM Projects	**16,60,816.93**	**27,536.00**	**33,43,476.43**	**37,08,850.85**	**78,236.00**	**90,89,476.00**
Less: Programme Implementation & Overhead	- -	-	- -		-	
Less: amount refunded to DST			-	(20,88,521.00)		(20,88,521.00)
Foreign Currency fluctuation			(80,399.61)			
Balance for Project Releases	**16,60,816.93**	**27,536.00**	**32,63,076.81**	**16,20,329.85**	**78,236.00**	**70,00,955.00**
DST- ANR Projects						-
Opening Balance- Project Release	34,95,562.00		34,95,562.00	44,60,713.00		44,60,713.00
Balance of Surplus Funds	(64,179.00)		(64,179.00)	(9,65,151.00)	-	(9,65,151.00)
Prior Period Items	- -	-	- -		-	
Adjsurnment for DSt-INRA programme	- -	-	- -		-	
Adjustment during the year	- -	-	-			-
Total DST-ANR Projects	**34,31,383.00**	**-**	**34,31,383.00**	**34,95,562.00**	**-**	**34,95,562.00**
Less: Programme Implementation & Overhead	-		-	- 22,956.00		22,956.00
Less: Amount Refunded To DST	(23,07,497.00)		(23,07,497.00)			
Balance for Project Releases	**11,23,886.00**	**-**	**11,23,886.00**	**34,72,606.00**	**-**	**34,72,606.00**
DST- INRA Projects						
Opening Balance	6,67,119.00	38,498.00	32,24,543.00	6,43,032.00	38,498.00	32,00,456.00
Balance of Surplus Funds	23,658.00	-	23,658.00	24,087.00		24,087.00
Adjustment for Core Programme	-	-	-	-		-
Prior Period Items	-	(30,000.00)	(23,31,072.00)	-		-
Adjustment for Non Core Programme	- -	-			- -	
Repatraition of funds	- -	-	- -		-	
Gain/(Loss) on Repatraition of Funds	- -	-			- -	
Total DST-INRA Projects	**6,90,777.00**	**8,498.00**	**9,17,129.00**	**6,67,119.00**	**38,498.00**	**32,24,543.00**
Less: Programme Implementation & Overhead	- -	-	- -		-	
Foreign Currency fluctuation			(1,12,406.46)			
Balance for Project Releases	**6,90,777.00**	**8,498.00**	**8,04,722.54**	**6,67,119.00**	**38,498.00**	**32,24,543.00**
DST- INRIA Projects						
Opening Balance	35,69,495.00	-	35,69,495.00	14,57,068.00	-	14,57,068.00
Balance of Surplus Funds	28,50,632.00	-	28,50,632.00	21,12,307.00	-	21,12,307.00
Adjustment during the year		- -		- 120.00		120.00
Adjustment from DSt-INRA	- -	-			- -	
Total DST-INRIA Projects	**64,20,127.00**	**-**	**64,20,127.00**	**35,69,495.00**	**-**	**35,69,495.00**
Less: Programme Implementation & Overhead		- -		- 56,983.00		56,983.00
Less: Amount Refunded To DST	16,68,831.00					
Balance for Project Releases	**47,51,296.00**	**-**	**64,20,127.00**	**35,12,512.00**	**-**	**35,12,512.00**

NIRBHAYA & ASSOCIATES DELHI Chartered Accountants

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INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
Schedules forming part of Balance Sheet as At 31st March 2019

Schdeule B- Targetted Programmes	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Amount (INR)	Amount (Euro)	Total Amount in INR	Amount (INR)	Amount (Euro)	Total Amount in INR
Raman Charpak Fellowship						-
Opening Balance	27,51,426.00	(9,606.50)	16,37,150.00	59,46,076.00	1,50,165.51	1,66,97,152.00
Balance of Surplus Funds	1,67,55,960.00	(10,087.06)	1,59,45,827.00	(80,35,916.00)	(49,772.01)	(1,15,65,817.00)
Foreign Currecy Fluctuation	- -	-				4,82,828.00
Repatriation of funds	(42,94,934.68)	50,000.00	-	88,18,279.00	(1,10,000.00)	-
Adjustment during the year	- -	-	-	-		
Amount refunded to DST	- -	-		(39,77,013.00)	-	(39,77,013.00)
Total Raman Charpak Fellowship	**1,52,12,451.32**	**30,306.44**	**1,75,82,977.00**	**27,51,426.00**	**(9,606.50)**	**16,37,150.00**
Less: Programme Implementation & Overhead	- -	-		- 97,287.00		97,287.00
Less: Interest refunded to DST	3,01,442.00					
Foreign Currency fluctuation			(88,488.74)			
Balance for Project Releases	**1,49,11,009.32**	**30,306.44**	**1,74,94,488.26**	**26,54,139.00**	**(9,606.50)**	**15,89,863.00**
Birac French Embassy						
Opening Balance	34,25,864.00	1,23,233.00	1,25,84,794.00	56,64,523.00	1,52,520.00	1,66,16,421.00
Balance of Surplus Funds	14,899.00	(15,749.00)	(12,49,968.00)	(22,38,659.00)	(29,287.00)	(43,15,734.00)
Foreign Currency Fluctuation	- -	-	-	-		2,84,107.00
Adjustment during the year	- -	-	-	-	-	
Total Birac French Embassy	**34,40,763.00**	**1,07,484.00**	**1,13,34,826.00**	**34,25,864.00**	**1,23,233.00**	**1,25,84,794.00**
Less: Programme Implementation & Overhead	- -			22,518.00		22,518.00
Foreign Currency fluctuation			(3,13,831.78)			
Balance for Project Releases	**34,40,763.00**	**1,07,484.00**	**1,10,20,994.22**	**34,03,346.00**	**1,23,233.00**	**1,25,62,276.00**
Economic Diplomacy R & D Programme						
Opening Balance	17,73,126.00	62,424.94	59,18,008.00	17,68,044.00	69,462.54	64,00,940.00
Balance of Surplus Funds	- -	-		(2,39,991.00)	(487.60)	(2,74,572.00)
Transfer from French Season in India	- -	-	-	-	-	
Transfer from India SI house and Innovation	- -	-		-	-	
Transfer from Project with IIT Rajasthan	- -	-		-	-	
Transfer from French Season in India	- -	-	-	-	-	
Repatriation of funds	- -	-		4,58,163.00	(6,550.00)	-
Transfer to group farming	-		-	(2,13,090.00)		(2,13,090.00)
Foreign Currency Fluctuation	- -				-	4,780.00
Total Economic Diplomacy R & D programme	**17,73,126.00**	**62,424.94**	**59,18,008.00**	**17,73,126.00**	**62,424.94**	**59,18,008.00**
Less: Programme Implementation & Overhead	- -	-	-	-	-	
Foreign Currency fluctuation			(1,82,268.34)			
Balance for Project Releases	**17,73,126.00**	**62,424.94**	**57,35,739.66**	**17,73,126.00**	**62,424.94**	**59,18,008.00**
India France Water Network						
Opening Balance	27,78,061.00	1,20,002.46	1,11,74,743.00	36,05,296.00	1,36,896.46	1,30,36,239.00
Balance of Surplus Funds	(1,42,944.00)	-	(1,42,944.00)	(8,27,235.00)	(16,894.00)	(20,25,381.00)
Adjustment for core programme	- -	-	-	-		
Transfer from Indo France Tech Summit	- -	-		-	-	
Foreign Currency Fluctuation	- -	-				1,63,885.00
Total India France water Network	**26,35,117.00**	**1,20,002.46**	**1,10,31,799.00**	**27,78,061.00**	**1,20,002.46**	**1,11,74,743.00**
Less: Programme Implementation & Overhead	- -	-		- 12,124.00		12,124.00
Foreign Currency fluctuation			(3,50,383.18)			
Balance for Project Releases	**26,35,117.00**	**1,20,002.46**	**1,06,81,415.82**	**27,65,937.00**	**1,20,002.46**	**1,11,62,619.00**
TDB Programme						
Opening Balance	2,21,733.00	-	2,21,733.00	- 3,19,927.00		3,19,927.00
Balance of Surplus Funds	- 68,125.00		68,125.00	(98,194.00)		(98,194.00)
Total Programme Implementation and Overhead Charges	**2,89,858.00**	-	**2,89,858.00**	- **2,21,733.00**		**2,21,733.00**

MEHTA & ASSOCIATES * DELHI * Chartered Accountants *

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Balance Sheet as At 31st March 2019

Schduele B- Targetted Programmes	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Amount (INR)	Amount (Euro)	Total Amount in INR	Amount (INR)	Amount (Euro)	Total Amount is INR
Birac BPI France Programme						
Opening Balance	4,72,400.00	-	- 4,72,400.00	-	-	
Balance of Surplus Funds	26,25,489.00	-	26,25,489.00	4,72,400.00	-	4,72,400.00
Total Birac French Embassy	**30,97,889.00**	-	**30,97,889.00**	**4,72,400.00**	-	**4,72,400.00**
Less: Programme Implementation & Overhead		-	-	11,827.00		11,827.00
Balance for Project Releases	**30,97,889.00**	-	**30,97,889.00**	**4,60,573.00**	-	**4,60,573.00**
DST - ESONN Fellowship						
Opening Balance	30,32,455.00	-	30,32,455.00	-	-	
Balance of Surplus Funds	(27,50,254.00)	-	(27,50,254.00)	30,32,455.00	-	30,32,455.00
Total Esson Fellowship	**2,82,201.00**	-	**2,82,201.00**	**30,32,455.00**	-	**30,32,455.00**
Less: Programme Implementation & Overhead	- -		-	60,000.00		60,000.00
Less: Amount refunded to DST	2,78,295.00		**2,78,295.00**			
Balance for Project Releases	- **3,906.00**		**3,906.00**	**29,72,455.00**	-	**29,72,455.00**

NIRBHAYA & ASSOCIATES * DELHI * Chartered Accountants

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INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2019-NON CORE PROGRAMMES

	SCH	Amount as on 31.03.2019	Total Amount in INR	Amount as on 31.03.2018	Total Amount in INR
Income	J				
IFCAM Projects		2,16,64,005.00		7,931.00	
DST-ANR Projects		1,17,560.00		37,11,832.00	
DST-INRA Projects		23,658.00		24,087.00	
DST-INRIA Projects		1,09,12,587.00		1,41,55,057.00	
Raman Charpak Fellowship		3,65,35,320.00		1,02,30,438.00	
BIRAC French Embassy		37,417.00		16,19,222.00	
Indo French Water Network		96,780.00		1,27,409.00	
TDB Programmes		11,28,266.00		4,90,494.00	
BIRAC BPI France Programme		27,52,377.00		33,76,283.00	
Economic Diplomacy		-		-	
DST- ESONN Fellowship		50,348.00		30,32,455.00	
Total Income			**7,33,18,318.00**		**3,67,75,208.00**
Expenditure	K				
IFCAM Projects		2,40,53,494.00		19,47,106.00	
DST-ANR Projects		1,81,739.00		46,76,983.00	
DST-INRA Projects		-		-	
DST-INRIA Projects		80,61,955.00		1,20,42,750.00	
Raman Charpak Fellowship		2,05,89,493.00		2,17,96,255.00	
BIRAC French Embassy		12,87,385.00		59,34,956.00	
Indo French Water Network		2,39,724.00		21,52,790.00	
TDB Programmes		10,60,141.00		5,88,688.00	
BIRAC BPI France Programme		1,26,888.00		29,03,883.00	
Economic Diplomacy		-		2,74,572.00	
DST- ESONN Fellowship		28,00,602.00		-	
Total Expenditure			**5,84,01,421.00**		**5,23,17,983.00**
Balance of Surplus Funds					
IFCAM Projects		(23,89,489.00)		(19,39,175.00)	
DST-ANR Projects		(64,179.00)		(9,65,151.00)	
DST-INRA Projects		23,658.00		24,087.00	
DST-INRIA Projects		28,50,632.00		21,12,307.00	
Raman Charpak Fellowship		1,59,45,827.00		(1,15,65,817.00)	
BIRAC French Embassy		(12,49,968.00)		(43,15,734.00)	
Indo French Water Network		(1,42,944.00)		(20,25,381.00)	
TDB Programmes		68,125.00		(98,194.00)	
BIRAC BPI France Programme		26,25,489.00		4,72,400.00	
Economic Diplomacy		-		(2,74,572.00)	
DST- ESONN Fellowship		(27,50,254.00)		30,32,455.00	
Total Balance of Surplus Funds			**1,49,16,897.00**		**(1,55,42,775.00)**

Accounting policies and notes to accounts are integral part of financial statements.

AUDITOR'S REPORT
As per our report of even date attached.
For NIRPHATA & ASSOCIATES
Chartered Accountants
Firm Registration No. 016125N

(Kumar Nishikant)
Partner
Membership No.538686
Place : New Delhi
Date :16.09.2019

(Simranjeet Singh)
Accounts Associate

(Dr. Purnima Rupal)
Director

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Income & Expenditure- Non Core Programme as At 31st March 2019

Schedule- J Income- Non Core Programme	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Amount (INR)	Amount (Euro)	Total Amount in INR	Amount (INR)	Amount (Euro)	Total Amount in INR
IFCAM Projects						
Grant in Aid	1,72,00,000.00	54,197.00	2,15,52,783.00	- -		
Programme Implementation and Overhead	1,00,000.00	-	1,00,000.00	- -		
Bank Interest	- 11,222.00		11,222.00	- 7,931.00		7,931.00
Total IFCAM Projects	**1,73,11,222.00**	**54,197.00**	**2,16,64,005.00**	**7,931.00**	**-**	**7,931.00**
DSt- ANR Projects						-
Grant in Aid	- -	-		31,96,974.00	-	31,96,974.00
Programme Implementation and Overhead	- -	-		3,00,000.00	-	3,00,000.00
Bank Interest	1,17,560.00		1,17,560.00	2,14,858.00	-	2,14,858.00
Total DST-ANR Projects	**1,17,560.00**	**-**	**1,17,560.00**	**37,11,832.00**	**-**	**37,11,832.00**
DSt- INRA Projects						-
Grant in Aid	- -	-	-	-	-	
Programme Implementation and Overhead	-	-	- -		-	-
Bank Interest	23,658.00	-	23,658.00	24,087.00	-	24,087.00
Total DST-INRA Projects	**23,658.00**	**-**	**23,658.00**	**24,087.00**	**-**	**24,087.00**
DSt- INRIA Projects						-
Grant in Aid	98,08,321.00	-	98,08,321.00	1,28,88,622.00	-	1,28,88,622.00
Programme Implementation and Overhead	8,84,942.00	-	8,84,942.00	11,00,000.00	-	11,00,000.00
Bank Interest	2,19,324.00	-	2,19,324.00	1,66,435.00	-	1,66,435.00
Total DST-INRIA Projects	**1,09,12,587.00**	**-**	**1,09,12,587.00**	**1,41,55,057.00**	**-**	**1,41,55,057.00**
Raman Charpak Fellowship						-
Grant in Aid	2,33,33,334.00	1,40,000.00	3,45,77,308.00	-	1,40,000.00	99,28,996.00
Programme Implementation and Overhead	16,66,666.00	-	16,66,666.00	- -		
Bank Interest	2,91,346.00	-	2,91,346.00	3,01,442.00	-	3,01,442.00
Total Raman Charpak Fellowship	**2,52,91,346.00**	**1,40,000.00**	**3,65,35,320.00**	**3,01,442.00**	**1,40,000.00**	**1,02,30,438.00**
Birac French Embassy						
Grant in Aid	- -	-		13,12,364.00		13,12,364.00
Programme Implementation and Overhead	- -	-		1,87,636.00		1,87,636.00
Bank Interest	- 37,417.00		37,417.00	1,19,222.00		1,19,222.00
Total Birac French Embassy	**37,417.00**	**-**	**37,417.00**	**16,19,222.00**	**-**	**16,19,222.00**
Indo french Water network						
Grant in Aid	- -	-	-	-		-
Programme Implementation and Overhead	- -	-	-	-	-	
Bank Interest	- 96,780.00		96,780.00	1,27,409.00	-	1,27,409.00
Total Indo French Water Network	**96,780.00**	**-**	**96,780.00**	**1,27,409.00**	**-**	**1,27,409.00**
TDB Programme						
Grant in Aid	- -	-	-	-	-	
Programme Implementation and Overhead	11,08,267.00	-	11,08,267.00	4,80,073.00	-	4,80,073.00
Bank Interest	- 19,999.00		19,999.00	- 10,421.00		10,421.00
Total TDB Programme	**11,28,266.00**	**-**	**11,28,266.00**	**4,90,494.00**	**-**	**4,90,494.00**

NIRBHAYA & ASSOCIATES DELHI Chartered Accountants

P Rupal

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Income & Expenditure- Non Core Programme as At 31st March 2019

Schedule- J Income- Non Core Programme	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Amount (INR)	Amount (Euro)	Total Amount in INR	Amount (INR)	Amount (Euro)	Total Amount in INR
BIRAC BPI France Programme						
Grant in Aid	26,48,822.00	-	26,48,822.00	32,61,222.00	-	32,61,222.00
Programme Implementation and Overhead	- 1,03,555.00		1,03,555.00	1,15,061.00	-	1,15,061.00
Bank Interest		- -	-	-	-	
Total BIRAC BPI France Programme	**27,52,377.00**	**-**	**27,52,377.00**	**33,76,283.00**	**-**	**33,76,283.00**
DST- ESONN Fellowship						
Grant in Aid	- -	-		29,40,000.00	-	29,40,000.00
Programme Implementation and Overhead	- -	-		- 60,000.00		60,000.00
Bank Interest	- 50,348.00		50,348.00	- 32,455.00		32,455.00
Total ESONN Fellowship	**50,348.00**	**-**	**50,348.00**	**30,32,455.00**	**-**	**30,32,455.00**
ECONOMIC DIPLOMACY						
Grant in Aid	- -	-	-	-	-	
Programme Implementation and Overhead	- -	-	-	-	-	
Bank Interest	- -	-	-	-	-	
Total Birac French Embassy	-	-	-	-	-	-

NIRBHAYA & ASSOCIATES DELHI Chartered Accountants

Rupal

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Income & Expenditure- Non Core Programme as At 31st March 2019

Schedule-K Expenditure Non Core Programme	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Amount (INR)	Amount (Euro)	Total Amount in INR	Amount (INR)	Amount (Euro)	Total Amount in INR
IFCAM Projects						
Project Expenses & Bank Charges	2,40,53,494.00	-	2,40,53,494.00	19,47,106.15	-	19,47,106.00
Programme Implementation and Overhead	1,00,000.00	-	-		-	-
Total IFCAM Projects	**2,41,53,494.00**	**-**	**2,40,53,494.00**	**19,47,106.15**	**-**	**19,47,106.00**
DST- ANR Projects						-
Project Expenses & Bank Charges	1,66,679.20	-	1,66,679.00	43,15,195.00	-	43,15,195.00
Programme Implementation and Overhead	15,060.00	-	15,060.00	3,61,788.00	-	3,61,788.00
Total DST-ANR Projects	**1,81,739.20**	**-**	**1,81,739.00**	**46,76,983.00**	**-**	**46,76,983.00**
DST- INRIA Projects						-
Project Expenses and Bank Charges	-	-	-	-	-	-
Programme Implementation and Overhead	-	-	-	-	-	-
Total DST-INRA Projects	-	-	-	-	-	-
DST- INRIA Projects						-
Project Expenses & Bank Charges	74,49,482.56	-	74,49,488.00	1,09,58,172.74	-	1,09,58,178.00
Programme Implementation and Overhead	6,12,522.00	-	6,12,522.00	10,89,577.00	-	10,89,577.00
Total DST-INRIA Projects	**80,61,954.56**	**-**	**88,61,955.00**	**1,20,42,749.74**	**-**	**1,20,42,750.00**
Raman Charpak Fellowship						-
Project Expenses & Bank Charges	74,91,090.00	1,50,087.06	1,95,45,197.00	71,67,849.00	1,89,772.01	2,06,26,746.00
Programme Implementation and Overhead	10,44,296.00	-	10,44,296.00	11,69,509.00	-	11,69,509.00
Total Raman Charpak Fellowship	**85,35,386.00**	**1,50,087.06**	**2,05,89,493.00**	**83,37,358.00**	**1,89,772.01**	**2,17,96,255.00**
Birac French Embassy						-
Project Expenses	-	15,749.00	12,64,867.00	36,61,318.00	29,287.00	57,38,393.00
Programme Implementation and Overhead	22,518.00	-	22,518.00	1,96,563.00	-	1,96,563.00
Total Birac French Embassy	**22,518.00**	**15,749.00**	**12,87,385.00**	**38,57,881.00**	**29,287.00**	**59,34,956.00**
Indo french Water network						
Project Expenses & Bank Interest	2,39,724.00	-	2,39,724.00	8,02,834.00	16,894.00	20,00,980.00
Programme Implementation and Overhead	-	-	-	1,51,810.00		1,51,810.00
Total Indo French Water Network	**2,39,724.00**	**-**	**2,39,724.00**	**9,54,644.00**	**16,894.00**	**21,52,790.00**
TDB Programme						-
Programme Implementation and Overhead	10,60,141.00	-	10,60,141.00	5,88,687.68	-	5,88,688.00
Total TDB Programme	**10,60,141.00**	**-**	**10,60,141.00**	**5,88,687.68**	**-**	**5,88,688.00**

NARENDRA & ASSOCIATES DELHI Chartered Accountants

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Income & Expenditure- Non Core Programme as At 31st March 2019

Schedule-K Expenditure Non Core Programme	Amount as on 31.03.2019			Amount as on 31.03.2018		
	Amount (INR)	Amount (Euro)	Total Amount in INR	Amount (INR)	Amount (Euro)	Total Amount in INR
BIRAC BPI France Programme						-
Project Expenses & Bank Charges	-		-	28,00,649.00	-	28,00,649.00
Programme Implementation and Overhead	1,26,888.00	-	1,26,888.00	1,03,234.00	-	1,03,234.00
Total BIRAC BPI France Programme	**1,26,888.00**	**-**	**1,26,888.00**	**29,03,883.00**	**-**	**29,03,883.00**
DST- ESONN Fellowship						-
Project Expenses & Bank Charges	27,40,602.00		-27,40,602.00	-	-	
Programme Implementation and Overhead	- 60,000.00		60,000.00	-		-
Total Birac French Embassy	**28,00,602.00**	**-**	**28,00,602.00**	**-**	**-**	**-**
Economic Diplomacy						-
Project Expenses & Bank Charges	- -	-		2,39,991.00	487.60	2,74,572.00
Programme Implementation and Overhead	- -	-		- -	-	
Total Birac French Embassy	**-**	**-**	**-**	**2,39,991.00**	**487.60**	**2,74,572.00**

NIRBHAYA & ASSOCIATES DELHI Chartered Accountants

PRupal

Sr. No.	Project No.	Name of the Equipment purchased	Date of Released	Amount in (Rs.)
		Opening as per Notes to Accounts given in Annual Report -(2015-16)		4,66,08,787.00
1	5504-2	HPz840 & EMC Storage	21.01.2016	8,00,000.00
2	5504-3	Roller Block/Diff Drive RH Metric, Back Illuminated EMCCD IXon, different capacity convex leses and silica+Meniscus lenses	07.05.2016	49,35,500.00
		Precision XYZ, Nanopositioning system, recommended congtroller digital mlti-channel piezo controller		
3	5505-2	Recycling type preparative HPL Flash Chromatography system with accessories, Low freezer refrigerator with accessories	11.05.2016	20,55,000.00
4	5601-1	MacBook-1	21.04.2017	86,900.00
5	5603-1	Inverted Research Fluorescent and Phase contrast research Microscope	21.10.2016	24,23,000.00
6	5604-1	Apple Imac 27Inch Retina 5K quad-core i5 3.5GB/8GB/1TB Fusion/AMD M290X, 3x Dual CPU 12 core node, with infiny bank network for data storage, 8 GPU cards	13.01.2017	40,00,000.00
7	5604-2	12.9" Inch Ipad Pro WiFI258GB Space Grey, 1 PMC593FEB, Pad APP-SUP software	27.11.2017	1,51,612.00
8	5604-3	Oscilloscope and Pulse Generator	21.10.2016	45,74,666.00
9	5605-1	Titrando Titrators	17.11.2016	10,79,706.00
10	5607-1	Lenovo workstation, Team Data and Processing Server	21.10.2016	10,18,490.00
11	5608-2	Hall measurement system, High Pressure Cell	20.12.2016	19,95,532.00
12	5703-2	Upgradation of Microscope	03.04.2017	10,16,892.00
13	5704-1	24 core x 4 computer nodes, Rotaevaporator & Kugelrohr	05.04.2017	25,25,776.00
14	5705-1	Rotaevaporator & Kugelrohr Distillation Unitt, Microscope	05.04.2017	14,40,000.00
15	5803-1	Computer workstation, Incubator shaker	22.12.2017	7,30,916.00
16	5804-1	Apple Macbook, Work Station (12 cores Zenon Processor)	22.12.2017	4,18,676.00
17	5804-2	Data acquisition system (ADWIN-Gold), Liquid Helium dewar with level sensor, SQUID based low tenp amplifier	10.11.2017	25,30,000.00
18	5805-1	Diacel chiral column, Rota evaporator	02.08.2017	9,99,975.00
19	5808-1	Lock-in amplifier, Probe station for Kerr microscopy	20.12.2017	21,71,313.00
20	5904-1	Laptop, BAY NAS and Hard Disk	18.12.2018	1,71,533.00
21	5904-2	Laptop, Printer, Data storage	18.12.2018	3,91,028.00
22	5905-1	Microscope, Photoraector, Ultrachill Cooler	02.11.2018	14,74,190.00
23	6005-2	Hydrogen Generator, Fume Hood, Mass flow controller, Spectrometer, Desktop	25.05.2019	15,66,511.00
24	6007-1	Nikon Stereozoom Microscope JPY 541589, Brunton make Axis Pocket, 21.5 inch New I-mac with Retina, Dremel Microdrill, Gramin Gps, Metter Torledo	22.05.2019	6,26,927.00
25	6008-1	CCD, Spectrophotometer including source and computer, High energy ball milling, Light measurement system, Microwave digestion system, Reduction tube furnace including Vacuum pump	29.03.2019	30,41,673.00
26	6103-1	Arabidopsis Growth Chamber	29.03.2019	16,00,000.00
27	6104-2	Cryostat With electric ports	29.03.2019	16,09,750.00
28	6105-1	Rotavapor R-300 System and Accessories	29.04.2019	5,63,340.00
29	6109-1	Auto Titrator	29.03.2019	9,97,540.00
		Total		9,36,05,233.00

CEFIPRA

Indo-French Centre for the Promotion of Advanced Research

Centre Franco-Indien pour la Promotion de la Recherche Avancée

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.

CEFIPRA

For further information, please contact:

Director

Indo-French Centre for the Promotion of Advanced Research (IFCPAR)/

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

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