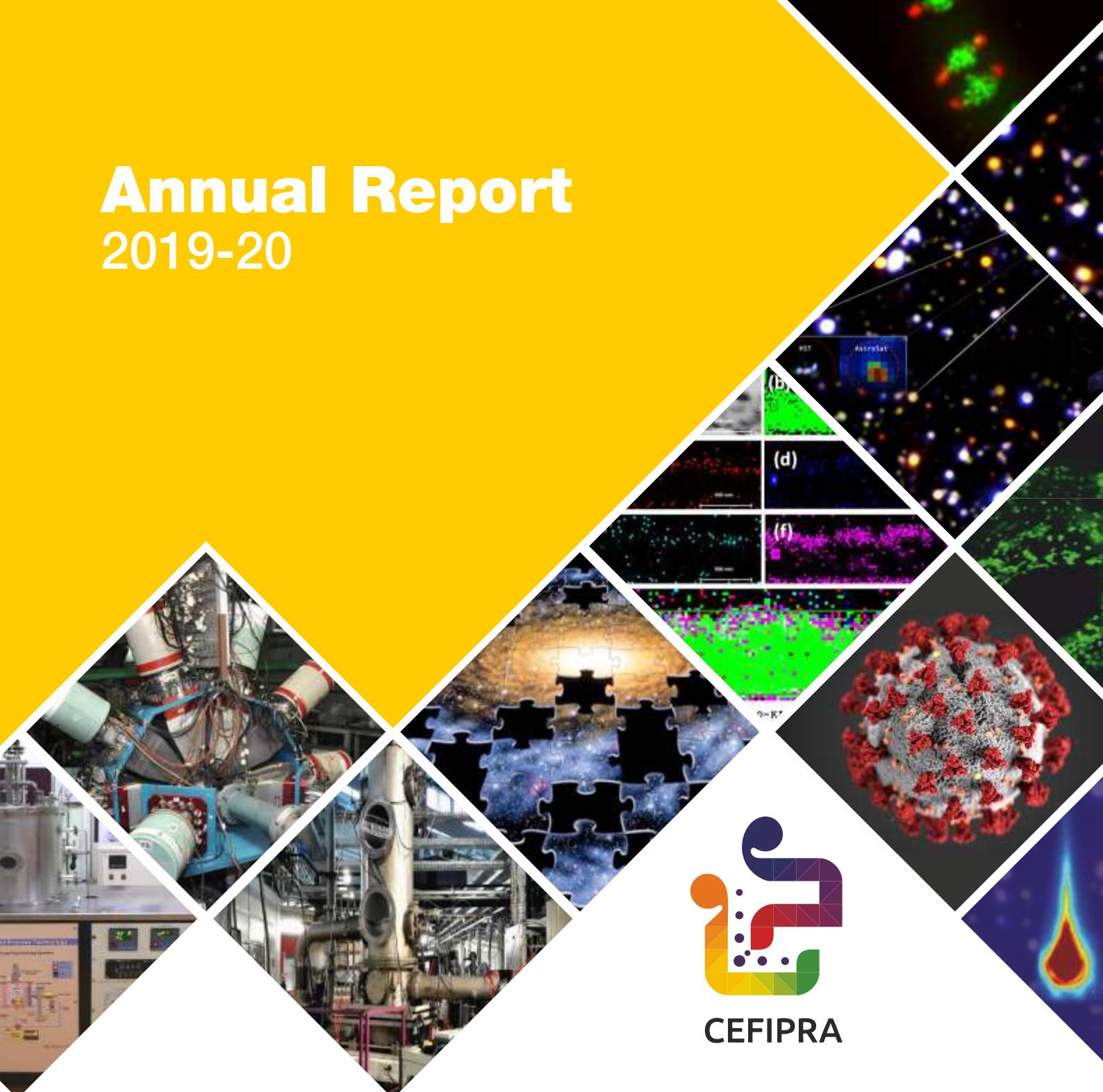


Annual Report

2019-20



CEFIPRA

Indo-French Centre for the
Promotion of Advanced Research

Centre Franco-Indien pour la
Promotion de la Recherche Avancée



Annual Report

2019-20

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

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

From the Director



During the year 2019-20, CEFIPRA continued to contribute significantly to the Indo-French S&T cooperation through its programmes and activities. The Centre has played a crucial role in nurturing scientific and academic partnerships between both the nations for decades. As the first bilateral S&T organization of both countries, CEFIPRA is the testimony of vibrant Indo-French S&T ecosystem which has evolved over the years and become the fulcrum of Indo-French scientific cooperation.

The current year yielded more than two hundred and fifteen (215) papers in high ranked, high impact, peer reviewed international journals, highest so far as compared to previous years. Eighty five percent of these papers have already been cited. Four seminars in areas of Green Chemistry, Marine Sciences, Biodiversity & Ecosystems and Optimisation, Variational Analysis and Applications were supported to facilitate interactions between the Indian and French scientists. The focus remained on developing new collaborations in these domains. Across all core programmes, CEFIPRA supported the exchange visits of over 120 researchers.

CEFIPRA was also represented at the “Second-Knowledge Summit” organized by French Embassy in India in Lyon, France. This event brought together several potential stakeholders in the priority areas namely Aeronautics, Eco-Energy & Renewable Energy, Smart Cities, Agriculture & Food Processing, Marine Sciences, Artificial Intelligence & Mathematics.

For showcasing the research achievements of its supported projects, CEFIPRA regularly publishes success stories emanating from these projects in areas such as Astronomy, Urban Transport, Internet of Things and Components of the Climate System etc. in its newsletter-*Ensemble*.

I look forward to the continued support and guidance of all our stakeholders in our journey into the future.


Purnima Rupal

Contents

1.	Overview & Activities of the Centre	1-5
2.	Governance & Guidance	7-13
3.	Seminars/Workshops & Outreach	15-21
4.	Dedicated Mobility Support Programmes	23-29
5.	Brief Reports of Research Projects	
	A. Collaborative Scientific Research Programme	31-105
	B. Industry Academia Research & Development Programme	107-116
	C. Targeted Programmes	117-135
6.	Analysis of Scientific Activities	137-152
7.	Human Resource Development supported under Projects	153-161
8.	Indian and French Organizations	163-166
9.	Financial Reports & Audited Accounts	167-203



I. Overview & Activities of the Centre

A seamless journey over three decades - At a Glance



TECHNOLOGICAL OUTPUTS

Process: 151+

Designs: 32+

Products: 25+

Patents: 40+

OVERVIEW & ACTIVITIES OF THE CENTRE

During the year 2019-20, Scientific Council and Industrial Research Committee of CEFIPRA met twice during 2-7 June, 2019 & 18-22 Nov, 2019 at Lille and Bhubaneswar, respectively. Scientific Council recommended twenty-two project proposals & four seminars under the **Collaborative Scientific Research Programme (CSRP)** and Industrial Research Committee (IRC) recommended two project proposals and two seminars under **Industry Academia Research & Development Programme (IARDP)** for support. The industry-academia projects approved for implementation under the IARDP include “Development of bio-composites and bioactive building materials from sheep wool wastes” and “Commercial pigment production by microalgae: towards the development of new biotech process”. The twenty-two new project proposals recommended by the Scientific Council from advanced inter-disciplinary research areas developed new collaborative linkages between five IITs, three CSIR labs, two Indian Universities, Indian Institute of Astrophysics, IISc, JNCASR, IISER, PRL and KMCH Hospital & Research Foundation with several French research Institutes. There were more than hundreds of exchange visits wherein interactions between scientists and training of young researchers were supported. More than two hundred publications in SCI journals and fourteen patents resulted out of the projects supported under CSRP & IARDP. CEFIPRA organized seminars/ workshops in topics of current relevance provided scientific interactions among two hundred and ten Indian and sixty five French scientists and researchers in the various disciplines like Marine biodiversity & Ecosystem dynamics, ElectroHydroDynamics, Molecules activation for fuels and commodity chemicals production and Optimization, Variational Analysis and Applications. During the year CEFIPRA facilitated IIT, Goa and consortium of nine French institutes to sign an MoU for bilateral exchanges of students, faculty members, etc. in area of Marine Science & Technology.

Out of the projects completed, there were several significant outcomes. Some of the notable ones include project between CSIR-CDRI Lucknow and Laboratoire de Chimie de Coordination du CNRS, Toulouse, where the collaborators have developed phosphorous dendrimers which are potential for antiTB-2. Two patents were filed under this project. Dual anticancer drugs (doxorubicin and curcumin) loaded electrospun patches were developed under one project between Anna University, Chennai and University of Montpellier. The project between Cochin University of Science and Technology and Ecole Normale Supérieure, Paris contributed in archiving and processing of satellite (ISCCP-B1) dataset. The climatology of high cloud fraction from satellite brightness temperature was derived over the Asian summer monsoon region. Recently CEFIPRA, through NISCAIR-CSIR measured the technological impact of supported projects accurately and periodically (Bibliometric Analysis).

As directed, under CSRP, the thematic call was launched for the year 2020 in the following areas i) AI & Big Data, ii) Science for sustainability, iii) Quantum Materials, & iv) Addressing Biological Questions Using or Developing Mathematical, Computational or Physical Approaches.

In addition, Knowledge-Product pathway had been catalyzed through nine ongoing/ completed 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 Industrial Research Programme. Video based on outcome of IARDP Projects showcased in Knowledge Summit 2 and shared on Social Platforms (Indira-B & PASAT). These shall be made available to DD Science for further dissemination.

During the year, CEFIPRA organized its 4th meeting of the Standard Expert Panel (SEP) comprised of patent attorney from India, Counsellor for Intellectual Property from French Embassy in India, Senior Principal Scientist, Innovation Protection Unit- CSIR, Industrial Research Committee Members, on 9 May, 2019 via Skype. SEP was set up in 2016 to mentor and monitor the Indian & French project Collaborators on Intellectual Property (IP) rights and commercial potential of their joint projects. Nine Indian and French Collaborators from CSRP & IARDP attended the 4th SEP meeting via skype. Various issues related to Intellectual Property (IP) management were addressed and Collaborators were encouraged to file more patents, whenever patentable outcome is available under their joint research programme.

An **Annual Lecture Series programme** was launched by CEFIPRA in 2012 with an aim to increase the interactions between the best S&T minds and young students/ researchers from India and France. This year's lecture was delivered on "Clustering and Computational Biology" by Prof. Sanghamitra Bandyopadhyay, Director, Indian Statistical Institute, Professor, Machine Intelligence Unit, Kolkata at Sorbonne Université, Université Paris-Est Crétail, Paris and Laboratoire d'Informatique de Grenoble, France during 14-16 Oct 2019.

The second edition of the Indo-French Knowledge Summit, dedicated to higher education, research and innovation was organized at the University of Lyon, France during 17-18 October, 2019. The two-day Summit was organized by the Embassy of France in India, in partnership with the Université de Lyon, Campus France and EMLyon business school, on the French side, the Ministry of Science and Technology and the Ministry of Human Resource Development (MHRD) on the Indian side. More than 300 participants from Indian and French academia, competitive clusters & start-ups, corporate houses, research organisations, and public authorities participated in the Summit. Director, CEFIPRA was a panelist in the session "New Models of Franco-Indian Partnerships and Financial Mobilization". She also interacted and shared several opportunities for the joint research and collaboration with the French representatives.

The Centre continued to offer a platform to facilitate '**Targeted Programmes**' for the national funding agencies such as DST from India, INRIA and CNRS from France to come together and support collaborative scientific research in focused areas of mutual interest. These programmes cover the domains of Big Data, Computer science for Biology and Life Sciences, Artificial Intelligence, Cyber Physical Systems etc. Currently, twenty two projects were being supported (nine ongoing + thirteen completed). Further, 7th Call for proposals of 2019 in areas of Big Data, Computer science for Biology and Life Sciences, Artificial Intelligence, Cyber Physical Systems, ICT and Applied Mathematics was launched in July, 2019. The meeting of the Expert Committee for evaluation of proposals was held on 5 February, 2020 at CEFIPRA office, New Delhi along with progress review of completed & ongoing projects. The Joint Selection Committee meeting between DST, Inria and CNRS was held on 5 February, 2020 wherein two projects were recommended for support. Under DST-CNRS Targeted Programme, 4 projects were initiated in areas of Biodiversity, Ecosystems and Human-environment interactions, Detector and theory developments in nuclear and particle physics & Engineering and Systems Sciences.

Under **Indo-French Health Technology Programme** (BIRAC, CEFIPRA and Bpifrance): One project ongoing assessed as satisfactory and achievement under this project.

In order to strengthen human resource development, under the existing **Raman-Charpak Fellowship-2019**, 25 Indian & 1 French PhDs & four French Masters' students were awarded to work in Indian and French laboratories. Further, the Governing Body renewed the programme for 3 more years (2019-2021). A detailed analysis of papers published by Raman-Charpak Fellows of year 2015 was carried out during the year.

Under, Technology Development Board (TDB)'s bilateral Programme with Bpifrance managed by CEFIPRA, one project is ongoing in the area of Medical devices between Panacea Medical Technologies Pvt Ltd, Bengaluru and DOSIsoft SA, Cachan, France. 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 in March 2018. The Project Monitoring Committee (PMC) assessed the progress on October, 2019 and found the progress satisfactory.

During the year it was continued to publish CEFIPRA newsletter "Ensemble" giving glimpses of activities of the Centre and three success stories of projects were also published by Vigyan prasar on various media platforms. In view to popularize science, with a larger audience, CEFIPRA periodically obtain success stories from the PIs of successful

OVERVIEW & ACTIVITIES OF THE CENTRE

projects, (graded Excellent and Very Good) in the form of articles/video clips and post them through various social media platforms of CEFIPRA. During the year 2019-20 four quarterly newsletter (*Ensemble*) were brought out. CEFIPRA is regularly contributing, outcomes of successful projects, to ‘Vigyan Samachar’ also. Director, CEFIPRA featured on the Talk show on DD Science Channel and outlined how CEFIPRA continues to play a pivotal role in strengthening S&T Cooperation telecasted on 23 Oct, 2019. CEFIPRA also organized three Science, Technology and Innovation Policy (STIP) Forum lectures in April 2019, Sept. 2019 and January 2020 on the topics of Infectious Diseases, STI for Society & Space Technology respectively.



2. Governance & Guidance

Guidance by the Governing Body

The 33rd meeting of Governing Body (GB) CEFIPRA was scheduled to be held on **20 March, 2020** at New Delhi, India. However, due to the COVID-19 pandemic and subsequent lockdown in India and France, it was suggested by the Co-Chairs of the Governing Body to hold the meeting through virtual mode/e-mail circulation.

The Governing Body took decisions and provided valuable guidance on CEFIPRA coordinated programmes and other policy matters. Some of the initiatives proposed for launching new programmes/activities were also approved. These new programmes/activities included Women Post-Doc Fellowship Programme, CEFIPRA Outstanding Project Award/PRIx Du projet Exceptionnel (PRIDE), Resuming CEFIPRA-ESONN Fellowship, 7th Annual Lecture Series, etc.

The French and Indian Co-Chairs also released the Annual Report 2018-19 along with compilation of three volumes of scientific publications emanated from CEFIPRA supported projects during the year-2019 under the Collaborative Scientific Research Programme (CSRP) & High Impact Scientific Network Programme. A bibliometric analysis of research paper emanated in 2018 under Collaborative Scientific Research Programme was also released by the Co-Chairs. The Co-Chairs appreciated the contribution of CEFIPRA in promoting S&T cooperation between France and India and further strengthening the collaborations with newer initiatives.

Members also recommended that CEFIPRA needs to address its innovative strategy with an aim to get Indian and French industry partners together in areas of multidisciplinary research. Additionally, GB should be kept informed of the outcome of this exercise meant for creating additional resources to launch more Industrial R&D programmes.

CEFIPRA may consider initiating a joint programme on Artificial Intelligence. Other themes for collaboration suggested were to include Sustainable Technologies, Data Science and S&T Policy. GB suggested that to launch videos of successful stories emanating from Industry - Academia projects on various social media platform such as YouTube and share the links on the websites of French organizations. Moreover, CEFIPRA should obtain success stories from the investigators of successful projects, (graded Excellent and Very Good) in the form of articles/video clips and post them through various social media platforms of CEFIPRA, at least one per month. It was suggested to limit it to a maximum of three areas for a focused output. The two areas suggested for call in Jan 2020 were a) sustainable technologies for carbon emission reduction and b) cyber physical systems including artificial intelligence.

GB felt that there, is indeed, a need to coordinate this task to work on a new model to put in place with other stakeholders in India and in France for the overall improvement of the efficiency of the IARDP program. With the support of French Ministries and IRC French members, the work is in progress, with the aim to approach new French partners i) French competitiveness clusters ii) Carnot Network and iii) the Network of technology transfer agencies (SATT). Industries may contribute upto 25% to the projects for their larger commitment, GB also suggested IRC to review the IP guidelines of CEFIPRA which are shared with the investigators for their utilisation.

GB accepted the proposal of Director, CEFIPRA for launch of a new postdoctoral programme for women scientists of both the countries, in principle and requested for submission of a concept note outlining the modalities for implementation of the programme. Moreover, GB recommended instituting an award to recognize scientific contribution of Indian and French Principal Investigators (PIs) of most successful collaborative projects of CEFIPRA. Each award will carry a Certificate of recognition by two Co-Chairs and cash prize of Rs. 1 lakh (One lakh to Indian Scientist)/ Euro 1500 (Euro One thousand five hundred to French Scientist).

Meetings of the Scientific Council

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 high-calibre scientists which are internationally recognized and are nominated by their respective Governments.

The SC evaluates joint research proposals submitted twice a year in ten domains of S & T under the Collaborative Scientific Research Programme (CSRP). These high-quality proposals are from prominent Indo-French research groups working in advanced areas of basic and applied sciences. Also, the SC closely monitors and assesses the progress (mid-term and final) of recommended collaborative research projects and other programmes/activities of the Centre.

The Governing-Body of CEFIPRA also appreciated the activities of the Scientific Council and the performance of CSRP. However, regarding the thematic areas, GB recommended limiting the number of areas to a maximum of three or four, for a focused output. The two areas for the next call in Jan 2020 were a) sustainable technologies for carbon emission reduction and b) Cyber-Physical Systems including artificial intelligence.

However, the SC was in a view that though the thematic area Calls were well received by the scientific community, it was recommended keeping a concurrent general call as well. Hence, for the January's deadline; one Call on Thematic areas and another Call on General topics were made available but for the deadline of July's, only General topic Call was made available as usual.

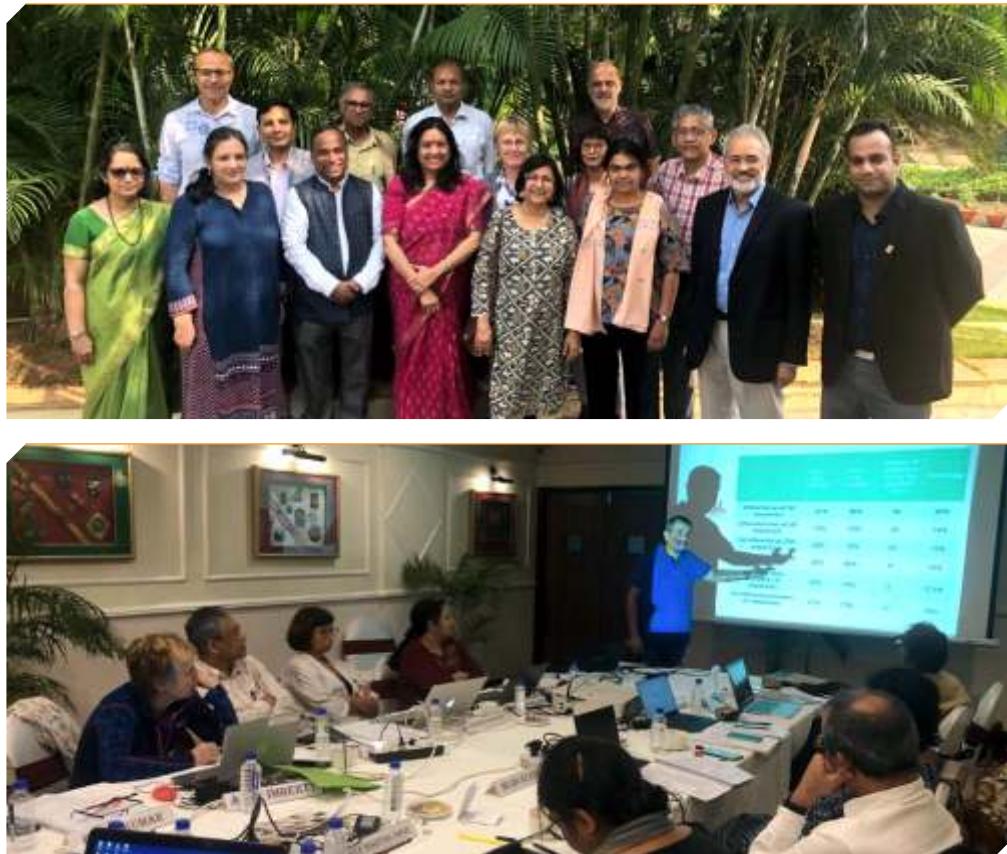
SC also revised the applications submission form which included new criteria such as preliminary results relevant to the proposal obtained by either side, the origin of a project details of prior interaction, the added value of collaboration, and 5 years cooling off period after completion of the previous project along with encouraging the Co-funded PhDs wherever possible.

The SC revised the CEFIPRA online web-format for the referees to accept no conflict of interest and maintain confidentiality clauses along with the project implementation guidelines of CEFIPRA. Accordingly, the changes were also suggested in the format for submission of proposals under seminars/workshops/training schools and the process of handholding for focused output.

The 63rd and 64th meetings of the Scientific Council (SC) were held during 2-4 June 2019 at Lille, France during 18-21 November 2019 at Bhubaneswar, India respectively. After initial screening at CEFIPRA, the SC considered 189 proposals, out of which 22 proposals were recommended for funding support from thematic areas (7) [AI & Big Data, Science for Sustainability, Quantum Materials, Addressing Biological Questions Using or Developing Mathematical, Computational or Physical Approaches] and general areas Computational Science (2), Life and Health Sciences (4), Pure and Applied Physics (3), Pure and Applied Chemistry (1), Earth and Planetary Sciences (1), Materials Science (2) and Mathematics (2).



63rd Meeting of Scientific Council at Lille

64th Meeting of Scientific Council at Bhubaneswar

Overlapping meeting of SC & IRC members

An Overlapping Meeting was organized between Members of Scientific Council (SC) and Industrial Research Committee (IRC) on 5 June, 2019 at Lille. The Committee deliberated on CSRP projects having potential for translation to industrial projects along with 32nd GB's recommendation for IRC for expansion of activities with focus on innovation, network centers and academia industry projects:

- I. Interaction between Industry associations of both countries
- ii. Competitive clusters in France
- iii. Cluster ecosystems of France and Incubator systems of India
- iv. Region to Region Collaboration

Co-Option of Members for SC and IRC from both countries

Recognising the pace of advances in research areas, especially interdisciplinary research areas and thematic areas, the members recommended having a panel of experts to assist SC/IRC members to review the proposals assigned to them. Considering the meetings being held in India and France alternately, it was also recommended that if the meeting is held in India, Indian experts may be co-opted for the meeting(s) and vice-versa.

GOVERNANCE & GUIDANCE



34th Meeting of IRC at Lille



35th Meeting of IRC at New Delhi

Meetings of the Industrial Research Committee

The Industrial Research Committee (IRC) of CEFIPRA consists of six members, comprising three members each from India and France, nominated by their respective Governments. The activities under Industrial Research Programme of CEFIPRA are guided by the members of the Industrial Research Committee.

The 34th and 35th Meetings of Industrial Research Committee (IRC) were held during 6-7, June, 2019 at Lille, France & on 22 November, 2019, at New Delhi, India, respectively. A total of nine proposals were received and considered during the above meetings.

The Committee after due deliberations, recommended two proposals entitled “(PPMB) Commercial pigment production by microalgae: towards the development of new biotech process” and “Green Valorization of sheep wool wastes towards bio-composites and bioactive building materials”.

During the two meetings, the Committee reviewed four seminar proposals for holding bilateral seminars/workshops/training schools. Based on the evaluation by members and the importance of the topics of the proposed seminars and industry participation, the IRC recommended two seminar proposals entitled “Microwave, Photonics and Flexible Electronic Technologies” by IIT, Chennai-XLIM Limoges and INDo-French symposium on clean and sustaINable Energy Technologies (INFINITE) by CSIR, Central Institute of Mining and Fuel Research, Dhanbad-CNRS.

IRC evaluated progress of three completed projects & the progress was found satisfactory in two projects and in the other project the committee opined that project was unsuccessful in accomplishing the overall objectives. IRC evaluated the progress of two ongoing projects & the progress was found satisfactory in one project and in the other project entitled “Customer Behaviour on Travel Marketplaces (for E-Commerce): Modelling and Decision Support”, committee opined that better teamwork could have yielded more quantifiable outcomes. Further, the committee also noted the status updates on additional five ongoing projects.

Committee also discussed and identified thematic areas for Industrial R&D seminars such as Natural products and cosmetics; Nano toxicology and Smart and digital manufacturing.

Standard Expert Panel (SEP)

CEFIPRA organized the 4th meeting of Standard Expert Panel (SEP) on 9 May, 2019 at CEFIPRA office, New Delhi, for mentoring and monitoring the Indian & French collaborators of CEFIPRA supported projects on Intellectual Property (IP) rights and commercial potential of their joint projects.

Director, CEFIPRA extended a warm welcome to the Members of SEP. She briefed the members about CEFIPRA activities along with the background and role of Standard Expert Panel (SEP). Several Indian and French collaborators attended the meeting via skype along with SEP members and CEFIPRA officials.



CEFIPRA contacted Project Investigators (PIs) of CEFIPRA supported projects, both Indian and French to participate in this meeting. Of these, nine PIs, five Indian and one French, one French Knowledge and Industry partner each and one Indian Industry Partner participated in the SEP meeting via Skype. SEP members advised and guided the project investigators regarding various issues of Intellectual Property (IP) rights of their joint projects. Members recommended that while submitting the proposal, the collaborators should do a provisional search on freely available databases such as Google Patents, Espacenet, etc. to ensure it fulfills the patentability criteria. Members of SEP further recommended that for monitoring purpose, PIs may be advised to participate in a mid-term review of IP mentoring session. If PIs find something interesting regarding IP, they should share the same with CEFIPRA so that SEP will be able to guide them on IP related issues.



3. Seminars / Workshops & Outreach

Marine Biodiversity, Ecosystem Dynamics and Conservation

Observatoire Océanologique de Banyuls, Banyuls sur Mer, France on Date - 8-10 July, 2019



This successful workshop provides a platform to six leading institutions to present their scientific presentations. A total of twenty one presentations were made by Indian and French scientists/ researchers. Two round tables were held, one dedicated to sharing knowledge about funding opportunities to support Indo-French collaboration and the other to share the ongoing projects of each participants.

As an outcome of the second round table, it was decided that the coordinators would create a list of internship opportunities for the coming years to circulate to students and on-going PhD projects in both Countries.

A scientific speed dating was also organized to further develop ideas about hands-on collaborations between participants. India, with its tropical climate, vast coastline, island territories and diverse marine ecosystems of coral reefs, seagrass meadows, mangroves and open ocean is unique in its exceptional richness of marine biodiversity. Marine biodiversity is a multidimensional concept, considered at many different levels, ranging from genetic variability among individuals and populations, to diversity of species, assemblages, habitats, landscapes and biogeographical provinces.

Despite this tremendous diversity, marine organisms remain largely unexplored by fundamental or applied research in India. Ocean productivity is controlled by

Indian Coordinator:
Prof. Kartik Shanker
Indian Institute of Science
Bangalore

French Coordinator:
Dr. Katell Guizien
Oceanological
Observatory of Banyuls (OOB),
Languedoc, Roussillon
Perpignan

both the diversity and identity of marine species forming functional communities. Human modifications to the collective biodiversity of the ocean can alter ecological functions and life support services that are ultimately essential to the well-being of human societies. Substantial local losses of biodiversity have already occurred in the ocean in response to overfishing, habitat destruction, pollution or non-indigenous species introduction. Climate change has also started to modify species assemblages at larger scales, due to profound modification of the ocean physics and chemistry.

The biodiversity in the Exclusive Economic Zone (EEZ) of India including coastal and deep-sea habitats and its functional role is largely unexplored. Yet, climate change is expected to significantly impact this part of the ocean. Thus, investigations of Indian marine biodiversity should be intensified.

Through the seminar, the idea of testing ecological concepts shaping species distribution across terrestrial and marine ecosystem emerged, in order to capitalize on the expertise of the Indian (terrestrial/marine) and French (marine) participants.

Small molecules activation for fuels and commodity chemicals production

In this seminar, twenty speakers from India and twelve speakers from France were participated along with sixty research scholars as beneficiaries. This seminar provided the opportunity to plan student exchanges and long term collaboration between the participating institutes. Institutional linkages were developed among Labex Arcane in Grenoble with the Indian Chemical Community/Society. Specific discussions have been made with consortium at IACS, IIT Gandhinagar and IIT Mumbai to discuss the need to transition towards a sustainable way of producing fuels and chemical. The seminar brought together different domain experts encourage sufficient discussion time and student presentations. The sessions greatly enriched the Brainstorming sessions benefited the seminar in envisaging several new Indo-French collaborations.

“Solar-Driven Chemistry” emerges as a new concept to making sustainable fuels and commodity chemicals at affordable materials and Earth surface costs, using solar energy as the only energy source and through the activation of readily available small molecules from this atmosphere, enabling the foundation of a global circular economy. This includes hydrogen production from water, nitrogen, NO_x and SO_x fixation and the conversion of atmospheric CO₂ into products, which will be a game changer in the fight against climate change and, last but not least, the control of oxygen activation to prepare advanced functionalized chemicals. To achieve this goal, there is a strong need to develop radically new catalytic technologies to control the activation of such small molecules. The idea of designing novel biohybrid-matrixes for enhancing catalysis was also discussed.

The activation of small molecules has long been the realm of bioinorganic chemistry, but in this seminar, the Coordinators abled to gather scientists which are working on developing nanocatalysis, catalysis for organic transformation and surface science in order to make the field progress towards industrial catalytic applications.



Indian Coordinator:
Prof. Abhishek Dey
Indian Association for the
Cultivation of Science
Kolkata



French Coordinator:
Dr. Vincent Artero
CEA Centre de Grenoble
Grenoble



4-6 February, 2020 at Indian Association for Cultivation of Sciences, Kolkata, West Bengal

Optimization, Variational Analysis & Applications

In the seminar, seventeen speakers from India and eight speakers from France participated along with fifty-five research scholars. Prof Sandeep Juneja, Dean, School of Technology and Computer Science, TIFR Mumbai was the Chief Guest & Dr Purnima Rupal, Director CEFIPRA was the Guest of Honor.

Deliberations covered vector optimization problems their sensitivity, uniform efficient solutions, extended real valued functions, their applications using sub differentials, Set valued optimization, essential solution sets in set-valued optimization, variational principles for set valued maps and applications, blind deblurring of barcodes as a complementarity constraint optimization problems, mathematical programming problems with equilibrium/vanishing constraints & their applications, shape optimization problems, bi-level programming & its applications, Variational mollifier approach to deconvolution of probability densities & applications, monotone variational inclusions, gradient based line search method for multi-objective optimization problems, spherical search algorithm and solid waste management problems.

The young faculty members, post-doctoral fellows and research scholars benefitted from the exposure to the current research in Optimization, Variational Analysis and applications in India and France. The Seminar was well attended by French and Indian researchers from University of Limoges, University of Toulouse (ENAC), University of Rennes (INSA), CMAP-Ecole Polytechnique, Palaiseau, University of Avignon & Chennai Mathematical Institute, Indian Statistical Institute, Delhi & Chennai, Aligarh Muslim University, University of Delhi, IIT Kanpur, Roorkee Patna and Kharagpur working in the area of Operational Research. This event was also well covered in local media. University of Limoges expressed a keen desire to exchange Masters Students with Deptt. of Mathematics, Institute of Science, Banaras Hindu University, Varanasi.

This seminar was coordinated by Prof. Pierre René Maréchal, Institut de Mathématiques de Toulouse, Université Paul Sabatier, Toulouse from French side & Prof. S. K. Mishra, BHU, Varanasi from Indian side 2-4 Feb., 2020 at Department of Mathematics, Institute of Science, Banaras Hindu University, Varanasi.



Interactions among Indian Optimizers and French Optimizers were very fruitful. Young students also got a chance to interact with French as well as Indian experts. Young research scholars got an exposure of the research work being carried out by leading French Optimizers. It was discussed that Mathematical Programming Problems with Equilibrium Constraints and Mathematical Programming Problems with Vanishing Constraints are very much applied to various disciplines of Science and Engineering.

Organized by Deptt. of Mathematics, Institute of Science, BHU, Varanasi during 2-4 February, 2020



Goa - Atlantic cooperation programme (GOAT) in Brest, France

Marine Science and Technology has been highlighted in the common declaration during the visit of the Indian Prime Minister to France (August 2019), considering the Letter of Intent signed by IIT Goa, CMM and NG during the first Knowledge Summit in New Delhi (8 December 2017), the GOAT Partners have agreed in moving ahead with the GOAT project and sign a Memorandum of Understanding.



The goal of this CEFIPRA's supported this Seminar was to establish bridges between individual academics, scientists and engineers in order to create links that support the signature of an MoU between IIT Goa and Campus Mondial de la Mer (CMM), Pôle Mer Bretagne Atlantique (PMBA), École Nationale d'Ingénieurs de Brest (ENIB), École Nationale Supérieure de Techniques Avancées Bretagne (ENSTA-B), École Navale, Université de Bretagne Occidentale (UBO), France Energies Marines (FEM), Service Hydrographique et Océanographique de la Marine (Shom), and Naval Group (NG).

Participants deliberated on various modes for Educational, Research and Innovation exchange Programme in the area of Marine Science and Technology. Indian partners had also the chance of meeting more than 50 French academics, researchers and engineers, which includes Pierre-Yves MORVAN (IxBlue), Anne Lebourg Dhaussy (IRD), Emmanuelle Platzgummer, (Officer in charge of Asia at IFRMER), as well as Mrs. Béatrice Nicolas-Meunier, Mr. François-Régis Boulvert, and Mr. Luc Martin (Naval Group). The Parties have mutual interests and intent to undertake cooperative activities to their mutual benefits in education and research, mainly in the following fields:

- Renewable marine energy,
- Advanced computational techniques, numerical modelling and mathematics,
- Combustion technologies,
- Chemical,
- Marine biotechnologies,
- Non-destructive evaluation and control,
- Bio environment,
- AUV: sensors, imaging, data processing and interpretation, autonomy,
- Acoustics,
- Physical oceanography and ocean sensors,
- Marine physics: ocean and climate, geophysics, hydrodynamics, and ocean data science.



The Memorandum of Understanding was signed at Brest Metropole on 19 January 2020

Twelve major cooperation topics have already been identified by NG and IITG with contact points from each country: Non Destructive Test tools; Friction Steer Welding; Circuits of freshwater, Chilled water and seawater; Polymers and hydraulic fluids; Physicochemical analyses; Acoustic Imagery; Digital twins / predictive Maintenance; Underwater communication and control; Scientific Computing; Environmental Protection & Eco Design; Bigdata and learning technologies.



6th Annual Lecture Series



► Prof. Sanghamitra Bandyopadhyay,
Director, Indian Statistical Institute
Professor, Machine Intelligence Unit
Kolkata

CEFIPRA organises lectures under its Annual Lecture Series Programme. In the year 2012, CEFIPRA, initiated this to commemorate 25th year's celebration with intent to increase the interactions between the best S&T minds and young students/researchers from India and France.

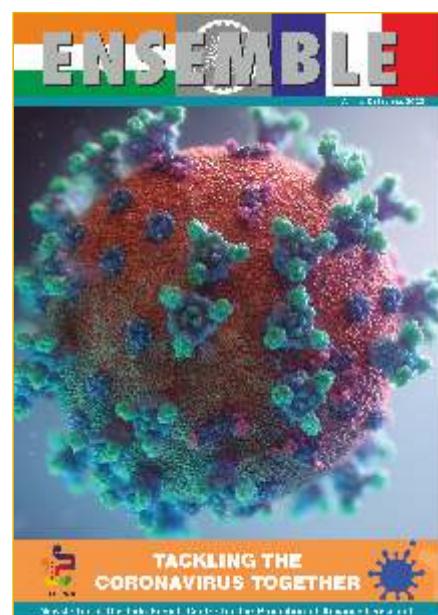
The first lecture was delivered by Prof. Jules Hoffmann, Nobel Laureate (Physiology/Medicine 2011) in India in 2012. CEFIPRA organised six Lectures under this series in India and France alternately.

6th Lecture under Annual Lecture Series of CEFIPRA was delivered by Prof. Sanghamitra Bandyopadhyay, Director, Indian Statistical Institute, Professor, Machine Intelligence Unit, Kolkata on 15 Oct., 2019 at Sorbonne Université, Paris (title: *Optimizing Multiple Objectives for Clustering*) and Université Paris-Est Crétail, Paris (title: *Advances in Multi-objective Optimization and Applications in Clustering and Computational Biology*). She delivered lecture on 15 & 16 Oct., 2019 at Sorbonne Université, Paris, Université Paris-Est Crétail, Paris and Laboratoire d'Informatique de Grenoble, France.

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 of 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 2019-20.

These editions highlighted Indo-French collaborative projects aimed at developing sustainable technologies for recycling and recovery of waste water to combat water issues. These newsletters also showcase research achievements of CEFIPRA supporting projects in area of Astronomy and Climate system





4. Dedicated Mobility Support Programmes

Raman-Charpak Fellowship

Raman-Charpak Fellowship aims to facilitate the exchange of doctoral students between India and France in order to broaden the scope and depth of future engagements in ST&I. The Call, were launched on 15 April, 2019 for French Masters students and on 15 May, 2019 for Indian and French PhD students. The Centre has received 291 applications (with some repetitions) against the deadline of 15 July, 2019 from Indian and French PhD students. The meeting for preliminary selection of candidates for the Raman-Charpak Fellowship-2019 was held on 22 August, 2019 at CEFIPRA office, New Delhi. The Committee had shortlisted 71 Indian candidates for consideration in the final selection meeting. The Expert Committee meeting for the final selection of pre-selected candidates was held on 27 September, 2019. These meetings were attended by area experts from different institutes/organizations, representatives of the granting agencies and officials of CEFIPRA. Director, CEFIPRA appreciated the cooperation and support received from Department of Science and Technology (DST), GOI & French Embassy in India for the Programme.



Raman-Charpak Fellowship-2019 Awardees

Indian Candidates:

S. No.	Name	Area of Interest	Name of Parent Institution / University	Name of the Host Institution / University
1.	Mr. Sreenath Reddy Thummaluru 	Engineering Sciences	Dr. Raghvendra K. Chaudhary Department of Electronics Engineering, IIT (ISM) Dhanbad	Dr. Julien Sarrazin Sorbonne University, Pierre and Marie Curie Campus, Laboratory of Electronics and Electromagnetism (L2E) Paris
2.	Mr. Shah Parth Mukeshbhai 	Mathematical and Computational Sciences	Dr. G.C. Samanta Department of Mathematics, BITS Pilani, K K Birla Goa Campus	Prof. David Langlois AstroParticule et Cosmologie (APC) University of Paris Paris
3.	Mr. Mullaivananathan. V 	Materials Sciences, Physical Sciences, Chemical Sciences	Dr. N. Kalaiselvi CSIR- Central Electrochemical Research Institute Karaikudi Tamilnadu/ Bharathidasan University	Dr. Sylvain Franger University Paris Sud/ ICMMO/ERIEE, CNRS 8182 Orsay

DEDICATED MOBILITY SUPPORT PROGRAMMES

S. No.	Name	Area of Interest	Name of Parent Institution / University	Name of the Host Institution / University
4.	Mr. Rohit Shukla 	Biological Sciences, Life and Medical Sciences	Dr. Tiratha Raj Singh Jaypee University of Information Technology Solan, HP	Prof. Brigitte Vannier Cell Biology University of Poitiers Poitiers
5.	Mr. Vipin Kumar 	Mathematical and Computational Sciences	Dr. Muslim Malik Indian Institute of Technology-Mandi	Prof. Mohamed Djemai Université Polytechnique Hauts-de-France LAMIH CNRS UMR 8201 Valenciennes
6.	Ms. Shrreya Krishnamurthy 	Materials Sciences, Physical Sciences, Chemical Sciences	Dr. Pallab Bhattacharya Stroke Research and Therapeutic Laboratory, National Institute of Pharmaceutical Education and Research Ahmedabad (NIPER-A) Gandhinagar	Prof. Luca Perfetti LSI Ecole Polytechnique Palaiseau
7.	Mr. Rakesh Kumar 	Mathematical and Computational Sciences	Prof. Kiran P. Adhi Department of Physics, Savitribai Phule Pune University	Prof. Denis Efimov Inria Lille-Nord Europe Research Center Science Park of Haute Borne Villeneuve de Ascq
8.	Mr. M.Sai Phani Kumar 	Engineering Sciences	Prof. Jayanta Mukhopadhyay Department of Computer Science and Engineering Kharagpur	Prof. Mohamed-Chaker Larabi University of Poitiers Poitiers
9.	Ms. Akanksha Gupta 	Atmospheric Sciences, Earth Sciences and Environmental Sciences	Dr. Anirban Guha Indian Institute of Technology Kanpur	Dr. Michel Benoit Irphé & Ecole Centrale Marseille Institut de Recherche sur les Phenomenes Hors Equilibre UMR 7342 Marseille

DEDICATED MOBILITY SUPPORT PROGRAMMES

S. No.	Name	Area of Interest	Name of Parent Institution / University	Name of the Host Institution / University
10.	Ms. Indu Joshi 	Engineering Sciences	Prof. Sumantra Dutta Roy Indian Institute of Technology Delhi	Prof. Antitza Dantcheva Inria Sophia Antipolis - Méditerranée Research Centre, Sophia Antipolis
11.	Mr. M Karnan 	Materials Sciences, Physical Sciences, Chemical Sciences	Dr. M. Sathish CSIR-Central Electrochemical Research Institute Karaikudi	Prof. Patrice Simon French Academy of Technologies Université Paul Sabatier, Toulouse France Laboratoire CIRIMAT Toulouse
12.	Ms. Meena Ghosh 	Materials Sciences, Physical Sciences, Chemical Sciences	Dr. Sreekumar Kurungot CSIR- National Chemical Laboratory Pune	Dr. Rabah Boukherroub Institut d'Electronique, de Microélectronique et de Nanotechnologie (IEMN) UMR CNRS 8520 Université de Lille Villeneuve d'Ascq
13.	Ms. Swati Varshney 	Biological Sciences, Life and Medical Sciences	Dr. Shilpi Sharma Environmental Genomic Lab, Indian Institute of Technology Delhi	Dr. Nour-Eddine Chihib Materials and Transformation Unit (Umet)-Inra Team Interfaces and Materials Hygiene Process Villeneuve d'Ascq Universite de Lille Lille
14.	Mr. Subarna Das 	Materials Sciences, Physical Sciences, Chemical Sciences	Dr. Aritra Banerjee Department of Physics University of Calcutta Kolkata	Prof. Antoine Maignan Laboratoire de Cristallographie et Sciences des Matériaux (CRISMAT) Cean
15.	Mr. Pranav Ajeet Nerurkar 	Engineering Sciences	Dr. S. G. Bhirud Dept. of Computer Engineering & IT, Veermata Jijabai Technological Institute/ Mumbai/ University of Mumbai	Prof. Yann Busnel IMT Atlantique Cesson-Sévigné

DEDICATED MOBILITY SUPPORT PROGRAMMES

S. No.	Name	Area of Interest	Name of Parent Institution / University	Name of the Host Institution / University
16.	Mr. Anshuman Chaupatnaik 	Materials Sciences, Physical Sciences, Chemical Sciences	Prof. Prabeer Barpanda Materials Research Centre (MRC) Indian Institute of Science (IISc) Bangalore	Prof. Laurence Croguennec Institut de Chimie de la Matiere Condensee de Bordeaux (ICMCB) Universite de Bordeaux Pessac
17.	Ms. Reetika Joshi 	Materials Sciences, Physical Sciences, Chemical Sciences	Prof. Ramesh Chandra Kumaun University Nainital	Prof. Guillaume Aulanier Observatoire de Paris Lesia Paris
18.	Mr. Rupam Roy 	Materials Sciences, Physical Sciences, Chemical Sciences	Dr. Apurba Lal Koner Indian Institute of Science Education and Research Bhopal	Dr. Cyril Poriel UMR CNRS 6226 - Institute of Chemical Sciences of Rennes University of Rennes 1 Rennes
19.	Mr. Krishnakanth Baratam 	Biological Sciences, Life and Medical Sciences	Dr. Anand Srivastava Indian Institute of Science Bangalore	Prof. Samuela Pasquali Laboratoire CiTCoM UMR 8038CNRS Université de Paris Paris
20.	Ms. Ankita Paul 	Atmospheric Sciences, Earth Sciences and Environmental Sciences	Dr. Arti Bhatia ICAR- Indian Agricultural Research Institute New Delhi	Dr. Benjamin Loubet Institut National de la Recherche Agronomique (INRA) UMR INRA AgroParisTech ECOSYS Université Paris-Saclay Thiverval-Grignon
21.	Mr. Aditya Singh 	Materials Sciences, Physical Sciences, Chemical Sciences	Prof. Rajendra Singh Department of Physics, Indian Institute of Technology Delhi New Delhi	Prof. Stephane Berciaud Institut de Physique et Chimie des Matériaux de Strasbourg (IPCMS) and Université de Strasbourg & CNRS (UMR 7504) Strasbourg

DEDICATED MOBILITY SUPPORT PROGRAMMES

S. No.	Name	Area of Interest	Name of Parent Institution / University	Name of the Host Institution / University
22.	Ms. Jyotsnamayee Nayak 	Biological Sciences, Life and Medical Sciences	Dr. Rajender Kumar Sardar Vallabhbhai National Institute of Technology Surat	Prof. Laurence Motte LVTS INSERM U1148 University of Paris 13 Sorbonne Paris City UFR-SMBH Cachin
23.	Mr. Alvin Anto 	Atmospheric Sciences, Earth Sciences and Environmental Sciences	Dr. Sreenath K. R. Central Marine Fisheries Research Institute, Kerala/ Cochin University of Science and Technology Kerala	Prof. Laetitia Hedouin CRIODE - Moorea USR3278 EPHE-CNRS-UPVD Moorea French Polynesia
24.	Ms. Purbita Bandopadhyay 	Biological Sciences, Life and Medical Sciences	Dr. Dipyaman Ganguly CSIR- Indian Institute of Chemical Biology Kolkata	Dr. Vanja Sisirak Prof. Patrick Blanco ImmunoConcEpT CNRS UMR 5164 University of Bordeaux Bordeaux
25.	Ms. Nisha Singh 	Atmospheric Sciences, Earth Sciences and Environmental Sciences	Dr. Gopala Krishna Darbha Department of Earth Sciences Indian Institute of Science Education and Research Kolkata	Dr. Fabienne Lagarde Le Mans Université, IMMM UMR-CNRS 6283 Le Mans

French Student:

S. No.	Name	Area of Interest	Name of Parent Institution / University	Name of the Host Institution / University
26	Mr. Pinguet-Poquet Théo 	Biological Sciences, Life and Medical Sciences	Prof. VADEZ Vincent IRD (Institut de Recherche pour le Développement) unit DIADE team CERES Montpellier	Dr. Jana Kholova ICRISAT (International Institute for the Semi-Arid Tropics) Hyderabad Telangana

DEDICATED MOBILITY SUPPORT PROGRAMMES

French Masters' Students:

S. No.	Name	Area of Interest	Masters' Registered Institute/University	Name of the Host Institution / University
27.	Mr. Hamelin (Roisné-Hamelin) Gaëtan 	Biological Sciences, Life and Medical Sciences	Dr. Dalila Azzout-Marniche AgroParisTech PNCA (Physiologie de la Nutrition et du Comportement Alimentaire) UMR 914 Paris	Dr. Anura Kurpad, Devi Sarita St Johns Medical College Bengaluru
28.	Mr. Mathieu HUBERT 	Materials Sciences, Physical Sciences, Chemical Sciences	Dr.Jean-Claude PASCAL Toulouse III Paul Sabatier University (UPS) Toulouse	Dr. Sanket Goel Department of Electrical and Electronics Engineering BITS-Pilani Hyderabad
29.	Ms. Rachida Nadia Harouna Mahamadou 	Engineering Sciences	Dr.Jean-Claude PASCAL Toulouse III Paul Sabatier University (UPS) Toulouse	Dr. Pramod K Namboothiri Department of Biomedical Enggineering, Manipal Institute of Technology-Manipal Karnataka
30.	Mr. Alloo Jérémie 	Biological Sciences, Life and Medical Sciences	Dr. Sylviane PIED Center for Infection & Immunity of Lille, Inserm U1019, CNRS UMR8204 Institut Pasteur de Lille Lille	Dr. Siddhesh Kamat Department of Biology, Indian Institute of Science Education and Research (IISER) Pune



5. Brief Reports of Research Projects

A. Collaborative Scientific Research Programme

Modelling Plasma Instabilities and Transport in a Hall Thruster

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.

Pure & Applied Physics

Project No. 5204-3

Mar. 2015 to Aug. 2019

Objectives

- Assessing the effect of dust on resistive and Rayleigh-Taylor instabilities
- Hamiltonian formalism to describe the dynamics of resonant electrons
- Numerical integration of pathlines, in slab geometry, statistical study over an electron distribution.
- Adding wall and B curvature
- If possible use true cylindrical geometry

Revised objectives

- analysing electron chaotic dynamics in electrostatic modes
- characterize the unexpected instability due to the presence of dusts

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



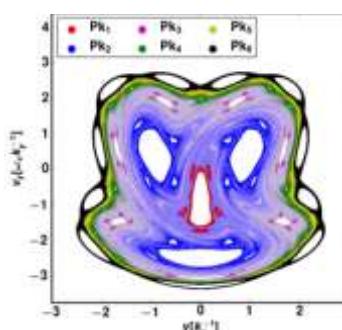
Yves Elskens
UMR 7345 du CNRS /
Aix Marseille Université
Marseille

Publications

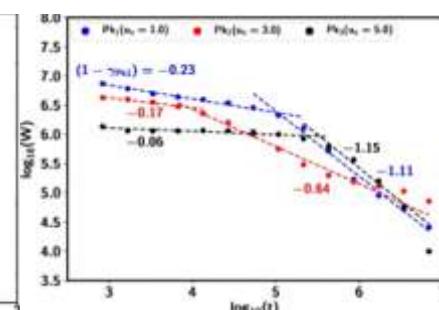
- No. of publications in SCI journals: 2
- No. of papers presented in conferences: 2

Mobility Support

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



Localization of six different sticky regions in the stochastic web structure associated to one electrostatic wave for $\epsilon=0.69$, $\beta^2=0.0000183$ and $X_0=1.39$.



Time evolution of number of points WPk in distinct sticky regions

(from D. Mandal, Y. Elskens, X. Leoncini, N. Lemoine and F. Doveil, Sticky islands in stochastic webs and anomalous chaotic particle transport by E×B electron drift instability, submitted for publication ; preprint arXiv : 2007.02526)

Large scale loss based learning via energy minimization

Computational Science

Project No. 5302-1

Apr. 2016 to Sept. 2019

Objectives

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

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)

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.

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

Original biocompatible phosphorus dendrimers as a new strategy to tackle pulmonary tuberculosis

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-Pyrénées
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

Life & Health Sciences

Project No. 5303-2

Sept. 2015 to Sept. 2019

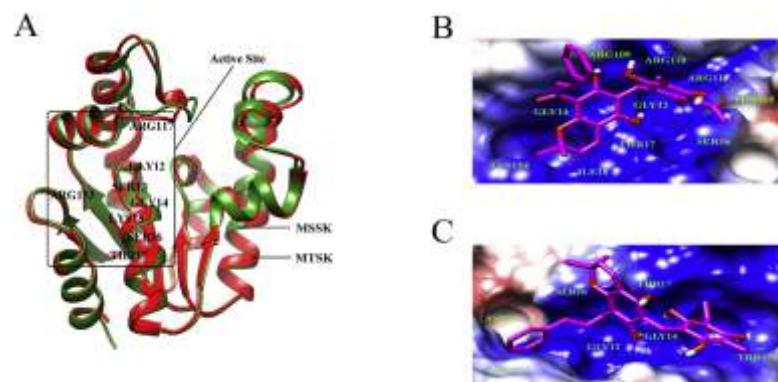
Objectives

- 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



Theoretical studies on ultra-cold dipolar gases

Pure & Applied Physics

Project No. 5304-1

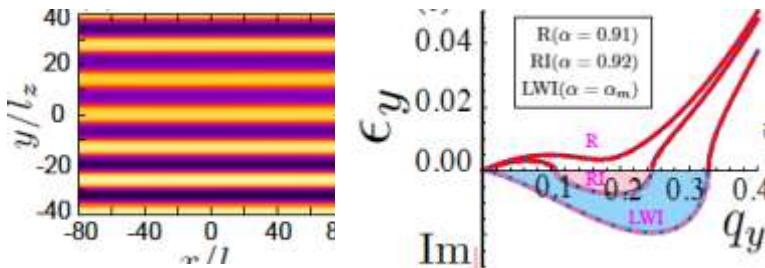
May 2015 to Apr. 2019

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



Ref: C. Mishra and R. Nath Phys. Rev. A, 94, 033633 (2016)

Background

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

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

Advanced time-domain integration schemes for the simulation of earth and planetary core dynamics

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.

Earth & Planetary Sciences

Project No. 5307-1

Sept. 2015 to Jun. 2019

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

Principal Collaborators



Binod Sreenivasan
Indian Institute of Science
Bangalore



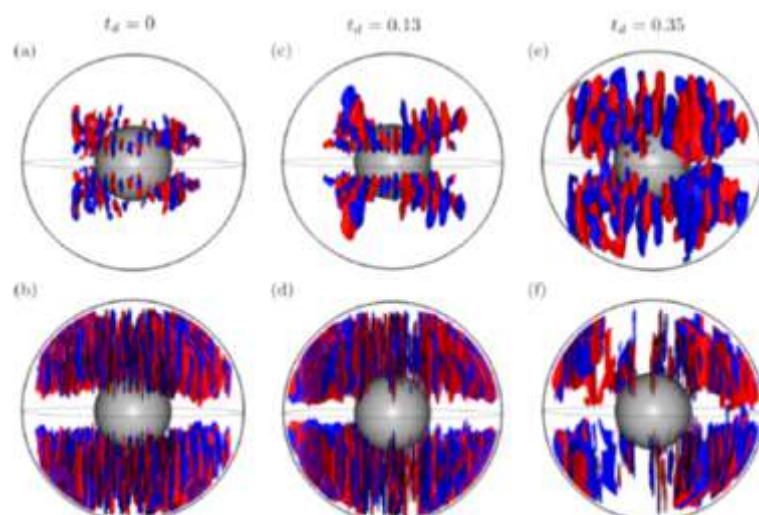
Alexandre Fournier
Institut de physique du globe de paris
(IPGP)
Paris

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



Top panels [a,c,e]: Snapshots in time (measured in units of the magnetic diffusion time) of the isosurfaces of u_z (contour level ± 80) for $E = 30$ in the nonlinear dynamo simulation. Bottom panels [b,d,f]: u_z (contour level ± 150) at the same times, but for $E = 30$. The parameters used are $E = 1.2 \times 10^{-6}$, $Pr = Pm = 1$, $Ra = 400$

Magnetism of self-organized structures at surfaces

Materials Science

Project No. 5308-1

Jul. 2015 to Jun. 2019

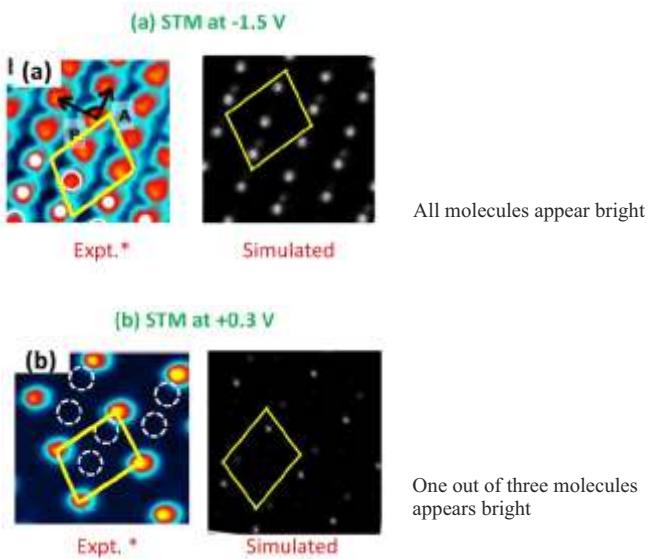
Objectives

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



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.

Principal Collaborators



Shobhana Narasimhan
Jawaharlal Nehru Centre for Advanced Scientific Research
Bangalore



Sylvie Rousset
UMR CNRS 7162
Université Paris Diderot – Paris 7
Paris

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

Pathogenic Aspergillus: interaction with innate immune cells

Background

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

Aspergillus fumigatus causes systemic infections worldwide, particularly in the immunocompromised individuals/patients, which are often fatal; whereas *A. flavus* causes superficial eye/corneal infection which is a major cause of keratitis in tropical part of the world. In this collaborative project, it is proposed to use combined expertise to (i) unravel the pathogenic components and their role in modulating host immune responses during infection and (ii) in identifying common and uncommon aspects of two pathogens while establishing their pathogenicity, which might lead us to the development of universal or differential therapeutic strategies against these two fungal infections. The study will be focused on the fungal cell wall polysaccharides and the cell surface/secreted proteins as they are the first fungal components interacting with the host.

Principal Collaborators



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



Vishukumar Aimananda
Institut Pasteur
Paris

Publications

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

Mobility Support

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

Life & Health Sciences

Project No. 5403-1

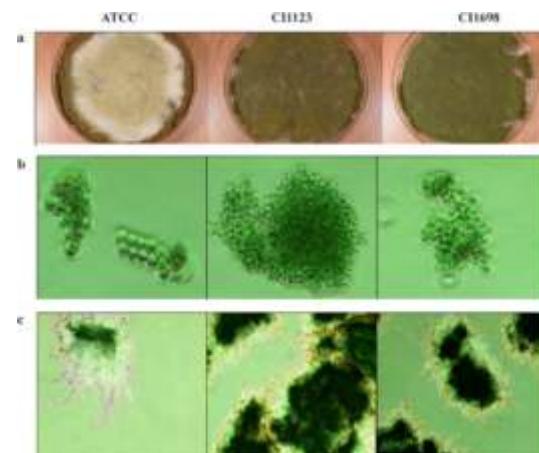
Jan. 2016 to Dec. 2019

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

- Innate immune response to *Aspergillus* infection is dependent on the infecting species and their conidial morphotype (dormant or germinating conidia)
- Exoproteome of the *Aspergillus* species comprises of a common core-proteome involved in growth and species-specific protein subset with potential roles in virulence
- Conidial and mycelia morphotypes of the two *Aspergillus* species differ in the cell wall polysaccharide composition as well as in their localization
- Complement pathways are activated on *Aspergillus* spore surface only in the presence of serum proteins or bronchoalveolar lavage but not with tear
- Aspergillus* cell wall polysaccharides are recognized by complement receptors; polysaccharides are degraded by classical endosomal and phagolysosomal pathways



Growth behaviour of saprophyte and clinical isolates of *A. Flavus* on solid culture media and liquid media
5) 104 Spores were spread in CZA plate and incubated at 30 °C for 7 days. B. 108 Spores were mixed with 100 ml of CZB and incubated for 3 h at 30 °C. Ten µl aliquot examined under phase contrast microscope. C. 108 Spores were mixed with 100 ml CZB and incubated for 12 h at 30 °C. Ten µl aliquot was examined under phase contrast microscope

LORIC: Long-Range Interactions in ultraCold gases

Pure and Applied Physics

Project No. 5404-1

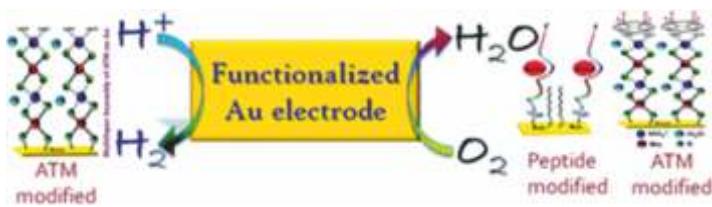
Mar. 2016 to Dec. 2019

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 homonuclear and hetero-nuclear (with a dipole moment) molecules
- Cooling molecules : innovative deceleration method for polar molecules, based on 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



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 or fermions in optical lattices with $1/r^3$ interactions ; at RRI, two-body and few-body long-range interactions will be studied, with a possibility to choose the exact power-law of the interaction $1/r^n$. At LAC, new strategies to produce dipolar or ionic molecules will be sought, including (experimentally) electronic Attachment, deceleration and trapping, and (theoretically) photo-association to create neutral molecules and molecular ions. A strong collaboration between the groups would therefore create a research platform on long-range interacting systems which has probably no equivalent in the world.

Principal Collaborators



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Raman Research Institute
Bangalore



Olivier Dulieu
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

Glimpses of new physics

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.

Principal Collaborators



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Palaiseau

Publications

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

Mobility Support

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

Pure and Applied Physics

Project No. 5404-2

Feb. 2016 to Dec. 2019

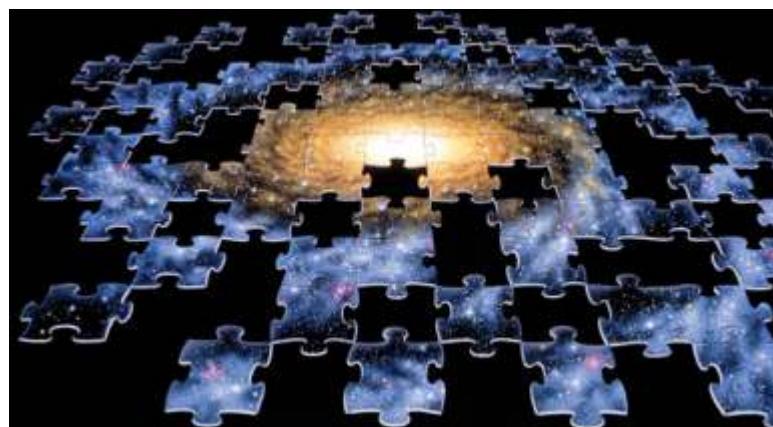
Objectives

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

- Construction of elegant models of dark matter, more specifically 'freeze-in' scenarios
- Construction of models with extended scalar boson sector
- Dark matter models with mediators having a supergravity/string theory origin (moduli)
- Landscape supersymmetric models extensions of the Standard Model with a large number of hidden sectors
- Application of landscape models to the flavour problem of supersymmetric theories



Unidentified dark matter fills most of matter in our Universe (a representative sketch only, and it does not correspond to any specific research output we produced in our papers)

Understanding mechanical size effects in metallic micro-wires: synergy between experiments and simulation

Computational Science

Project No. 5408-1

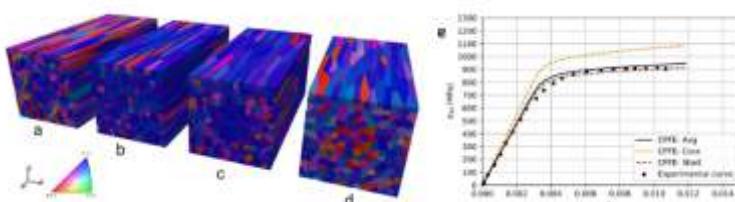
Nov. 2015 to Oct. 2019

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 electro-polishing 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



(a) to (d): Digital microstructures with assigned textures according to the different micro-wires tested in the study. (e) case of digital core-shell microstructure (a) with comparison between experimental stress-strain curve (dots) and simulated curves for the global core-shell structure as well as individual contributions from core and shell

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.

Principal Collaborators



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Ludovic Thilly
Institut Pprime (UPR 3346)
CNRS-Université de Poitiers-ENSMA
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

Chromite: Assessment of chromium release from sukinda mining overburden: an isotopic, chemical, physical and microbiological study

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.

Environmental Science

Project No. 5409-1

May 2016 to Nov 2019

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) \Rightarrow Cr(III) reduction);
- To evaluate the quality of surface and ground waters, in term of Cr species concentrations, in the Sukinda Valley
- To identify the biogeochemical processes that enhance or limit chromium mobility, from the alteration of over burden phases to surface and ground waters, through the use of Cr isotopic signatures

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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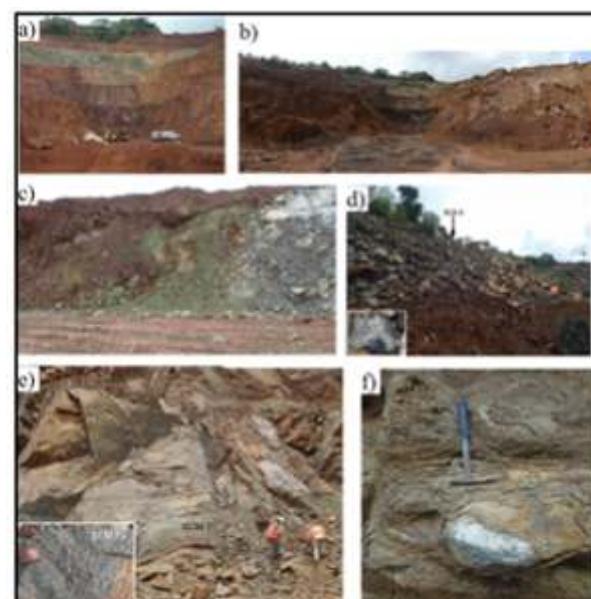
Yann Sivry
Institut de Physique du Globe de Paris
Paris

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 dunite rock. (b) insitu chromite band in dunite. (c) Dolorite dyke (d) Chromite rich rocks inside mine region. (e) pyroxenite, (f) weathered websterite

Elucidation of conserved molecular signatures and regulators for blood cell progenitor maintenance

Life & Health Sciences

Project No. 5503-1

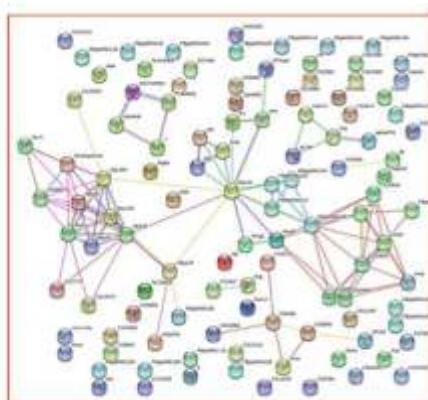
Apr. 2016 to Apr. 2019

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



String-based analysis of the genes down (left) or up (right) regulated by asrij in both *Drosophila* and mouse blood cell progenitors

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.

Principal Collaborators



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Lucas Waltzer
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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

Molecular analysis of a capacitor Hox protein motif

Background

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

Life & Health Sciences

Project No. 5503-2

May 2016 to Jul. 2019

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



L. S. Shashidhara
Indian Institute of Science Education and Research Pune



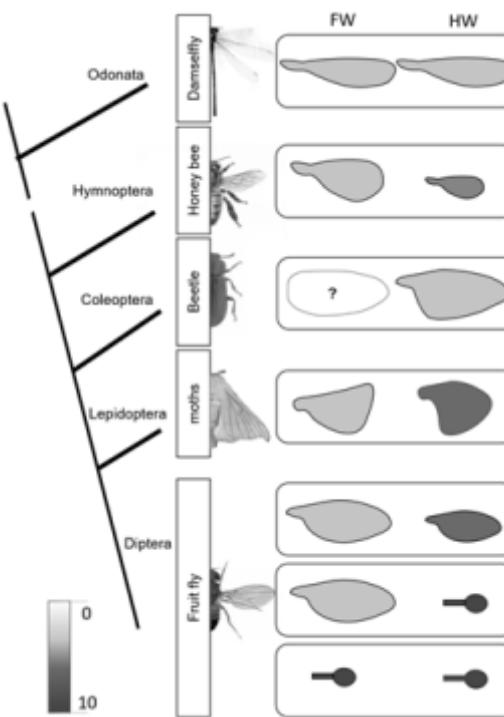
Samir Merabet
Institut de Génomique Fonctionnelle de Lyon (IGFL), Ens de Lyon - CNRS UMR 5242 Lyon

Publications

- No. of publications in SCI journals: 6
- No. of papers presented in conferences: 4

Mobility Support

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



Cosmological evolution of cold gas from quasar absorption lines

Pure & Applied Physics

Project No. 5504-2

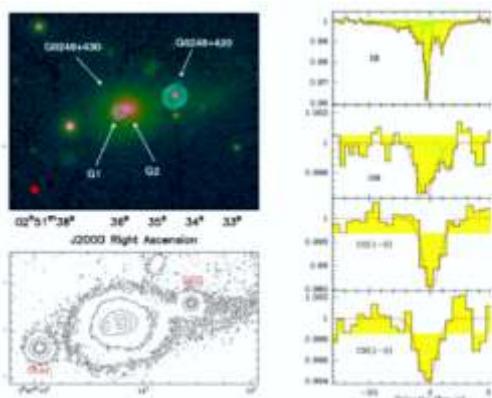
May 2016 to Oct. 2019

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



The figures below shows radio continuum and optical images of the merging galaxy pair and underground QSO made using the uGMRT telescope in India and PSI survey. The spectral lines of HI 21-cm, OH, CO and CN detected using telescopes: uGMRT (India), WSRT (The Netherlands) and IRAM/NOEMA (Spain)

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.

Principal Collaborators



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



Pasquier Noterdaeme
Institut d'Astrophysique de Paris
Paris

Publications

- No. of publications in SCI journals: 9
- No. of papers presented in conferences: 12

Mobility Support

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

Electrical addressing and control of the plasmonic properties of coupled metal nanowire

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.

Principal Collaborators



Pawan Kumar
Indian Institute of Science Education and Research, Pune



Alexandre Bouhelier
Laboratoire Interdisciplinaire Carnot de Bourgogne (ICB), UMR6303, Dijon

Publications

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

Mobility Support

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

Pure & Applied Physics

Project No. 5504-3

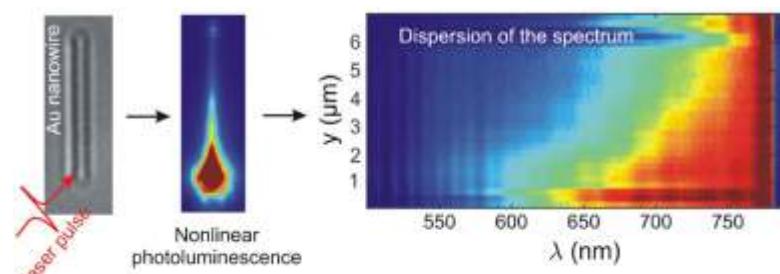
May 2016 to May 2019

Objectives

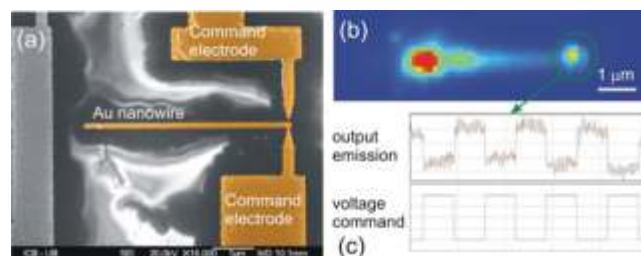
- To control the directivity of plasmonic emission from nanowire junction by tailoring the angle between the coupled nanowires
- To electrically excite surface plasmon polaritons in single-crystalline coupled-nanowires made of silver
- To probe nano-optical emission effects at the junction of coupled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

Knowledge Generated/Products Developed

- Design and development of fabrication procedures of single crystalline plasmonic nanowires with kinks using soft solution processing
- Implementation of a multi-modal optical microscopy platform for linear and nonlinear light scattering of plasmonic objects
- Understanding of the unique role of surface plasmon propagation and hot electron emission in the nonlinear responses observed in nanowires
- Discovery of the control of the electron temperature by a field-induced change of the local charge density
- Scattering of orbital angular momentum carrying beams with plasmonic nanowires



Left: Scanning electron microscopy of Ag nanowire produced by colloidal synthesis. Middle: optical image of the same nanowire excited by a pulsed near infrared laser beam tightly focused at the bottom extremity. The small luminous spot at the distal ends indicate the propagation of a surface plasmon along the nanowire (y -axis). Right: spectrally filtered optical image. The nonlinear absorption of the laser creates a hot electron gas at the excitation spot, which radiatively decay and gives rise to a secondary up-converted emission. This secondary emission is delocalized throughout the nanowire by the mediation of a surface plasmon. (b) Spectra of the hot electron gas emission taken along the nanowire. The short wavelength signal decreases with propagation as a result of a cooler electron gas toward the distal end



Scanning electron micrograph of a Au nanowire and command electrodes. The bottom electrode polarises the nanowire and the top electrode creates a large electric field in the 50 nm gap separating the tip to the nanowire. (b) Hot electron-induced luminescence map developing in the nanowire when excited by a pulsed laser beam focused at the left extremity. (c) Temporal evolution of the photoluminescence when a voltage bias is applied. The capacitive coupling creates an increase of the electron surface density that partially quenches the nonlinear signal

N-Heterocyclic Carbene (NHC)-Organocatalyzed Enantioselective Trifluoromethylation and Trifluoromethylthiolation of Unactivated C-H Bonds

Pure & Applied Chemistry

Project No. 5505-1

May 2016 to May 2019

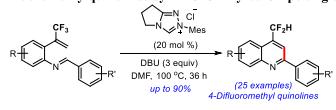
Objectives

- 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 $\text{C}(\text{sp}_3)\text{-CF}_3$ and $\text{C}(\text{sp}_3)\text{-SCF}_3$ bond formation at the α -, β - and γ -position of carbonyl compounds

Knowledge Generated/Products Developed

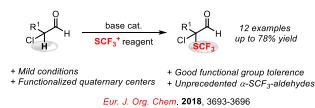
- NHC-catalyzed synthesis of 4-difluoromethylquinoline derivatives
- N-Heterocyclic Carbene-Catalyzed Synthesis of α -Trifluoromethyl esters
- Enantioselective N Heterocyclic Carbene-Catalyzed Cascade Reaction for the Synthesis of Pyrroloquinolines
- Development of the Trifluoromethylthiolation of α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

Synthesis of 4-Difluoromethylquinolines by NHC-Catalyzed Umpolung of Imines



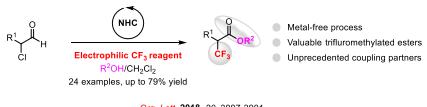
Org. Lett. 2018, 20, 1086-1089

Trifluoromethylthiolation of α -Chloroaldehydes: Access to Quaternary SCF_3 -Containing Centers



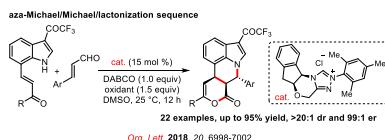
Eur. J. Org. Chem. 2018, 3693-3696

N-Heterocyclic Carbene-Catalyzed Synthesis of α -Trifluoromethyl Esters



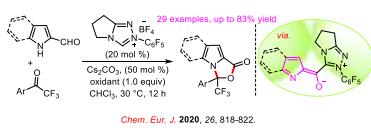
Org. Lett. 2018, 20, 3897-3901

Enantioselective N-Heterocyclic Carbene-Catalyzed Cascade Reaction for the Synthesis of Pyrroloquinolines via N-H Functionalization of Indoles



Org. Lett. 2018, 20, 6998-7002

N-Heterocyclic Carbene-Catalyzed Formal [6+2] Annulation Reaction via Cross-Conjugated Aza-Trienolate Intermediates



Chem. Eur. J. 2020, 26, 818-822

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 proposed to develop an efficient and new protocol to achieve unprecedented transformations so far inaccessible by using NHC-catalyzed asymmetric C-H functionalization reactions. Precisely, a new concept is envisioned for the direct α , β and γ C-H trifluoro-methylation and trifluoromethyl thiolation 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 α , β and γ trifluoromethyl (thiolated) compounds are expected to have interesting biological properties. Hence, we intend to bring promising and eco-friendly solutions for enantioselective $\text{C}(\text{sp}_3)\text{-CF}_3$ and $\text{C}(\text{sp}_3)\text{-SCF}_3$ bond constructions.

Principal Collaborators



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Bangalore



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UMR 6014-COBRA; Universite de Rouen
Mont St Aignan

Publications

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

Mobility Support

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

Chiral Phosphahelices in gold (I) enantioselective catalysis

Background

Aim of this project is the parallel development of new gold (I) catalyzed processes, and the design and synthesis of new series of helically chiral ligands. The targeted catalytic processes are either intermolecular reactions or skeletal rearrangements of polycyclic-saturated substrates which involve electrophilic activation of the substrates and carbene-gold derivatives as the key intermediates. The targeted ligands are phosphahelices 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.

Pure & Applied Chemistry

Project No. 5505-2

Apr. 2016 to Mar. 2019

Objectives

- Design and synthesis of a broad array of chiral phosphahelices and phosphathiahelicene. At first modular methods will be established for the synthesis of helical scaffolds with embedded phosphorus functions (typified by phosphahelices 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 phosphahelices 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 phosphahelices was expanded to: enantioselective organocatalyzed cyclisations, new organo-metallic 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 Tetrahydro-Diels-Alder (TDDA) reaction of alkyne-tethered-ynamides also been demonstrated

Principal Collaborators



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Hyderabad



Angela Marinetti
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Gif Sur Yvette

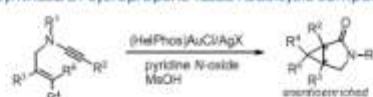
Publications

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

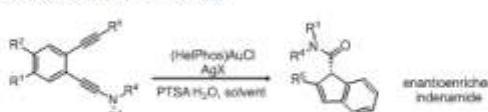
Mobility Support

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

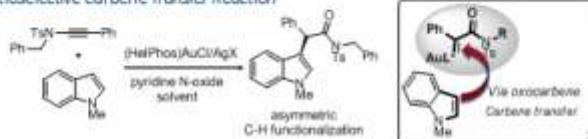
Enantioselective Synthesis Of Cyclopropane-fused Azabicyclo Compounds



Pharmaceutical/Active 1H-indene Scaffold



Enantioselective Carbene Transfer Reaction



p-ADIC aspects of automorphic forms and their L-functions

Pure & Applied Mathematics

Project No. 5601-1

Nov. 2016 to Oct. 2019

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 its 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

- PIs achieved the main objective since their manuscript was accepted for publication in the prestigious Compositio Mathematica
- Several talks in major conferences have been given by both Indian and French collaborators on the results obtained
- The visits of the PIs were vital to keep active existing and foster new connections
- Several lectures were delivered during the exchange visits lectures and even organize study days, including a mini-conference NUMBER THEORY DAY at IISER Pune on January 13, 2019
- The graduate students greatly benefited from the respective visits of the PIs

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.

Principal Collaborators



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Pune



Mladen Dimitrov
CNRS / Laboratoire Paul
Painlevé University of Lille
Lille

Publications

- No. of publications in SCI journals: 1
- No. of papers presented in conferences: 8

Mobility Support

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

Functional genomics of glioblastoma: from epigenetics to proteomic investigation of tumor initiating cell secretome

Background

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

Principal Collaborators



Kumaravel Somasundaram
Indian Institute of Science
Bangalore



Philippe Marin
Institut de Génomique Fonctionnelle
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

Life & Health Sciences

Project No. 5603-1

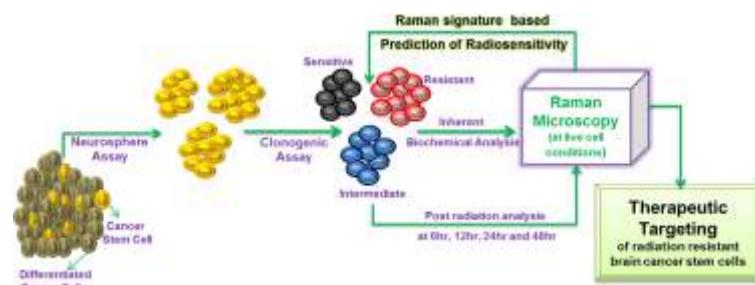
Nov. 2016 to Oct. 2019

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



Overview of the study. GSCs established from GBM tissue samples were cultured as neurospheres

Extreme events and large deviations in strongly correlated many body systems

Pure & Applied Physics

Project No. 5604-2

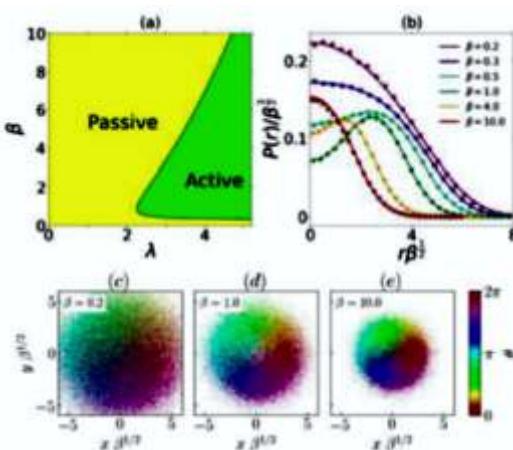
Nov. 2016 to Oct. 2019

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-tumble model and Study of large deviations and first-passage properties for two-dimensional active particles in a harmonic trap
- Study of the out-of-time ordered correlator in classical spin chain and connection with growth models
- Exact results for long-range interacting systems in a confining potential
- Exact results on steady state, relaxation and fluctuations using fractional equation description of interacting systems with anomalous transport



Observation of re-entrant active-passive transition obtained from an exact solution of the steady state distribution of an active Brownian particle in a harmonic trap potential. (a) Phase diagram, (b) Plot of the radial distribution function, (c) Plot shows the orientational distribution

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.

Principal Collaborators



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Orsay

Publications

- No. of publications in SCI journals: 16
- No. of papers presented in conferences: 6

Mobility Support

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

Interplay between MgO oxygen vacancies and tunnelling spin transfer torque

Background

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

Pure & Applied Physics

Project No. 5604-3

Oct. 2016 to Jan. 2019

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



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New Delhi



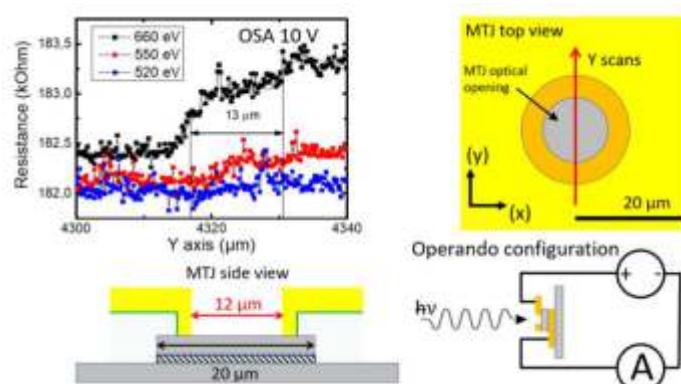
Martin Oliver Bowen
Institut of Physics and Chemistry of Strasbourg
Strasbourg

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 $\pm 10\text{mV}$ of biases in order to suppress any offset effects. The measurements set-up is in floating mode (*i.e.* not grounded.)

Metal chelators derived from imidazole thiones and selones for detoxification

Pure & Applied Chemistry

Project No. 5605-1

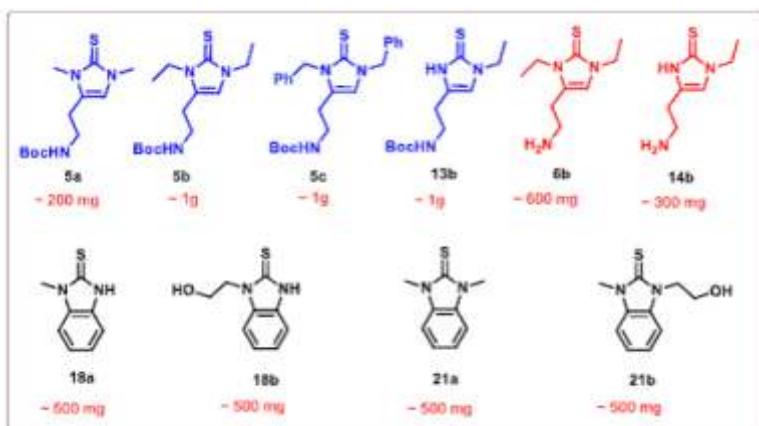
Jan. 2017 to Dec. 2019

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

- Identification of a suitable N-heterocyclic-based thione with an excellent antioxidant properties to protect biomolecules from copper-mediated oxidation
- Identification of a N-heterocyclic-based selone with an potential to remove redox-active Cu(I) ion from glutathione, a major cytosolic Cu-binding ligand in the cellular system, and thereafter converts it into CuSenanozyme that exhibits glutathione eroxidise (GPx)-like activity
- Synthesis of a series of pure tripodal ligands derived from imidazole-based thiones
- Affinity of the tripodal ligands for the targeted Cu(I) metal ion
- Functionalization of the tripod demonstrating the largest affinity for Cu(I) to target hepatic cells
- Efficient uptake of the targeted compound in hepatic cells



Metal chelation and metal binding studies with Building Blocks (BB)

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.

Principal Collaborators



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Pascale Delangle
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Grenoble

Publications

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

Mobility Support

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

Impact of the Indian monsoon convection on the tropical tropopause layer and climate

Background

The Tropical Tropopause Layer (TTL) is the gateway which processes the convective air, including anthropogenic pollution, and controls the composition of the stratosphere. Due to this role and the radiative effects of its ubiquitous cirrus clouds, the TTL is a key component of the climate system.

During summer, it is mostly under the influence of the Indo-Asian monsoon. The distribution of ground sources and the transport properties across the TTL are still poorly understood. The project takes the opportunity of new observations, by the airborne StratoClim campaign in 2016, and by new satellites and the expertise of the two partners in modelling to advance our understanding of the processes ruling the composition of the TTL and the paths of air parcels going through.

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

Principal Collaborators



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Kerala



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

Earth and Planetary Sciences

Project No. 5607-1

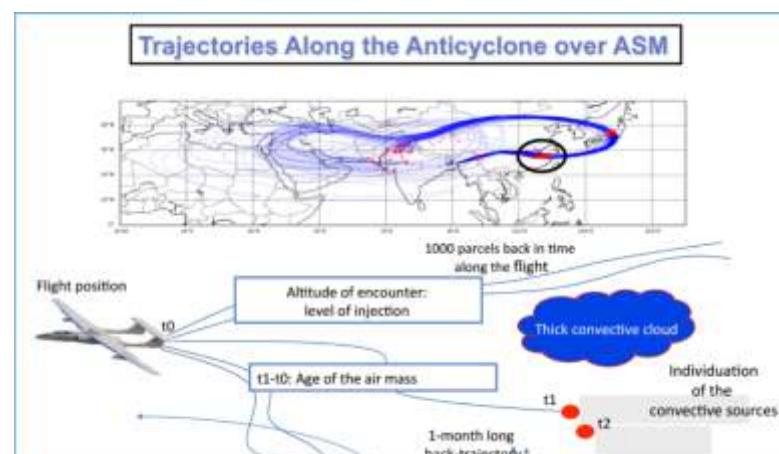
Nov. 2016 to Oct. 2019

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



StratoClim flight campaign, and the estimation of the age of air mass trajectories along the Asian summer monsoon anticyclone

Biodegradable core shell electrospun mats and interconnected porous scaffolds for tunable anticancer drug delivery and tissue engineering application

Materials Science

Project No. 5608-1

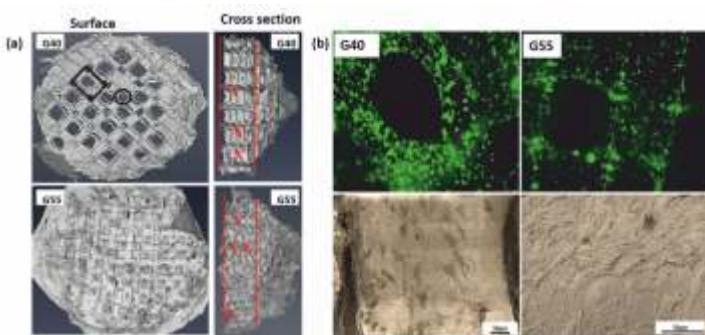
Nov. 2016 to Aug. 2019

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



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

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.

Principal Collaborators



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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

Wavelet graphs for gravitational wave searches

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.

Pure & Applied Physics

Project No. 5504-1

Apr. 2016 to Apr. 2020

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

- Identification the algorithm that provides the best approximation of the signals that are most with a reasonable computational cost
- Detection statistics and noise rejection
- The analysis algorithm has been implemented and integrated to the source code of Coherent WaveBurst. It is freely available online
- The tools developed have been integrated into the LIGO/Virgo collaboration and can therefore be used in production

Principal Collaborators



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Mumbai



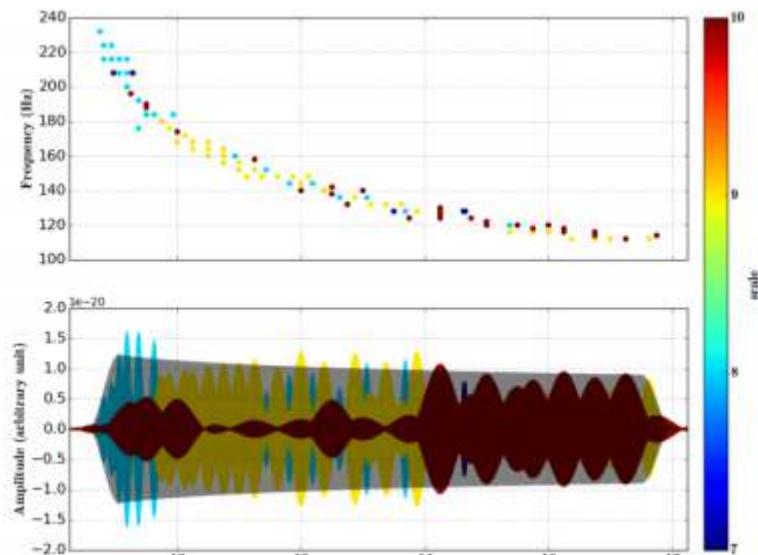
Eric Chassande-Mottin
Laboratoire, Astroparticule et
Cosmologie laboratory (APC)
University Paris Diderot
Paris

Publications

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

Mobility Support

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



Time-frequency cluster obtained with the updating matching pursuit algorithm applied to the GW waveform model associated to an accretion disk instability which develops in a newly formed $10M_\odot$ black hole with spin $a = 0.95$ surrounded by a $1.5M_\odot$ accretion disk. The bottom plot shows the extracted wavelets (time domain) by WG and how they describe the signal (light black). The approximation error of the UMP is fixed to 10% and the decomposition results in 89 time-frequency pixels

Modeling Soft Glassy Flow from Micro to Macro Scale

Pure & Applied Physics

Project No. 5604-1

Dec. 2016 to May 2020

Objectives

- To develop appropriate coarse-grained description of the response of an amorphous solid to external stress. PIs want to understand the transient response of the system, in the vicinity of the yielding threshold, depending upon the initial state of the material. This is of utmost importance in many practical applications, where stress is a control parameter
- Studying the origin of residual stress in soft glasses. Understanding how stresses get locked in, once the external straining is stopped, is important for using these materials. PIs will study how coarse-grained models can correctly reproduce the spatio-temporal distribution of local stresses, once the deformation has been stopped, validating against particle simulation results
- Probing response to oscillatory shear. By using our multi-scale analysis, PIs aim to understand the origin of the predicted non-equilibrium transition in such a shear protocol

Knowledge Generated/Products Developed

- For the study of creep response using particle based simulations, PIs have developed a novel simulation protocol that is based on a feedback mechanism. PIs could thereby perform the first simulational study of the bulk response of an amorphous solid to an externally imposed stress, using periodic boundary conditions. This is a setup that is very common for a fixed driving rate but that was lacking for the study of the creep response to an imposed external stress
- PIs evidenced and characterised precursor dynamics prior to yielding that can be detected in the variance of shear-rate fluctuations prior to catastrophic failure. This type of signal could be helpful in preventing failure by removing the causing stresses in time (example: closing a bridge before catastrophic collapse)
- To study the mechanical response of athermal amorphous solids PIs developed a novel framework via a coupling of mesoscale and microscopic models. Using measurements of coarse grained quantities from simulations of dense disordered particulate systems, PIs present a coherent elasto-plastic model approach for deformation and flow of yield stress materials. For a given set of parameters, this model allows to match consistently the transient and steady state features of driven disordered systems, under both applied shear-rate and creep protocols
- PIs developed a particle based protocol to study the rheology of active systems that account for an internal activity of the constitutive particles in the form of breathing. It is possible to fluidise the system upon a critical breathing amplitude. We characterise in detail this transition that we think to be of importance for example in the dynamics of biological tissues
- To understand better the underlying physics of the fluidisation process of active materials, we derived a mesoscopic description based on the knowledge obtained from the particle based simulations. PIs successfully reproduce the fluidisation transition within this approach and can relate it to the statistical properties of the mechanical noise that is created by the active particles and the induced plasticity in the surroundings

Background

The focus of this project lies on the physics of amorphous materials, which are ubiquitous in industrial applications, nature and even in biological matter. We derive a multi-scale approach for the mechanical response of such systems, paving the path to new material design strategies via microscopic tuning leading to tailored responses, in terms of yielding or failure. Thus, the project's scope is interdisciplinary, bridging physics, material science and engineering. The applications lie in the realm of soft materials (foams, gels, emulsions, colloids) constituting a variety of industrial products. Further, based on ideas of universality and scale invariance close to the dynamical phase transition (onset of flow), we expect these approaches, primarily built for soft matter, to be relevant on a much wider range. Thus, even understanding geophysical phenomena (like avalanches, landslides etc.) can also build on this kind of multiscale studies, with the aim of building strategies for risk management.

Principal Collaborators



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Chennai*



Kirsten Martens
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Grenoble*

Publications

- No. of publications in SCI journals: 5
- No. of papers presented in conferences: 3

Mobility Support

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

Nuclear structure at the extreme of isospin and spin

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 an imbalance 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.

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: 4
- No. of papers presented in conferences: 9

Mobility Support

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

Pure & Applied Physics

Project No. 5604-4

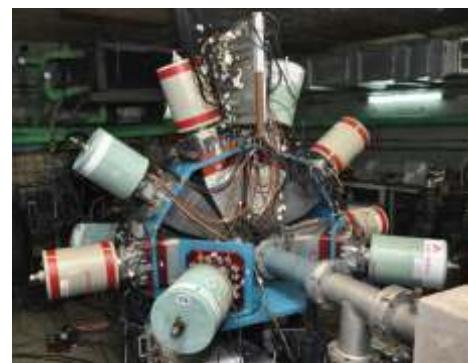
May 2017 to Apr. 2021

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 ^{133}Sn 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

- Complete isotopic (A, Z) identification over a wide range of isotopes of the nuclear chart (from $Z=31$ to $Z=62$) in an experiment at GANIL, France using the unique state-of-art setup, VAMOS++ (magnetic spectrometer) coupled to AGATA (Advanced gamma tracking array) and EXOGAM gamma ray spectrometers
- Prompt-delayed spectroscopy of neutron rich Sb ($Z=52$) and In ($Z=49$) nuclei that have an extra (less) proton adjacent to $Z=50$ ("magic number") shell closure. These measurements allowed to improve the widely used shell model interaction
- Identification of new states above high spin isomers and observation of a new long lived state (isomer) in even-A neutron rich Iodine isotopes. These measurements investigated the role played by nucleons in certain orbits in generation of the states with a high angular momentum in these nuclei
- First identification of high spin states above the long-lived isomers in neutron rich even-A-Pm isotopes and the investigation of presence of reflection-asymmetric shapes (octupole collectivity) in odd-A Pm isotopes beyond $N=90$. These measurements are not possible elsewhere
- The Indian National Gamma Array (INGA) and high energy alpha beam from K-130 cyclotron in Kolkata were used to explore complementary states (compared to what could be measured in France) to identify and understand single particle and collective structures in ^{131}Xe



The setup of Indian National Gamma Array (INGA) at the K-130 cyclotron at VECC, Kolkata. Figure shows the setup of 8 Compton suppressed Clover HPGe detectors and 2 LEPS (Low Energy Photon Spectrometer) of Indian National Gamma Array (INGA) at the K-130 cyclotron at VECC, Kolkata

Studies on the topological insulator behaviour in heavy metal based ternary chalcogenides

Materials Science

Project No 5608-2

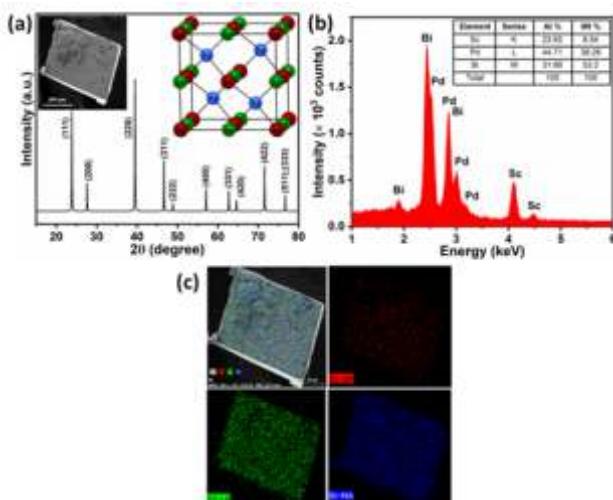
Jan. 2017 to Jul. 2020

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

- Successfully prepared Sb doped Bi₂Te₂Se single crystals were prepared using direct reaction technique
- Magneto-transport studies were done on these single crystals
- Magneto-transport and Hall measurements were carried out on Bi₂Te₂Se, Sb₂Te₂Se and Bi₂Te₂S
- Apart from these compounds, PIs tried to probe the topological surface states in half-Heusler ScPdBi single crystals
- PIs have successfully synthesized the ScPdBi single crystals and studied electrical transport properties under extreme conditions



(a) Powder X-ray diffraction pattern of ScPdBi, insets show the crystal structure and scanning electron microscopic image of ScPdBi single crystal
 (b) Compositional analysis on ScPdBi single crystals (c) Elemental colour mapping on ScPdBi single crystal, showing uniform distribution of Sc, Pd and Bi elements (J. Alloys Compd.848, 156632 (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 photo emission spectroscopy (ARPES) measurements. The project will be extended to further level with the possibility of doping heavy metals to tune the TI behavior.

Principal Collaborators



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Marie-Aude Measson
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Publications

- No. of publications in SCI journals: 6
- No. of papers presented in conferences: 1

Mobility Support

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

The Economics of Networks and Queues

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.

Computational Science

Project No. 5702-1

May 2017 to Oct. 2020

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

- Six journals and 10 conference papers
- One patent filed
- Workshop Organized
- An Android app developed for net neutrality detection

Principal Collaborators



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Indian Institute of Technology,
Bombay,
Mumbai



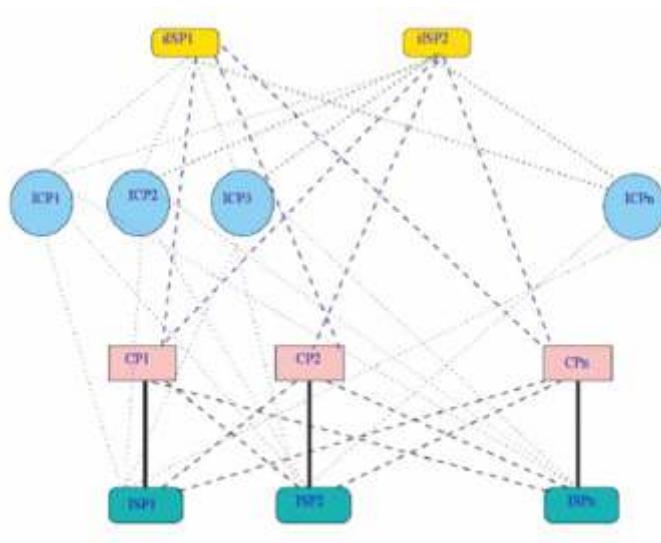
Yezekael Hayel
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Avignon

Publications

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

Mobility Support

- India to France: 6
 - France to India: 3
- Patent : 1



Control of microtubule dynamic instability by the tubulin code

Life and Health Sciences

Project No. 5703-1

May 2017 to Apr. 2021

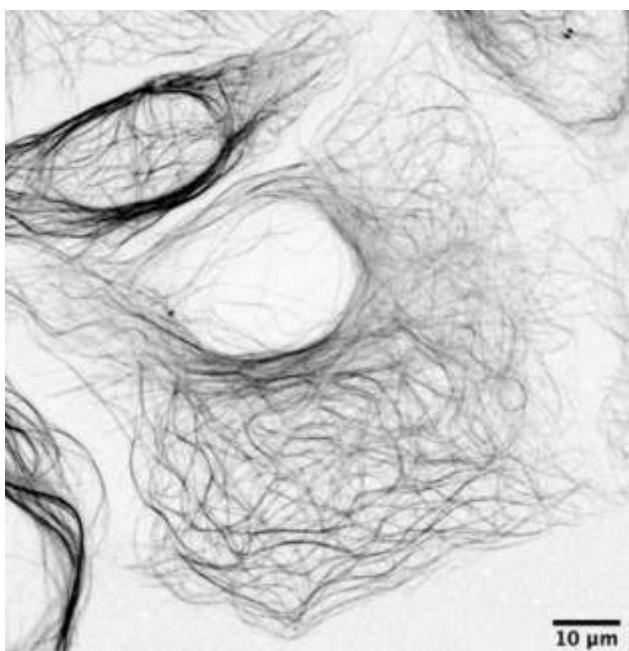
Objectives

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

- Recombinant tubulin purification and in vitro microtubule polymerization assay
- Screening binders and identifying the sequence of binder proteins
- Determining biochemical properties of binders against tubulin PTMs
- Validating the binders as live cell sensors of tubulin PTMs
- Commercialization of tyrosination sensor



Microtubules of human cells in grey scale imaged using Tyrosination sensor developed during the duration of CEFIPRA funded study.

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 variability 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*.

Principal Collaborators



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Publications

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

Mobility Support

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

A genome-wide study to identify novel regulators of chromosome stability using a human pathogenic yeast *Candida albicans* as the model system

Life and Health Sciences

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



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Paris

Publications

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

Mobility Support

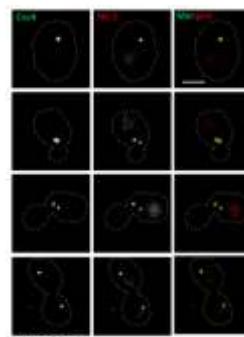
- India to France: 3
- France to India: 2

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 LOH 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 over-expressing 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 above mentioned LOH reporter strain in the French lab. Using the well-established *C. albicans* 96-well plate transformation protocol from the Frenchlab, the Indian lab has successfully generated ~1200 *C. albicans* over-expression strains
- The flow cytometry analyses of ~1000 over-expression strains has been carried out to determine the effect of over-expression on LOH frequency in *C. albicans*. Our primary and secondary screens have identified six genes which upon over-expression showed an increased rate of LOH in *C. albicans*
- Among the six genes identified, there is one novel gene (hit 2) that was previously unknown to have a role in genome maintenance. PIs are currently addressing the function of this gene in *C. albicans* by carrying out knock out studies, over-expression studies and sub-cellular localisation studies
- The chromosome segregation reporter strain for functional-characterization of the rest of the identified genes has been constructed and validated by microscopy. This strain will be used to determine the effect of over-expression of the identified genes on kinetochore integrity, spindle organization and nuclear segregation



Sub-cellular localization of one of the identified regulators of genome stability in *C. albicans*: Hit 2 is a novel regulator of genome stability that we identified from our over-expression screen. Cse4 is a known kinetochore protein. Hit 2 localizes close to the kinetochores throughout the cell cycle phases

Yielding in glasses and colloidal systems under cyclic deformation

Pure & Applied Physics

Project No. 5704-1

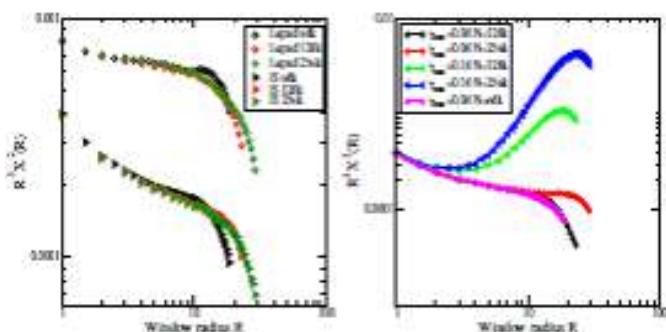
Jun. 2017 to Mar. 2021

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



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

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.

Principal Collaborators



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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

Bifunctional catalysts for cooperative C-H bond cleavage via intramolecular deprotonation toward direct functionalizations of alkanes

Pure & Applied Chemistry

Project No. 5705-1

May 2017 to Apr. 2020

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, -CO₂-, -NTf, -NTs, -SO₃-, -PO₃;- 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



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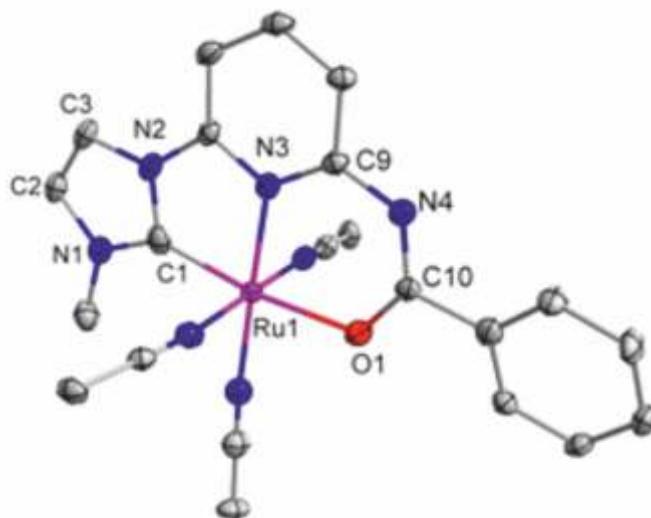
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Publications

- 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 atoms labelled. Displacement ellipsoids are set at 30% probability and hydrogen atoms omitted for clarity. selected bond distances (Å) 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-C11 93.64(8), C5-N3-C9 118.8(3)

Durable fuel cells based on Polymer coated Nanocarbon Composites (DUPONT)

Materials Science

Project No. 5708-1

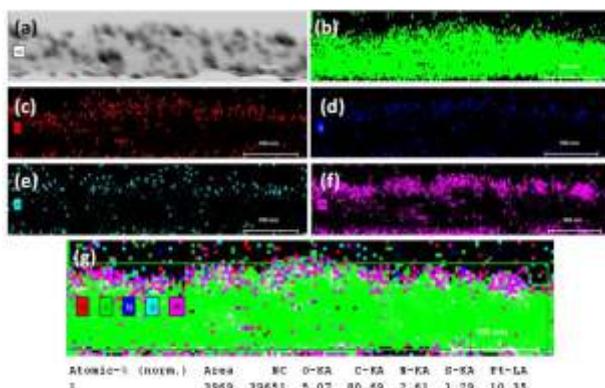
May 2017 to May 2020

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. We propose to disperse Pt alloy nanoparticles (NPs) on highly active and stable heteroatoms incorporated ionomer coated polymer wrapped CNT/graphene based catalyst support. The presence of the heteroatom (N or S) on CNTs or graphene improves the substrate-catalyst interaction and achieves a higher electrochemical surface area of the catalyst. In addition, the ionic conductivity of the electrode is improved by the ionomer coating on the catalyst support. A second objective of the project is 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, EELS, WAXS and RAMAN

Knowledge Generated/Products Developed

- Visit of Professor Ramaprabhu in Toulouse (2018, 2019) and Professor Bacsa (2017, 2019) in Madras
- Visit Toulouse: Meenakshi Seshadri (2018), Rashmi Chandrabhan Shende (2018)
- Postdoc in Toulouse 2017-2019, Divya Nechiyil
- 1 publication: D. Nechiyil, M. S. Garapati, R. Ch. Shende, S. Joulié, D. Neumeyer, R. Bacsa, P. Puech, S. Ramaprabhu and W. Bacsa, Journal of Colloid and Interface Science 561 (2020) 493
- 1 manuscript under review: "Proton Conducting Polymer wrapped Cathode Catalyst for Enhancing Triple-Phase Boundaries in Proton Exchange Membrane Fuel Cells" M S Garapati, Divya N, Sébastien Joulié, Revathi Bacsa, S Ramaprabhu, and Wolfgang Bacsa



STEM-EDX analysis of Pt/PVPA6_NSPNT (a) STEM image, the spatial distribution of (b) carbon, (c) oxygen, (d) nitrogen, (e) sulfur and (f) platinum, and (g) quantification of elements over a selected region

Background

Fuel cells are alternatives to internal combustion engines in automobile applications due to their higher efficiency and zero CO₂ emission. PEMFCs currently use Pt as the catalyst both at the cathode and at the anode due to its high stability under the operating conditions of the cell, but reduce the economic viability of these devices. We propose to disperse Pt alloy nanoparticles (NPs) on highly active and stable heteroatoms incorporated ionomer coated polymer wrapped CNT/graphene based catalyst support. This will lead to a higher electrochemical surface area of the catalyst and enhance the ionic conductivity. The mechanism of degradation at different temperatures will be studied using state of the art characterization techniques. The catalyst performance will be evaluated by the Indian partner in single PEM fuel cells with a cell performances of a maximum power density of 500 mW/cm². The French partner will play an active role applying characterization techniques.

Principal Collaborators



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Indian Institute of Technology Madras,
Chennai



Wolfgang S Bacsa
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Publications

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

Mobility Support

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

Interactions between dynamical systems, geometry and number theory

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 Γ 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/Γ . In the case that Γ is a lattice subgroup, namely when G/Γ carries a finite G -invariant measure, this is a well studied topic and includes the famous theorems of M. Ratner. However, the case when Γ 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.

Pure & Applied Mathematics

Project No. 5801-1

Jan. 2018 to Jan. 2021

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 subjects and 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

Mechanism of polarity reversals in *Myxococcus xanthus*

Life & Health Sciences

Project No. 5803-1

Jan. 2018 to Sept. 2021

Objectives

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

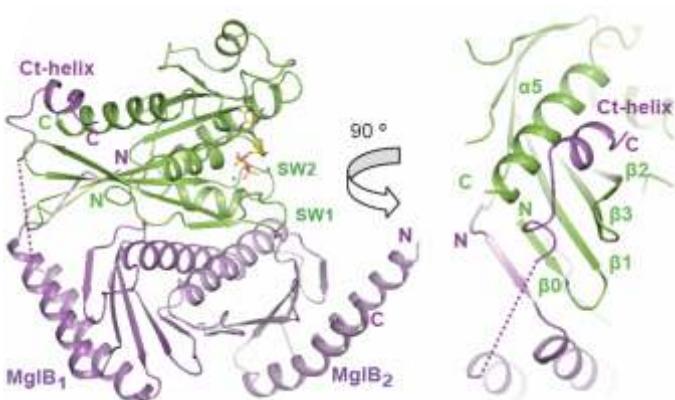
- the role of the GTPase MglA and MglB in driving the oscillations
- the role of the bacterial cytoskeleton MreB in positioning the motility complexes
- how FrzCD senses the signal that modulates the frequency of oscillation

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 DNA receptor-bound complexes has been achieved
- Analysis of MglA and B oscillations in multicellular contexts and their role in the formation of multicellular patterns is ongoing



Crystal structure of MglAB complex highlighting the C-terminal helix of MglB bound to MglA

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



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Tam Mignot
Laboratoire de chimie bactérienne
CNRS
Marseille

Publications

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

Mobility Support

- India to France: 2
- France to India: 0

Directing the ballet of Meiotic chromosomes: regulation of Separase and control of Monopolar Kinetochore orientation

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.

Life & Health Sciences

Project No. 5803-2

Jan. 2018 to Dec. 2020

Objectives

- Identify and characterize factors that regulate separase activity at meiosis and mitosis in *Arabidopsis*
- Identify and characterize factors that ensure monopolar 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



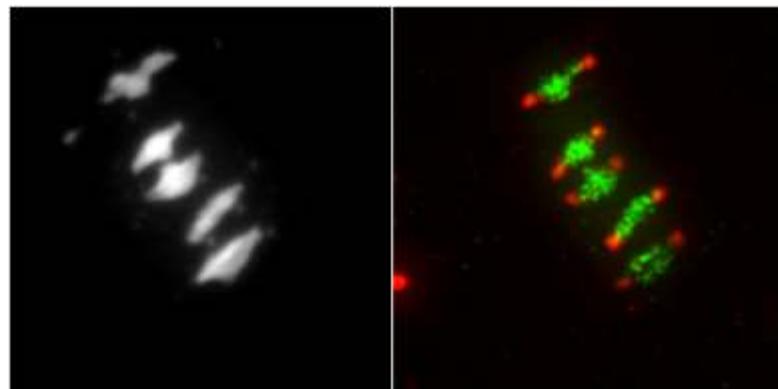
Raphael Mercier
INRA, Plant Biology and Breeding
Versailles

Publications

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

Mobility Support

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



The pairs of meiotic chromosomes (bivalents) held together by crossovers are arranged on the metaphase plate (left). The protection of cohesin and monopolar orientation of sister kinetochores at the first meiotic division (Right)

The assembly history of disk galaxies over the last 8 billion years

Pure & Applied Physics

Project No. 5804-1

Jan. 2018 to Dec. 2020

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 $z \sim 1$ to $z \sim 0$
- 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 $z \sim 1$ to $z \sim 0$
- 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

- PIs have discovered a clumpy galaxy at $z=1.42$ leaking ionizing radiation caught by the far-UV filter of the UVIT/AstroSat. This galaxy lies in the GOODS-South field and a detailed modeling of the broadband spectral energy distribution has been performed. PIs estimated at least 20% of the ionizing photons are leaking from this galaxy to the intergalactic medium. This might have important consequences on how early galaxies might have formed. This work has been published in Nature Astronomy recently
- Dr. Soumavo Ghosh has analyzed a set of numerical simulations of minor mergers using the GALMER database provided by the French side. In this setup, the energy as well as the morphology of the perturber has been varied. A general result has emerged from this study — namely the bar is weakened at the end, in some cases the bar is completely destroyed. This work has been submitted for publication. In continuation to this effort, PIs are also analysing new suit of simulations to understand the impact of thick disk on galactic bar formation
- A set of isolated galaxy simulations with off-centered dark halo has been performed to study the formation of global lopsidedness and lensed S0 galaxies in the local universe. A draft has been written and will be submitted soon
- Anshuman Borgohain (a PhD student) has worked on an interesting problem of detecting extended-UV (XUV) emission from the outskirts of distant blue compact dwarf (BCD) galaxies. This work primarily uses the deep imaging observation of the GOODS-South field using the far and near-UV filters of the UVIT/AstroSat. In other words, the UV observation of the BCDs come from the AstroSatUv deep field that PIs have created. Finding XUV emission from dwarfs provides a tale-tale signs of the inside-out growth mode of galaxy formation and that in dwarfs is a bit surprising. One draft is fully ready and another with more than 90% complete. PIs plan to release both the draft simultaneously
- With Barbara Mazzilli, PIs observed in UV a series of Double-Peaked spectrum galaxies (DP), a rare event in the sky, corresponding to close mergers. PIs are accumulating multi-wavelength data of these DP in atomic and molecular gas (HI and CO), Halpha/NII velocity field with MANGA, to understand the dynamics of the systems, and their merger stage

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



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Francoise Combes

*Observatories de Paris
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Publications

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

Mobility Support

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

Micro-SQUID magnetometry of nano-scale magnetic structures

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-particles. It is proposed to investigate the coupled dynamics of nanoparticle 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 $100\mu\text{B}/\sqrt{\text{Hz}}$ 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: 3
- No. of papers presented in conferences: 3

Mobility Support

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

Pure & Applied Physics

Project No. 5804-2

Jan. 2018 to Dec. 2020

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 nanoparticles with core-shell structure
- Further optimizing the setup to obtain magnetic moment sensitivity better than $100\mu\text{B}/\sqrt{\text{Hz}}$ so as to investigate the nano-structures with non-ferromagnetic orderingI

Knowledge Generated/Products Developed

- 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 micro-SQUIDs were tested for the anticipated phase dynamic regime and results published in Phys. Rev. B. A novel technique for eliminating hysteresis by using an inductive shunt was also found and published in Phys. Rev. B. This is partially towards the objective-3 of the proposal. Another manuscript that was recently submitted is on the stochastic resonance in superconducting weak links. This helps us in understanding the micro-SQUIDs noise better for improving the performance
- The magnetometry setup has been successfully made and tested by making anisotropy studies on permalloy nano-structures using both hysteretic and non-hysteretic SQUIDs. This was published in JMMM. Thus Objective-1 of the project has been successfully achieved
- Some detailed studies on switching statistics in Magnetite nano-particles have also been done using this setup. PIs see unusually narrow switching field and time histograms that PIs understand from presence of serial barriers in the path of a vortex. A manuscript for this work is in preparation



Fig. 1: (a) shows the vertical magnetometer assembly with a blue dewar containing liquid helium. (b) shows the schematic of the assembly with labels: Dewar, Regenerator, Helium tank, Liquid helium inlet, Sample holder, and Vortex shield. (c) shows the assembly with a needle valve and a sample tube. (d) shows the assembly with an 18K pot and a Cu powder filter. (e) shows the assembly with a vortex magnet and a sample holder. (f) shows the assembly with a vortex magnet and a sample holder, along with a close-up of the vortex magnet. (g) shows the assembly with a vortex magnet and a sample holder, along with a close-up of the vortex magnet. The brass cylindrical piece is a ϕ -filter assembly used for all sample sets.

Phase transitions in sub-saturation nuclear matter and applications to core-collapse supernova and nuclear experiments

Pure & Applied Physics

Project No. 5804-3

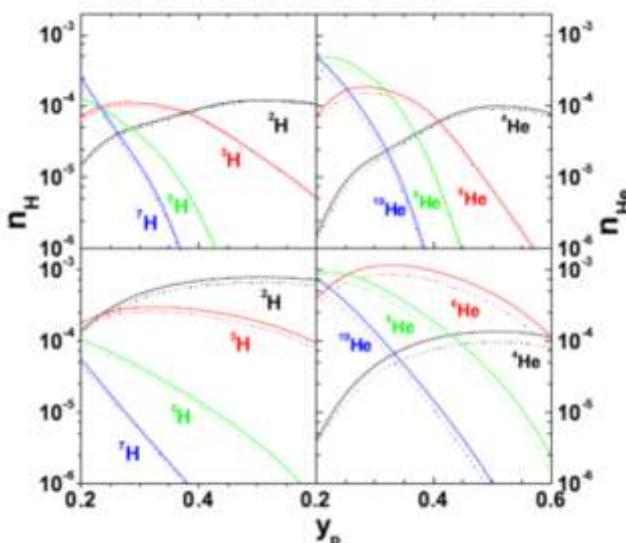
Feb. 2018 to Sept. 2021

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

- An improved cluster function was implemented in the canonical thermal model and extended calculations were performed to study the N/Z cluster ratio predicted by this improved model in comparison to the prediction of the spinodal instability
- A paper was submitted to Physical Review
- A thermodynamically consistent procedure to treat the continuum states was developed and implemented in the Nuclear Statistical model that PIs have built during the first year of the project
- A paper was submitted to Physical Review
- Extended calculations were performed on central collisions of Ni+Ni systems in collaboration with an experimental team



Density of Hydrogen (left panels) and Helium (right panels) isotopes as a function of the global proton fraction, in four different density and temperature conditions explored both in supernova dynamics and in experimental multifragmentation

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.

Principal Collaborators



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Kolkata



Francesca Gulminelli
LPC / ENSICAEN
Caen

Publications

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

Mobility Support

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

Novel Chiral First row Transition Complexes for Asymmetric Catalysis via Activation of inert C-H and C-Heteroatom bonds

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.

Pure & Applied Chemistry

Project No. 5805-1

Oct. 2017 to Apr. 2021

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

- Design and synthesis of enantiomerically pure ferrocene-based tridentate ligands with PSP donor atoms
- Design and synthesis of enantiomerically pure ferrocene-based tridentate ligands with PNN donor atoms
- Uncover the new reactivity and mechanism with $\text{Cp}^*\text{Co(III)}$ -catalysis for dehydrogenation
- Chemical recycling of polymer waste into chemical was achieved using well defined $\text{Cp}^*\text{Co(III)}$ -catalysts
- Three graduate students trained during the joint-project (2-India, 1-France)

Principal Collaborators



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Indian Institute of Technology
Kanpur



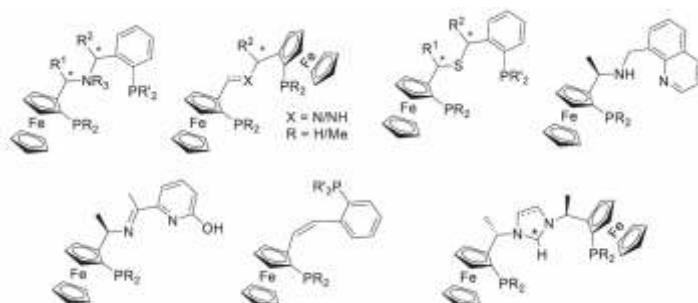
Rinaldo Poli
Laboratoire de Chimie Coordination (LCC)
Toulouse

Publications

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

Mobility Support

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



Schematic representation of some targeted planar-chiral ligands

Tuning the interfacial Dzyaloshinskii-Moriya interaction in ultrathin magnetic films:toward the stabilization of skyrmions in spintronics devices

Materials Science

Project No. 5808-1

Jan. 2018 to Jun. 2021

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 fabricated Si/SiO₂(native)/Ta (5 nm)/Pt (6 nm)/Co (t_{Co})/Ta (5 nm) and Si/SiO₂(100 nm)/Ta (5 nm)/Pt (6 nm)/Co₄₀Fe₄₀B_{20m} (t_{CFB})/MgO (2 nm)/Ta (2 nm) series of samples in order to achieve perpendicular anisotropy (PMA). The PMA plays a crucial role to host a skyrmion in a thin film. The competition between PMA, exchange energy, DMI energy and Zeeman energy has stabilized skyrmions in thin films. Here, the skyrmion size is found to be in the range of 100-300 nm. PIs have also stabilized skyrmions at zero field in Pt/CoFeB/MgO thin film which is very useful for practical application purpose
- PIs have determined the depinning field of Pt/Co₄₀Fe₄₀B₂₀/MgO multilayer which is around 10 mT. The depinning field gives an idea about magnetic disorder that acts on a magnetic domain or a skyrmion
- PIs have prepared nanotracks with different width for transport measurements of skyrmions using EBL. The widths of track are 1 mm and 3 mm. Dynamics (nucleation, propagation) studies are beginning
- iDMI constant has been quantified for the Pt/CoFeB/MgO using BLS. Also, PIs have investigated the dependency of iDMI on FM thickness. The linear dependency of iDMI with 1/t_{CFB}, t_{CFB} = thickness of CoFeB, confirms its interfacial nature. The observed iDMI value varied in between 0.44-0.56 mJ/m² for Pt/CoFeB/MgO
- PIs have quantified iDMI first time in Bi₂Se₃/CoFeB/Ta thin films by BLS, where Bi₂Se₃ is a topological insulator. This opens some perspectives of new materials for skyrmions, with an expected increased sensitivity to current induced dynamics

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.

Principal Collaborators



Subhankar Bedanta

National Institute of
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Bhubaneswar



Stanislas Rohart

Université Paris-Sud
Paris

Publications

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

Mobility Support

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

NOVIS60: Non-contact vital sign estimation with 60 GHz radar technology

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.

Computational Sciences

Project No. 5902-1

Jul. 2018 to Jul. 2021

Objectives

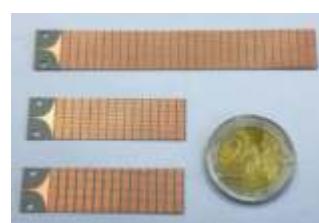
- To design the 60 GHz antenna system that will be able to scan in 2-dimension the room to be monitored
- To design the radar transmitter and receiver with frequency scanning capabilities in 65nm UMC Technology
- To operate the radar in order to estimate its accuracy and its robustness

Revised objectives, if any

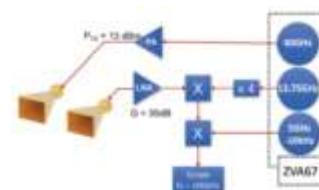
- To design the radar transmitter and receiver with frequency scanning capabilities in 40 nm TSMC Technology (As validated model are not available in 65 nm UMC for 60 GHz design, especially for inductor)

Knowledge Generated/Products Developed

- Design of oscillator is done for 60 GHz and achieved approx. 3 GHz bandwidth
- Frequency of oscillators is 57.06 GHz to 59.9 is achieved
- Design of an enhanced beam-scanning antenna using metasurface
- A specification of the transceiver has been finalized with the help of literature survey and experiment done at Sorbonne University, France
- Preliminary design of a metamaterial-based switch to switch the signal input of the antenna in order to switch beams in one dimension



Three prototypes of enhanced leaky wave antennas based on metasurfaces



Block Diagram for the measurement of the Radar implemented prototype



Laboratory setup for the measurement of the Radar

Principal Collaborators



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IIT Bombay
Mumbai



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Sorbonne Université
UPMC – University Pierre and Marie Curie
Paris

Publications

- No. of publications in SCI journals: 15
- No. of papers presented in conferences: 11

Mobility Support

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

Hematopoiesis and metabolism

Life And Health Sciences

Project No. 5903-1

Aug. 2018 to Jul. 2021

Objectives

- Energy distribution of *Drosophila* myeloid cells across developmental scales
 - Investigate effects of altering myeloid cells on systemic metabolism

Knowledge Generated/Products Developed

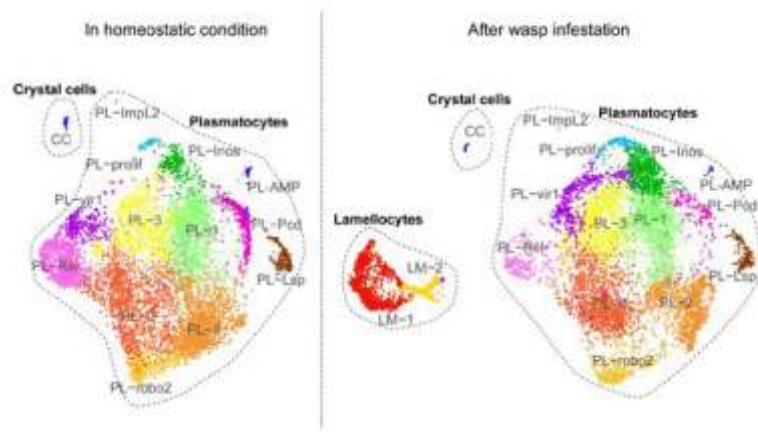
- Non-autonomous control of animal growth and metabolism by blood cells in *Drosophila*
 - Generation of blood specific driver lines and established mass-spectrometric analysis of *Drosophila* larval blood cells, both circulating and from the lymph gland
 - Differential gene expression profile of blood cells from *Drosophila* embryo and larvae
 - Identification of thirteen hemocyte populations in the *Drosophila* immune system
 - Hemocytes undergo a transcriptional and metabolic switch during development

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.

Single cell RNA seq of hemocytes from *Drosophila* larvae



Hemocyte populations identified by single cell RNA-seq

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*

Publications

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

Mobility Support

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

Modelling and observing pulsars: from high energy to radio emission

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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Jérôme Petri
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Observatoire astronomique de Strasbourg,
CNRS
Strasbourg

Publications

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

Mobility Support

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

Pure & Applied Physics

Project No. 5904-1

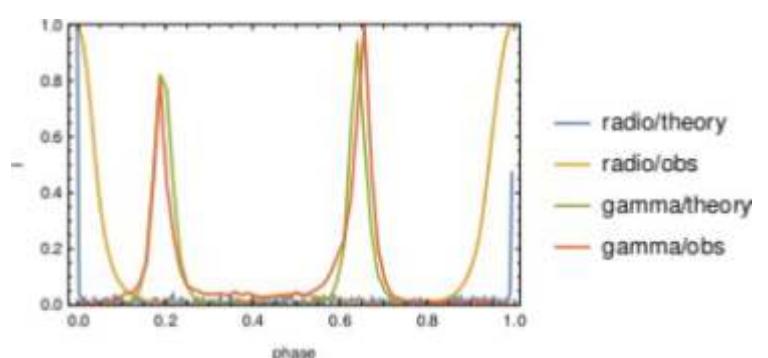
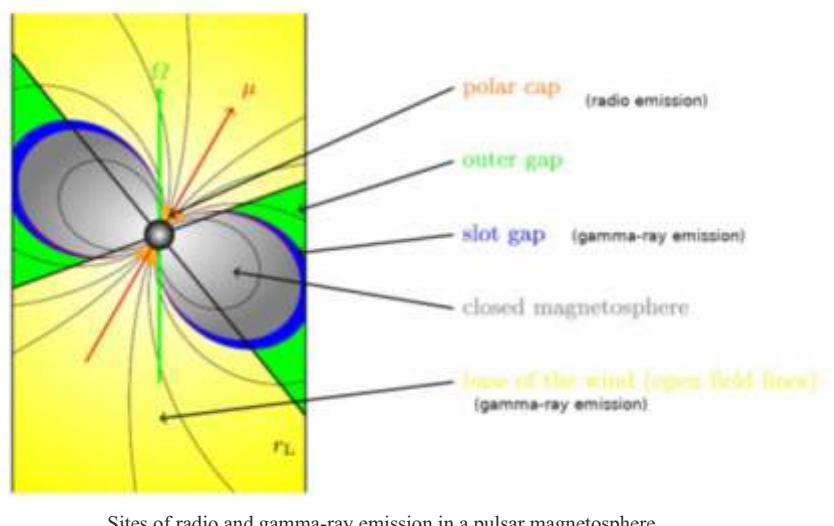
Jun. 2018 to Jun. 2021

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

Knowledge Generated/Products Developed

- Simultaneous radio and non thermal X-ray emission from off-centred dipole (Petri & Mitra, 2020)
- Simultaneous radio and gamma-ray light curves fitting for millisecond pulsars (Postdoc et al, in preparation)
- Simultaneous radio and gamma-ray light curves fitting for young pulsars (Petri & Mitra, in preparation)



Radio and gamma-ray light-curve best fit for PSR J1028-5819

Composite Models at the Interface of Theory and Phenomenology

Pure & Applied Physics

Project No. 5904-2

Jun. 2018 to May 2021

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

Knowledge Generated/Products Developed

- The study of vector-like quarks at present and future collider experiments as a search for compositeness
- Probes of novel interactions resulting from models of compositeness as a way of zeroing on to smoking-gun signals of composite models
- Studying collider signatures in models of strong dynamics which are related by duality to higher-dimensional theories
- Studying possible signatures of strong dynamics in Higgs precision studies
- Completing an up-to-date review of the subject of Compositeness

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



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Giacomo Cacciapaglia

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Institut de Physique Nucléaire de Lyon
Université Lyon 1
Lyon*

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

Pre-evolutionary processes in autocatalytic RNA networks

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



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TIFR
Mumbai



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

Publications

- No. of publications in SCI journals: 3
- No. of papers presented in conferences: 10

Mobility Support

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

Multi Disci (Physics, Chemistry, Biology)

Project No. 5904-3

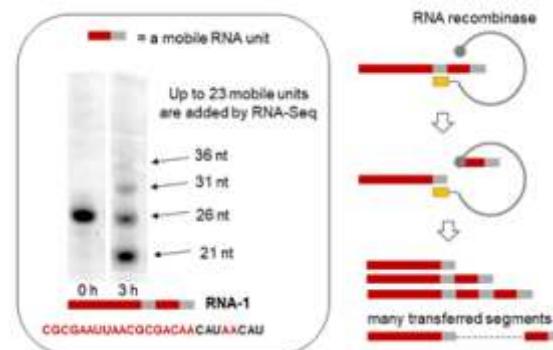
May 2018 to Apr. 2021

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

Knowledge Generated/Products Developed

- PIs have developed a technology to generate and measure a large diversity of autocatalytic RNA networks, by adapting single cell transcriptomics using droplet microfluidics and molecular bar-coding
- PIs have measured the impact of perturbations in the RNA substrates provided in the environment and have provided a first order model of the perturbation laws. PIs found the key network parameters which control perturbation, and tested them experimentally
- PIs found the experimental RNA autocatalytic system did not exhibit multistability, a necessary ingredient for heredity. PIs used mathematical modelling to show that this was due to the spontaneous self-assembly of the catalysts. Work is underway to modify the RNA so that they do not display such self-assembly
- PIs have exploited the activity of a naturally occurring group I intron ribozyme to construct a system that recombines RNA fragments to produce open ended variation in RNA sequences. The variation produced has been characterized by PAGE, next-generation sequencing, and mathematical modelling
- PIs have classified all possible minimal motifs that must be present in all autocatalytic systems. Using the theory of hypergraphs PIs have managed to prove that there are exactly 5 such universal motifs. This a major advance which will be very useful in analysing the nature of autocatalytic networks that arise in the experimental system



Recombinase-mediated transfer of mobile units. Left box: representative PAGE after the diversification of sequences.

Boron-controlled CO₂ reduction

Pure & Applied Chemistry

Project No. 5905-1

May 2018 to Apr. 2021

Objectives

- To get benefited from both the Lewis acid and the hydride donor ability of boron-based reagent to activate and transform Co₂
- 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 CO₂ and to get deeper insights about mechanistic pathways and to disclose new transformations

Knowledge Generated/Products Developed

- Synthesis of diborane(5) stabilized in the classical form in the coordination sphere of bimetallic tantalum complex, [(Cp*Ta)₂(μ,η²:η²-B₂H₅)(μ-H)(κ²,μ-S₂CH₂)₂], from the reaction of [Cp*TaCl₄] with LiBH₄·THF followed by addition of S₂CPh₃ has been demonstrated. The unusual stability of classical [B₂H₅]²⁻ in this complex is mainly due to the stabilization of the sp³-B center by electron donation from tantalum. Reactions to replace the hydrogens attached to the diborane moiety in this complex with a 2e⁻ {M(CO)₃} fragment (M=Mo or W) resulted in simple [{(Cp*Ta)(CH₂S₂)₂(B₂H₅)(H){M(CO)₃} } (M=Mo and W) adducts, that retained the diborane(5) unit
- Synthesis of B-H activated ruthenium complexes and ruthenium silyl complexes from borane and hydrosilane activation by κ²-N,S-chelated ruthenium borate species, respectively. These compounds have been completely characterized by multinuclear NMR spectroscopy and single crystal X-Ray diffraction analysis. The reactivity of these synthesized borate and silyl complexes with CO₂ under different reaction conditions will be explored
- Synthesis and structural characterization of various novel rhodium-diborane(6) species, [{(OC)₄Re}{Re(CO)₃}(μ₃-η²:η²-B₂H₆)(μ-H)], [{(OC)₄Re}{Re(CO)₃}(μ₃-η²:η¹-B₂H₆)(μ-H)] and [{(OC)₄Re}₂(μ-η²:η²-B₂H₆)] with diverse coordination modes of the [B₂H₆]²⁻ ligand was carried out. A combined experimental and theoretical study proposed that these complexes are stabilized by electron donation from the B-H bond to metals with very little contribution of metal-to-ligand back-donation. In addition, single-base-stabilized diborane(5) complexes, [{Mn(CO)₃}{Mn(CO)₂Pcy₃}(μ-η²:η²-B₂H₅·Pcy₃)(μ-H)], and [{Mn(CO)₂Pcy₃} (η³-B₂H₅·Pcy₃)] were also isolated
- Synthesis of a series of 4 mono-phosphine borate compounds featuring various borate moieties with a phenyl or naphtyl linker. These species are original species since only one type of mono Lewis base-borate compound was reported before with an amine borate compound.
- PIs were able to characterize P-B coupling by thorough NMR investigations. Several evidences point toward an unprecedented through space P-B coupling
- Reactivities of these phosphine borate compounds toward metal precursors and CO₂ were probed showing their propensity to release the hydride moiety. PIs exploited this feature to get a new synthetic pathway to phosphine borane compounds which are important species as catalysts or ligands. PIs used this strategy to get access to a new phosphine borane compound featuring a chiral boryl moiety. The latter compound traps CO₂ reversibly
- New (PBP)borate pincer type ligands Li[R₂B(C₆H₄-P'Pr₂)₂] (R₂= (Ph)₂, BBN) were synthesized and their coordination chemistry will be studied
- Hydride transfer property of our new phosphine borate allowed PIs to isolate and crystallographically characterize a lithium Ru complex featuring 5 hydride ligands and stabilized by two tricyclopentylphosphines. The corresponding potassium salt was briefly mentioned in the literature but not isolated nor characterized

Background

Due to the increasing level of CO₂ 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 CO₂ by transferring hydride(s) to the electrophilic central carbon atom of CO₂. On another hand, the Lewis acidity of the borane moiety has been used in ambiphilic compounds to activate CO₂. 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 CO₂ will be investigated in detail.



Sundargopal Ghosh's group with Sylviane Sabo-Etienne after her lecture at IIT Madras

Principal Collaborators



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Publications

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

Mobility Support

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

Nutrient transfers through groundwater in India (NUNDERGROUND)

Background

There are a limited number of studies of GW biogeochemical processes and contribution to chemical budgets of Indian Ocean. NUNDERGROUND proposes to gather ongoing complementary surveys from different labs in France and India adding advanced isotopic tools and expertise on C, N, Si, Ca, Sr, H₂O 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.

Earth & Planetary Sciences

Project No. 5907-1

Aug. 2018 to Jul. 2021

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

Knowledge Generated/Products Developed

- Field trip during wet season (August) to sample GW and surface water when available at the three locations studied Mule Hole (forest), Berambadi (agriculture), Godavari estuary
- Measurements of most core biogeochemical parameters of the wet season samples (nutrients, cations and anions)
- First series of measurements of silicon isotopes and completion of water isotopes of the wet + dry season samples (Si isotopes analyses need to be validated / duplicated)
- Measurements of NH₄⁺, NO₂⁻, NO₃⁻ concentrations and of δ¹⁵N & δ¹⁸O of NO₂⁻ and NO₃⁻, δ¹⁵N of NH₄⁺



Principal Collaborators



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Publications

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

Mobility Support

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

Preparing the water sampling device to collect groundwater from a well in a village next to Godavari estuary (Andhra Pradesh, August 2019)

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

Material Sciences

Project No. 5908-1

Sept. 2018 to Mar. 2021

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

Knowledge Generated/Products Developed

- Development of a novel high temperature stable tandem absorber of WAlN/WaSiN/SiON/SiO₂ on various substrates with very high absorptance and low thermal emittance.
- Complete characterization of the developed coating using FESEM, AFM, SAD, HRTEM, XPS, FTIR, UV-Vis-NIR, scratch tester, etc. To understand the microstructure and optical properties
- Thermal stability studies carried out till 700°C in air and vacuum. Coating stable up to 700°C in vacuum for longer durations
- Solar accelerated aging tests of the developed materials in a solar furnace (SAAF)
- High temperature measurements of optical properties, up to 500°C



Solar Accelerated Aging Facility (SAAF) at the focus of 1.5 kW solar furnace in PROMES-CNRS Odeillo/France (left) and its sample holder mounted with CSIR-NAL Bangalore sample (right)

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



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Publications

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

Mobility Support

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

2D Materials for novel nano electronic device applications

Background

In this project we are interested in light-matter interaction in 2D materials and their heterostructures for the applications of optoelectronic devices.

During this year, in SPPU, atomically thin, few-layer indium selenide (In_xSe_y) have been synthesized by RF sputtering and their photoelectrochemical properties investigated, namely the electron transfer kinetics and electric double-layer capacitance, supported by an extensive physical and chemical characterization. Thin films of vacuum-processed few layer In^2Se^3 display n-type photocurrent densities of 0.15 mA cm^{-2} simulated solar irradiation. We have also synthesized lead free inorganic $\text{K}_x\text{Bi}_2\text{I}_3$ perovskite thin films by facile one-step spin coating method and investigated its structural, optical and morphological properties. The fabricated films showed strong absorption in UV and visible region of solar spectrum and possess optical band gap $\sim 2 \text{ eV}$.

At Sorbonne we have advanced with the objectives of the project which includes synthesis, fabrication and characterization of materials and devices. In materials we have chosen the mono to few layer MoS_2 for electrostatic doping and likewise, for bipolar devices we have chosen the few layer InSe. While working on these approaches, we have also modified & developed the new protocols & instruments which can be generalized for other optoelectronic experimentation.

Principal Collaborators



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Publications

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

Mobility Support

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

Material Sciences

Project No. 5908-2

Aug. 2018 to Jul 2021

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

Knowledge Generated/Products Developed

- Modulation of electronic structure in 2D materials with electrostatic doping: Photoluminescence measurements
- Fabrication and characterization of bipolar devices in electrostatically doped few layer materials
- Investigation of phase change in ultra-thin NDR materials
- Development of laboratory prototypes for photoelectrochemical activity
- Lead free perovskite based materials



RF Sputtering system utilized for thin film deposition

High performance formation control in the presence of uncertainties and communication constraints

Pure & Applied Mathematics

Project No. 6001-1

Feb. 2019 to Jan. 2022

Objectives

Cooperative control of mechanical systems and in particular formation control has recently seen a proliferation of research and applications, primarily due to low cost, robustness and specific application requirements. The target of the current proposal is to establish formation control while minimizing communication and control effort under a variety of uncertainties due to modelling and measurement errors. The specific application domain for the current proposal will be mechanical systems interacting through a variety of communication channels (optical, wireless, ultrasound etc.) with the objective being that individual agents achieve and maintain a relative pose (position and orientation) with respect to its neighbours. The current proposal extends recent research activity of the proposers in three fundamental directions namely, a) formation under sensor bias and graph uncertainties, b) formation under time-varying and state-dependent interconnections, and c) optimal control for formation under constraints

Knowledge Generated/Products Developed

- The Indo-French cooperation within the consortium was strengthened and few co-authored works have been already accepted for presentation in well-known conferences. Our common effort will pursue and submissions of journal papers will be done soon
- A PhD student has been hired on the French side and is being jointly co-advised by the PI and collaborators in France. The work with this student has already resulted in a conference and a journal article
- Indian and French collaborators have met a couple of times, once in India and another time in France. Extensive discussions on collaborative work were held. Work on two new articles have started
- 2 PhD students on the India side have been hired on the Indo French project, one with each investigator in India as primary adviser. Work has been going well on both the students' projects. A conference publication has resulted from the same already
- An undergrad student in cooperation with the Indian PI has sent out a full journal article which is now under review in the top journal in the field



Dinner with Antonio Loria and Elena Panteley in Orsay, France

Background

Cooperative control has application in many areas of mechanical/aerospace engineering, electrical engineering, computer science and social networks/infectious disease networks. Our focus is on primarily on aero-mechanical systems cooperating over networks. Network interaction bring about several issues, one of them is related to inaccurate relative information collection. This effects the performance of the cooperating systems adversely and hence these errors in information need to be accurately estimated. Another set of concerns arise from network connections that are state and time varying, analysis of systems evolving over such networks brings about its own challenges and standard results in literature do not apply. Another impactful area is that of sparse control of large cooperating networks under constraints. Typical social marketing schemes require sparse schemes which impact very few nodes in the network directly, but the user expect the opinion to propagate uniformly over the network. It is therefore critical to devise such sparse control strategies for networks.

Principal Collaborators



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Publications

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

Mobility Support

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

Computing on Encrypted Data: New Paradigms in Functional Encryption

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 $\text{SK}(C)$. The user can apply this key to any ciphertext $\text{CT}(X)$, 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



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Publications

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

Mobility Support

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

Computational Sciences

Project No. 6002-1

Feb. 2019 to Jan. 2022

Objectives

- Supporting the Turing machine and RAM models of computation and overcome the limitations of the circuit model of computation, which are two-fold: (I) It prevents dynamic data length as the input length must be *a priori* bounded; (ii) It incurs running in worst-case time on every input
- Improving hardness assumptions underlying constructions of functional encryption so as to rely on better understood ones
- Obtaining efficient constructions for specific functionalities of practical relevance
- Investigate the space between standard lattice assumptions and existing ill-understood assumptions by introducing principled new assumptions which may lead to new cryptographic constructions

Knowledge Generated/Products Developed

- Realization under a well-accepted LWE assumption of a multi-client functional encryption scheme allowing to evaluate linear functions over inputs coming from distinct parties
- Evidence that functional encryption schemes for linear functions can satisfy a strong definition of simulation-based security for adaptive adversaries
- Construction of attribute-based encryption for (deterministic and non-deterministic) finite-automata from standard assumptions 4. Optimal efficiency tradeoffs for public-key broadcast encryption using bilinear maps and the Learning-With-Errors assumption
- Attacks and fixes against obfuscation candidates and recently proposed assumptions used in the designed of FE schemes

Design and Control of many-body states in hybrid quantum systems

Pure & Applied Physics

Project No. 6004-1

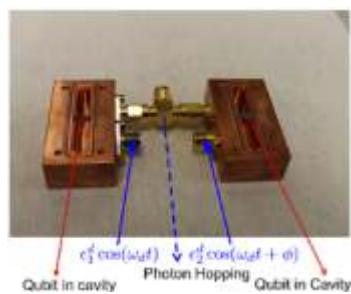
Feb. 2019 to Jan. 2022

Objectives

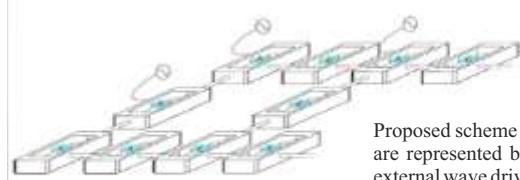
- Propose a driven-dissipative scheme to generate indefinitely long-lived multipartite quantum entanglement in lattices (both 1D and 2D) of qubits, by bringing ideas from quantum-bath design and from condensed-matter physics. The concrete scheme will be geared towards the rapidly maturing cavity quantum 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

Knowledge Generated/Products Developed

- Joint hiring of a postdoc (Hari Kumar Yadalam in Sept 2020) & close collaboration
- Submitted joint paper: Camille Aron and Manas Kulkarni “Non-Analytic Non-Equilibrium Field
- Published/submitted papers in high impact journals directly related to the CEFIPRA project
- In the process of developing close collaboration with theoretical and experimental groups (both in France and India). Some such new collaboration as a result of CEFIPRA visits have already yielded publications in high impact journals
- In the process of successfully developing and adapting theoretical and computational tools as planned to tackle non-equilibrium problems in light-matter systems



3D microwave cavity implementation of the entanglement driven-dissipative scheme that the PIs proposed and realized in the Quantum Nanoelectronics Laboratory at UC Berkeley



Proposed scheme on a Lieb lattice. The qubits are represented by the blue boxes and three external wave drives have been represented

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 maturing 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



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Publications

- No. of publications in SCI journals: 10
- No. of papers presented in conferences: 5

Mobility Support

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

From molecules to aerosols and dust particles: applications to the physics and chemistry of planetary atmospheres and the interstellar medium

Pure & Applied Chemistry

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



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Publications

- No. of publications in SCI journals: 2
- No. of papers presented in conferences: 6

Mobility Support

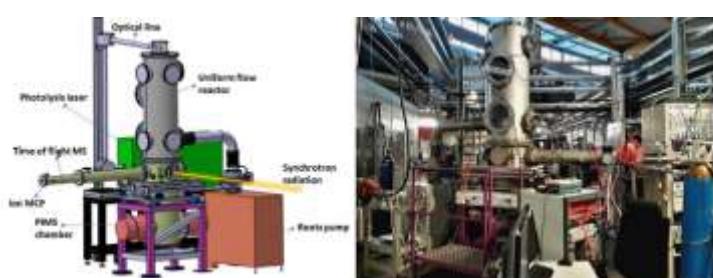
- India to France: 3
- France to India: 3

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

Knowledge Generated/Products Developed

- Rennes' efforts on the topic of aerosol formation have been focused on the study of the kinetics of HCOOH dimer formation at low temperature. Formic acid HCOOH was selected for its strong polarity and ability to form strong hydrogen bonds
- A unique hypersonic device designed and fabricated at IPR has been employed to conduct another key part of the project, which aims to experimentally validate the Paris-Durham shock code
- PIs were able to record *in situ* and in real-time the shock-induced evolution of interstellar dust analogues, namely C60 and SiC



Outside view of the CRESUSOL instrument installed on the DESIRS beamline of the SOLEIL synchrotron facility

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

Earth & Planetary Sciences

Project No. 6007-1

Feb. 2019 to Jan. 2022

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

Knowledge Generated/Products Developed

- With the research scholar under the CEFIPRA project we have completed collecting samples in two field seasons from the entire Gorumahisani belt
- Representative samples were petrologically characterized and in-situ major and trace element data were procured from chromite and Ni-Cu-sulfide minerals. One manuscript has been prepared and another one will be prepared based on these data
- A hitherto unknown section of a Komatiitic suite of rocks has been discovered in the westernmost part of the belt (known as the Chuka Pahar section) and extensively sampled for analytical work under this project
- A postdoc (Xiaoyu Zhou) has joined the CNRS-CRPG team to work on the CEFIPRA project. Originally planned for June 2020, her arrival was postponed until mid-September due to the Covid crisis. She will conduct PGE and Re-Os and Pt-Os isotopic studies of the CEFIPRA samples, and she is currently engaged in implementing an improved PGE analytical protocol based on techniques she developed during her thesis
- Dr Reisberg (France) has already visited Prof Mondal's laboratory and presented 2 talks in the oneday workshop under the CEFIPRA at the Dept. of Geological Sciences (JU), and presented a seminar at Presidency University, Kolkata



Ratul Banerjee (middle), CEFIPRA Research Scholar with Chirasree Bhattacharjee (DST-INSPIRE Research Scholar) and Aranab Dey (UGC-Research Scholar) conducting fieldwork and collecting metavolcanic samples from Tiring area in the last winter under the CEFIPRA 6007-1 project

Background

Komatiites are >2.5 billion-year-old high-Mg lavas 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, petrology, geochemistry, PGE-abundances and Os isotopes will be used to characterize komatiitic rocks from the Archean Gorumahisani-Badampahar greenstone belts 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.

Principal Collaborators



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Publications

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

Mobility Support

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

Membrane Biogenesis in Apicomplexa parasites: Trafficking and recycling lipid sources for membrane remodelling as drug targets against malaria and toxoplasmosis

Principal Collaborators



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Institut Albert Bonniot (IAB)
Grenoble

Objectives

- To assess the functional significance (localization, essentiality, life stage specificity, molecular partners, role in intracellular development) of (lyso)phospholipases ((L)PLs) for parasite survival, using systematic gene disruption and tagging strategies in *P. falciparum* and *T. gondii*
- To understand the functional role of LPLs in lipid trafficking/homeostasis and membrane biogenesis, by using detailed lipidomics and fluxomic analyses on gene knock-down parasite lines (i.e. identify the affected pathways/organelles, and the specific function of each LPL in lipid fluxes)
- To identify specific inhibitors of these selected enzymes as lead compounds, for the development of new anti-malarials and anti-toxoplasmosis

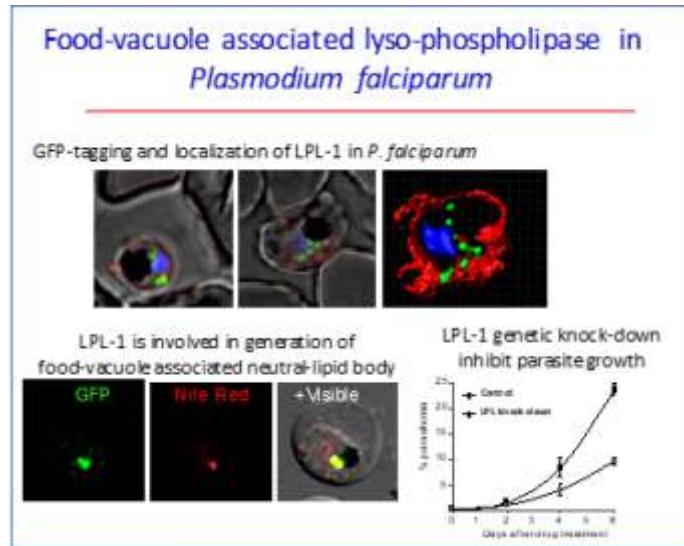
Life & Health Sciences

Project No. 6003-1

Apr. 2019 to Mar. 2022

Background

Apicomplexa is a phylum of obligate intracellular parasites, including major pathogenic parasites such as *Plasmodium* spp. and *Toxoplasma gondii*, causative agent of malaria and toxoplasmosis, respectively. There is no vaccine against these diseases and appearances of multi-drug resistant strains, especially for malaria, both argue for the urgent development of new drugs. This project aims to understand the lipid-processing pathway involved in the transfer of fatty acids from the host and within the parasite and their recycling into lipids. It will focus on a group of non-characterized proteins, putatively important for parasite membrane biogenesis: (lyso) phospholipases. Molecular tools such as knockout, knockdown strains and tagged protein expression strains will be generated in both *P. falciparum* and *T. gondii*. Second, using those modified strains, protein localization and their phenotypes will be assessed. Third, the protein function in the parasite lipid metabolism will be determined by lipidomic analysis on mutant parasite lines. Final goal of this project is to understand the complex parasite mechanisms of lipid trafficking and biogenesis and identify novel drug targets by initiating in vitro drug screening. The overall aim of the project is to decipher the functional roles of key proteins, involved the lipid homeostasis, membrane remodelling and survival in both Apicomplexa models *Toxoplasma gondii* and *Plasmodium falciparum*. It is proposed to assess their potential as drug targets against both malaria and toxoplasmosis.



Mechanism of miRNA-dependent and independent targeting of mRNAs to P-bodies

Life & Health Science

Project No. 6003-2

Nov. 2019 to Nov. 2022

Background

In eukaryotic cells, RNA processing bodies (P-bodies) are considered as sites of mRNA storage and degradation, and targeted mRNAs can be stored reversibly in a translationally inactive manner. These tiny granules are enriched for different RNA binding proteins, and in particular Ago proteins and their associated miRNA. Indeed, when microRNAs bind to target mRNAs to repress their translation, they also induce transport of the resulting complex to P-bodies. P-bodies play important roles in cellular physiology, and, although the full spectrum of their importance is yet to be uncovered, they appear particularly important in neurons. In these cells, P-bodies are dynamic structures that use motors to move in dendrites. Their composition also appears more heterogeneous than in other cell types, and it furthermore respond to extra-cellular stimuli.

The present proposal aims at deciphering the mechanistic details of how the targeting of mRNAs to P-bodies is achieved, in a context relevant for the physiology of neuronal cells. Indeed, differentiation and death of neuronal cells has been previously shown to be P-body dependent. Using state-of-the-art imaging and biochemical techniques, PIs will first perform screens to identify mRNAs that localize to P-bodies in a regulated manner during neuronal differentiation. Using few model mRNAs, PIs will then determine the RNA targeting element and interacting protein factors, thereby identifying the decisive factors/steps in P-body compartmentalization of mRNAs. Finally, PIs will perform experiments to demonstrate the functional significance of this transport. Overall, the proposed work will provide mechanistic insights into how mRNAs are transported to P-bodies, and will reveal how P-bodies contribute to the physiology of neuronal cells.

Principal Collaborators



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Objectives

To demonstrate the importance of mRNA localization in P-bodies in neuronal cells, to characterize P-body heterogeneity, and to identify the cellular mRNAs whose localization is dynamically regulated and is physiologically important. This general objective will be attained through several specific aims:

- Establishment of assays to visualize the localization of mRNA to P-bodies
- Identification of mRNAs that are differentially accumulated in P-bodies during neuronal differentiation, and selection of few important model mRNAs
- Identification of cis-regulatory elements on the model mRNAs, which allow them to localize to P-body in a regulated manner during neuronal differentiation
- Identification of trans-acting factors such as miRNPs
- Demonstrate the relevance of mRNA localization in P-bodies for neuronal differentiation

Enhanced CO₂ adsorption and its photo-electrochemical conversion using semiconductor-metal complex hybrids

Principal Collaborators



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CSIR-Indian Institute of Petroleum
Dehradun



Rabah Boukherroub
Institute for Electronics Microelectronics
and Nanotechnology
Villeneuve d'Ascq

Objectives

- Design and synthesis of semiconductor supports such as, transition metal substituted polyoxometalates (POMs) having MO_x basic units, silicon nanowires (SiNW), MoS₂ and composites of SiNW with TiO₂ and MoS₂ (1-12 months)
- Synthesis of mono or polymerized molecular complexes/clusters of ruthenium and low cost metals such as Cu, Co (1-18 months)
- Covalent attachment of metal complexes/clusters with POM or other semiconductor supports through in situ or post grafting methods (12-20 months)
- CO₂ adsorption study and simultaneous solar photo-electrochemical reduction to high value chemicals under visible light irradiation (18-24 months)
- The catalytic yield, selectivity and efficiency of the prepared photo-electrocatalysts will be investigated and the reaction mechanism will be determined by diverse spectroscopic and advanced material characterisation techniques (18-30 months)
- Best selected photoelectrocatalyst will be targeted to explore further to develop a lab scale process for reduction of CO₂ to valuable C1 product (30-36 months)

Pure & Applied Chemistry

Project No. 6005-1

Apr. 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/TiO₂, MoS₂ or SiNW/TiO₂/MoS₂ composites as semiconductors support for grafting of metal complexes for enhanced CO₂ adsorption and its simultaneous conversion to high value chemicals such as formic acid, formates, methanol via photo-electrochemical conversion route using visible light. CO₂ adsorption is of highest concern during the CO₂ reduction process because CO₂ reduction kinetics is highly correlated to the CO₂ 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 CO₂ through CO₂-M bond and thus can enhance the adsorption of CO₂ on its surface. In this 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 CO₂ reduction.

Nanowire white LEDs based on innovative nano-phosphors

Material Sciences

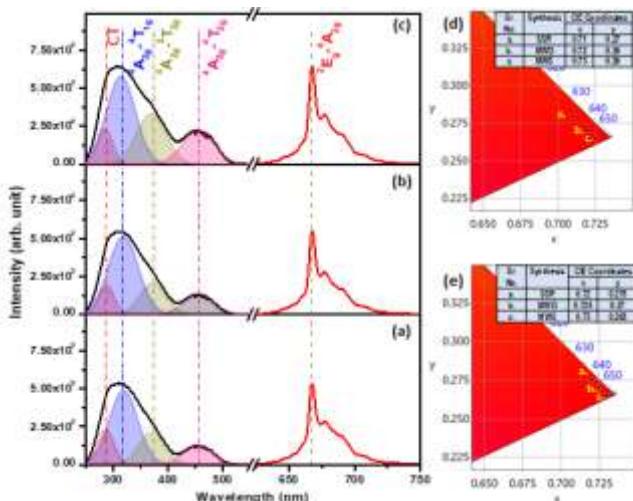
Project No. 6008-1

Apr. 2019 to Mar. 2022

Background

Flexible light emitting diodes (LEDs) are today a topic of intense research, motivated by their easy integration on a soft surface. The ambition of this project is to demonstrate a high-efficiency and high purity white light flexible LEDs based on the combination of nitride NWs and nanophosphors. To reach this goal, it is proposed to focus on the optimization of flexible NW blue LEDs and on the synthesis of novel nanosized phosphors producing not only yellow but also the red spectral component. C2N-CNRS will develop organized InGaN/GaN NW arrays with high quantum efficiency (QE) in the blue spectral range. Hence, large area (several cm²) fully flexible blue LEDs will be optimized. CSIR-NIIST will work on the synthesis of nanophosphors with high QE. Especially, a novel concept for nanophosphor synthesis to achieve high quantum yield, small size (to be integrated in a flexible NW LED) and an appropriate shape producing low light scattering will be developed. These novel nanophosphors will solve the color purity and the efficiency issues faced by standard WLEDs. Based on a scalable technology of nanophosphors/flexible blue-LEDs integration, the WLED devices will be optimized to deliver a novel and improved WLED for a variety of lighting applications requiring mechanical flexibility.

The consortium of this project consolidates all the required expertizes in nanosciences and nano-micro-fabrication. C2N has a long know-how in NW synthesis and characterization, as well as a long experience on the design, fabrication, and testing of NW-based LEDs; and NIIST has a long expertize in the fabrication of nanophosphors and device fabrication and testing.



Comparative plots for the deconvoluted PLE and PL spectra for the sample prepared through (a) SSR, (b) MWD and (c) MWS under the UV excitation of 300 nm. The CIE color diagram and the corresponding coordinates of the sample prepared via three different methods recorded under the excitation wavelengths at (d) 300 nm and (e) 455 nm

Principal Collaborators

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**Maria Tchernycheva**

*Center for Nanosciences and
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Orsay*

Objectives

To demonstrate a high-efficiency flexible WLEDs based on nitride NWs and nanophosphors producing a high purity white light. The point-by-point objectives of the project are:

- Synthesis of novel nanophosphors with high quantum efficiency using a new fast elaboration approach
- Demonstration of a flexible NW LEDs using organized NW arrays with a wire diameter below 100 nm to achieve a homogeneous light generation with high quantum efficacy
- Integration of the nanophosphors into a NW LED to demonstrate a flexible white light source with an EQE above 40% and high color purity

Maximal abelian subalgebras in operator algebras

Principal Collaborators



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 Chennai*



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 Basse-Normandie
 Caen*

Objectives

- Global and generic properties of MASAs in von Neumann algebras
- Analysis of MASAs in quantum group von Neumann algebras

Pure & Applied Mathematics

Project No. 6101-1

Jun 2019 to May 2022

Background

The project aims to make a systematic study of maximal abelian subalgebras (MASAs) of operator algebras, from both local and global perspectives.

The proposal can be broken up into three interconnected modules. They are 1-Properties of MASAs in specific von-Neumann algebras, 2-A study of MASAs from a global perspective and 3-A systematic study of singular MASAs in von-Neumann algebras.

A study of MASAs in von-Neumann algebras from a global perspective will be carried out, which will involve study of subspaces of MASAs in spaces of von-Neumann algebras given specific topologies like Effros-Marechal topology and Christensen topology. The aim here is in particular to show that singular MASAs are in fact the generic MASAs and hence, are the natural object of study. This study will be carried out first individually, and will leverage a preliminary investigation carried out on this topic. Finally, this will lead to a comprehensive study of singular MASAs in von-Neumann algebras, where the collaborators aim to obtain a satisfactory structure theory of the same. Since this is envisioned to be the hardest part of the program, this will involve close collaboration of all participants, and will be the most intense part of the program. This study will lead to unprecedented insights not just into MASAs in von-Neumann algebras, but into the theory of von-Neumann algebras as a whole.

Integrating machine learning with feature selection to build interpretable models for precision oncology

Computational Sciences

Project No. 6102-1

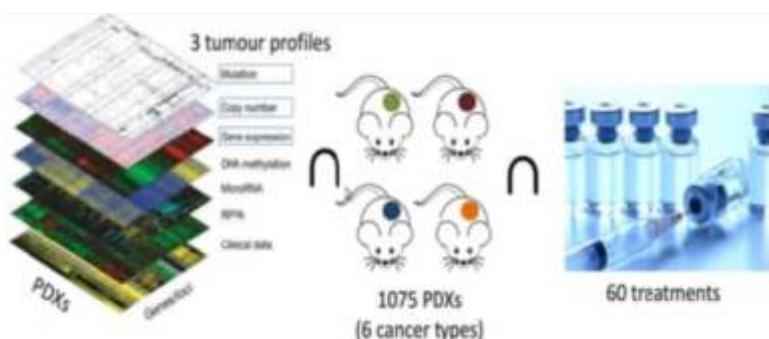
Apr. 2019 to Mar. 2022

Background

There is a growing realisation that single-gene markers are generally too simple to be able to predict tumour response for most drugs. This has opened the door to the use of machine learning algorithms to build models combining instead multiple gene alterations. The project is timely owing to the recent availability of more suitable training data in terms of size and relevance to patients.

Two challenges posed by this emerging approach will be addressed in this project. First, tumours are characterised by high-dimensional multi-omics data sets. Optimal combinations of machine learning and feature selection techniques to reduce overfitting in modelling these data sets will be investigated. Second, these models will identify concise lists of genes predictive of tumour response to the treatment. Using these gene lists and associated multi-omics data sets, it is proposed leverage of current knowledge of cancer pathways to help understanding the molecular basis of tumour sensitivity or resistance to the treatment.

The codes of the developed methods will be made freely available too in order to facilitate their use by the relevant communities as well as reproducibility.



Principal Collaborators



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Objectives

- Investigating optimal combinations of machine learning and feature selection techniques to predict *in vivo* drug response across Patient-Derived Xenografts (PDXs) from any cancer type
- Develop methodologies that leverage current knowledge to help understanding the molecular basis of tumour sensitivity or resistance to each considered treatment

The genomic and evolutionary landscape of azole resistance in budding yeast

Principal Collaborators



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Indian Institute of Technology-Madras
Chennai



Gianni Liti
Institute for Research on Cancer and
Ageing of Nice
(IRCAN), Nice

Objectives

- Species-wide variation inazole drug resistance and pathogenic related traits
 - a) High-resolution phenotypic screening of sequenced collection that include large cohorts of clinical, domesticated & wild *S.cerevisiae*, and *S.paradoxus* strains
 - b) Genome-wide association study for azole resistance and pathogenic related traits
- Generation of recombinant populations from selected founders
 - a) Multiple linkage analysis approaches
- Experimental evolution of drug resistance and combined stresses
 - a) Evolution of isogenic lines from multiple genetic backgrounds
 - b) Evolution of heterogeneous populations to identify pre-existing and de novo mutations
- 4. An integrated view of drug resistance by experimental validation and multi-omics approach
 - a) A deep catalogue of pathogenic variants
 - b) The phenotypic landscape of pathogenic variants

Life & Health Sciences

Project No. 6103-2

Dec. 2019 to Nov. 2022

Background

It is proposed in the project proposal to test species-wide variation in azole drug resistance and pathogenic related traits in a large cohort of 1011 clinical, domesticated and wild sequenced *S.cerevisiae* strains. Genome-wide association studies on these traits will identify drug resistance natural genetic variants. By generating recombinant combinations from specific founders, genetic networks regulating drug-resistance and the impact of rare variants will be identified. To study the mechanisms of acquired drug resistance in clinical environments, experimental evolution of isogenic lines from multiple backgrounds will be performed to identify pre-existing and de-novo mutations. Finally, genetic analysis of evolved strains will identify how genetic networks vary in response to the drug, giving a comprehensive framework for drug resistance.

How mechanical conflicts contribute to organ shape reproducibility in plants

Life & Health Science

Project No. 6103-1

May 2019 to Apr. 2022

Background

How does an organism reach its final size and shape, in the face of stochastic variation at the cellular level? In this project, it is proposed that cell-cell communication mechanisms coordinate cell stochastic variability so as to yield consistent organs. Since growth remains locally heterogeneous, these mechanisms may, counter-intuitively, maintain or even enhance local heterogeneity. It is proposed to test this hypothesis in *Arabidopsis thaliana*, as it produces a large number of almost identical floral organs and early leaves with stereotyped shape and size. The PIs will choose to work on sepals, cotyledons and first leaf pair, since they are of varied ontogenetic origin and are easily accessible for live imaging and mechanical measurements. It is proposed to use genetic manipulations to generate mosaic tissues with heterogeneous mechanical properties and investigate how adjacent cells behave. In other words, it is proposed to investigate whether organs use growth heterogeneity to sense their global shape and/or whether organs filter growth heterogeneity to generate reproducible organ shapes.

Principal Collaborators



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Olivier Hamant
INRA Plant Biology and Breeding
Lyon

Objectives

- To decipher the role of growth heterogeneity and the associated mechanical conflicts in shaping organs with reproducible structure

Turbulent flows in equilibrium

Principal Collaborators



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Kanpur



Stéphan Fauve
Ecole Normale Supérieure
LPS
Paris

Objectives

- Experimental, numerical, and analytical studies of helical turbulent flows with forcing at small scales both in hydrodynamics and in magnetohydrodynamics
- Analyse the kinetic energy spectrum and flux of such flows.
- Analyse scale-by-scale energy transfers at large scales of the flow
- Test whether the modes in above flow are in equilibrium, for example, do they satisfy principle of detailed balance?
- Compare the experimental, numerical, and analytical results
- From the above results deduce the conditions for efficient dynamos generated by turbulent flows

Pure & Applied Physics

Project No. 6104-1

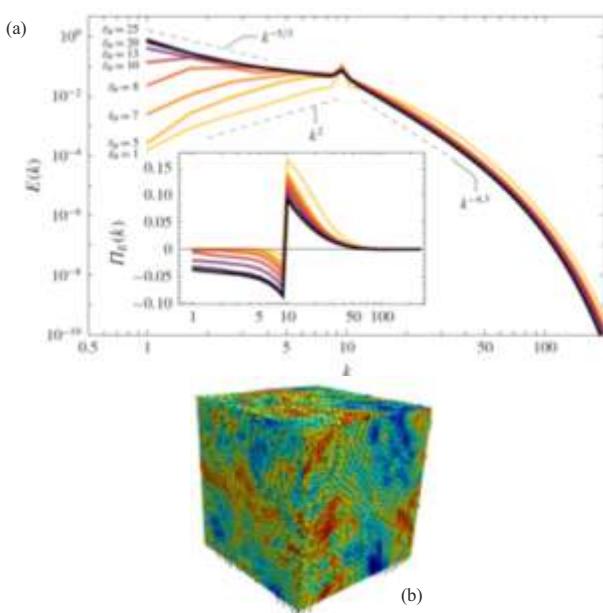
Jun. 2019 to May 2022

Background

In this project it is proposed to investigate latter kinds of flows using experimental, numerical, and analytical tools.

The first objective of the project is to understand the dynamical and statistical properties of turbulent flows at scales larger than that of forcing, which are beyond the range of the Kolmogorov cascade. The fundamental questions in this field are as follows: What is the energy spectrum? Is there an equipartition of energy among large-scale modes as is typically assumed? What is the nature of nonlinear energy transfers? For example, does the mean energy flux at the scales larger than the forcing scale vanish? Do fluctuation-dissipation theorem or detailed balance apply to such systems? How to quantify the fluctuations in the energy flux and the velocity correlations? How do we model the large scales flow patterns in such flows?

The second objective of the project is to study similar mechanism in dynamo (magnetic field generation). The magnetic field growth rate is enhanced when the flow is mirror-asymmetric, and when it is forced at scales smaller than the system size. It is proposed to study the dynamo mechanism for such turbulent flows; the insights gained will be useful for designing efficient dynamo experiments.



(a) Kinetic energy spectra and fluxes (inset). The energy injection is applied at wavenumber $k=10$. The helicity injection is applied at all wave numbers. The level of helicity injection is given by the parameter e_h . An inverse cascade of energy is obtained provided the level of helicity injection is sufficiently high. (b) Snapshot of the velocity field on the three faces of the cubic resolution domain for $e_h=25$, showing that the turbulent flow is three-dimensional

Optoelectronics in van der Waals heterostructures: from fundamentals to quantum device engineering

Pure & Applied Physics

Project No. 6104-2

Apr. 2019 to Oct. 2023

Background

The project aims at demonstrating novel optoelectronic phenomena, including in the single photon regime by profiting from the aforementioned assets of 2DM. Meeting these technologically relevant challenges requires addressing the following fundamental questions:

- Q1 Are conventional descriptions of interlayer charge and energy transfer (IET, ICT) between 2DM still valid in the case of sub-nanometer thick van der Waals gaps between interacting 2DM? How to tailor the dissociation of tightly bound excitons at a 2D heterointerface? Can one selectively probe and engineer the efficiencies of ICT and IET in charge tunable vdWH?
- Q2 How does substrate-induced doping, scattering and screening affect the electronic transport and optical properties of 2DM? How to engineer the substrate to tune the (opto-) electronic properties of 2DM? Can PIs detect strain and doping-induced phase transitions electronically?
- Q3 Single photon emitters embedded in 2DM can be formed by strain engineering. How can PIs harness this unique possibility to demonstrate quantum optoelectronic systems and devices?

It is proposed to develop a synergistic effort that builds upon i) 2DM growth, substrate nano-patterning and 2DM device nanofabrication and ii) ultrasensitive optical spectroscopy, time-correlated single photon counting, electron transport and optoelectronics. It is also proposed to follow a logical progression starting by mapping band offsets and uncovering the fundamentals of ICT and IET in custom-designed vdWH (Task 1). The collaborators will proceed with improving the (opto) electronic performance of 2DM and vdWH through substrate engineering (Task 2). The project culminates with the realization of quantum optoelectronic devices based on arrays of single photon emitters embedded in 2DM, a 3rd task that takes full benefit from the outcomes of tasks 1 and 2. It is proposed to perform original advances within a particularly competitive international research field.



Photoluminescence image of monolayer Ws₂

Principal Collaborators



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Stephane Berciaud

*Université de Strasbourg
Strasbourg*

Objectives

- To uncover and further engineer the complex set of microscopic mechanisms that govern the optoelectronic response of two-dimensional materials and related heterostructures
- To demonstrate novel optoelectronic functionalities, including in the quantum regime using 2D-materials deposited on nano-patterned substrates

ROYCE (diveRsity Oriented sYnthesis of Complex hEterocycles)

Principal Collaborators



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Mumbai



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CNRS/UHA/UNISTRA, Laboratoire
Moléculaire Applications (Lima)
Mulhouse

Objectives

The ROYCE project is organized in 3 scientific objectives and 2 soft-skills work packages as given below:

- Pericyclic reactions
 - Task 1: rapid synthesis of halo-pyridines via a pericyclic sequence
 - Task 2: Focus on functionalized heterocycles able to be included in the elaboration of libraries
 - Task 3: Focus on the scalability of the process up to gram-scale (in batch or continuous flow)
 - Task 4: Active intellectual property management in agreement with the PIs? institutions
- Copper-catalyzed amination reactions
 - Task 1: rapid synthesis of the amination reactions precursors
 - Task 2: Focus on functionalized heterocycles able to be included in the elaboration of libraries
 - Task 3: Focus on the scalability of the process up to gram-scale (in batch or continuous flow)
 - Task 4: Active intellectual property management in agreement with the PIs? institutions
- DFT calculations
 - Task 1: DFT exploration of the mechanism of the pericyclic sequence
 - Task 2: DFT exploration of the mechanism of the copper-catalyzed amination reaction

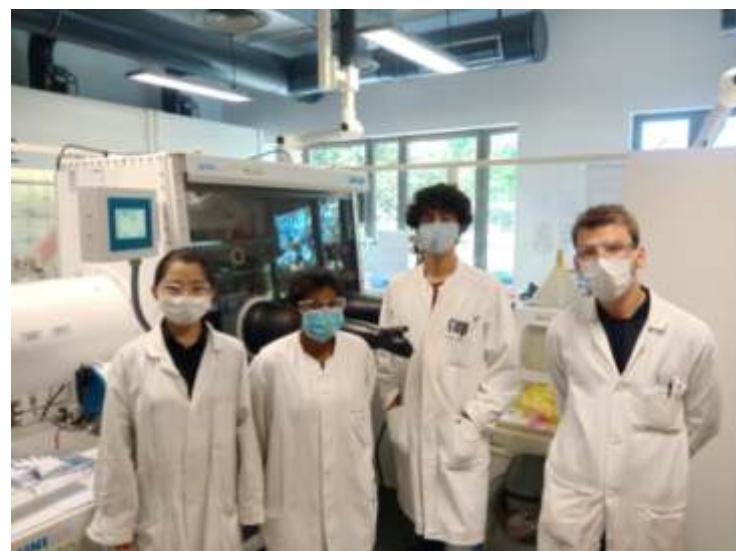
Pure & Applied Chemistry

Project No. 6105-1

Aug. 2019 to Jul. 2022

Background

The ROYCE project aims at capitalizing on the complementary expertise developed by the French and the Indian PIs to expand significantly the Chemical Space of pyridines and benzimidazoquinazolinones by preparing the promising class of N-pyridinyl benzimidazoquinazolinones. A general synthetic strategy that relies on two key steps: a pericyclic cascade (Objective 1) followed by a copper-catalyzed cascade amination (Objective 2) are proposed in this project. It is proposed to investigate reaction mechanisms at the DFT level (Objective 3) to shed light on the intimate details of the transformation, with the goal to improve the synthetic sequence.



Ms. Diksha Singh in the French Laboratory with her labmates.
Pictures taken on September 8th, 2020

Plasmonic hot electron pockets as exciton luminescence promoters and regioselective chemical triggers

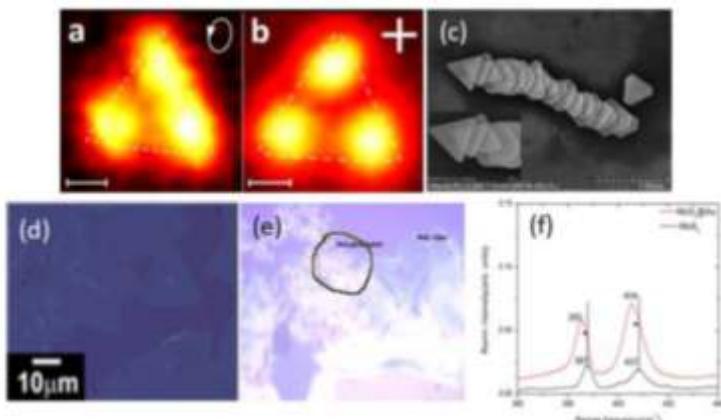
Material Sciences

Project No. 6108-1

Apr. 2019 to Apr. 2022

Background

This collaboration aims at exploiting the spatial and spectral addressability of SP modes borne by ultrathin 2D metallic crystals to locally trigger (1) nonlinear luminescence of excitons in monolayer transition metal dichalcogenides (TMD) and (2) chemical reactions by thermal activation or hot electron transfer. Beyond the fundamental understanding of light matter interactions in these hybrid plasmonic structures, the proposed work will contribute to engineering advances in sensing and optoelectronic nanodevices and on-surface catalytic chemistry.



Two photon luminescence (TPL) signals and plasmonic density of states. (a) Experimental map of an Au nanoprisms excited with quasi-circularly polarized light. (b) Symmetrical TPL map of another nanoprisms obtained by summing the images obtained for two orthogonal linearly polarized excitations. (c) SEM images of Au nanoprisms. (d) Optical image of MoS₂ grown on SiO₂/Si substrate. (e) Optical image of Hybrid nanostructures: MoS₂@Au on SiO₂/Si substrate. (f) Raman spectra of MoS₂@Au hybrid nanostructures

Principal Collaborators



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Objectives

- To design more efficient exciton-plasmon coupled systems that influences the nanooptical response from 2D-TMD plasmonic hybrids
- To investigate chemical anisotropy mediated by hot spots enabling design of chemical or biomedical sensors with better selectivity

Chromium isotopes as tracers of environmental contamination and remediation

Principal Collaborators



Abhas Singh
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Bernard Bourdon
ENS de Lyon
Lyon

Objectives

- Develop new isotope methods to characterize the processes involved in the mobilization of hexavalent chromium in the environment, together with a full characterization of the source materials of contamination
- Apply these novel tools to field area near Kanpur with demonstrated Cr contamination
- Establish a collaboration to enhance knowledge in both Indian and French parties in the acute environmental issue

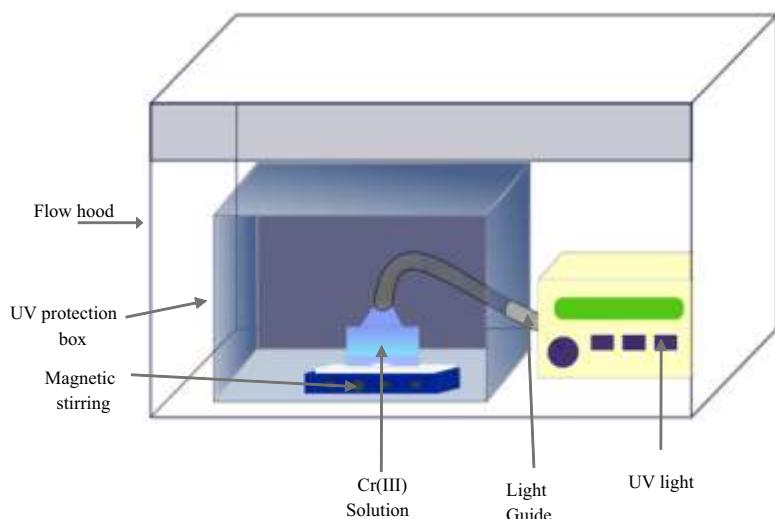
Environmental Sciences

Project No. 6109-1

May 2019 to Apr. 2022

Background

With the large scale industrial use of chromium (Cr), this metal has become a worldwide pollutant representing an important health hazard to local populations. Of particular concern is the oxidized Cr (VI) which is mobile and carcinogenic, while the reduced form Cr(III) is insoluble in natural waters and considered harmless. This project will focus on the application of Cr isotopes to understand and control the fate of chromium in the environment (soils, waters, aquifers) with a combination of laboratory experiments and a field study located near Kanpur, Uttar Pradesh, where numerous tanneries have release Cr in the environment as chromite ore processing residues that are dumped illegally. Cr-rich waters are also released from effluent treatment plants. First, the collaborators may characterize the isotope signature of chromium released from Cr rich solid wastes sampled in the field. This will enable us to identify the main sources and processes that release Cr (VI) to the environment. The ores, Cr-rich wastes, and soils will also be characterized by X-ray diffraction (XRD), X-ray photoelectron spectroscopy and electron microscopy to understand the parameters controlling its Cr release. Second, through lab experiments, it is proposed to determine the variations in Cr isotope compositions, the rates of oxidation of Cr and with MnO₂ or during photooxidation and Cr (VI) remediation with chemically or electrochemically dosed ferrous iron. An important novelty is that both mass dependent and mass independent Cr isotope fractionation will be investigated. Third, it is proposed to sample waters from local wells, and determine their Cr concentrations and speciation, and analyze them for Cr isotopes, as well as trace and major elements. The efforts will be taken to identify the processes that take place during the transport of Cr and to identify the main sources of contamination.



Experimental setup with a UV light to produce Cr(VI) from a Cr(III) solution

Macrophage lipid mobilization in tuberculosis infection

Host-Microbe-Interactions in Health & Agriculture?

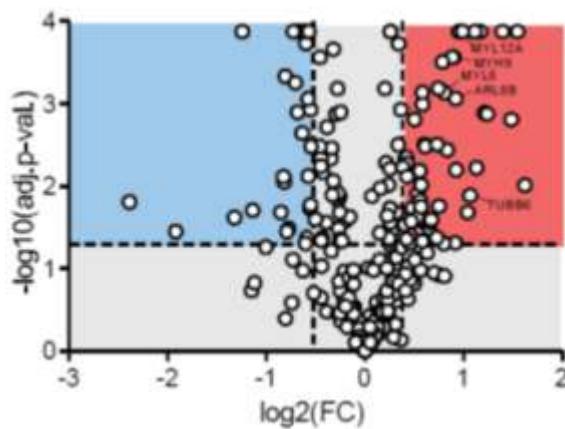
Project No. 62T4-1

Feb. 2020 to Jan. 2023

Background

Tuberculosis is characterized by the presence of lipid rich foamy macrophages where the causative pathogen, *Mycobacterium tuberculosis*, finds a safe haven despite an active host immune response. This proposal aims to understand how manipulation of host lipid droplets by live *M. tuberculosis* regulates lipid trafficking to the bacilli. Stemming from our lipid droplet proteomics studies from Mtb infected macrophages, it is proposed to hypothesize that vesicular trafficking proteins may be key to lipid trafficking to intracellular bacilli. How do these proteins alter lipid homeostasis in the infected cell, and what would be the consequence of inhibiting these processes for lipid transfer to the bacilli?

Answers to these questions require the amalgamation of experimental approaches of biophysics, cell biology, and mycobacterial infection biology, with expertise in lipid droplet biology. The team comprising of mycobacteriologist and biophysicist has a common interest of understanding lipid droplet homeostasis in health and disease. The Indian investigators lab will lead experiments on genetic manipulation of macrophages and bacilli, performing experiments to understand changes in lipid droplet abundance, localization, and lipid transfer to bacilli. The French investigators lab will lead experiments on evaluating lipid droplet-protein interaction and structural alterations to lipid droplets upon binding of the candidate protein. This unique combination of investigators and approaches is likely to provide the functional relevance of lipid droplet manipulation by the bacilli and the mechanism for lipid trafficking to bacilli. These answers are likely to provide new avenues for targeting host pathways as antibacterial strategies to fight infection.



Volcano plot representing significantly differentially abundant (FDR adjusted p-value<0.05) proteins, pink region reflects proteins increased by a ratio of >1.3 while blue region reflects protein decreased by a ratio<0.7 in the LD proteome of macrophages infected with live Mtb to that of heat killed Mtb

Principal Collaborators



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Abdou Rachid Thiam
Ecole Normale Supérieure
Paris

Objectives

- To study role of vesicular trafficking proteins in lipid trafficking to intracellular Mtb
- To identify mechanism for ARL8B recruitment to lipid droplets
- To identify mechanism of ARL8B dependent lipid homeostasis during infection

Understanding mechanobiological basis of the evolutionary diversity in spindles dynamics of nematodes

Principal Collaborators



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Indian Institute Science Education and Research
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Marie Delattre
Laboratoire de Biologie et Modélisation de La Cellule (LBMC)
Lyon

Objectives

To understand to what extent biophysical parameters of the cell evolve during asymmetric embryonic cell division in diverse nematode species by

- Estimating the variability in forces acting on the spindle in 10 selected species;
- i) Exploring evolutionary changes in spindle dynamics using in silico simulations
- ii) Experimentally perturbing the mechano-chemical components of the spindle/model testing

Biological Questions Using or Developing Mathematical, Computational or Physical Approaches

Project No. 62T5-1

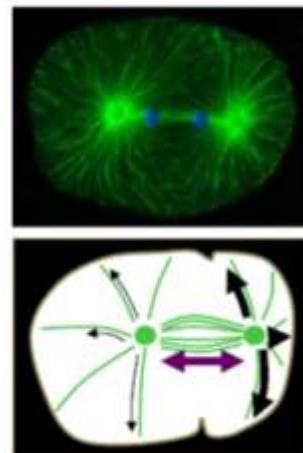
Feb. 2020 to Jan. 2023

Background

Evolutionary theory and practice has for long remained distinct from cell biology. The remarkable conservation in basic cell functions across organisms however raises a vital question: to what extent do cellular mechanisms evolve without disrupting the basic function that they sustain?

French PIs team pioneered the study of the first asymmetric embryonic cell division of nematodes as a model to address this longstanding problem. In parallel, the lab of Indian PIs has been simulating the transport and positioning of microtubule (MT) asters during spindle assembly by molecular motors. By reconciling computer simulations to experiments, they have identified some principles of aster positioning based on motor-MT mechanics.

The project will focus on i) measure key biophysical parameters in 10 species displaying the most divergent phenotypes when compared to *C. elegans*, ii) extend pre-existing mechanical models of the spindles and phenocopy the different species by changing parameters and iii) test the model by experimentally perturbing the cytoskeleton and its associated proteins in embryos. The results are expected to reveal novel cross-disciplinary insights in the study of asymmetric cell division and the evolution of cellular systems.



One-cell embryo of *C. elegans* (Mts in green and Dna in blue). Below schematic representation of the spindle (green) and the asymmetric pulling forces (black). Posterior side of the cell is to the right

New electron sources based on nonmetallic nanoneedles for ultrafast electron bunches

Multifunctional Materials and The Underlying Science

Project No. 62T8-1

Feb. 2020 to Sept. 2023

Background

Project aims to develop new ultrafast electron sources due to One-dimensional (1D) heterostructures illuminated by femtosecond (fs) laser pulses. The field electronemitters (cold cathodes) owing to their unique features such as monoenergetic, low power consumption, high brightness, miniature size, etc., are superior to the thermionic emitters and thus, being used in electron microscopes, X-ray sources, and Electric Propulsion Thrusters for space applications. In addition, thermal-field and photo enhanced field emitters have been developed to relax the stringent operating conditions imposed by pure field emitters. In the context of photo-field emitters, various semiconducting nanostructures (CdS, TiO₂, SnS₂, Bi₂Se₃, etc.), along with CVD diamond been investigated subjected to light illumination using lamps (polychromatic and noncoherent sources). Project proposes to develop new ultrafast electron sources due to novel 1D heterostructure emitters illuminated by femtosecond laser pulses, which has been unexplored at international level. Proposed hetero structure emitters be comprised of rare earth hexaborides (LaB₆ and GdB₆), wide band gap semiconductor (HfO₂) coated Si nano needles, and CVD diamond mico-nanocrystalline (un-doped and N-doped) thin films grown on Si substrates. Furthermore, attempts will be made to reveal the underlying physics and understand the mechanisms of electron emission from these hetero structure emitters under ultra-short laser (fs) illumination.

Principal Collaborators



MA More
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Pune



Angela Vella
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UMR6634, University of Rouen
Rouvray

Objectives

- To develop and optimize novel field emitters due to Si nano needles coated with ultra-thin layer of rare earth hexaborides (LaB₆ and GdB₆), and wide band gap semiconductor (HfO₂). Optimization of process variables followed by physico-chemical characterization
- To characterize these new electron sources by the combination of various techniques including high resolution TEM, Atom probe tomography and ultraviolet Photoelectrons spectroscopy (UPS)
- To characterize the field emission properties of these new electrons sources with and without femtosecond laser illumination. Optimization of the illumination conditions to enhance the specific features of these sources
- To reveal the underlying physics and provide better understanding of the laser-matter interaction under high electric field, at the origin of the laser assisted field emission process

Q-Walker: programmable quantum dynamics simulator

Principal Collaborators



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Shannon Whitlock
Université de Strasbourg
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Objectives

- Realisation of the Q-Walker programmable quantum dynamics simulator
- Quantum transport enabled network tomography

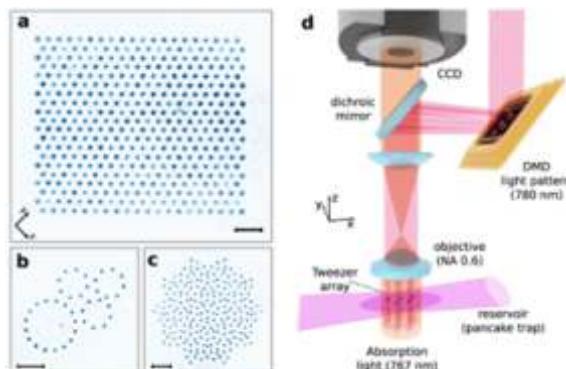
Exotic States of Materials and Quantum Criticality

Project No. 62T9-1

Mar. 2020 to Feb. 2022

Background

The transport of energy, charge and information is of fundamental importance in nature and technology as it plays key roles in diverse settings ranging from chemical reactions to the operation of nano-electronic devices and future quantum information networks. Q-Walker: the programmable quantum dynamics simulator will leverage strong and long range dipolar state-changing interactions between Rydberg dressed ultra-cold atoms to improve understanding of quantum transport, but under very controllable conditions concerning the spatial and temporal scales and coherence properties. By preparing the atoms in programmable arrays of optical micro-traps, it is proposed to study how a quantum of excitation migrates through non-trivial networks with different system-bath interactions and find general laws linking key transport quantities with the underlying network topologies. This can ultimately lead to novel exotic light harvesting materials, exploiting room temperature quantum coherence. A crucial ingredient of this project is the intensive interaction between theory and experiment, which will be needed to bring Rydberg-atom quantum simulation to full maturity where it can compete with and exceed state-of-the-art classical quantum dynamics simulations. One of the outcomes of these studies will be to find conditions which lead to the most robust and efficient transport through quantum networks, with importance for PIs understanding of whether quantum coherence may affect biological light harvesting and potentially inspiring future quantum devices based on single-molecule emitters, dye sensitized solar cells or two-dimensional optoelectronic materials. It is also proposed to find out how characteristic transport quantities are linked to the topology of different quantum networks. In this way, it may extend the notion of random walk network tomography to the quantum realm, serving as a powerful new tool for classifying complex networks and for revealing quantum correlations in many-body systems.



Quantum simulations of 2D spectroscopy (a) Two-dimensional spectrum of Rydberg dimer, (b) comparison between simulation and analytical calculation. (c) The 2D spectrum is obtained by interrogating Rydberg dimers in an ultra cold gas through microwave pulses

Fluorescent-amyloid-beta peptides to study interaction with copper, aggregation and reactive oxygen species

Biological Chemistry

Project No. 62T10-3

Mar. 2020 to Feb. 2023

Background

Copper and zinc ions are highly accumulated in amyloid plaques, a hallmark of Alzheimers disease (AD). They are coordinated to the peptide amyloid-beta (Abeta), the main constituent of these amyloid plaques in which it is present in aggregated forms. However, it is not known at which time point or in which aggregation state metal ions bind to Abeta *in vivo*. There is a large body of evidence that a dyshomeostasis of Abeta, Zn and Cu ions occurs in AD. Approaches to restore the homeostasis of Abeta and metal ions have shown a limited success so far. The current compounds used to intervene in metal homeostasis with a therapeutic aim were rather unspecific metal ion binders. Targeting specifically Cu instead of Zn seems to be of interest as Cu, but not Zn, is able to catalyze the production of reactive oxygen species and hence to induce oxidative stress, a key feature commonly observed in AD.

The project aims at developing luminescence tools to monitor several critical events linked to the etiology of AD at physiologically relevant concentrations in the test tubes and in cell cultures. The targeted events are: i) the binding of Cu ions to Abeta and their release, ii) the production of reactive oxygen species by the Cu-Abeta complex. These new tools will then be combined with established and commercial available tools to study the oligomerization of the Abeta peptide. Then, these tools will be used to follow Cu events, iii) at physiological relevant concentrations (nM to low μ M) in the test tube and in more biological relevant environment like cell medium or cell culture. These tools will provide fundamental mechanistic insights and enables to test *in situ* via sensitive fluorescence the effects of compounds with therapeutic interest for their impact on Cu binding, aggregation and ROS inhibition in more physiological relevant conditions.

Principal Collaborators



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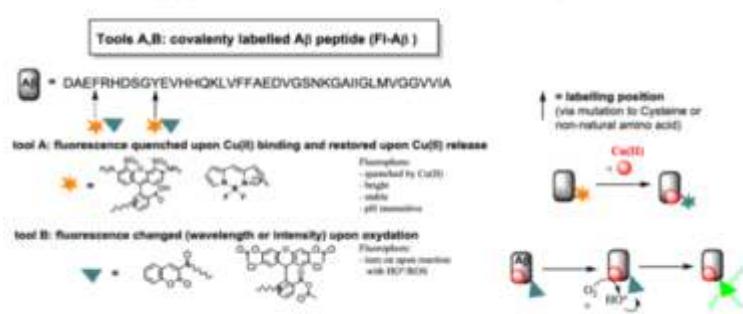


Peter Faller
Université de Strasbourg
Strasbourg

Objectives

Synthesis and validation of different fluorescence labelled amyloid-beta peptides (Abeta) enabling to:

- measure Cu(II)- binding and release of Abeta
- monitor aggregation of Abeta - measure reactive oxygen species production by Cu-Abeta all at low concentration and in a biological relevant medium





5. Brief Reports of Research Projects

B. Industry Academia Research & Development Programme

Adhesive bond inspection technique development using Electro Magnetic Acoustic Transducer (EMAT) for aerospace company

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



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French Partners



Michel Castaings
Université de Bordeaux
Talence



Oudea Coumar
Ariane Group SAS
Pessac

Domain: Aerospace

Apr. 2014 to Jan. 2020

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

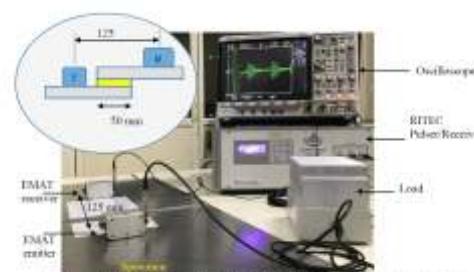
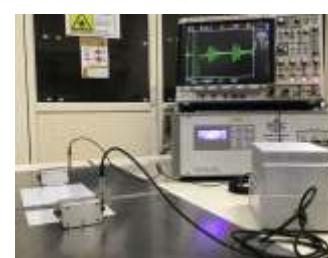


Fig. 8 Photograph of the experimental set up. Inset shows the schematic of the distance between the probes



Customer behaviour on travel marketplaces (for e-commerce): modelling and decision support

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

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

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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French Partners



Christine Balagué
Institut Mines -
Télécom Business School of Management
Evry



Pierre-Alexandre Chiron
Planet Ride
Paris

Development of loop heat pipe for avionics and terrestrial applications

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



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

French Partners



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Claude Sarno
Thermal Systems Packaging
Thales Avionics (THALES)
Valence

Domain: Avionics

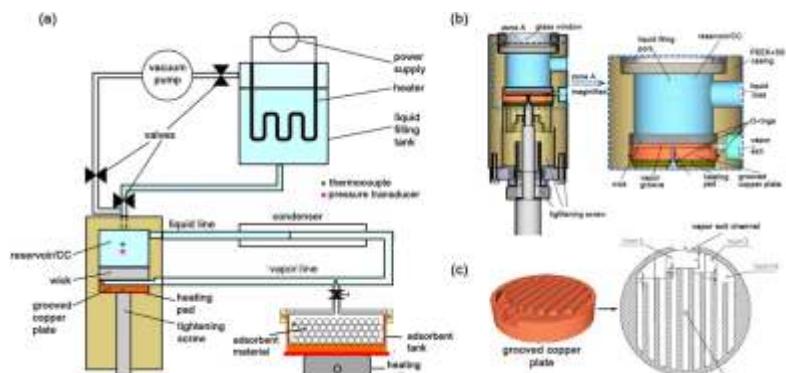
Apr. 2017 to Mar. 2020

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

- Copper and Nickel wicks have been developed
- Optimization of Nickel wicks is in progress
- Loop heat pipe with Copper wicks has been performance tested. Some design issues due to higher heat leak from the evaporator to the compensating chamber have been identified and are being addressed. This will enhance the performance even further
- LHP at INSA Lyon has been made operational and an adsorber based anti-freezing system (patented by INSA) has been tested by the post doc scholar. This is importance from avionics application point of view



(a) Schematic of the experimental setup with the LHP connected to the adsorption tank (b) Enlarged view of the evaporator/reservoir section of the LHP designed for experimental purpose (c) Design of grooved copper plate used as evaporator in the LHP

Piezoelectric actuator systems for automotive translation systems (PASATS)

Domain: Automotive

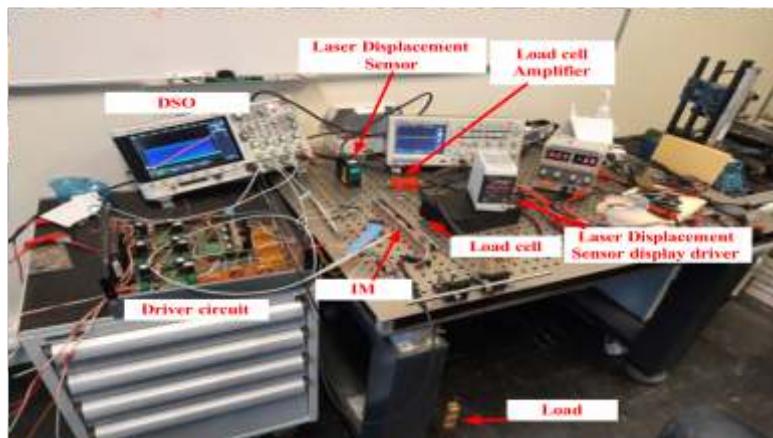
Feb. 2017 to Sep. 2020

Objectives

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

Knowledge Generated/Products Developed

- Prototype development of the actuation system comprising novel designs of Inchworm Motor for two different configurations
- Experimental analysis of the actuation system under different laboratory test cases
- Development of non linear control regimes for piezoelectric actuator based Inchworm motor
- Design and experimental analysis of power electronics drive circuit for high voltage, high frequency actuation
- Collaboration between French the Indian side to test actuation system test under high frequency (2kHz), publication of research output – IPR generation and HRD training



Experimental test bench to measure speed of the Inchworm motor at high frequency in loaded and unloaded condition (In French Laboratory)



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.

Indian Partners

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French Partners

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Faurecia / CentraleSupélec / Esigelec
GeePs, Gif-sur-Yvette

Yves Bernard
Ignacio Alvarez
Brières-les-Scellés

Packmark-development of new anti counterfeit printing techniques for medicine packaging

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.

Indian Partners



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Mr. Ashish Bhattacharya
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French Partners



Tremeau Alain Anne
Laboratoire Hubert CURIEN
(UMR 5516)

Domain: Printing

Aug. 2017 to Jun. 2021

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](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

- Introduction of variable watermark to protect specific time dependent information of the pharmaceutical product
- Use of Color Characterization for Printing Authentication
- Study for the effect of temporal stability of the printed watermark against light exposition, humidity rate, etc. has been completed
- Study of the lightfastness properties of prints on blister foils by spectral reflectance"
- Study on Artificial neural network approach to predict the lightfastness of gravure prints on the plastic film has been completed -to Predict the Waterfastness Rate of Foil Print Applying Artificial Neural Network



Presentation of Scholar in JU on December 2019

Reactive programming and compilation for the redefine manycore

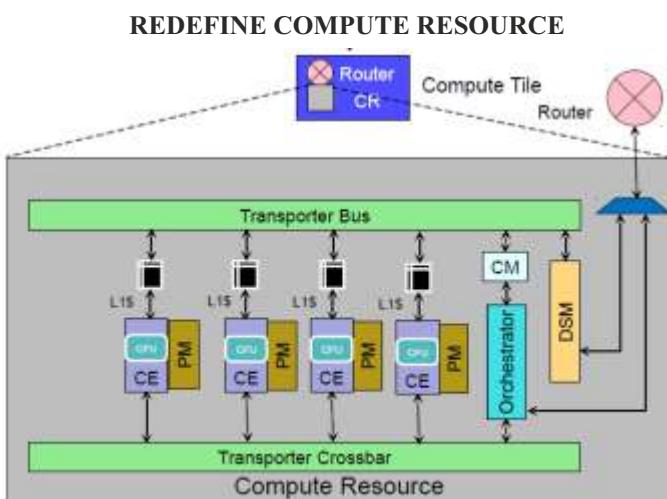
Domain: Comp. Sc. Feb. 2018 to Jan. 2021

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 research 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



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

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



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*Safran Electronics and Defense
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Marc Pouzet
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Cost-effective strategy for the induction of immune tolerance to the therapeutic factor VIII in hemophilia A

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

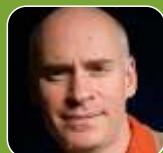


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Domain: Immunology

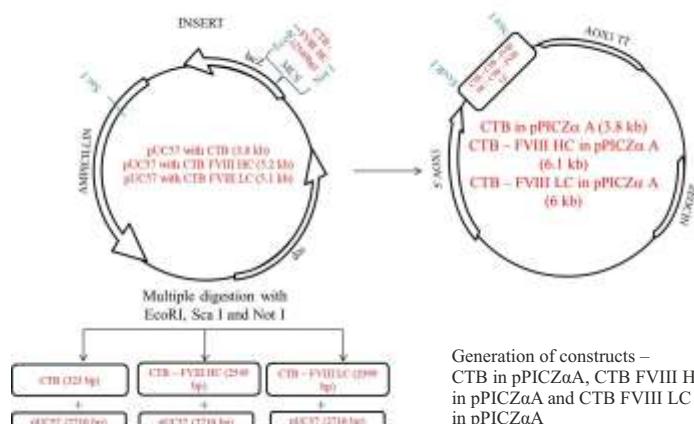
May 2018 to Apr. 2022

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 FVIIIC, FVIIILC, CTB-Fused FVIIIC 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 (FVIIIC)
 - (c) Factor VIII Light Chain (FVIIILC)
- Custom made cDNA clones in pUC57 were procured from Genscript, NJ USA
 - (a) CTB
 - (b) CTB fused with FVIIIC 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-FVIIIC
 - (c) pPICZ alpha containig CTB-FVIIILC



ONGOING 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 Nov 2021

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

- A proof of concept was developed for recovery of rare earths from spent NdFeB magnets using chloridizing roasting and water leaching method. Various parameters such as roasting temperature, time and quantity of chloridizing agent was studied and optimized. The rare earths from roasted NdFeB powder were selectively recovered and iron oxide remained in the leach residue
- High pure mixed rare earth oxide of neodymium, praseodymium and dysprosium was prepared from the leach solution, which could be used in pigment industries
- Design and synthesis of lipophilic hydromagnetic and EDTA/DTPA ligands and solubility of the ligands in organic diluents and ionic liquids
- Studies and optimisation of process parameters for the separation of rare earth ions (Nd, Pr, Dy) by solvent extraction
- MD simulations of the liquid-liquid interface reveal that, under conditions relevant to the SX of REEs by acidic ligands, the interface is 'rough' with a variety of complexes formed between the ligands, metal ions and water molecules. The structural and dynamic features of the interface is intimately related to the chemical heterogeneity at the interface. De-protonation of acidic ligand is a necessary condition for the formation M-L complexes at the interface and their eventual extraction into the organic phase
- Extraction experiments using a combination of a neutral (TOPO) and acid ligand (D2EHPA) did not depict any synergism in the extraction of water and nitric acid over a range of aqueous phase pH. With increase in the aqueous phase acidity and the proportion of TOPO in the mixture, nitric acid was preferentially extracted over water. MD simulations revealed the nature of complexes formed by a mixture of TOPO, D2EHPA, nitric acid and water in the organic phase at varying TOPO:D2EHPA mole fractions
- Machine learning models have been developed to predict the lanthanide ligand binding affinities under a variety of conditions. For the first time ever, a large scale prediction of the binding affinities of all molecules in the pubchem database with all the lanthanide ions has been carried out

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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French Partners



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Christian Louis Thomas
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Lille

Design of flexible sweat sensors and stretchable batteries embedded in e-textile to monitor personal health and fitness parameters

Background

The innovative approach of the microbattery technology relies on the assembling of two stretchable substrates carrying arrays of serpentine micropillar electrodes and being separated by a self-healing polymer electrolyte. The technological approach proposed in this project is new in terms of 1) Achieving the fabrication of a stretchable micropower source fully integrated into the wearable device. 2) Attaining high electrochemical performance and long life due to the use of 3D microstructured electrodes and a good electrode/electrolyte interface that can be restored (polymer with self-healing properties). Compared to results reported in the literature, the design proposed in this work will lead to stretchable batteries showing high energy and power densities as well as long lifetime under multiple engineering strains.

Indian Partners



Alok Nath De
Samsung R&D Institute India
Bangalore



Siddhartha Panda
Indian Institute of Technology
Kanpur

French Partners



DJENIZIAN Thierry
Ecole Nationale Supérieure
Des Mines De Saint-Etienne,
Provence-Alpes-Côte Dazur



David Noel Christophe
@Health, Provence-Alpes-Côte Dazur,
Aix-En-Provence

Domain: Nano Materials | Aug. 2019 to Jul. 2022

Objectives

- Flexible biosensor design for sweat analysis
- Fabrication and optimization of a new stretchable microbattery
- E-textile design and integration
- Electronic system design and device prototype

Knowledge Generated/Products Developed

- Sweat sensor design and a corresponding machine learning model to estimate/predict blood sugar levels from sweat biomarkers
- A stretchable microbattery design and prototype with high areal capacity ($>> 1\text{ mAh/cm}^2$)
- A wearable platform that integrates the sweat sensor, battery with a processing and communication module
- A prototype device with the biosensors and battery integrated into e-textile



Conceptual design of the sensing unit, its construction and integration in a wearable device





5. Brief Reports of Research Projects

C. Targeted Programmes

Learning from bigdata: First-order methods for kernels and submodular functions

Background

Machine learning is a recent scientific discipline involving Applied Mathematics, Statistics and Computer Science. Its goals are the optimization, control, and modeling complex systems from observations generated by the system. It applies to data from numerous engineering and scientific domains (e.g., vision, bioinformatics, neuroscience, audio processing, text processing, E-Commerce, 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.

Completed Project

Jul. 2016 to Jun. 2019

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 to ensure approximate solutions are always accompanied with a guarantee on their in-feasibility. PIs also presented improvement in oracle complexity for different smoothness classes
- In linear regression PIs proposed to identify groups of variable by introducing the family of Smoothed Ordered Weighted L₁-norms (SOWL) which allows the model to be flexible inside a group. We also presented a computationally efficient way to compute the norm and its proximal operator
- For graph transduction learning problems we proposed spectral regularized orthonormal embedding formulation based on learning theoretic bound. PIs also designed an efficient first-order algorithm to solve the resulting optimization problem which is a computationally challenging SDP

Principal Collaborators



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SIERRA, INRIA Paris-Rocquencourt

Publications

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

Mobility Support

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

Reflection aware ICC analysis framework for android apps

Completed Project

Jul. 2016 to Jun. 2019

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.
- A hybrid approach that uses static analysis as pre-processing to identify reflection APIs and their targets (slices) for more time-efficient dynamic analysis with better code coverage

Principal Collaborators



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Jaipur



Akka Zemmar
LaBRI, Université de Bordeaux
CNRS
Bordeaux

Publications

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

Mobility Support

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

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).

Modelling and control of mobile co-operating bionic arms

Background

The project is about modelling and control of mobile cooperating bionic arms. It involves modelling, fault tolerant control, validation of control, communication and coordination among robots, reconfiguration of robot systems. Improve the performance of the overall control and supervision of collaborative system of bionic handling manipulator robots, based on unified modeling for both organizational and behavioral aspects.

Completed Project

Jul. 2016 to Jun. 2019

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
- Dynamic model of cooperative special bionic manipulator has been done. Model based control of cooperative special bionic manipulator has been achieved
- Development of a controller for the bionic soft manipulator taking care of the load at end effector has been done
- Development of a fault tolerant control/reconfiguration scheme for a bionic soft manipulators for different fault scenario has been done

Principal Collaborators



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

Publications

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

Mobility Support

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

Study of privacy accounting and ownership in IoT

Completed Project

Jul. 2016 to Jun. 2019

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

Devised a new primitive, termed as Private Polynomial Evaluation (PIPE), and validated this primitive with a formal security model, which is a novel contribution to the scientific community

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**.

Principal Collaborators



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Publications

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

Mobility Support

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

Polyhedral compilation and optimization for dataflow programming languages

Background

The project aims to develop new scalable compiler optimization techniques based on the polyhedral framework. The polyhedral framework is an abstraction relying on linear algebra and linear programming to represent, analyse, transform, and optimize sequences of loop nests for parallelism, locality, and memory usage. The framework has been used in compilers for general-purpose languages, high-performance domain-specific languages, and data-flow programming languages such as LabVIEW. Our work will be structured into two complementary tasks, in which we will leverage our common background and tool flows to experiment with new language semantics and compilation algorithms. PIs will also continue our investment into more mature demonstrators, within software tools developed in our groups (e.g., Pluto+, PolyMage, LLVM/Polly, and ISL), most of them free software, and through direct industry transfer.

Completed Project

Jun. 2016 to Jun. 2019

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
- Provided an LP-based approach for the polyhedral compilation of loop nests capable of determining schedules competitive with state-of-the-art optimizers; PIs identified connections between the solutions of the ILP and the relaxed LP formulations of Pluto
- Proposed a new automatic transformation framework, pluto-lp-dfp, that decomposed the affine scheduling problem into fusion-cum-permutation scaling-cum-shifting, and skewing components
- 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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Publications

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

Mobility Support

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

IoT software testing using timed automata

Ongoing Project

Nov. 2017 to Nov. 2020

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

- Partial order reduction for timed automata
- Liveness verification for timed automata: Work on liveness for timed automata commenced during the first year has been accepted for publication in the journal ACM Transactions on Computational Logic (ToCL)
- Timed automata with diagonal constraints
- Open source tool T-Checker released: An open source tool for real-time modelling and verification using timed automata has been released in the last year
- Formal semantics for EDT: A preprint of the formal semantics for Expressive Decision Tables is ready

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.

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: 2

Looking beyond backpropagation in deep learning

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.

Ongoing Project

Nov. 2017 to Oct. 2020

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 MM algorithms
- Parallel / distributed versions + numerical implementation on GPGPUs
- Block alternating proximal algorithms

Principal Collaborators



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Publications

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

Mobility Support

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

Modelling of human intention during gait rehabilitation

Ongoing Project

Nov. 2017 to Oct. 2020

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

- Validation of CSIR-CSIO developed Wireless Foot Sensor Module (WFSM) performance w.r.t. high precision digital encoder integrated in NAO bipedal robot during dynamic gait
- Model for estimation of Zero Moment Point (ZMP) for bipedal walking from force as well as joint angle data measured using developed WFSM
- Organised three day workshop in the emerging area of Robotics for Rehabilitation (Robo-Rehab 2019) at CSIO Chandigarh, involving a network of different French experts, Indian experts and Healthcare experts/technologists

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.

Principal Collaborators



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Publications

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

Mobility Support

- India to France: 7
- France to India: 4

Machine learning for network analytics

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.

Principal Collaborators



Vivek S. Borkar
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Konstantin Avrachenkov
*Inria
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Publications

- No. of publications in SCI journals : 4
- No. of papers presented in conferences: 6

Mobility Support

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

Ongoing Project

Dec. 2017 to Nov. 2020

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

- Reinforcement learning algorithms for learning threshold policies and Whittle index policies in Markov decision processes
- Opinion shaping on networks
- Analysis of content caching and delivery schemes under various settings
- Dynamic urn models and their algorithmic applications

Formal verification of autopilot software for UAVS

Ongoing Project

Nov. 2018 to Oct. 2021

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

- Instead of verifying a traditional autopilot, first create an autopilot that is driven by a controller synthesized in the form of a Deep Neural Network (DNN)
- Model this autopilot and the closed loop system in the ROS Gazebo simulator
- Translate the closed loop model manually to a hybrid system with the dynamics of the quadcopter and the DNN controller
- Develop a framework for verifying a closed-loop dynamical system with DNN controller
- Verify the UAV Autopilot with the DNN controller
- Update the DNN controller automatically to satisfy the safety requirements

Knowledge Generated/Products Developed

- Created an autopilot software that is driven by a controller synthesized in the form of a Deep Neural Network (DNN)
- Model this autopilot and the closed loop system in the ROS Gazebo simulator
- Translated the closed loop model manually to a hybrid system. The closed loop model contains the dynamics of the quadcopter and the DNN controller
- Evaluated the currently available tools for verifying closed loop systems with DNN controllers, for example Verisig from UPenn and Sherlok from University of Colorado Boulder
- In the process of developing a framework for verifying a closed-loop dynamical system with DNN controller

Principal Collaborators



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Publications

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

Mobility Support

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

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]).

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.

Efficient quantitative verification

Ongoing Project

Sep. 2018 to Aug. 2021

Objectives

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

Knowledge Generated/Products Developed

- Regarding timed and concurrent systems:
 - First, the work on Free choice time Petri nets has resulted in a journal paper [AHP19]. Subsequent work on boundedness problems for this class is underway and PIs expect results soon
 - Defined a new model of time and concurrency, namely timed negotiations, generalizing the negotiation primitive. Work on this has been submitted and is under review
 - Developed a new logical approach to analyze timed systems, published in conference [AGJK19]
 - Started two lines of work on resilience and attack synthesis in timed systems
- Regarding stochastic systems progress on two fronts:
 - Work on uniform control of populations of finite state protocols initiated last year was accepted in a journal (LMCS) [BDGGG19]
 - Classification problems for partial observation of systems depicted by hidden Markov Models accepted at FSTTCS 2019 [ABG19]

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: 3

Games and optimization for energy management with stochasticity (GOEMS)

Ongoing Project

Sep. 2018 to Aug. 2021

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

Knowledge Generated/Products Developed

- Proposed a primal-dual pair of second order cone programs whose optimal solutions give a saddle point equilibrium of a zero-sum chance constrained game. PIs published this result in European Journal of Operational Research. The journal is highly reputed in the field of operations research
- Considered n-player distributionally robust chance constrained games with joint chance constraints. For various uncertainty sets, PIs showed the existence of Nash equilibrium. Based on these results PIs have submitted a research paper to an international journal
- Showed existence of Nash equilibrium for an n-player stochastic Nash game with individual chance constraints. PIs proposed an equivalent optimization problem to compute Nash equilibrium. PIs have also performed some numerical test

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 constraints & its equivalent formulations as mathematical programs, complementarity problems and variational inequality problems.

Principal Collaborators



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Publications

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

Mobility Support

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

FOGCITY: QoS-aware resource management for smart cities

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. 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.

Ongoing Project

Aug. 2018 to Jul. 2021

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

Knowledge Generated/Products Developed

- Designed a pricing-based resource management scheme, named FogPrime, for fog networks
- In FogPrime, used dynamic coalition-formation game with transferable utility to allocate resources in intra-cluster of fog networks
- Additionally, used utility game to allocate resources in inter-clusters of fog networks
- Simulated the proposed scheme, FogPrime, in a python-based simulation platform, and compared the performance of FogPrime with the existing schemes

Principal Collaborators



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Publications

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

Mobility Support

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

Monitoring and modelling of the Mahanadi river basin in preparation of the SWOT

New Project

Jan. 2020 to Jan. 2023

Objectives

This project associates the expertise of two teams in the cal/val, the processing and interpretation of satellite data for the spaceborne monitoring of the water cycle. It is also an opportunity for the altimetry mission SWOT to be better validated and consequently better renowned and valued by academics and stakeholders working in the domain of the water cycle in the Indian Subcontinent. During the project, PIs intend to

- Calculate water level time series with all the past and in-flight altimetry missions. In this work, PIs will pay a particular attention to:
 - The measurements of the SARAL mission (2013-2016) since it was (1) the first Indo French altimetry mission and (2) its altimeter AltiKa was the only one operating in the Ka band, as SWOT will
 - The measurements collected today by the SENTINEL-3 missions of the EU COPERNICUS space program since they are planned for two decades at least, hence they will still operate in 2021, at the time of SWOT
- Assess the quality of these series in the basin by comparison with the gauge data and with model outputs. In this work PIs will collaborate with researchers leading the Indo-French satellite mission MEGHA-TROPIC. This mission is dedicated to measure hydrometeors in the Tropical band. Owing to this collaboration, we will analyze the ability of different hydrological (rain-discharge)/hydrodynamical models in retrieving more or less accurately the water flows in the basin when different rain field data are used as input
- Gather, inform, train people potentially interested in joining a larger project on this question

Background

Over the last two decades, existing studies have documented applications and validation studies of satellite altimetry over many large river basins of the World, although these missions were primarily designed for the oceans, including the Indo-French mission. The first dedicated mission for measurement of river stages, the Surface Water and Ocean Topography (SWOT) mission is proposed to be launched in 2021. The river stage measurements from SWOT shall empower hydrologists to detect transboundary flows for downstream nations by providing observations of width, height and slope for large terrestrial water bodies. [Bonemma and Hossain [2017] Pavelsky et al. [2014] Biancamaria et al., [2010] have examined the potential of SWOT observations to terrestrial hydrology. SWOT shall provide worldwide mapping of river levels over $\sim 2 \times 60$ km swath with a repeat cycle of 21 days with a spatial resolution of at least 100 m. The quality check for the SWOT products requires an absolute vertical accuracy of ± 5 cm at 1σ (minimum) or ± 2 cm at 1σ (target). Because SWOT will use a highly innovative technology, a Ka band wide swath altimeter (instead of pulses emitted sequentially along-track at the nadir), a specific phase will take place right after the launch for a 6 week period. Intense Calibration/validation works (hereafter cal/val) operations are planned to be conducted during this phase. They are based on the monitoring and modeling of the water cycle in very specific places, actually those water bodies lying under the swaths of the 1 day repeat orbit. Such works are already being carried out in good progress in USA, France, South America and some African basins. There is lack of such studies over South Asian countries like India. Therefore, we have selected the Mahanadi basin to be the first cal/val site for SWOT in India. When satellite track crosses over river segments, they present an opportunity to assess the quality of satellite altimetry data. This is owing to the independent measurement of information of the same water body. The motivation of our study stems from a need to compare satellite derived time series for river stages with readings at in situ gauges. If 2 km is roughly the half width of the radar beam over flat surface, a satellite track can be considered to pass over an in-situ station when the station be located less than 2 km from the satellite track. In accordance with the report by Central Water Commission (CWC) of India, Mahanadi basin has a total of 18 gauge stations (G), 3 gauge + discharge (GD) stations, 1 station for measuring gauge, discharge and water quality (GDQ), 17 stations for measuring gauge, discharge, silt and water quality (GDSQ) respectively. Our study is proposed to be repeated during the SWOT temporary orbit with a fast sampling rate (with 1 day repeat orbit) during the cal/val work.

Principal Collaborators



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LOC approaches for Separation and Analysis of Exosome derived biomarker for Cancer Prognostic

Background

Cancer is one of the most lethal malignancies. Exosomes, which are released by multiple cell types, such as cancer cells, contain functional biomolecules (including proteins, nucleic acids and lipids) that can be horizontally delivered to recipient cells. Exosomes act as the most prominent mediator of intercellular communication and can regulate, instruct and re-educate their surrounding microenvironment and target specific organs. Contamination of exosome preparations with non-exosome proteins can lead to incorrect conclusions about exosome biological activity. The scarcity of tumor-derived exosomes and microvesicles relative to those originating from healthy cells, their overlap in size with other nanoscale objects present in clinical samples, and the short half-life of protein surface markers once removed from the body further complicate these measurements. While next-generation deep sequencing (NGS) provides fast profiling of miRNA or other biomarkers in biological fluids, including from exosomes, liquid biopsy sample preparation is sometimes crucial to reliably differentiate between diseased and healthy patients. The characterization of tumor derived Exosomes for different cancer cells is very essential to develop a bench top system suitable for cancer prognostic and hence a detailed study is required for the same. Nanoscale vesicles that originate from tumor cells and which can be found circulating in the blood (i.e. exosomes and microvesicles) have been discovered to contain a wealth of proteomic and genetic information to monitor cancer progression, metastasis, and drug efficacy. Because exosomes can be secreted from both the healthy and tumor cells, samples collected from cancer patients usually contain a mixture of normal and tumor-derived exosomes. Over the past several years, considerable progress has been made in the development of methods for the isolation and specific detection of exosomes in body fluids. However, the use of exosomes and microvesicles as biomarkers to improve patient care has been limited by their small size (30 nm– 1 µm) and the extensive long time sample preparation required for their isolation. Similarly, conventional detection techniques such as western blotting and enzyme linked immunosorbent assays (ELISA) require large amounts of sample and extensive technical steps for detection. Additionally, most of these methodologies are limited to specifically quantifying tumor-derived exosomes in bulk exosome mixture. In this case, the isolation of exosomes can improve the sensitivity of biomarker amplification and reduce the number of false-negative results. Therefore, there is still a strong interest to imagine and develop innovative concepts enabling exosome separation and selective exosome-derived analytes detection in small volume of sample, with high reliability, sensibility and selectivity. In that context, the overall objective of this proposal is to put in place the first elements of a new method to Separate and Analyse Exosome derived protein for Cancer Prognostic. We propose a microfluidic approach coupling hydrodynamic and acoustofluidic separation of exosomes with electrochemical detection.

New Project

Jan. 2020 to Jan. 2023

Objectives

- LOC based exosome separation: The aim of this task is to develop a microfluidic module enabling the separation of exosomes from the biological sample (blood in our case) and their sorting according to their size. Hydrodynamic and acoustofluidic methods will be investigated
- Detection of exosome derived protein by nanomaterial-based electrochemical system for cancer diagnosis: Electrochemical based biosensors have been shown to be a promising alternative to mass and fluorescence-based sensors for the specific detection of exosome or which is the biomarker for liquid biopsy. Exosome or exosome-derived proteins etc. are believed to be important for cancer diagnosis and prognosis serving as reliable molecular biomarkers. In this work, PIs propose an electrochemical sensor for exosome or exosome-derived protein detection based on the different nanomaterials. Specifically, exosome or exosome-derived proteins will be captured by the pre-immobilized probes on the electrode and recognized by electrochemically active redox mediator
- Coupling all the suitable methods to realize an Integrated LOC platform for Exosome derived protein analysis: The objective of this task is to demonstrate LOC compatible exosome separation and electrochemical analysis of exosome derived protein. Lab On Chip platform (i.e., one that involves the fusion of acoustics and microfluidics) which can isolate exosomes directly from biofluids like blood samples. This LOC based, automated point-of-care system allows single step, on-chip isolation of exosomes from biological fluids (such as blood, urine, saliva, plasma, and breast milk) or in vitro cell cultures. It also represents a unique integration of exosome isolation Module, exosome lysis module and electrochemical sensing module

Principal Collaborators



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France-India Group for High Technology Equipments at Colliders

New Project

Sep. 2020 to Aug. 2023

Objectives

The HH production as well as the VV scattering are rare processes that will greatly profit from the increase of luminosity expected at the LHC and the HL-LHC. The next three years are absolutely crucial to understand the capability of the actual CMS experiment at the LHC and of the upgraded experiment at HLLHC. The research and developments concerning a new high granularity calorimeter (HGCAL) for electron and photon measurements, energy flow and timing measurements for the forward (large rapidity) regions in CMS are expected to converge within the next three years. Understanding the sensitivity to new physics in HH production and VV scattering in the actual and future CMS experiments is on the critical path for the CMS experiment.

With this French-Indian FIGHTEC project, PIs intend to contribute to the performance studies for HGCAL in test beam before the final detector production, contribute to the electron clustering and identification for HGCAL in situ, with machine learning techniques for shower analysis, contribute to the legacy analysis for the search of HH production at LHC, and study the impact of very forward reconstruction of electrons with HGCAL on physics in the scalar sector and for VV scattering n searches for physics beyond the standard model of particle physics.

Background

Following the discovery of the Higgs (H) boson in the year 2012 by the ATLAS and CMS collaborations at the Large Hadron Collider (LHC), the experiments are now focusing on the new physics searches opportunities offered by the LHC and the future high luminosity LHC (HL-LHC).

The measurements of the H boson properties in all the main production and decays channels has shown that it resemble the boson expected in the Standard Model (SM) with a minimal scalar sector containing one doublet of complex scalar fields. The existence of at least one physical boson was predicted by the Brout-Englert-Higgs mechanism and incorporated in the SM for electroweak Z and W boson vector boson interactions. The scalar sector in the SM is responsible for the existence of massive particles and is at the origin of the distinction between flavour families. The H boson is expected to regularize the SM interactions, especially in vector boson (VV) scattering, and allows to extend the validity of the theory beyond the TeV scales. The parameters of the fundamental scalar potential of the SM will be tested via the search for Higgs boson pair (HH) production and via VV scattering at HL-LHC.

The H boson unfortunately introduces a fundamental instability in the theory because its own mass is not protected by any symmetry. This creates a problem in understanding the hierarchy between the scale of electroweak interactions of O (100 GeV) and the scale of a grand unification O(10¹⁶ GeV) or of quantum gravity at the Planck scale O(10¹⁹ GeV). The HL-LHC ultimately allow to better explore the sensitivity to new physics beyond the standard model in connection with possible extension of the scalar sector and the existence of new particles necessary stabilize the scalar sector and solve the hierarchy problem. The HH production and VV scattering measurements at HL-LHC have sensitivity to many new physics models.

Principal Collaborators



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Yves SIROIS
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Exceptionnelle (DRCE),
LLR École polytechnique
Palaiseau

Deep Summarization Evaluation

Background

Automatic summarization is one of the most difficult tasks in Natural Language Processing as it requires a comprehensive understanding of input documents, identification of relevant content, and generation of a synthetic instrument, often subject to a length constraint. Yet, this task is very important in the context of the deluge of varying quality information our generation has to tackle. Even with recent advances in the field, building reliable automatic summarization systems remains a challenge, due to the variety of ways to express important concepts using language. Building better summarization systems requires progress in summarization evaluation metrics, which are used to assess the quality of the summaries they produce. There are two current trends to summarization evaluation: manual and automatic evaluation. Manual evaluation consists in ranking summaries or parts of summaries according to a set of factors such as faithfulness to the original, linguistic fluency... Automatic evaluation focuses more on comparing the system production to a set of human-authored summaries deemed a gold standard. Manual evaluation is more accurate but much more costly than automatic evaluation, and it is often not actionable in a machine learning environment (systems require rapid and repeated evaluation of their output in order to learn how to summarize). Current methods for automatic evaluation fail because they involve a too candid representation of meaning (through word n-grams for ROUGE, for example), a problem which has been identified as a major hurdle for the advancement of the field. This project proposes to tackle automatic evaluation of summaries by tracking how systems select and present information independent of their meaning representations. In order to do so, PIs plan on leveraging and extending advances in machine reading, representation learning and textual entailment, in the context of summarization.

New Project

Jan. 2020 to Jan. 2023

Objectives

- To build extractive and abstractive summarization methods
- To evaluate the summarization system we will use traditional evaluation metrics
- To build textual entailment/ semantic text similarity approaches based on deep learning methods
- To evaluate the summarization system by our text entailment/semantic text similarity approaches

Principal Collaborators



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Design Automation for Intelligent Vision Hardware in Cyber

New Project

Nov. 2019 to Oct. 2022

Objectives

- Automated analysis of machine learning (ML) and deep learning (DL) based (i.e. AI based) vision algorithms for their computational complexity from the perspective of hardware implementation
- Design Space Exploration of ML/DL based vision algorithms with respect to energy and power consumption by examining bitwidth optimization and number system selection
- Automated Design Flow: Vision Algorithm to Architecture with focus on hardware assisted acceleration using Field Programmable Gate Array (FPGA) and FPGA-Systems on Chip
- Examination and deployment of AI techniques using Over the Air (OTA) update principle

Background

The proposed collaborative research work is focused on the design and development of artificial intelligence based embedded vision architectures for cyber physical systems (CPS). Embedded vision architectures for cyber physical systems (CPS), sometimes referred to as “Visual IoT [1]”, are challenging to design because of primary constraints of compute resources, energy and power management. Embedded vision nodes in CPS, when designed with the application of Artificial Intelligence principles and algorithms, will turn into intelligent nodes (self-learning devices) capable of performing computation and inference at the node resulting in node-level cognition. This would allow only necessary and relevant post processed data to be sent to a human or a computer-based analyst for further processing and refinement in results. However, design and development of such nodes is non-trivial. Many existing computer vision algorithms, typically ported to embedded platforms, are compute and memory intensive thus limiting the operational time when ported to battery powered devices. In addition, transmission of captured visual data, with minimal processing at the node to extract actionable insights poses increased demands on computational, communication and energy requirements. Visual saliency i.e. extraction of key features or regions of interest in images or videos captured by an embedded vision node and related post processing for inference using AI techniques is an interesting and challenging research direction. The primary reason being that such an approach is expected to cover a wider range of application specific scenarios than statically determined approaches specific to each scenario involving remote off-loading of compute or scenario specific data on servers. Apart from a general approach to visual saliency in nodes using AI based methods (machine and deep learning methods), another principal goal of the proposed project is also to examine and propose methods that allow rapid deployment of AI techniques in these nodes. Many AI techniques are data driven and for a node to adapt from one environment or application specific scenario to another, rapid deployment of AI techniques over the air (OTA) would be an interesting and challenging research direction.

Principal Collaborators



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6. Analysis of Scientific Activities

CEFIPRA supports high quality research groups through collaborative research projects in advanced areas of basic and applied sciences to nurture scientific competency, making research more competitive and innovative. The partnership between India and France has expanded in a number of areas of S&T and many new engagements especially in field of technological innovation as well as identified thematic priorities have been undertaken for strengthening partnership further.

CEFIPRA over a period of three decades emerges as a unique single window bilateral platform for the Indo-French scientific community having great visibility, and flexible tool to fund research and innovation, thus plays an active role between the two scientific communities in promoting the emergence of collaboration and partnerships. The Indo-French collaboration has helped the scientific institutions & scientists by providing opportunities for transfer of technologies / products / processes / publications / patents / joint PhDs / joint labs. Every year CEFIPRA supported projects made a great impact through their outputs generated. The key for the success of this model was our scientists working jointly and productively. Including industries and R&D labs in their programs has further added value to their programmes.

The research Centre has made significant contributions in terms of creating futuristic networks, greater interaction and linkages opportunities for academia & industries of both nations and enhancing research skills as well as capacity building of young researchers through its dedicated student mobility programmes. Moreover, scientists achieved fruitful results for societal benefits.

Core Programmes

The programmes which are funded by the Centre are called Core Programme like Collaborative Scientific Research Programme (CSRP), Industry-Academia Research & Development Programme (IARDP) and Seminar/workshops etc. whereas for Non-Core Programmes, National Funding agencies for research & development in India and France are coming together and CEFIPRA's role is of a catalyst, facilitator and enabler to reach out to new Indian & French stakeholders with emphasis on developing systematic linkages to support these programmes.

Collaborative Scientific Research Programme

In the year 2019-20, eighteen new projects were initiated under the Collaborative Scientific Research Programme (CSRP), while fifty-six projects were ongoing from the previous years, out of which twenty four were completed during the period. During two calls in the year 2019-20, CEFIPRA received 189 new proposals out of which 22 (11.64%) were recommended for support, after discussion based on scientific merit and importantly on the depth of collaboration.

ANALYSIS OF SCIENTIFIC ACTIVITIES

New proposals received/recommended under Thematic Areas considered during 63rd SC meetings depicted in Figure 1&2:

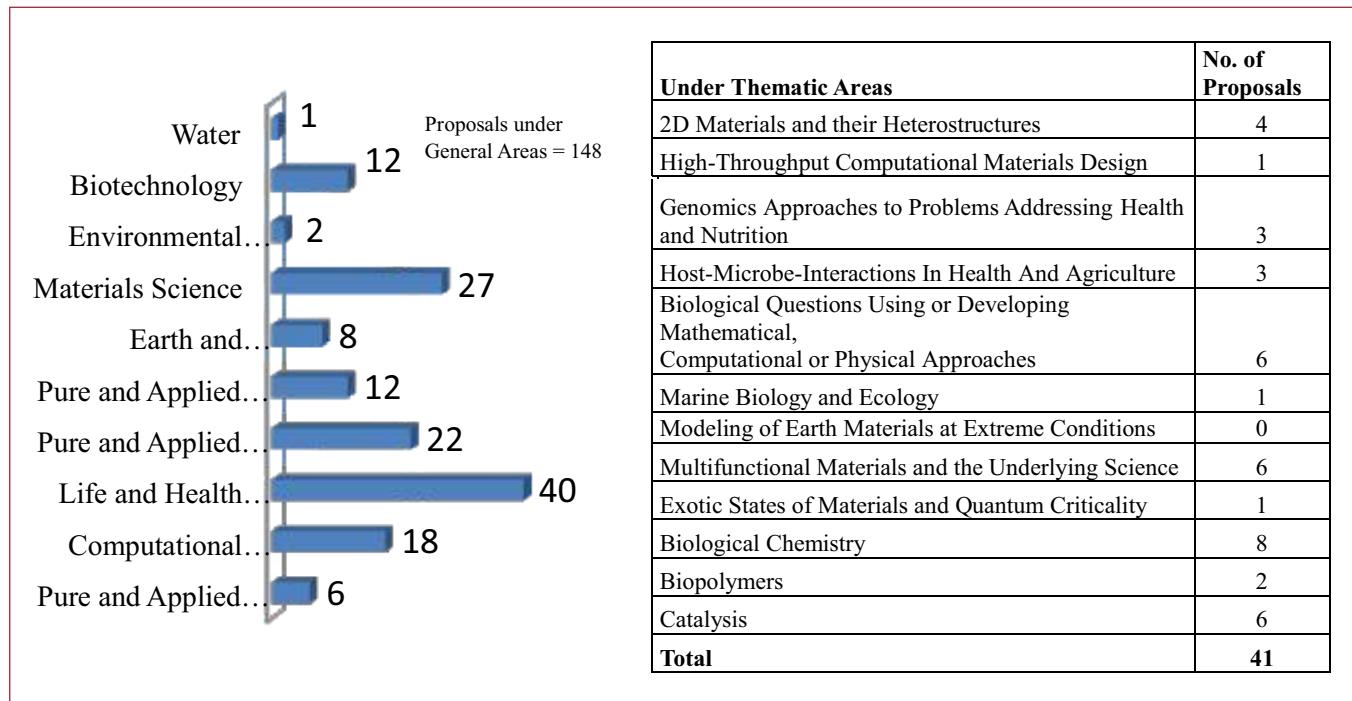


Figure 1: Thrust Area-wise Distribution of Proposals Considered by 63rd and 64th SC

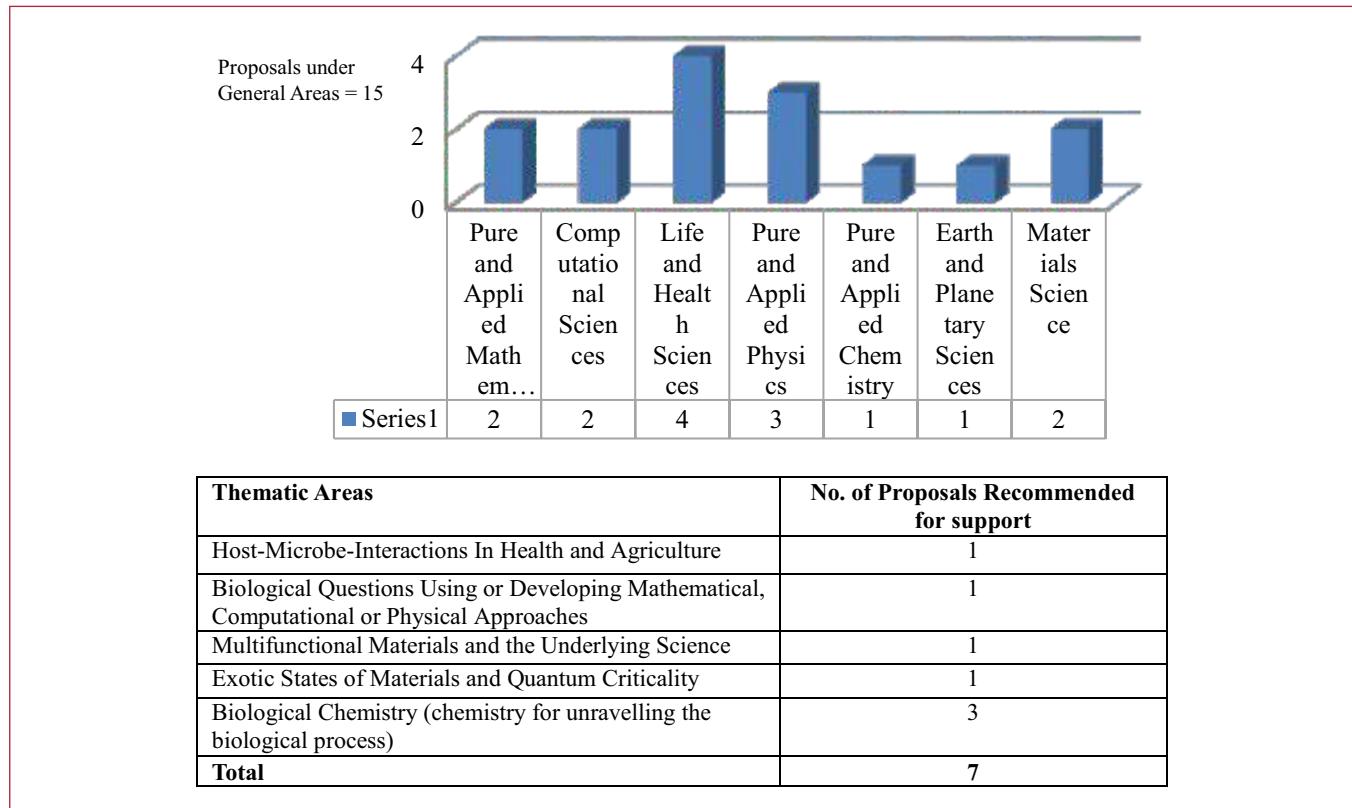


Figure 2: Area-wise distribution of recommended proposals in General Areas (15)
Table1: List of Proposals recommended in Thematic Areas (7)

New Projects Commenced:

The Council evaluated the scientific merit of 189 proposals on the basis of comments from the referees and discussions amongst the members. Consequently, the Scientific Council in its 63rd and 64th meetings recommended 22 proposals for support from thematic call and general call. Seven Proposals were recommended in Thematic Areas (7) [AI & Big Data, Science for Sustainability, Quantum Materials, Addressing Biological Questions Using or Developing Mathematical, Computational or Physical Approaches].

The thrust area-wise distribution of the proposals received and recommended for support during the year 2019-20 is given in figures 2. From the figures 2, it is prominent that the area of Life and Health Sciences & Pure and Applied Physics continues to have a higher share of the proposals recommended whereas Life Health Sciences have a higher share of the proposals received. The Scientific Council had adopted a pre-selection process as decided by the 55th Scientific Council met in May, 2015. Each proposal was discussed in depth on the basis of quality of scientific aspects and regard to collaboration before recommendation.

A total of eighteen new projects were initiated during the year 2019-20 and figure 3 depicts the thrust area-wise distribution of projects commenced.

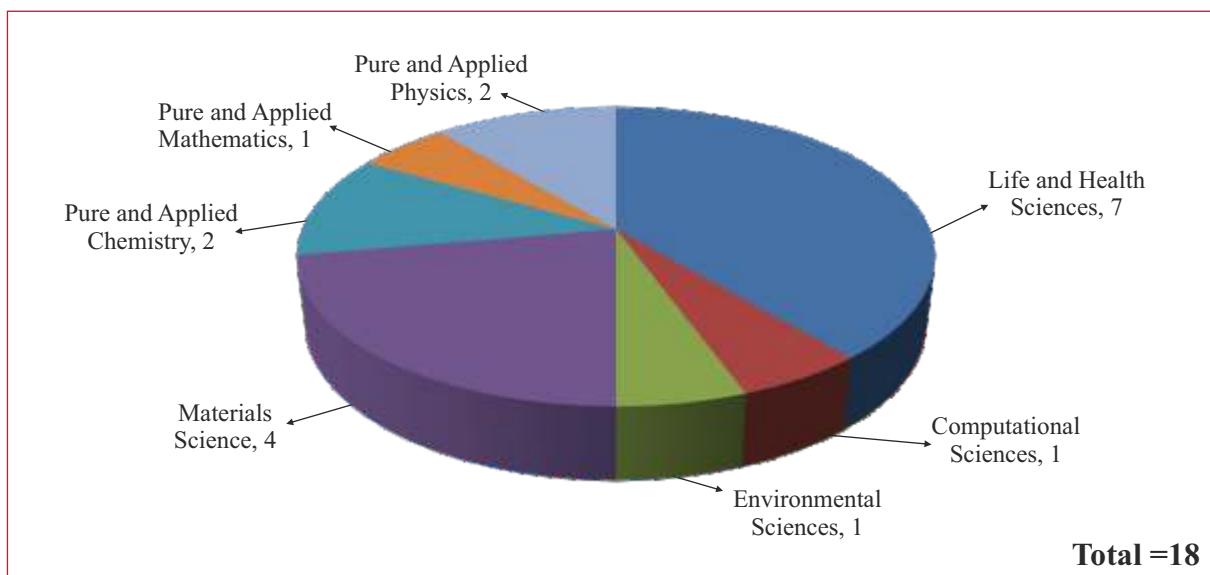


Figure 3: Area-wise Distribution of New Projects initiated

Ongoing Projects:

The Council discussed the procedure of mid-term review of projects and recommended that the Indian and French Scientific Council Members may review the mid-term report submitted by the PIs of the projects and interact with them to assess the progress. Therefore, only a total of 16 on-going projects were physically reviewed wherein Principal Collaborators of projects made presentations to the Scientific Council suggested their assessments for smooth operation of projects.

As on 31st March 2020, 32 projects (excluding 17 new projects started) were under implementation at various Indian and French research institutes. In figure 4, an area-wise distribution of ongoing projects is depicted.

ANALYSIS OF SCIENTIFIC ACTIVITIES

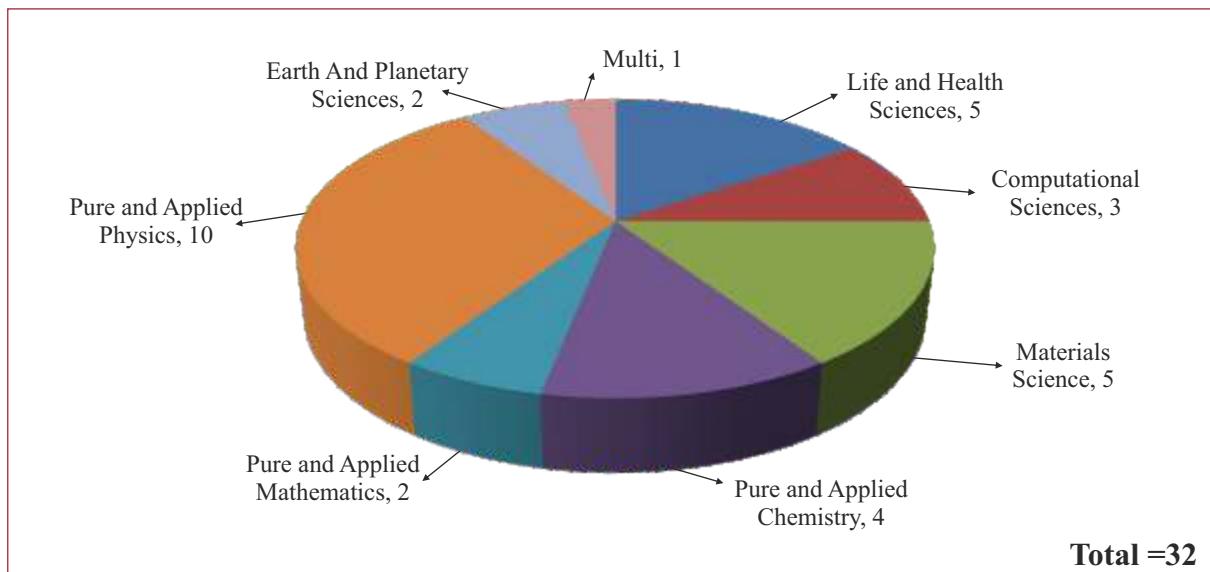


Figure 4: Area-wise Distribution of Ongoing Projects

Completed Projects:

Twenty four projects, completed during the reported year, and seventeen were reviewed by Scientific Council meetings. The Scientific Council had graded the seventeen projects based on the achievements made vis-à-vis aims and objectives, the number and quality of publications including joint publications and the scientific excellence of the research outputs. Seven projects could not be finally evaluated till March 2020. During final review of the completed projects, by SC the performance index of nine projects was rated as ‘Excellent’, five as ‘Very Good’, one as ‘Good’ and two ‘satisfactory’. The nine projects graded as ‘Excellent’ were from the areas of Physics & Materials Sciences (3), Chemistry (2) and one in Earth & Planetary Sciences (1). Additionally, 3 projects were graded as ‘Very Good’ in the areas of Life & Health Sciences. And one project each from Material Sciences and Earth & Planetary Sciences. In figure 5, an area-wise distribution of completed projects is depicted.

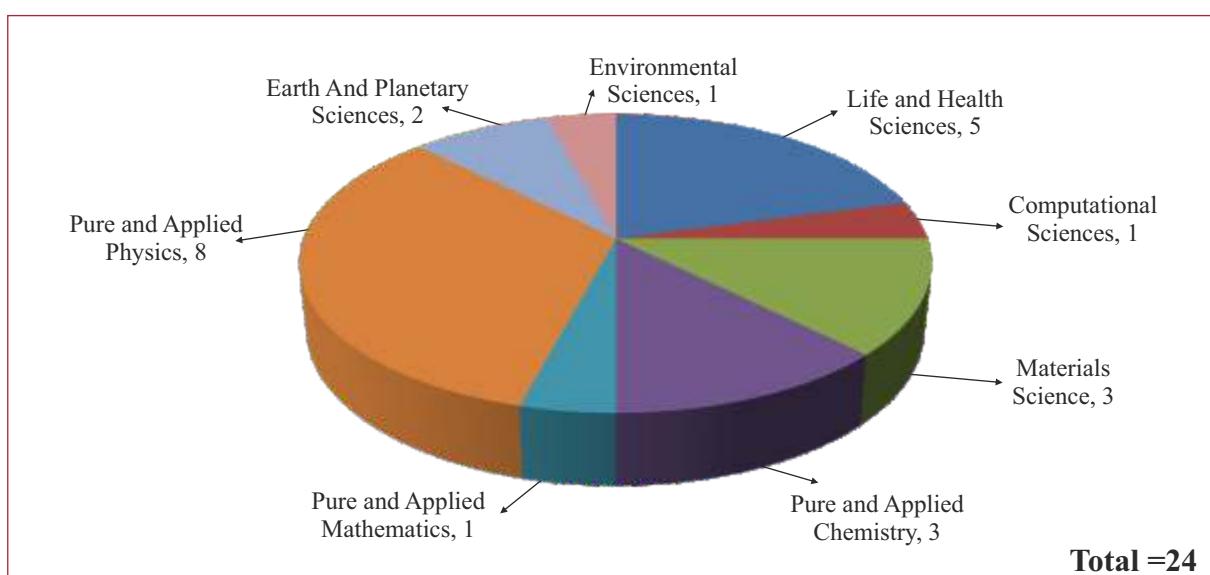


Figure 5: Area-wise Distribution of Completed Projects

ANALYSIS OF SCIENTIFIC ACTIVITIES

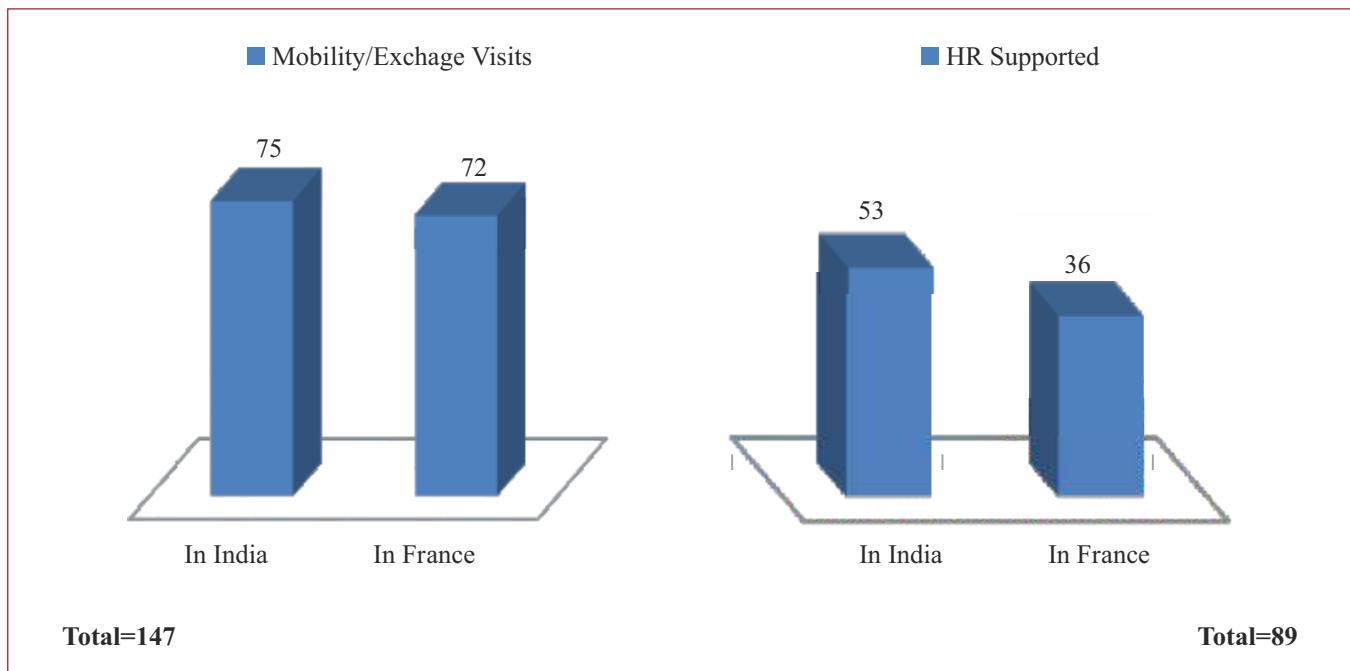


Figure 6: Outcomes in terms Exchange Visits and HR supported under completed projects.

A total of 89 persons as Human Resource Development (53 from India & 36 from France) were supported through Doctoral and Post-Doctoral training comprising of students along with few master students. 147 mobility/ exchange visits (75 from India to France and 72 from France to India) were supported (Figure 6) under 24 completed projects.

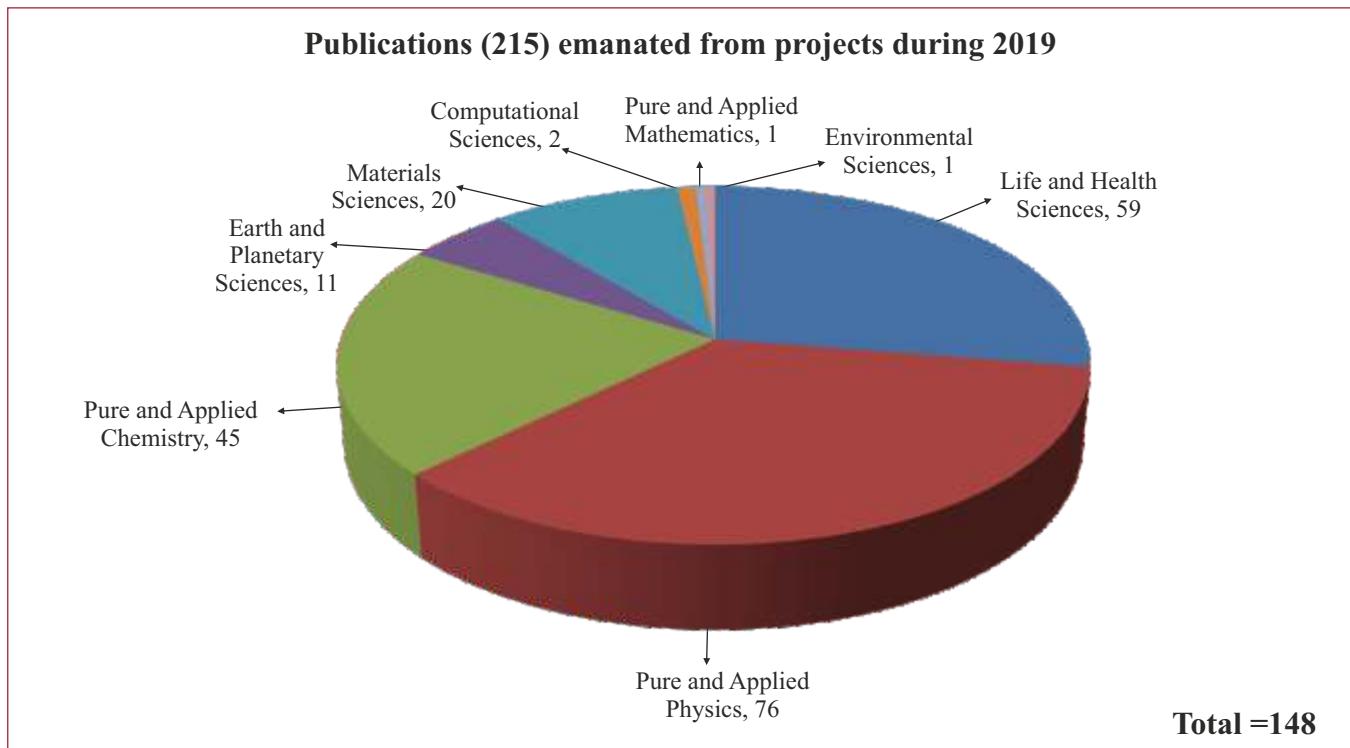


Figure 7: Thrust Area-wise Number of Publications Emanated from CSRP Projects

Publications Emanated from Completed Projects

The number of papers emanating from a project depends on several factors such as the nature of project, subject area of project, number of scientists and researchers working in the project, number of collaborators in the project and so on. The 24 completed projects have resulted in 215 publications. CEFIPRA projects are supported across 10 subject areas/domains of science and technology. The “Pure and Applied Physics” domain that has 8 projects, contributed the maximum number of 75 papers (35 %) followed by “Life and Health Sciences”- 59 papers, Pure and Applied Chemistry-45 and “Materials Science” with 20 papers.

A look at the average Impact Factors of these subject areas reveal that the “Pure and Applied Chemistry” area has the highest average Impact Factor of 5.894. The areas of Pure and Applied Physics, Life Health Sciences, Pure and Applied Chemistry and Materials Sciences (Table 8) are having 93% highest share of publications out of all domains.

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 Materials Chemistry C, Development, Cell Death and Disease and Other Scientific Reports.

The completed projects based on sum of impact factor as per NISCAIR (CSIR) study are given as follows - The number of papers emanating from a project depends on several factors such as the nature of the project, the subject area of the project, the 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.

Number of papers based on CEFIPRA domains/	No. of Projects	Papers
Life and Health Sciences	5	59
Computational Sciences	1	2
Material Sciences	3	20
Pure And Applied Chemistry	3	45
Pure And Applied Mathematics	1	1
Pure And Applied Physics	8	76
Earth And Planetary Sciences	2	11
Environmental Sciences	1	1
Total	24	215

Table 8: Area-wise Number of Publications Emanated from completed CSRP Projects

Projects Title/Number	Papers	Sum-IF	Avg. IF
Original biocompatible phosphorus dendrimers as a new strategy to tackle pulmonary tuberculosis12(IPR)+2 patent	12	25.343	6.336
Cosmological evolution of the cold gas from quasar absorption lines	19	31.191	6.238
Electrical addressing and control of the plasmonic properties of coupled metal nanowire	16	9.098	4.549
N-Heterocyclic Carbene (NHC)-Organocatalyzed Enantioselective Trifluoromethylation and Trifluoromethylthiolation of Unactivated C-H Bonds	5	22.694	5.674
Chiral Phosphahelices in Gold(I) Enantioselective Catalysis	17	9.584	4.792
Extreme events and large deviations in strongly correlated many body systems	16	22.15	3.692
Original biocompatible phosphorus dendrimers as a new strategy to tackle pulmonary tuberculosis	12	25.343	6.336
Glimpses of New Physics	7	16.034	5.345
Molecular analysis of a capacitor Hox protein motif	6	8.907	4.454
Magnetism of self-organized structures at surfaces	3	22.744	7.581
Pathogenic Aspergillus: Interaction with innate immune cells	3	10.28	3.427
LORIC: LOnG-Range Interactions in ultraCold gases	5	24.646	4.929
Understanding mechanical size effects in metallic microwires: synergy between experiments and simulation	1	3.998	3.998
CHROMITe: Assessment of CHromium Release from	1	3.475	3.475

Table 9: Some of Completed Projects Based on Sum of Impact Factor [Source; CEFIPRA-NISCAIR (CSIR) Study January 21]

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

Life and Health Sciences

Standardization of methods for Pharmacokinetic studies of large sized Dendrimers with evaluation of dendrimers in Mouse and in Guinea pig models against Drug resistant mycobacteria in animals was done. Dendrimers can be potential therapeutics for anti TB. **(5303-2)**

Study concluded in whole-genome expression data sets of anterior and posterior lobes from wild type and *asrij* mutant *Drosophila* lymph glands to be deposited on Gene Expression Omnibus (GEO) repository. Whole-genome expression data sets of wild type and *asrij* mouse bone marrow stem cells to be deposited on GEO. Mouse mutant model of transplantable leukemia was developed. **(5503-1)**

Poor knowledge of pathobiology is the reason for increase in the infections caused by different *Aspergillus* species. The study established the major proteomic differences identified between *A. flavus* and *A. fumigatus* that could serve as candidate biomarkers for the early diagnosis of infection. PIs developed monoclonal antibodies against β -(1,3)-glucan, successfully used them against systemic fungal infection. In this line, factors that distinguish two *Aspergillus* species identified in the study should allow the development of species-specific immunotherapeutic strategy. Overall, the data generated in this project should lead to explore the possibilities of translational research. **(5403-1)**

ANALYSIS OF SCIENTIFIC ACTIVITIES

Pure and Applied Physics

Outcomes of the studies that are futuristic about the spinor-condensates is that, not only the interaction parameters that leads to interesting physics, but also the external magnetic fields. The latter provides us a big playground for future studies. The studies also include the Rydberg dressed interactions. Numerical toolbox for studying spinor condensates with long-range interactions in any dimension was developed. The same program could handle any spin ($S=1,2,3\dots$). This opens up a lot of possibilities to study various systems with complicated interaction patterns. (5304-1)

Automated Radio Telescope Imaging Pipeline (ARTIP): ARTIP automates the entire process of flagging, calibration and imaging for MALS. The automation is the only way to effectively use modern radio telescopes. It is written in Python 3.6 and makes extensive use of CASA (<https://casa.nrao.edu/>) tasks and tools for calibration and imaging. The custom code using standard python modules and libraries such as NumPy and Pandas is developed for data manipulation, flagging and parallelization of various processing steps. The pipeline follows a stage-driven architecture ensures flexibility and extensibility of various processing steps. The prototype of ARTIP was realised using the high-end. It is available at (<https://github.com/RTIP/artip>) for the community to process narrow-band datasets from radio telescopes (interferometers) such as uGMRT, VLA and MeerKAT. This prototype has allowed us to benchmark algorithms and adopt optimal processing strategy for MALS. (5504-2)

The gained knowledge on plasmon propagating modes could be utilized in design and development of nanowire waveguides in elastic and inelastic, nonlinear optical regimes. The fabrication procedures developed could be utilized for electric excitation of plasmons and probably other collective excitations in solid state. Use of the electrical control of the plasmonic response to design new functionalities such as integrated reconfigurable plasmonic Boolean gates. (5604-2)

Pure and Applied Chemistry

- a) Several imidazole and benzimidazole-based thiones and selones were developed and their synthesis was optimized.
- b) A series of imidazole-based tripodal ligands was developed and their synthesis was optimized.
- c) New Cu(I) complexation data with tripodal ligands grafted with three imidazole thiones, including stability in water at physiological pH and Cu-induced oxidative stress quenching, was obtained allowing to get structure-affinity relationships.
- d) An hepatocyte-targeting moiety was synthesized and its ability to efficiently promote uptake in hepatocytes validated. (5605-1)

Material Sciences

The study brings out first to show that epitaxial strain affects the properties of a monolayer of deposited spin-crossover molecules. This has significant implications for their use in spintronic devices. (5308-1)

Earth and Planetary Sciences

Numerical code for two-dimensional thermal convection in spherical annulus was developed. This experiment is an important development in the understanding of outer core and inner core dynamics in terrestrial planets. (5307-1)

Studied the Tropical Tropopause Layer (TTL) together with the Asian summer monsoon, which is one of the major challenges in Climate science, though, coordinated observational and modelling studies was carried out for *In situ* measurements to fully characterize the distribution of ice within cirrus clouds, the detailed chemical composition of gases and aerosols in the TTL. The study concluded with unparalleled information European StratoClim project performed a measurement campaign during summer 2017 over Nepal and India with a high-altitude aircraft.

The aircraft payload included instruments devoted to characterize aerosols and ice crystals as well as the chemical composition of gas tracers. The project benefits also from correlated ground-based measurements made in India, in particular by the new ST wind profiler operated at CUSAT, Cochin by the Indian Partner. (**5607-1**)

Industry-academia Research & Development Programme (IARDP)

Nine projects were ongoing during the reported period in the following areas- Structural Health Monitoring, Avionics, Automotive Design, Printing Packaging , Computational and Immunology.

During the year, two IRC meetings were organized wherein eight ongoing projects and two completed projects were reviewed. The research proposal was recommended in the area of (PPMB) Commercial pigment production by microalgae: towards the development of new biotech process and Bio-wool (Green Valorization of sheep wool wastes towards bio-composites and bioactive building materials).

The three completed projects (INDIRA-B Innovative Wheel Drive & EMAT) were evaluated during the reporting period. The performance index of INDIRA-B & Innovative Wheel Drive) project was graded Partially Successful and for EMAT it was Successful based on the achievements made vis-à-vis aims and objectives, and the technical comprehensive research outcome.

Following are the salient achievements under these projects:

INDicators of Reliability and Variability of Bus Systems (INDIRA-B)

Product/technology developed: The technology developed is of significant interest to various public transport operators, particularly in India. The technologies, along with the indicators developed in this project, were demonstrated to twenty officials from thirteen State bus operating organisations in India during the October 2018 workshop in Delhi. The organisations found the technology and indicators to be highly useful for their own assessments and evaluations. Negotiations are underway with French manufacturers such as Thales, which is already established in India.

Linkage: Work progress has been satisfactory. Good collaboration between three partners-two academic partners and 1 industrial partner. There is a synergy between the three partners who have different strengths and capabilities.

Innovative Wheel Drive to Enable Widespread Electric Bicycle Transportation

Testing facilities developed under the project: Vel Tech hosts Vel Tech - FranceCol Research Lab for Innovative Devices in its Research park, which is well-equipped with all the required facilities. The Lab was set up with internal resources.

Considering the importance given to E – Mobility by Govt. of India, there is the potential for commercial viability for the technology developed under the project. A potential user of this Technology in India includes the Puducherry government and Andhra Pradesh government which have expressed their interest in this project.

Linkage:

Industry: Small scale industries in TamilNadu were enthused to take up works related to precision machining, special coil winding, magnetic lamination, etc.

Academia: A major spin-off from this project was the mobility of students between French Universities and Vel Tech. The students were assigned mini projects related to wheel drive development.

ANALYSIS OF SCIENTIFIC ACTIVITIES

Adhesive Bond Inspection Technique Development using Electromagnetic Acoustic Transducer (EMAT) for Aerospace Company

A new and novel approach using higher order SH ultrasonic wave modes generated using EMATs is the key technology developed here. The approach allows for the quality assurance of adhesive bonded structures, particularly in the aerospace industry. The technology potentially solves a long term requirement from the aerospace industry for an NDT method that is quantitative and provides acceptance criteria for adhesively bonded components.

The major output from this project is knowledge based; the understanding of physics of interaction of SH waves with adhesive lap joints and how interfacial strength affects the propagation. A 3D-multiphysics model was developed to visualize the SH wave propagation in lap joints. The multi-physics model incorporates electro-elasto-dynamic coupling hence, the EMAT generation of ultrasonic waves can be modelled. This aids in the development of EMAT sensors for experimental validation of models. From Finite Element (FE) modeling insights, were gained on the effect of interfacial condition on wave propagation. From this a method for inverse calculation and determining the interfacial stiffness was developed. Further, the experiments were performed to corroborate the FE findings.

Linkage: The technology development was with close linkages between Airbus Space system in France and with the startup Dhvani Research in India. There were also linkages established between the group at IIT Madras, IISc Bangalore and the University of Bordeaux.

The level of interaction was very close with the PhD students, one from IITM, one from IISc, and one from University of Bordeaux interacting with each other and with the faculty in the academic collaborators and the Airbus team in France. The collaboration included one month internship for the 2 Indian PhD students in Bordeaux and a similar period for the UB student in IITM/IISc.

Publications-5 Emanated

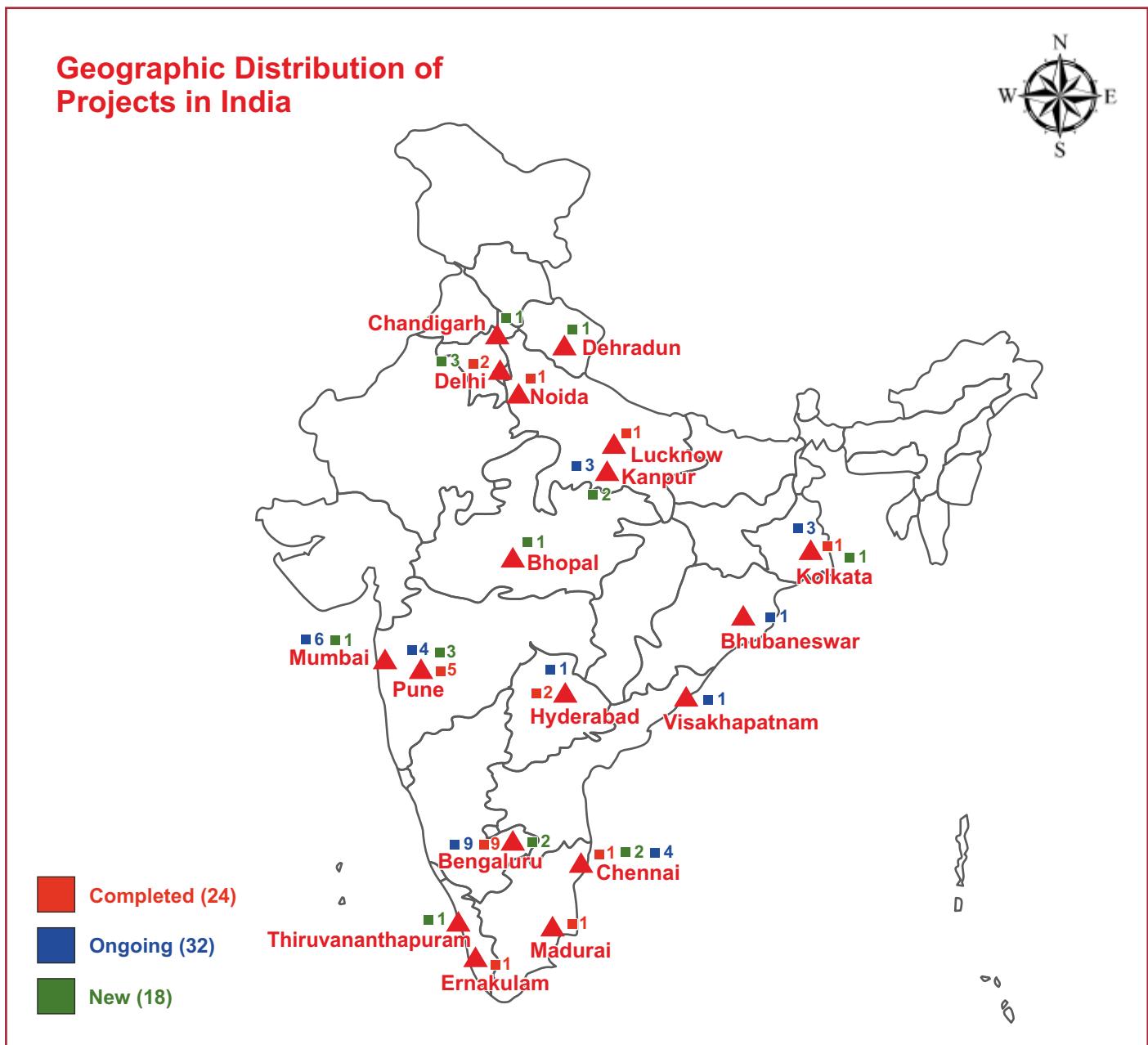
Non-Core Programmes

During the year, five projects were completed in the area of Big Data (1), Internet of Things (2), Cyber Security (1), Distributed and Autonomous Systems (1) which has yielded 9 publications and 26 visits from India to France and 16 from France to India.

Moreover, 8 projects are ongoing in the areas of Big Data (1), Internet of Things (1), Stochastic Optimization and Games (1) & Machine Learning (3) & Cyber Physical Systems (2). Under these ongoing projects, 14 publications were emanated and 13 visits from India to France and 15 from France to India. Further, 5 new projects were initiated in Biodiversity & Ecosystems (1), Cancer Prognostics (1), Particle Physics (1), Artificial Intelligence (1) & Cyber Physical Systems (1).

Geographic Distribution of Projects in India

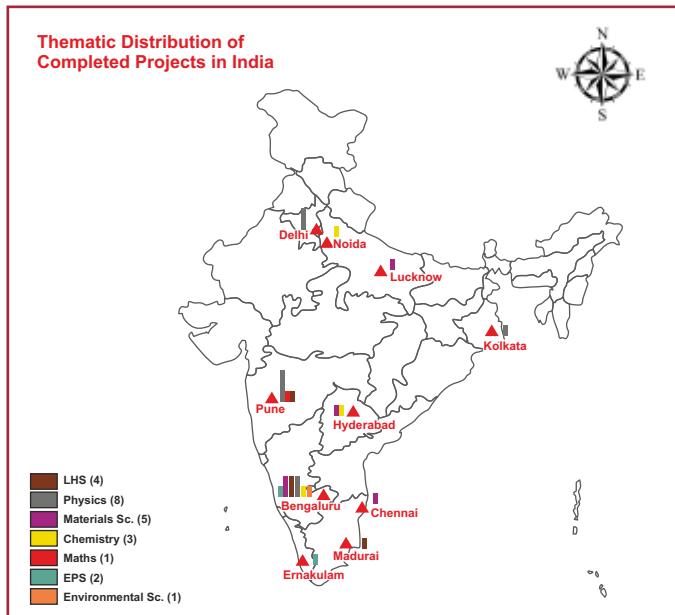
Map 1



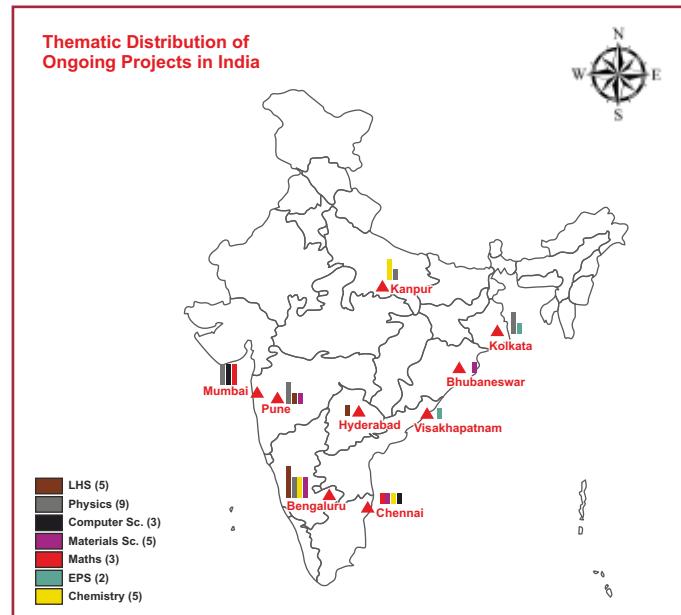
Thematic Distribution of Projects in India

The following three Indian maps are showing the spatial heterogeneity with respect to completed (24) ongoing (32) and new initiated (18) Collaborative Scientific Research Projects of CEFIPRA in different subject domains.

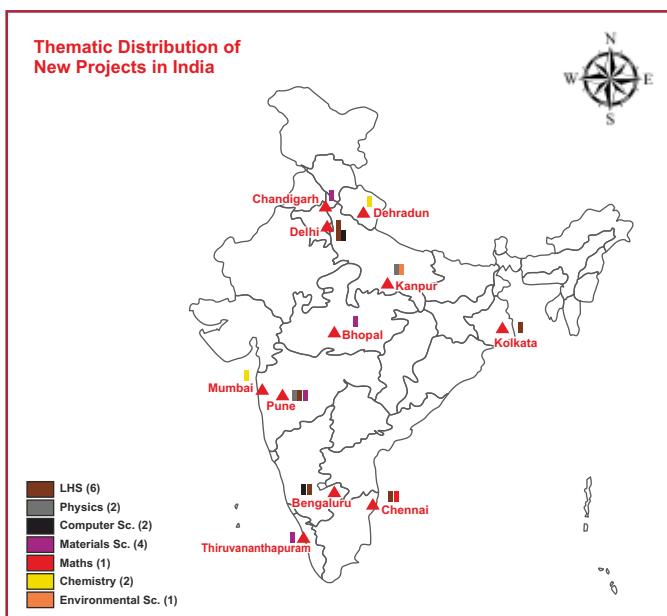
Map 2



Map 3

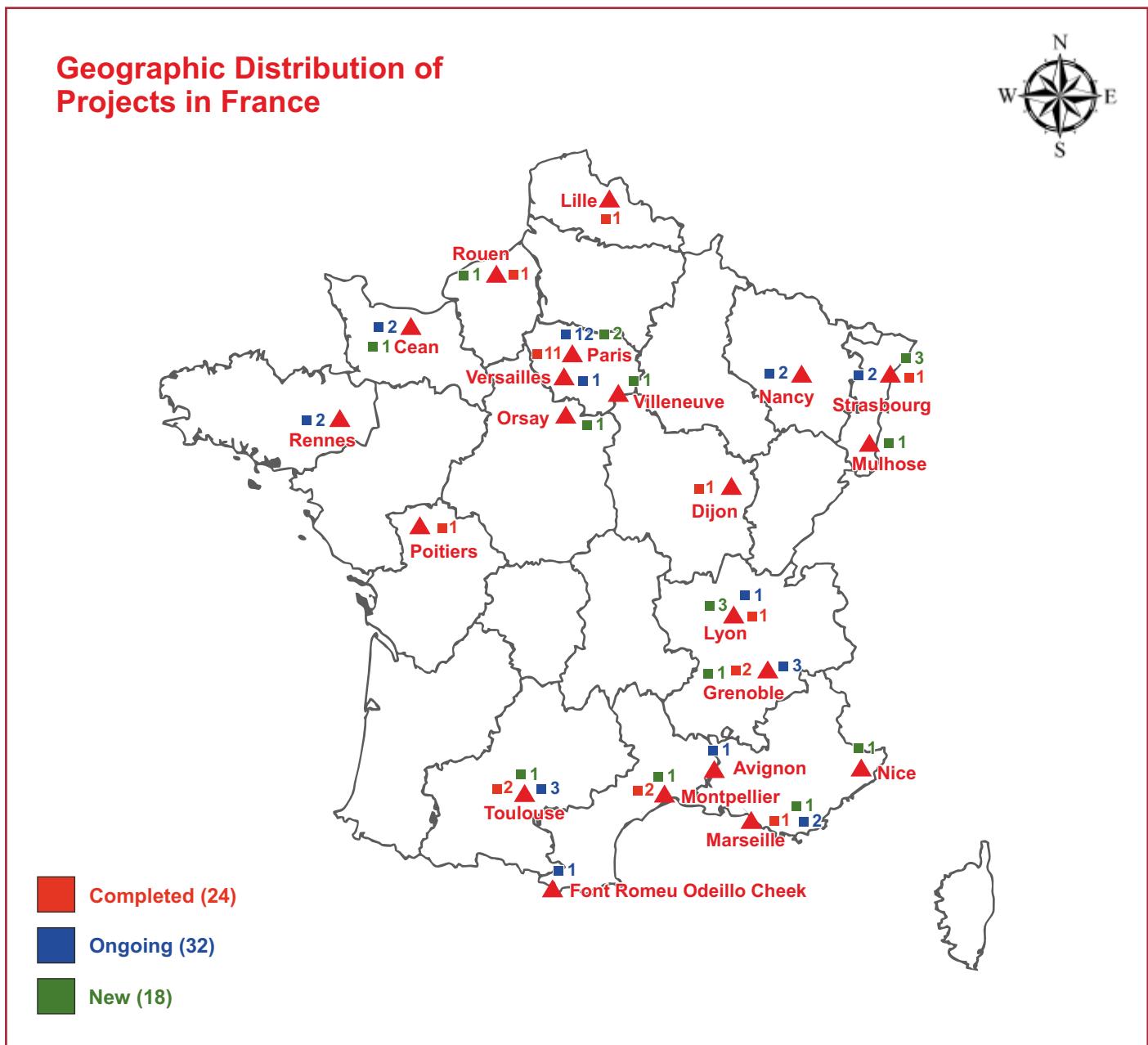


Map 4



Geographic Distribution of Projects in France

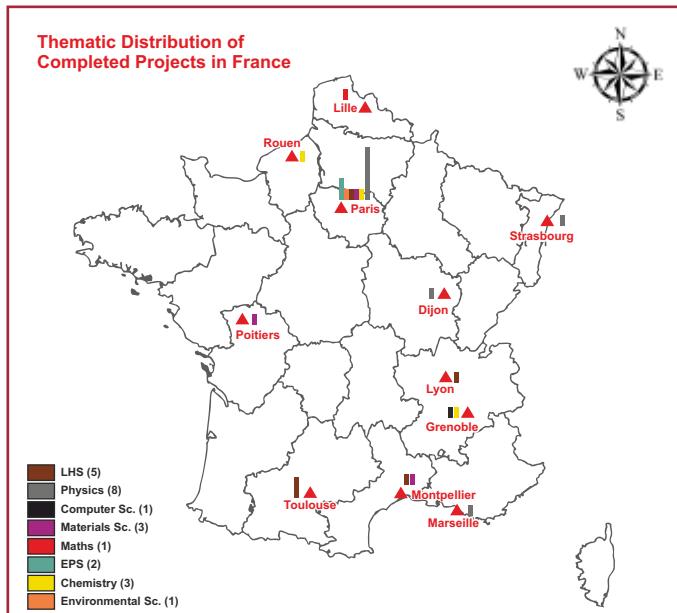
Map 5



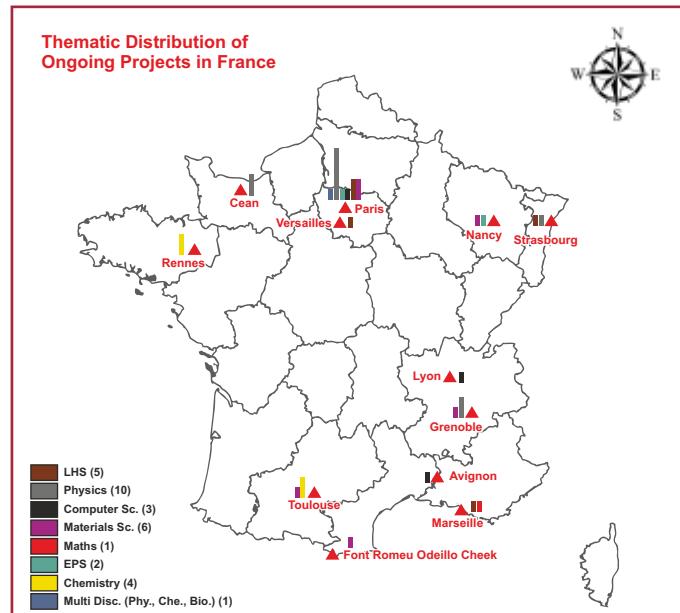
Thematic Distribution of Projects in France

The following three French maps are showing the spatial heterogeneity with respect to completed (24) ongoing (32) and newly initiated (18) Collaborative Scientific Research Projects of CEFIPRA in different subject domains.

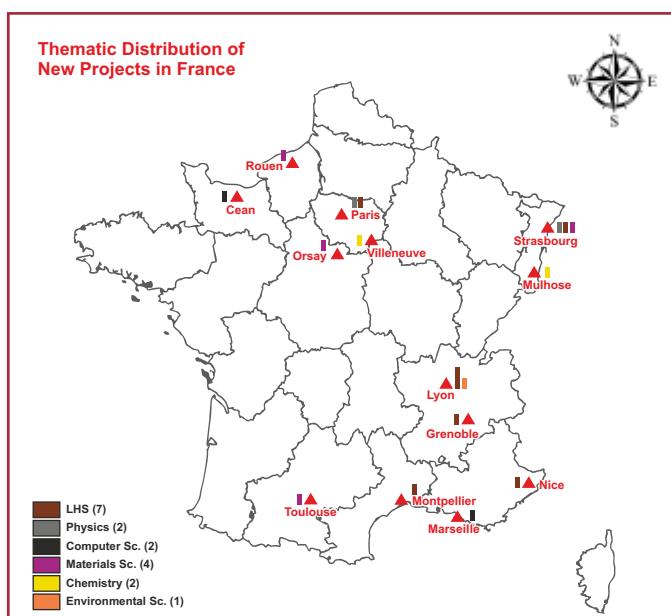
Map 6



Map 7



Map 8





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 lead 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 2019 to March 2020 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 2019 to March 2020

Mobility of Indian Scientists

April - June 2019

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	NOVIS60: Non-contact vital sign estimation with 60 GHz radar technology	Prof. Jayanta Mukerjee & Mr. Sandeep Kumar Misra Indian Institute of Technology Mumbai	Dr. Julien Sarrazin UPMC – University Pierre and Marie Curie Paris
2.	Boron-controlled CO ₂ reduction	Mr. Kaushik Saha IIT Chennai	Dr. Sebastien Bontemps Laboratoire de Chimie de Coordination, Toulouse
3.	CHROmITe: Assessment of CHromium Release from sukinda mining Overburden: an IsoTopic, chemical, physical and microbiological study	Prof. S Subramanium, Prof. Praveen Ramamurthy & Ms. Veni Sudarsan Indian Institute of Science Bangalore	Dr. Yann Sivry Institut De Physique Du Globe De Paris
4.	A genome-wide study to identify novel regulators of chromosome stability using a human pathogenic yeast Candida albicans as the model system	Dr. Kaustuv Sanyal, Jawaharlal Nehru Centre for Advanced Scientific Research Karnataka Bangalore Urban District	Dr. Christophe D'Enfert Institut Pasteur, Paris, Ile-De-France Paris
5.	Nutrient transfers through groundwater in India (NUNDERGROUND)	Dr. V.V.S.S. Sarma National Institute of Oceanography Goa	Prof. Damien Cardinal Université Curie Paris
6.	Modelling and observing pulsars: from high energy to radio emission.	Dr. Dipanjan Mitra National Centre for Radio Astrophysics, inStem, GKVK Post, Bellary Road Bangalore	Dr. Angela Giangrande Institut de Génétique et de Biologie Moléculaire et Cellulaire, Alsace Strasbourg

HUMAN RESOURCE DEVELOPMENT SUPPORTED UNDER PROJECTS

Mobility of Indian Scientists

April - June 2019

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
7.	Biodegradable core shell electrospun mats and interconnected porous scaffolds for tunable anticancer drug delivery and tissue engineering application	Prof. Narayana Kalkura, Anna University Chennai	Dr. Mikhael Bechelany European Institute Of Membranes de Montpellier Montpellier
8.	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
9.	Nutrient transfers through groundwater in India (NUnderGROUND)	Dr. SivakiranKuma Busala National Institute of Oceanography Goa	Prof. Damien Cardinal Université Curie Paris
10.	Durable Fuel Cells Based On Polymer Coated Nanocarbon Composites (DUPONT)	Prof. Ramaprabhu Sundara Indian Institute of Technology Chennai	Prof. Wolfgang S Basca Centre D'Élaboration De Matériaux Et D'Études Structurales Toulouse
11.	Durable Fuel Cells Based On Polymer Coated Nanocarbon Composites (DUPONT)	Ms. Meenakshi Seshadri Indian Institute of Technology Chennai	Prof. Wolfgang S Basca Centre D'Élaboration De Matériaux Et D'Études Structurales Toulouse
12.	Impact of the Indian Monsoon convection on the Tropical Tropopause Layer and climate	Dr. Ajil Kottayil Advanced Centre for Atmospheric Radar Research, Cochin University of Science and Technology Cochin	Dr Bernard Legras Laboratoire de Météorologie Dynamique, Ecole Normale Supérieure, 24 rue Lhomond, 75005 PARIS
13.	Micro-SQUID magnetometry of nano-scale magnetic structures	Dr. Anjan Kumar Gupta Indian Institute of Technology Kanpur	Prof. Hervé Courtois CNRS et Université Grenoble Alpes Grenoble
14.	Original biocompatible phosphorus dendrimers as a new strategy to tackle pulmonary tuberculosis	Prof. Kishore K. Srivastava Division of Microbiology CSIR-Central Drug Research Institute Lucknow	Dr. Serge Mignani Laboratoire de Chimie de Coordination du CNRS Toulouse
15.	The Economics of Networks and Queues	Prof. Manjesh Hanawal& Prof. Jayakrishnan Nair Indian Institute of Technology Bombay	Dr. Yezekael Hayel Neel Institute Grenoble
16.	Large-Scale Loss-based Learning via Energy Minimization	Prof. Jawahar CV International Institute of Information Technology Hyderabad	Prof. Olivier Lafon Unite de Catalyse et de Chimie du Solide (UCCS) CNRS UMR 8181, Université de Lille 1
17.	The assembly history of disk galaxies over the last 8 billion years	Dr. Kanak Shah Inter University Center for Astronomy & Astrophysics (IUCAA), Pune	Prof. Hervé Courtois CNRS et Université Grenoble Alpes Grenoble

HUMAN RESOURCE DEVELOPMENT SUPPORTED UNDER PROJECTS

Mobility of Indian Scientists

April - June 2019

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
18.	Composite Models at the Interface of Theory and Phenomenology	Prof. K Sridhar Tata Institute of Fundamental Research, Mumbai	Dr. Giacomo Cacciapaglia IPNL, Universite Lyon Villeurbanne
19.	Modelling Plasma Instabilities and Transport in a Hall Thruster of planetary atmospheres and the interstellar medium	Prof. Hitendra Kumar Indian Institute of Technology (IIT) Delhi	Prof. Yves Elskens Physique des interactions ioniques et moléculaires (PIIM) Marseille

Mobility of French Scientists

April - June 2019

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	Micro-SQUID magnetometry of nano-scale magnetic structures	Prof. Clemens Winkelmann CNRS et Université Grenoble Alpes Grenoble	Dr. Anjan Kumar Gupta Indian Institute of Technology Kanpur
2.	Composite Models at the Interface of Theory and Phenomenology	Prof. Aldo Deandra IPNL, Universite Lyon Villeurbanne	Prof. K Sridhar Tata Institute of Fundamental Research Mumbai
3.	CHROmITe: Assessment of CHromium Release from sukinda mining Overburden: an IsoTopic, chemical, physical and microbiological study	Prof. Yann Sivry Ms. Evelyne Adjei Mensah & Ms Ourissa Chennit (Student) Institut De Physique Du Globe De Paris	Prof. S Subramanium Indian Institute of Science Bangalore
4.	Design and Control of many-body states in hybrid quantum systems	Dr. Camille Aron Ecole Normale Supérieure Paris	Prof. Manas Shreekanth Kulkarni International Centre for Theoretical Sciences (TIFR) Bangalore

Mobility of Indian Scientists

July - September 2019

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	Nuclear structure at the extreme of isospin and spin	Dr. Sarmishtha Bhattacharyya Variable Energy Cyclotron Center Kolkata	Dr. Navin Alahari Grand Accelerateur National D'Ions Lourds (GANIL) Caen
2.	Metal chelators derived from imidazole thiones and selones for detoxification	Mr. Ranajit Das Shiv Nadar University Gautam Buddha Nagar	Dr. Pascale Delangle CEA Centre de Grenoble Grenoble
3.	A genome-wide study to identify novel regulators of chromosome stability using a human pathogenic yeast <i>Candida albicans</i> as the model system	Dr. Kaustuv Sanyal Jawaharlal Nehru Centre For Advanced Scientific Research Bengaluru	Dr. Christophe D'Enfert Institut Pasteur-Paris Paris
4.	Phase transitions in sub-saturation nuclear matter and applications to core-collapse supernova and nuclear experiments	Dr. Naosad Alam Variable Energy Cyclotron Centre Kolkata	Prof. Francesca Gulminelli , LPC/ENSICAEN, Basse-Normandie Caen

HUMAN RESOURCE DEVELOPMENT SUPPORTED UNDER PROJECTS

Mobility of Indian Scientists

July - September 2019

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
5.	Extreme events and large deviations in strongly correlated many body systems	Dr. Abhishek Dhar, Dr. Anupam Kundu, Mr. Varum Dubey & Mr. Prashant Singh International Centre for Theoretical Sciences (TIFR) Bengaluru	Prof. Cedric Bernardin University of Nice Sophia-Antipolis Parc Valrose Nice
6.	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 Electronic Equipment's)	Ms. Aarti Kumari CSIR-NMLCSIR-National Metallurgical Laboratory, Burmamines Jamshedpur Mr. Santosh Daware & Ms. Shally Gupta TRDDC Tata Research Development and Design Centre, 54 B, Hadapsar Industrial Estate, Hadapsar Pune	Dr. Stéphane Pellet-Rostaing ICSM Bagnols-sur-Cèze Institut de Chimie Separative de Marcoule (ICSM) Montpellier
7.	Development of new anti-counterfeit printing techniques for medicine packaging	Ms. Paulomi Kundu Department of Printing Engineering Jadavpur University Salt Lake Campus Kolkata	Prof. Alain Tréneau University Jean Monnet (UJM), Laboratoire Hubert Curien UMR 5516 (LaHC), Bâtiment F 18 Rue du Professeur Benoît Lauras 42000 Saint-Etienne
8.	The Economics of Networks and Queues	Prof. D. Manjunath Industrial Engineering and Operations Research IIT, Bombay Mumbai	Dr. M. Liviu Nicu Laboratory for Analysis and Architecture of Systems (LAAS-CNRS) Toulouse
9.	Chiral Phosphahelicenes in Gold(I) Enantioselective Catalysis	Prof. Akhila Kumar Sahoo University of Hyderabad Hyderabad	Dr. Angela Marinetti Institut de Chimie des Substances Naturelles, Gif sur Yvette
10.	Wavelet Graphs for Gravitational Wave Searches	Dr. Disha Sawant Indian Institute of Technology Mumbai	Dr. Eric Chassande-Mottin Astro Particule et Cosmologie University Paris Denis Diderot Paris
11.	Hematopoiesis and metabolism	Dr. Tina Mukherjee Institute for Stem Cell Biology and Regenerative Medicine	Dr. Angela Giangrande Institut de Génétique et de Biologie Moléculaire et Cellulaire, Alsace Strasbourg
12.	Yielding in glasses and colloidal systems under cyclic deformation	Prof. Srikanth Sastry & Dr. Himangshu Bhoumick Jawaharlal Nehru Centre for Advanced Scientific Research Bengaluru	Prof. Giuseppe Foffi Université Paris Sud Paris
13.	Modeling Soft Glassy Flow from Micro to Macro Scale	Dr. Pinaki Chaudhuri Institute of Mathematical Sciences Chennai	Dr. Kirsten Martens Laboratoire Interdisciplinaire de Physique University of Grenoble-Alpes Grenoble

HUMAN RESOURCE DEVELOPMENT SUPPORTED UNDER PROJECTS

Mobility of French Scientists

July - September 2019

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	Nutrient transfers through groundwater in India (UNDERGROUND)	Dr. Dameien Cardinal Université Curie Paris	Dr. V.V.S.S.Sarma CSIR-National Institute of Oceanography Visakhapatnam
2.	Pathogenic Aspergillus: Interaction with innate immune cells	Dr. Vishu Kumar Aimanianda Bopaiah Dr. Sze Wah Sarah Institut Pasteur Paris	Dr. Lalitha Prajna Aravind Medical Research Foundation Aravind Eye Hospital Madurai
3.	Enhanced CO ₂ adsorption and its photo-electrochemical conversion using semiconductor-metal complex hybrids	Dr. Shubhadip Chakraborty Institut de Physique de Rennes, University of Rennes Rennes	Prof. E. Arunan Indian Institute of Science Bengaluru
4.	Impact of the Indian Monsoon convection on the Tropical Tropopause Layer and climate	Dr. Bernard Legras Ecole Normale Supérieure de Paris Paris	Prof. Kesavapillai Mohanakumar Cochin University of Science and Technology (CUSAT) Cochin

Mobility of French Scientists

October - December 2019

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	p-adic aspects of automorphic forms and their L-functions	Mr. Mladen Dimitrov CNRS / University Lille 1 Lille	Prof. Anantharam Raghuram Indian Institute Science Education and Research (IISER) Dr. Homi Bhabha Road, Pashan Pune
2.	From molecules to aerosols and dust particles: applications to the physics and chemistry of planetary atmospheres and the interstellar medium	Dr. Ludovic Biennier Institut de Physique de Rennes & Prof Robert Georges Institute of Physics, UMR6251 du CNRS - Université, de Rennes 1 Rennes	Prof. E. Arunan Department of Inorganic and Physical Chemistry Indian Institute of Science Bangalore
3.	Enhanced CO ₂ adsorption and its photo-electrochemical conversion using semiconductor-metal complex hybrids	Dr. Rabah Boukherroub Institute for Electronics Microelectronics and Nanotechnology, Avenue Poincaré Villeneuve	Dr. Suman Lata Synthetic Chemistry and Petrochemicals CSIR-Indian Institute of Petroleum Dehradun
4.	Interactions between dynamical systems, geometry, and number theory	Prof. Yann Bugeaud Institut De Mathématique de Marseille, Marseille	Dr. Anish Ghosh Tata Institute of Fundamental Research (TIFR) Mumbai
5.	Tuning the interfacial Dzyaloshinskii-Moriya interaction in ultrathin magnetic films: toward the stabilization of skyrmions in spintronics devices	Dr. Sougata Mallick & Prof. Vincent Jeudy Laboratoire de Physique des Solides Université Paris-Sud Orsay	Dr. Subhankar Bedanta Laboratory for Nanomagnetism and Magnetic Materials (LNMM) National Institute of Science Education and Research (NISER) Bhubaneswar

HUMAN RESOURCE DEVELOPMENT SUPPORTED UNDER PROJECTS

Mobility of French Scientists

October - December 2019

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
6.	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	Dr. Laurie Reisberg Centre De Recherches Pétrographiques Et, Géochimiques (CRPG), CNRS Université de Lorraine Nancy	Prof. Sisir Kanti Mondal Jadavpur University Kolkata
7.	Boron-controlled CO ₂ reduction	Dr. Ramaraj Ayyappan & Dr. Sylviane Sabo-Etienne Laboratoire de Chimie de Coordination Toulouse	Prof. Sundargopal Ghosh Indian Institute of Technology Chennai

Mobility of Indian Scientists

October - December 2019

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	Glimpses of New Physics	Mr. Avik Banerjee (Student) Saha Institute of Nuclear Physics (SINP), Bidhannagar Kolkata	Dr. Emilian Dudas Centre de Physique Théorique Ecole Polytechnique 91128 Palaiseau
2.	Phase transitions in sub-saturation nuclear matter and applications to core-collapse supernova and nuclear experiments	Dr. Gargi Chaudhuri Variable Energy Cyclotron Centre Department of Atomic Energy Bidhannagar Kolkata	Prof. Francesca Gulminelli University of Caen, Laboratoire de Physique, Corpusculaire 6 Bd du Maréchal Juin, 14050 Caen
3.	Modeling Soft Glassy Flow from Micro to Macro Scale	Dr. Panaki Chaudhuri & Dr Suman Dutta (Post Doc) Institute of Mathematical Sciences Chennai	Dr. Kirsten Martens Laboratoire Interdisciplinaire de Physique, Av. de la physique Grenoble
4.	Tuning the interfacial Dzyaloshinskii-Moriya interaction in ultrathin magnetic films: toward the stabilization of skyrmions in spintronics devices	Dr. Subhankar Bedanta & Mr. Brindaban Ojha (Stu) Laboratory for Nanomagnetism and Magnetic Materials (LNMM) National Institute of Science Education and Research (NISER) Bhubaneswar	Dr. Stanislas Rohart Laboratoire de Physique des Solides Universite Paris-Sud, F-91405 Orsay
5.	Metal chelators derived from imidazole thiones and selones for detoxification	Prof. Gouriprasanna Roy Shiv Nadar University Gautam Buddha Nagar Greater Noida	Dr. Pascale Delangle INAC / SyMMES, Team Reconnaissance Ionique et Chimie de Coordination, CEA Centre de Grenoble Grenoble
6.	High performance formation control in the presence of uncertainties and communication constraints	Prof. S Srikant System and Control Engineering Indian Institute of Technology Mumbai	Dr. Irinel Constantin Morarescu Centre De Recherche En Automatique De Nancy (Cran), Umr7039, Lorraine Nancy
7.	LORIC: LOng-Range Interactions in ultraCold gases	Prof. Sadiqali Abbas Rangwala Raman Research Institute Bangalore	Dr. Olivier Dulieu Laboratoire Aimé Cotton Bat 505 Université Paris-Sud Paris

HUMAN RESOURCE DEVELOPMENT SUPPORTED UNDER PROJECTS

Mobility of Indian Scientists

January - March 2020

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	Interactions between dynamical systems, geometry and number theory	Prof. Anish Ghosh Tata Institute of Fundamental Research Maharashtra Mumbai	Prof. Arnaldo Nogueira Institut de Mathématiques de Marseille Aix Marseille Université 163, avenue de Luminy - Case 907 13288 Marseille
2.	Tuning the interfacial Dzyaloshinskii-Moriya interaction in ultrathin magnetic films: toward the stabilization of skyrmions in spintronics devices	Dr. Subhankar Bedanta Associate Professor School of Physical Sciences Dr. Subhankar Bedanta Laboratory for Nanomagnetism and Magnetic Materials (LNMM) National Institute of Science Education and Research (NISER, Bhubaneswar)	Dr. Stanislas Rohart Assistant researcher at CNRS Laboratoire de Physique des Solides Universite Paris-Sud Batiment 510, UMR 8502 F-91405 Orsay
3.	The assembly history of disk galaxies over the last 8 billion years	Dr. Kanak Saha Inter University Center for Astronomy & Astrophysics (IUCAA) Pune	Prof. Francoise Combes Observatories de Paris Paris
4.	Turbulent flows in equilibrium	Prof. Mahendra Kumar Verma Department of Physics Indian Institute of Technology Kanpur	Dr. Stéphan Fauve Department of Physics Ecole Normale Supérieure, Laboratoire de Physique Statistique 24 rue Lhomond 75005 Paris

Mobility of French Scientists

January - March 2020

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
1.	Boron-controlled CO ₂ reduction	Dr. Sébastien Bontemps Chargé de Recherche CNRS Laboratoire de Chimie de Coordination (LCC) TOULOUSE	Prof. Sundargopal Ghosh Department of Chemistry Indian Institute of Technology Madras Chennai
2.	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	Dr. Audrey Soum-Glaude Laboratoire procédés, matériaux et énergie solaire PROMES-CNRS Font-Romeu-Odeillo-Via	Prof. Harish Bharsilia CSIR-National Aerospace Laboratory Pune
3.	Modelling and observing pulsars: from high energy to radio emission	Mr. Jérôme Petri Astronomical Observatory Université de Strasbourg 11 rue de L'université Strasbourg	Prof. Dipanjan Mitra National Centre for Radio Astrophysics, Tata Institute of Fundamental Research Pune
4.	Enhanced CO ₂ adsorption and its photo-electrochemical conversion using semiconductor-metal complex hybrids	Dr. Rabah Boukherroub Institute of Electronics, Microelectronics & Nanotechnology Avenue Poincaré Villeneuve d'Ascq Cedex	Dr. Suman Lata Jain CSIR-Indian Institute of Petroleum Haridwar Road, Mohkampur Dehradun Uttarakhand

HUMAN RESOURCE DEVELOPMENT SUPPORTED UNDER PROJECTS

Mobility of French Scientists

January - March 2020

S.No.	Project / Programme Title	Institutional Affiliation (From)	Institution Visited (To)
5.	Characterization of factors that determine the balance between Genomic integrity and diversity in <i>Helicobacter pylori</i>	Dr. J. Pablo Radicella UMR967 INSERM/CEA Institut de Radiobiologie Cellulaire et Moléculaire Commissariat à l'Energie Atomique 18 Route du Panorama F-92265 Fontenay-aux-Roses	Prof. D. Narasimha Rao Department of Biochemistry Indian Institute of Science Bangalore
6.	Modeling Soft Glassy Flow from Micro to Macro Scale	Dr. Kirsten Martens LIPhy Université Grenoble Alpes & CNRS 140 Av. de la physique BP 87 Saint Martin d'Hères	Dr. Pinaki Chaudhuri IMSc 4th Cross Street, CIT Campus Taramani Chennai
7.	Variable Energy Cyclotron Centre	Prof. Francesca Gulminelli University of Caen, Laboratoire de Physique, Corpusculaire 6 Bd du Maréchal Juin CAEN	Dr. Gargi Chaudhuri Variable Energy Cyclotron Centre Department of Atomic Energy 1/AF Bidhannagar
8.	Nuclear Structures at the extreme of Isospin and Spin	Dr. Navin Alahari Grand Accelerateur National D'Ions Lourds (GANIL) Bd. Henri Becquerel BP 55027 CAEN	Dr. Sarmishtha Bhattacharyya Variable Energy Cyclotron Centre (VECC) 1/AF Bidhan Nagar Kolkata



8. Indian and French Organizations

Collaborative Scientific Research Projects

INDIAN ORGANIZATIONS

Indian Institute of Technology		
1	Indian Institute of Technology Bombay	5 CSIR-National Institute for Interdisciplinary Science and Technology
2	Indian Institute of Technology Delhi	6 CSIR:National Institute of Oceanograph
3	Indian Institute of Technology Kanpur	7 CSIR:Institute of Genomics and Integrative Biology
4	Indian Institute of Technology Madras	8 Indian Association for the Cultivation of Sciences
Universities		9 Indian Institute of Information, Hyderabad
1.	Anna University	10 Indian Institute of Science
2.	Cochin University of Science & Technology	11 Indian Institute of Science Education and Research
3.	Jadavpur University	12 Institute for Stem Cell Biology and Regenerative Medicine
4.	Punjab University	13 Institute of Mathematical Sciences
5.	Pune University	14 International Centre For Genetic Engineering and Biotechnology
6.	Shiv Nadar University	15 International Centre for Theoretical Sciences
7.	Savitribai University	16 Jawaharlal Nehru Centre for Advanced Scientific Research
8.	University of Hyderabad	17 PG Institute of Ophthalmology, Aravind Eye Hospital
Other Academic / Research Institutions		18 Saha Institute of Nuclear Physics
1	CSIR: Central Drug Research Institute	19 Tata Institute of Fundamental Research
2	CSIR: Centre for Cellular and Molecular Biology	20 Translational Health Science and Technology Institute
3	CSIR: Indian Institute of Chemical Technology	21 Variable Energy Cyclotron Centre
4	CSIR: National Aerospace Laboratories	

Industry Academic Research Projects

INDIAN ORGANIZATIONS / INDUSTRIES

1	CSIR- National Metallurgical Laboratory	9 M/s. Joshi Electronics & Electricals Pvt Ltd
2	CSIR-Central Mechanical Engineering Research Institute	10 Morphing Machines Pvt Ltd
3	Dhvani Research & Development Solutions	11 Pandora Connect LLP
4	Golden Star Technical Services	12 Samsung India R&D Institute
5	Indian Institute of Science	12 Sergusa Solutions Pvt. Limited
6	Indian Institute of Technology Delhi	13 Tata Consultancy Services
7	Indian Institute of Technology Madras	14 Vel Tech Dr. RR & Dr. SR Technical University
8	Jadavpur University	15 Vellore Institute of Technology
		16 Virchow Biotech Private Limited

Targeted and Innovation Projects

INDIAN ORGANIZATIONS / INDUSTRIES

1	Birla Institute of Technology and Science (Goa Campus)	13	Indian Statistical Institute
2	Center for Incubation, Innovation, Research and Consultancy (CIIRC)	14	Indraprastha Institute of Information Technology, New Delhi
3	Chennai Mathematical Institute	15	Jadavpur University
4	CSIR-Central Scientific Instruments Organisation	16	Jyothy Institute of Technology, Bangalore
5	Dhirubhai Ambani Institute of Information and Communication Technology, Gandhinagar	17	National Environmental Engineering Research Institute
6	Indian Institute of Science Bangalore	18	National Institute of Technology Karnataka
7	Indian Institute of Technology Bombay	19	National Institute of Technology Silchar
8	Indian Institute of Technology Delhi	20	Tata Research & Development Jamshedpur
9	Indian Institute of Technology Goa	21	Transintegra Healthcare Pvt. Ltd., Bhubaneswar
10	Indian Institute of Technology Kanpur	22	University of Petroleum and Energy Studies
11	Indian Institute of Technology Kharagpur	23	Venza Water Management Solutions
12	Indian Institute of Space Science and Technology	24	Vishwakarma International Private Limited Bangalore
		25	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 d'élaboration de matériaux et d'études structurales (CEMES)
3	Centre national de la recherche scientifique (CNRS)
4	Commissariat à l'énergie atomique (CEA)
5	Institut Albert Bonniot (IAB)
6	Institut de Physique du Globe (IPGP)
7	Institut Pasteur
8	Institut de Recherches en Astrophysique et Planétologie, Toulouse
9	Institut Mathématique de Marseille, Marseille
10	Institut national de la recherche agronomique (INRA)
11	Institut national de la santé et de la recherchemédicale (INSERM)
12	Institut national de recherche dédié au numérique (Inria)
13	Institut National des Sciences Appliquées (INSA)
14	Institute for Research on Cancer and Ageing of Nice (IRCAN)
15	Laboratoire de Biologie et Modélisation de la Cellule (LBMC)
16	Laboratoire de Chimie de Coordination, Toulouse
17	Laboratoire des Symbioses Tropicales & Méditerranéennes (IRD)
18	Observatoire de Paris

Universities	
1	Université de Bordeaux
2	Université de Caen
3	Université Paris Diderot
4	University Pierre and Marie Curie
5	Université de Avignon
6	Université d'Aix-Marseille
7	Université de Nancy
8	Université de Paris-Sud
9	Université de Paul Sabatier
10	Université de Poitiers
11	Université de Reims Champagne-Ardenne
12	Université de Rennes
13	Université de Strasbourg
14	Université de Toulouse
15	Université Joseph Fourier, Orsay
16	Université Montpellier
17	Université Sorbonne
18	ENSICAEN

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, Les Meureux
2	Centrale Supelec
3	Centrale Supélec, Gif-Sur-Yvette
4	CETHIL, INSA Lyon
5	École Normale Supérieure, Paris
6	Faurecia / CentraleSupelec / Esigelec GeePs, Gif-sur-Yvette
7	Institut Mines Telecom
8	INSERM

9	Inria
10	Planet Organic Rude Health
11	Safran Electronics & Defense SAS
12	Span Diagnostics SAR
13	Telecom Paris Tech, Paris
14	Terra Nova Development
15	THALES
16	Université de Bordeaux
17	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	Ecole des Mines de Nantes (EMN), Nantes
9	Institut national de la recherche agronomique (INRA)
10	Institut national de recherche dédié au numérique (Inria)
11	IRMB Hôpital St Eloi, Montpellier
12	Laboratoire Bordelais de Recherche en Informatique

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



9. Financial Reports & Audited Accounts

Financial Report for FY 2019-20

The CEFIPRA receives grants-in-aid of Euro 1.55m each from the Indian and French Governments annually. The nodal agency on the Indian side is the Ministry of Science and Technology and on the French side is the Ministry for Europe and Foreign Affairs. The grants-in-aid are released based on the budgetary projections made by the Centre and duly approved by the Governing Body of the Centre.

a) Core Programmes

The grants-in-aid received from both the Governments are utilized towards expenditure, **which is shared on equal basis** on the following core programmes of the Centre:

- i) Collaborative Scientific Research Programme (CSRP)
- ii) Industry Academia Research and Development Programme (IARDP)
- iii) Seminars/Workshops
- iv) Others

During the year 2019-20, Rs 35 million (0.44 million) and Rs.121.15 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 2017-18, 2018-19 & 2019-20

(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	
2019-20	71.13	35.00	109.24	121.11	Rs. 336.48 (Euro 4.30 million)
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)

During the Financial Year 2019-20, one hundred fifty five (155) new collaborative scientific research project proposals (CSRP) and eight (8) Industry Academia Research and Development project proposals (IAR&DP) were received. Out of this twenty four proposals (24) of CSRP at

budgeted cost of Rs. 241.09 million (Euro 3.10 million) and four (04) proposals of IAR&DP at budgeted cost of Rs. 58.26 million (Euro 0.75 million) were recommended. The details of expenditure incurred during the year towards core activities are given below:

- I) **As on March 31 2020, seventy four (74) projects (including 18 new projects and 24 completed during the year) of CSRP were under implementation.** The core expenditure of the Centre towards collaborative scientific research projects is Rs. 115.19 million (Euro 1.47 million).
- ii) **As on March 31, 2020, 9 (1 new project and 2 Completed during the year) of IAR&DP were under implementation.** Rs. 22.99 million (Euro 0.29 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, four seminars/workshops were supported by the Centre at a cost of Rs. 5.66 million (Euro 0.075 million).

- iv) Rest of the expenses of Rs. 27.46 million (Euro 0.315 million) are for expense on meetings of Governing Body, Scientific Council and Industrial Research Committee (Rs. 6.25/Euro 0.07 millions) as well as running expenses (Rs. 19.26/Euro 0.225 million).

The details of the expenditure incurred by the Centre during the Financial Year 2019-20 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 2017-18, 2018-19 & 2019-20

(Rs./Euro in million)

		2017-18		2018-19		2019-20	
	Budgetary Components	Expenditure Rs.	% of total	Expenditure Rs.	% of total	Expenditure Rs.	% of total
1.	Scientific Research Projects	134.73 (1.67 M Euro)	64.82%	136.42 (1.75 M Euro)	67.98%	115.19 (1.47 M Euro)	67.29%
2.	Industrial Research Projects	26.72 (0.33 M Euro)	12.85%	19.62 (0.25 M Euro)	9.79%	22.99 (0.29 m Euro)	13.41%
3.	Seminars & Workshops	14.16 (0.18 M Euro)	6.81%	10.52 0.135 M Euro)	5.24%	5.66 (0.075 M Euro)	3.30%
4.	PPP Programme (SGRI Projects & Airbus)	2.12 (0.03 M Euro)	1.02%	0.00	0.00%	0.00	0.001%
5.	General Scientific Expenses (activities like Publication of research papers, ESONN, SOLEIL Synchrotron Programmes, Lecture Series etc.)	4.23 (0.05 M Euro)	2.04%	0.290 (0.003 M Euro)	0.14%	1.95 0.02 M Euro	1.12%
6.	Governing Body, Industrial Research Committee & Scientific Council meetings	7.30 (2.47 M Euro)	3.51%	8.87 (Euro 0.114 M)	4.41%	6.25 (0.07 M Euro)	3.64%
7.	Running expenses of the Centre (Salaries, Office maintenance & Travel)	18.60 (0.23 M Euro)	8.95%	24.98 (Euro 0.33 M)	12.44%	19.26 (0.225 M Euro)	11.24%
	TOTAL	207.86 (2.58 M Euro) @ 1 Euro = Rs 80.6222		200.7 (2.58 M Euro) @ 1 Euro = 77.7024		171.34 (2.19 M Euro) @ 1 Euro = 78.16	

Figure X: Annual Expenditure Over the Years - Core Programmes
(Figures in Rs./Euro in Million)

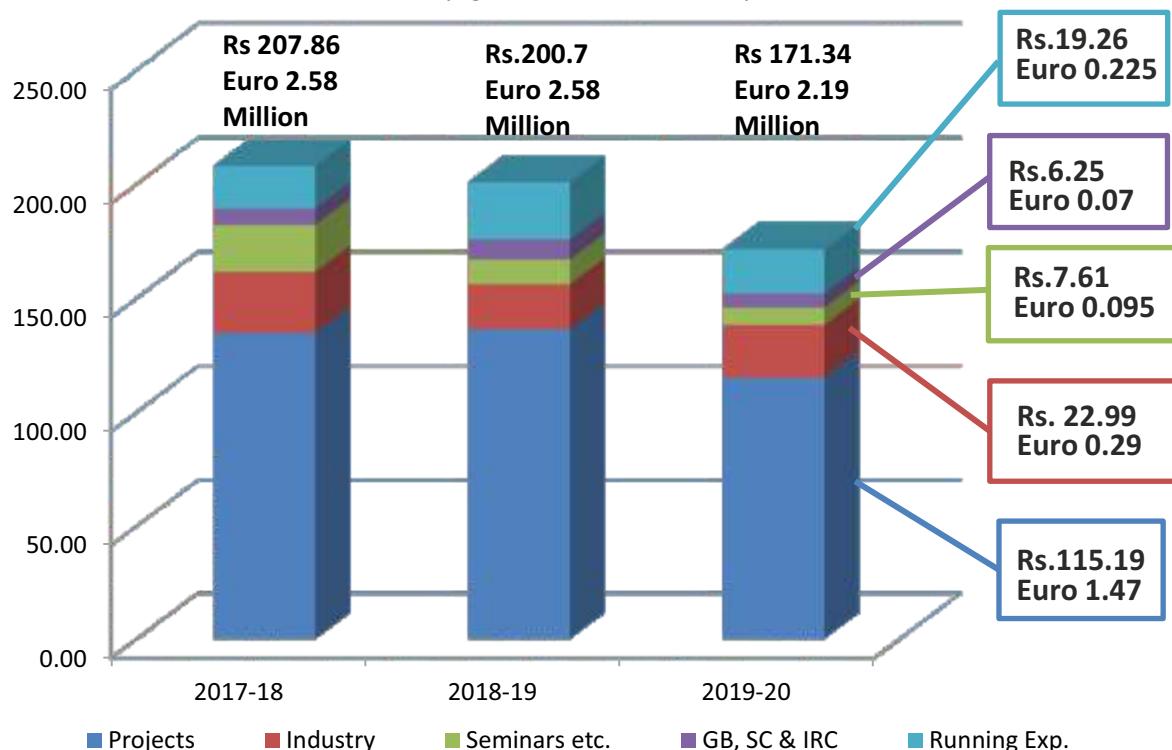
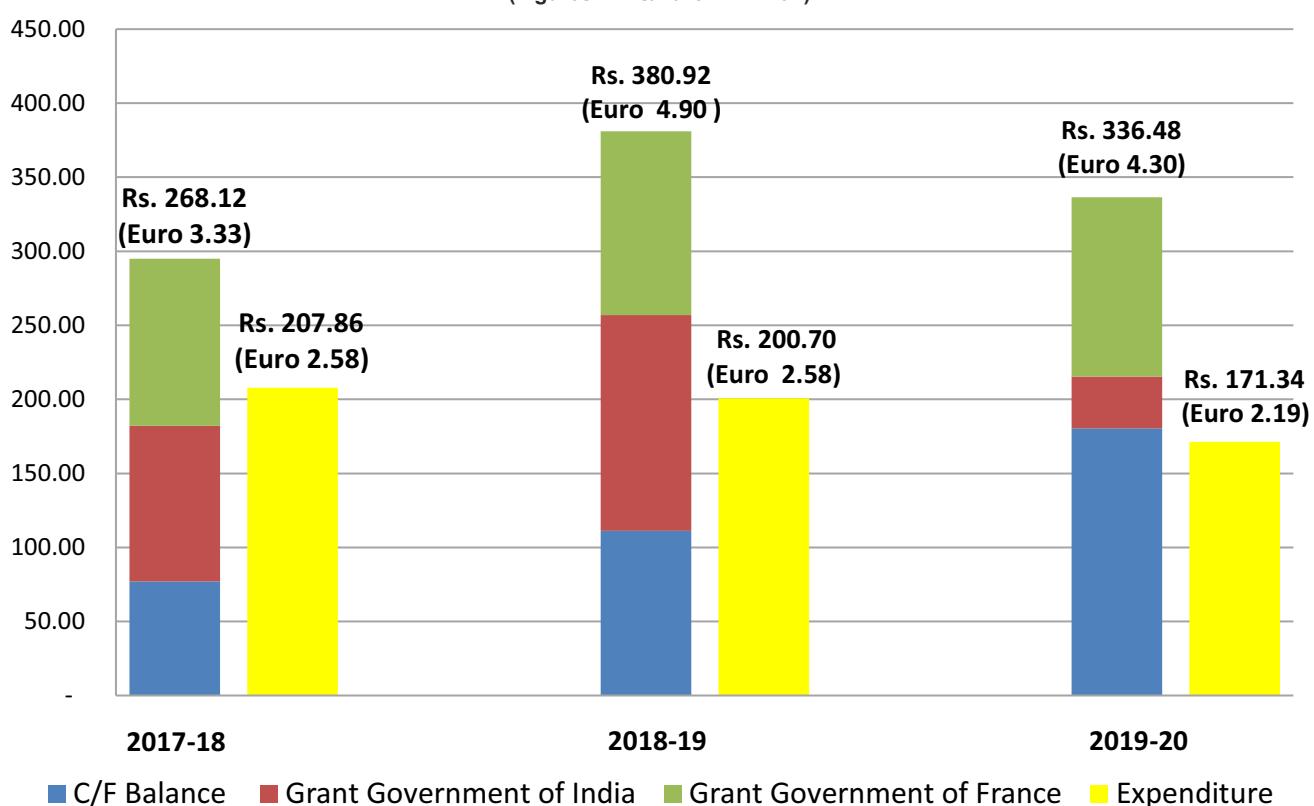


Figure Y: Fund Position v/s Expenditure - Core Programmes
(Figures in Rs./Euro in Million)



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 2019-20 are given in the **Table 3A (Rs in million), Table 3B (in Euro)**

Table 3A - Non Core Programmes: Fund Position & Expenditure incurred during FY 2019-20

(Rs. in million)

Non- Core Programmes : Fund Position & Expenditure incurred during Financial Year 2019-20												
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)	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)	3.34	17.00	5.09	-	25.43	13.37	-	-4.24	-	9.13	16.30
2	RAMAN CHARPAK FELLOWSHIP (DST-Fr.Embassy)	17.58	15.00	10.52	-	43.10	8.90	15.36	-	0.30	24.56	18.54
3	DST-INRA PROJECTS	0.92	-	-	0.02	0.94	-	-	-0.47	-	-0.47	1.41
4	DST-Inria-CNRS PROJECTS	4.75	8.63	-	-	13.38	4.66	-	-	2.29	6.95	6.43
5	DST-ANR PROJECTS	1.12	-	-	0.03	1.15	-1.67	-	-0.55	3.37	1.15	-
6	BIRAC- FRENCH EMBASSY PROJECTS	11.02	-	-	0.08	11.10	-	1.35	-1.24	-	0.11	10.99
7	Indo-French Water Network	11.03	-	-	0.09	11.12	-0.42	-1.08	-1.60	-	-3.10	14.22
8	TDB Programee	0.29	1.08	-	0.04	1.41	1.18	-	-	-	-1.18	0.23
9	BIRAC-BPI FRANCE	3.09	-	-	-	3.09	-0.001	-	-	-	-0.001	3.09
10	Economic Diplomacy	5.91	-	-	-	5.91	-	-	-1.02	-	-1.02	6.93
11	DST-CNRS Fellowship	5.23	-	-	-	5.23	3.17	-	-	-	3.17	2.06
TOTAL		64.280	41.710	15.610	0.260	121.860	29.193	15.630	-9.124	5.960	41.659	80.202

NOTE for 2019-20:

- (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.

Table 3B - Non Core Programmes: Fund Position & Expenditure incurred during FY 2019-20

(Euro in Million)

Non- Core Programmes : Fund Position & Expenditure incurred during Financial Year 2019-20												
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		Indian Side	French Side				
1	IFCAM (DST-CNRS)	42,732.86	2,17,502.56	65,214.00	-	3,25,449	1,71,059	-	-54,247.70	-	1,16,811.67	2,08,638
2	RAMAN CHARPAK FELLOWSHIP(DST-Fr.Embassy)	2,24,923	1,91,914	1,40,000	-	5,56,837	1,13,869	1,96,463	-	-	3,10,332	2,46,505
3	DST-INRA PROJECTS	11,771	-	-	256	12,027	-	-	-6,013	-	-6,013	18,040
4	DST-Inria-CNRS PROJECTS	60,773	1,10,415	-	-	1,71,187	59,621	-	-	29,299	88,920	82,267
5	DST-ANR PROJECTS	14,330	-	-	371	14,701	-21,366	-	-7,037	43,117	14,700	-
6	BIRAC- FRENCH EMBASSY PROJECTS	1,40,993	-	-	1,024	1,42,016	-	17,288	-15,865	-	1,423	1,40,593
7	Indo-French Water Network	1,41,121	-	-	1,164	1,42,285	-5,322	-13,890	-20,471	-	-39,683	1,81,968
8	TDB Programee	3,710	13,818	-	512	18,040	15,097	-	-	-	15,097	2,943
9	BIRAC-BPI FRANCE	39,534	-	-	-	39,534	-13	-	-	-	-13	39,547
10	Economic Diplomacy	75,614	-	-	-	75,614	-	-	-13,101	-	-13,101	88,715
11	DST-CNRS Fellowship	66,914	-	-	-	66,914	40,558	-	-	-	40,558	26,356
	TOTAL	8,22,416	5,33,649	2,05,214	3,327	15,64,605	3,73,503	1,99,861	-1,16,735	72,416	5,29,032	10,35,573

NOTE for 2019-20:

- (1) The C/F balances 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.

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.



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, 2020, 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.



204, SAGAR PLAZA, PLOT NO-19, DISTRICT CENTER, LAXMINAGAR, NEW DELHI-110092
MOBILE NO-9718013350, Email-ankesh134@gmail.com, info@canirbhaya.com

BIHAR - NEW DELHI - UTTRAKHAND - UTTAR PRADESH - JHARKHAND

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



(ANKESH)

Partner

Membership No.550940

Place : New Delhi

Date : 15th January, 2021

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, 2020

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.



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A handwritten signature in black ink, appearing to read "Prupali".

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.

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.

6.4 IFCPAR, every year receives a fixed Grant in EURO account from France Government for carrying the core and non-core programmes for which separate books of accounts are maintained as part of Non-Integral Foreign Operation.

The Non-Integral Foreign operations have been incorporated in the Financial Statement of IFCPAR as per Para – 24 of AS-11 "The Effects of Changes in Foreign Exchange Rates" which is as follows:

"Non-integral Foreign Operations

24. In translating the financial statements of a non-integral foreign operation for incorporation in its financial statements, the reporting enterprise should use the following procedures:

(a) the assets and liabilities, both monetary and non-monetary, of the non-integral foreign operation should be translated at the closing rate;

(b) income and expense items of the non-integral foreign operation should be translated at exchange rates at the dates of the transactions; and

(c) all resulting exchange differences should be accumulated in a foreign currency translation reserve until the disposal of the net investment."

For practical reasons, an average exchange rate at the dates of receipt of grant-in-aid from France Government (in EURO) which is Rs. 78.16 / euro is used to translate income and expense items of a foreign operation.



S. Singh *Ramgarh*

The translation of the financial statements of a non-integral foreign operation results in the recognition of exchange differences amounting to Rs. 23,31,537.24 (i.e. 501891.56*(82.8055-78.16)) which has been recognised as "Foreign Currency Translation Reserve" under the head Liabilities in 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. IFCPAR has received a sum of Rs. 3,50,00,000/- 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. IFCPAR 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. IFCPAR has received a sum of Euro 2,05,214/- and Rs.4,96,53,222/- 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.66,23,853/- as on 31st March 2019 has been increased to Rs.89,58,009/- 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 2018-19 amounting Rs.1,08,713/. In respect of premium of pension the decision was made to pay the amount through Reserve and surplus account amounting to Rs 2,80,20,812/- which will be paid in next financial year.



A handwritten signature in black ink, appearing to read "J. Singh".

A handwritten signature in black ink, appearing to read "Pragya".

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 2020-21 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 2019-20.
9. During the year total ongoing projects were 62 and the total liability towards these projects as per sanctioned amounts aggregates to Rs.8,40,11,078/- for the Indian side and Euro 7,82,584/- for the French side at 31st March, 2020.

For NIRBHAYA & ASSOCIATES

Chartered Accountants

Firm Registration No. 016125N

ANKESH
Partner
Membership No.550940
Place : New Delhi
Date : 15.01.2021



J. Singh .
SIMRANJEET SINGH
Assistant Accounts Officer

Rupal.
Dr. Purnima Rupal
Director

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI						
Balance Sheet as at 31st March 2020						
						INR Version
I. Liabilities		SCH	Amount as on 31.03.2020		Amount as on 31.03.2019	
			Total Amount in INR		Total Amount in INR	
Reserve Fund						
Core Programmes	A		18,13,12,581.60	18,13,12,581.60	19,66,35,422.69	19,66,35,422.69
Current Liabilities						
Targeted Programmes	B					
IFCAM Project			1,63,07,882.43		32,63,076.81	
DST-ANR Projects			-		11,23,886.00	
DST-INRA Projects			14,17,874.00		8,04,722.54	
DST-INRIA Projects			64,26,960.00		64,20,127.00	
Raman Charpak Fellowship			1,85,47,521.97		1,74,94,488.26	
BIRAC French Embassy			1,09,91,804.88		1,10,20,994.22	
Economic Diplomacy R & D Programme			69,42,254.37		57,35,739.66	
BIRAC BPI France			30,96,001.00		30,97,889.00	
DST- ESSONN Fellowship			5,868.00		3,906.00	
DST-CNRS Fellowship			20,59,620.00			
Indo French Water Network			1,42,29,423.43		1,06,81,415.82	
Programme Implementation & Overhead	B			8,00,25,210.07		5,96,46,245.30
DST-ANR Projects			-		-	
DST-INRIA Projects			-		-	
Raman Charpak Fellowship			2,98,273.00		-	
BIRAC French Embassy			-		-	
Indo French Water Network			-		-	
TDB Programme			2,28,030.00		2,89,858.00	
BIRAC BPI France			-		-	
DST-ESSONN Fellowship			-		-	
Expenses Payable				5,26,303.00		2,89,858.00
Salaries and Office Expenses Payable	C		6,10,137.00		1,01,578.00	
TDS Payable	C		36,528.00		88,361.00	
Seminar & Workshop	C		33,69,615.00		39,01,708.00	
GB/SC Expenses Payable			50,150.00		2,088.00	
Expenses on Publication					7,000.00	
Interest Payable to DST						
Sbi Core			11,68,963.00			
Raman Charpak Fellowship			8,85,911.00			
DST CNRS Fellowship			42,208.00			
DST Inria Fellowship			3,33,668.00			
IFCAM			1,63,238.00			
Scientific expenses payable					6,356.00	
Travel Expenses Payable					5,277.00	
Group Farming				66,60,418.00		41,12,368.00
Grant-In Aid-2017-18				6,11,502.00		8,54,726.40
Foreign Currency Adjustment Account	D			89,55,390.00		66,23,853.00
Total Liabilities				27,80,91,404.67		26,81,62,473.39

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.

(Ankesh)

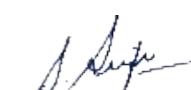
Partner

Membership No.

Place : New Delhi

Date : 15.01.2021




(Simranjeet Singh)

Assistant Accounts Officer


Purnima Rupal

(Dr. Purnima Rupal)
Director

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Balance Sheet as at 31st March 2020

Balance Sheet as at 31st March 2020				INR Version
	SCH	Amount as on 31.03.2020		Amount as on 31.03.2019
		Total Amount in INR		Total Amount in INR
				INR Version
II. Assets		Amount as on 31.03.2020	Amount as on 31.03.2019	
Fixed Assets	E	43,68,243.00		45,71,433.00
Cash & Cash Equivalents		Total Amount in INR	Total Amount in INR	
Core Bank Balances				
State Bank of Hyderabad Account		2,44,72,058.95	6,65,09,909.36	
Union Bank of India Accumulated Reserve		5,48,02,261.00	5,31,95,118.48	
Union Bank of India		4,52,198.00	4,37,139.00	
Axis Bank Account		78,315.00	8,17,916.00	
State Bank of India (GPF) Account		14,55,934.00	78,315.00	
State Bank of Hyderabad (Gratuity) Account		10,50,38,528.33	15,17,175.00	
CIC, Paris Account		18,62,99,295.28	7,46,68,737.46	19,72,24,310.30
Non Core Bank Balances				
Union Bank of India - Raman Charpak Account		2,84,30,154.92	2,09,08,820.48	
Union Bank of India - DST INRIA Account		96,68,223.00	70,51,920.64	
Union Bank of India - DST INRA Account		7,08,458.00	6,84,866.00	
Union Bank of India - IFCAM Account		72,83,751.00	1,19,061.82	
Union Bank of India-DST ANR Account		48,287.73	17,04,535.73	
Union Bank of India-TDB Programme		12,05,242.90	7,82,660.16	
State Bank of Hyderabad-IFWN		31,42,417.00	27,59,582.00	
State Bank of Hyderabad-BIRAC		27,00,595.50	26,18,248.50	
State Bank Of India- BPI France		32,10,734.00	30,88,157.00	
Union Bank DST CNRS		23,80,521.58		
Union Bank Of India-ESONN		56,754.76	54,556.76	
Current Assets		5,88,35,140.39		3,97,72,409.09
Seminars & Workshops	F	35,37,748.00	34,81,415.00	
Income Tax & TDS Receivable		1,91,225.00	3,47,190.00	
Other Deposits	F	87,18,838.00	81,93,743.00	
Tour Advances- Core		78,54,879.00	73,92,414.00	
Tour Advances-Non Core			1,23,300.00	
Accrued Interest-IFCAM		66,432.00	1,028.00	
Accrued Interest-ESSONN		480.00	716.00	
Accrued Interest-ANR		392.00	14,710.00	
Accrued Interest-TDB		10,250.00	7,198.00	
Accrued Interest-Raman Charpak		2,92,167.00	1,25,172.00	
Accrued Interest-INRIA		85,707.00	53,150.00	
Accrued Interest CNRS		21,306.00		
Accrued Interest Accumulated Reserve		5,25,291.00	4,69,402.00	
Accrued Interest- INRA		5,735.00	5,911.00	
Accrued Interest-Core		3,661.00		
IIC Membership Fee Advance		1,59,300.00	1,35,700.00	
Electonic Project Proposal Management		4,90,875.00	27,080.00	
Cash -in-transit		66,24,440.00	62,16,192.00	
Security Deposit, Campus France, Paris		2,85,88,726.00		2,65,94,321.00
		27,80,91,404.67		26,81,62,473.39
	Total Assets			

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

TOP NIRBHATA & ASSOCIATES
Chartered Accountants

Firm Registration No. 016125N

FIMI Registration No.

(Ankesh)

(Animesh)
Partner

Partner
Membership No. 5

Membership No.5
Place : New Delhi

Place : New Delhi
Date : 15-01-2021

Date : 15.01.2021

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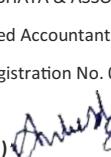
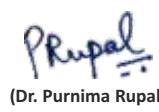


(Simranjeet Singh)
Assistant Accounts Officer

Assistant Accounts Officer

Proposal

(Dr. Purnima Rupal)
Director

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI						
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2020-CORE PROGRAMME						
Income	SCH	Amount as on 31.03.2020			INR Version	
		Total Amount in INR			Amount as on 31.03.2019	
					Total Amount in INR	
Grant-in Aid	G	3,50,00,000.00	12,11,54,898.00	15,61,54,898.00	14,57,25,044.00	26,99,73,044.00
From Government of India				22,25,698.00	12,42,48,000.00	26,81,837.00
From Government of France				8,480.00		2,68,914.00
Interest From Bank Accounts	H					
Misc. Income						
I. Total Income				15,83,89,076.00		27,29,23,795.00
Expenditure	I					
Running Expenditure of the Centre			1,76,23,225.00		2,42,74,154.00	
Salaries and Office Expenses of the Centre					7,11,901.00	
Travel Expense			16,45,292.00		88,72,491.00	
GB/SC/IRC/SEP/Vision Group Expenses			62,57,019.00		67,34,933.00	
Office Expenses-Accumulated Reserve			-			
Total Running Expenditure (A)				2,55,25,536.00		4,05,93,479.00
Scientific Expenditure of the Centre						
General Scientific Expenses			19,56,662.00		2,90,272.00	
Research Projects/Seminar and Workshop			14,38,65,410.00		16,65,81,176.00	
Total Scientific Expenditure (B)				14,58,22,072.00		16,68,71,448.00
II. Total Expenditure(A+B)				17,13,47,608.00		20,74,64,927.00
Excess of Income over Expenditure(I-II)	E		(1,29,58,532.00)			6,54,58,868.00
Depreciation			(7,02,106.00)		(7,24,117.00)	
Loss on Sale assets			-		-	
Prior period Items			-		(77,198.11)	
Exchange Rate Fluctuation(Repatriate Fluctuation difference)			-		(1,18,267.20)	
Balance of Surplus Funds				(7,02,106.00)		(9,19,582.31)
				(1,36,60,638.00)		6,45,39,285.69
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. 016125M						
(Ankesh) 		NIRBHAYA & ASSOCIATES M. No. 550940 Chartered Accountants		(Simranjeet Singh)		 (Dr. Purnima Rupal)
Partner				Assistant Accounts Officer		Director
Membership No. 550940						
Place : New Delhi						
Date : 15.01.2021						

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI RECEIPT AND PAYMENT FOR THE YEAR ENDED ON 31st March 2020				
	Amount as on 31.03.2020		Amount as on 31.03.2019	
	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	2,09,08,820.48		26,80,240.73	
Union Bank of India DST INRA Account	6,84,866.00		6,61,411.00	
Union Bank of India DST INRIA Account	70,51,920.64		45,69,094.20	
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-Esson	54,556.76		30,05,890.00	
Union Bank Accumulated Reserve	5,27,25,716.48			
Union Bank of India-TDB	7,82,660.16		2,19,452.32	
State Bank of India 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 India (Gratuity Fund) Account	15,17,175.00		26,16,693.00	
State Bank of India-BIRAC	26,18,248.50		38,26,933.50	
State Bank of India-IFWN	27,59,582.00		28,05,806.00	
State Bank of India GPF	78,315.00			
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
Total Opening Balance(A)	16,18,58,579.93	9,60,957.93	10,37,78,389.03	6,30,435.56
B. Grant Received and Interest Earned				
i. Grant-in-aid Core Programmes				
Grant From Govt. of France				
Grant from Govt. of India				15,50,000.00
ii. Grant-in-aid Non Core Programmes				
Government of France				
Government of India				1,94,197.00
TDB-Programme				
iii. Interest from Bank Accounts(Net of TDS)				
State Bank of India				
UBI-Bank				
State Bank of India-Gratuity account				92,103.00
Union Bank of India - Raman Charpak Account				
Union Bank Accumulated Reserve				2,04,935.00
Union Bank of India - DST INRIA Account				
Union Bank of India - DST INRA Account				2,05,106.00
Union Bank of India - IFCAM Account				23,455.00
Union bank of India CNRS				18,125.00
Union Bank of India-DST ANR Account				
State Bank of India Account-IFWN				1,51,422.00
Union Bank of India-TDB				96,780.00
State Bank of India Account-Birac				15,082.00
Axis bank Interest				1,15,986.00
Union Bank Of India-ESSONN				28,011.00
Cash in Transit				76,197.00
iv. Misc.Income				64,22,696.00
v. Prior Period Items				3,47,229.00
vi. Repatriation of Funds				
vi. Income Tax Recoverable				2,06,70,089.00
TOTAL (B)	10,59,40,063.00	15,55,204.00	23,36,11,533.00	14,98,688.00
TOTAL RECEIPTS(A+B)	26,77,98,642.93	25,16,161.93	33,73,89,922.03	21,29,123.56



INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI RECEIPT AND PAYMENT FOR THE YEAR ENDED ON 31st March 2020					
		Amount as on 31.03.2020		Amount as on 31.03.2019	
		Transaction in INR	Transaction in Euro	Transaction in INR	Transaction in Euro
II. PAYMENTS					
(A) Running Expenses of the Centre					
Salaries and office Expenses of the Centre		1,75,06,976.17	5,095.00	2,54,99,078.00	4,224.93
Travel Expenses		12,94,420.00	4,489.15	5,98,276.00	1,394.40
GB/SC/IRC/SEP/Vision Group Expenses		43,83,801.00	23,993.17	64,91,031.00	22,577.29
Non Shareable Expenses		-		19,02,369.00	37,349.84
Total Running Expenses(A)		2,31,85,197.17	33,577.32	3,44,90,754.00	65,546.46
(B) Scientific Expenses of the Centre					
General Scientific Expenses		19,63,018.00		3,46,535.00	
Research Projects/Seminar and Workshop		6,55,64,215.00	10,14,531.74	8,90,63,096.00	10,43,689.85
Total Scientific Expenses (B)		6,75,27,233.00	10,14,531.74	8,94,09,631.00	10,43,689.85
(C) Other Payments					
Non Core Programmes		3,09,90,118.00	1,99,861.31	4,65,30,407.56	1,48,386.26
Non Core Programmes Programmed		29,36,049.00		32,81,888.54	
Implementation and Overhead charges		4,94,061.00		4,52,349.00	
Purchase of Assets Net of sales		25,50,395.00		13,66,312.00	993.51
BRICS Meetings				-	(90,450.45)
Prior Period Items		19,683.00	(305.44)	5,16,30,957.10	58,929.32
Interest refunded to DST					
Meeting Advance		3,69,90,306.00	1,99,555.87		
Other Deposit					
Total Other Payments(C)		12,77,02,736.17	12,47,664.93	17,55,31,342.10	11,68,165.63
TOTAL PAYMENTS(D=A+B+C)					
III. Cash & Cash Equivalent					
Balance carried forward					
Union Bank of India Raman Charpak Account		2,84,30,154.92		2,09,08,820.48	
Union Bank of India DST INRIA Account		96,68,223.00		70,51,920.64	
Union Bank of India DST INRA Account		7,08,458.00		6,84,866.00	
Union Bank of India IFCAM Account		72,83,751.00		1,19,061.82	
Union Bank of India-DST ANR Account		48,287.73		17,04,535.73	
Union Bank of India-TDB		12,05,242.90		7,82,660.16	
Union Bank of India Accumulated Reserve		5,48,02,261.00		5,27,25,716.48	
State Bank of India Account		2,44,72,058.95		6,65,09,909.36	
Union Bank of India-CEFIPRA Account		4,52,198.00		4,37,139.00	
Union Bank- DST ESONN Fellowship		56,754.76		54,556.76	
Union Bank DST CNRS Account		23,80,521.00			
Axis Bank Account				8,17,916.00	
State Bank of India (Gratuity Fund) Account		14,55,934.00		15,17,175.00	
State Bank of India - BIRAC French Embassy		27,00,595.50		26,18,248.50	
State Bank of India -IFWN		31,42,417.00		27,59,582.00	
State Bank of India-BIRAC BPI France		32,10,734.00		30,88,157.00	
CIC Paris			12,68,497.00		9,60,957.93
State Bank Of India- GPF Account		78,315.00	.	78,315.00	
TOTAL CLOSING BANK BALANCE (D)		14,00,95,906.76	12,68,497.00	16,18,58,579.93	9,60,957.93
TOTAL PAYMENTS (C+D)		26,77,98,642.93	25,16,161.93	33,73,89,922.03	21,29,123.56
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					
(Ankesh) 					
Partner					
Membership No. 550940					
Place : New Delhi					
Date : 15.01.2021					
					
					
(Simranjeet Singh)					
Assistant Accounts Officer					
					
(Dr. Purnima Rupal)					
Director					

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st March 2020-NON CORE PROGRAMMES					
Income	SCH J	Amount as on 31.03.2020		Amount as on 31.03.2019	
		Total Amount in INR		Total Amount in INR	
IFCAM Projects		2,20,97,126.00		2,16,64,005.00	
DST-ANR Projects		29,775.00		1,17,560.00	
DST-INRA Projects		23,416.00		23,658.00	
DST-INRIA Projects		86,32,857.00		1,09,12,587.00	
Raman Charpak Fellowship		2,59,42,400.00		3,65,35,320.00	
BIRAC French Embassy		82,347.00		37,417.00	
Indo French Water Network		91,272.00		96,780.00	
TDB Programmes		11,22,494.00		11,28,266.00	
BIRAC BPI France Programme		-		27,52,377.00	
DST CNRS		52,37,123.00		-	
DST- ESONN Fellowship		1,962.00		50,348.00	
Total Income			6,32,60,772.00		7,33,18,318.00
Expenditure	K				
IFCAM Projects		1,33,76,994.00		2,40,53,494.00	
DST-ANR Projects		(16,73,060.00)		1,81,739.00	
DST-INRA Projects		-		-	
DST-INRIA Projects		46,68,383.00		80,61,955.00	
Raman Charpak Fellowship		2,42,54,856.00		2,05,89,493.00	
BIRAC French Embassy		13,51,230.00		12,87,385.00	
Indo French Water Network		(15,01,646.00)		2,39,724.00	
TDB Programmes		11,84,322.00		10,60,141.00	
BIRAC BPI France Programme		1,888.00		1,26,888.00	
DST CNRS		31,77,503.00		28,00,602.00	
DST- ESONN Fellowship		-			
Total Expenditure			4,48,40,470.00		5,84,01,421.00
Balance of Surplus Funds					
IFCAM Projects		87,20,132.00		(23,89,489.00)	
DST-ANR Projects		17,02,835.00		(64,179.00)	
DST-INRA Projects		23,416.00		23,658.00	
DST-INRIA Projects		39,64,474.00		28,50,632.00	
Raman Charpak Fellowship		16,87,544.00		1,59,45,827.00	
BIRAC French Embassy		(12,68,883.00)		(12,49,968.00)	
Indo French Water Network		15,92,918.00		(1,42,944.00)	
TDB Programmes		(61,828.00)		68,125.00	
BIRAC BPI France Programme		(1,888.00)		26,25,489.00	
DST CNRS		20,59,620.00			
DST- ESONN Fellowship		1,962.00		(27,50,254.00)	
Total Balance of Surplus Funds			1,84,20,302.00		1,49,16,897.00

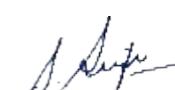
Accounting policies and notes to accounts are integral part of financial statements.

AUDITOR'S REPORT

As per our report of even date attached.

For NIRBHAYA & ASSOCIATES
Chartered Accountants
Firm Registration No. 015125N
(Ankesh) Partner
Membership No.550940
Place : New Delhi
Date :15.01.2021




(Simranjeet Singh)
Assistant Accounts Officer


(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 2020							
	Amount as on 31.03.2020			Amount as on 31.03.2019			
Schduele B- Targetted Programmes	Amount (INR)	Amount (Euro)	Total Amount in INR		Amount (INR)	Amount (Euro)	Total Amount in INR
IFCAM Projects							
Opening Balance-Project Release	16,60,816.85	27,536.00	33,43,476.43		37,08,850.85	78,236.00	90,89,476.00
Balance of Surplus Funds	36,23,006.00	65,214.00	87,20,132.00	(68,42,272.00)	54,197.00	(23,89,489.00)	
Repatriation of Funds				47,94,238.00	(61,700.00)		
Funds In Transit	33,43,850.00		-		(43,197.00)		(33,56,510.57)
Adjustment during the year			-				-
Total IFCAM Projects	86,27,672.85	92,750.00	1,20,63,608.43		16,60,816.85	27,536.00	33,43,476.43
Less: Programme Implementation & Overhead	-	-	-				
Less: amount refunded to DST			-				
Foreign Currency fluctuation			42,44,274.00				(80,339.61)
Balance for Project Releases	86,27,672.85	92,750.00	1,63,07,882.43		16,60,816.85	27,536.00	32,63,136.82
DST- ANR Projects							
Opening Balance- Project Release	11,23,886.00	-	11,23,886.00		34,95,562.00		34,95,562.00
Balance of Surplus Funds	17,02,835.00	-	17,02,835.00	(64,179.00)	-		(64,179.00)
Prior Period Items	5,46,680.00	-	5,46,680.00		-		-
Adjusment for DST-INRA programme	-	-	-		-		-
Adjustment during the year	-	-	-		-		-
Total DST-ANR Projects	33,73,401.00	-	33,73,401.00		34,31,383.00	-	34,31,383.00
Less: Programme Implementation & Overhead	-	-	-		-		-
Less: Amount Refunded To DST	33,73,401.00	-	33,73,401.00	(23,07,497.00)	-		(23,07,497.00)
Balance for Project Releases	-	-	-		11,23,886.00	-	11,23,886.00
DST- INRA Projects							
Opening Balance	6,90,777.00	8,498.00	9,17,129.00		6,67,119.00	38,498.00	32,24,543.00
Balance of Surplus Funds	23,416.00	-	23,416.00		23,658.00	-	23,658.00
Prior Period Items	-		-		(30,000.00)		(23,31,072.00)
Total DST-INRA Projects	7,14,193.00	8,498.00	9,40,545.00		6,90,777.00	8,498.00	9,17,129.00
Less: Programme Implementation & Overhead	-	-	-		-		-
Foreign Currency fluctuation			4,77,329.00				(1,12,406.46)
Balance for Project Releases	7,14,193.00	8,498.00	14,17,874.00		6,90,777.00	8,498.00	8,04,722.54
DST- INRIA Projects							
Opening Balance	47,51,296.00	-	47,51,296.00		35,69,495.00	-	35,69,495.00
Balance of Surplus Funds	39,64,474.00	-	39,64,474.00		28,50,632.00	-	28,50,632.00
Adjustment during the year	-	-	-		-		120.00
Total DST-INRIA Projects	87,15,770.00	-	87,15,770.00		64,20,127.00	-	64,20,247.00
Less: Programme Implementation & Overhead	-	-	-		-		-
Less: Amount Refunded To DST	22,88,810.00	-	22,88,810.00		16,68,831.00	-	-
Balance for Project Releases	64,26,960.00	-	64,26,960.00		47,51,296.00	-	64,20,247.00



INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI Schedules forming part of Balance Sheet as At 31st March 2020							
				Amount as on 31.03.2020		Amount as on 31.03.2019	
Schduele B- Targetted Programmes	Amount (INR)	Amount (Euro)	Total Amount in INR	Amount (INR)	Amount (Euro)	Total Amount in INR	
Raman Charpak Fellowship							-
Opening Balance	1,49,11,010.00	30,306.44	1,75,82,977.00	27,51,426.00	(9,606.50)	16,37,150.00	
Balance of Surplus Funds	61,00,692.00	(56,463.00)	16,87,544.00	1,67,55,960.00	(10,087.06)	1,59,45,827.00	
Repatriation of funds	-	-	-	(42,94,934.00)	50,000.00	-	
Adjustment during the year	-	-	-	-	-	-	
Amount refunded to DST	-	-	-	-	-	-	
Total Raman Charpak Fellowship	2,10,11,702.00	(26,156.56)	1,92,70,521.00	1,52,12,452.00	30,306.44	1,75,82,977.00	
Less: Programme Implementation & Overhead	2,98,273.00	-	2,98,273.00	-	-	-	
Less: Interest refunded to DST	-	-	-	3,01,442.00	-	(88,488.74)	
Foreign Currency fluctuation	-	-	(21,65,907.03)	-	-	-	
Balance for Project Releases	2,07,13,429.00	(26,156.56)	1,85,47,521.97	1,49,11,010.00	30,306.44	1,74,94,488.26	
Birac French Embassy							
Opening Balance	34,40,733.00	1,07,484.00	1,10,20,995.00	34,25,864.00	1,23,233.00	1,25,84,794.00	
Balance of Surplus Funds	82,347.00	(17,288.00)	(12,68,883.00)	14,869.00	(15,749.00)	(12,49,968.00)	
Total Birac French Embassy	35,23,080.00	90,196.00	97,52,112.00	34,40,733.00	1,07,484.00	1,13,34,826.00	
Less: Programme Implementation & Overhead	-	-	-	-	-	-	
Foreign Currency fluctuation	-	-	12,39,692.88	-	-	(3,13,831.00)	
Balance for Project Releases	35,23,080.00	90,196.00	1,09,91,804.88	34,40,733.00	1,07,484.00	1,10,20,995.00	
Economic Diplomacy R & D Programme							
Opening Balance	17,73,126.00	62,424.94	59,18,008.00	17,73,126.00	62,424.94	59,18,008.00	
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	-	-	10,24,246.37	-	-	(1,82,268.34)	
Balance for Project Releases	17,73,126.00	62,424.94	69,42,254.37	17,73,126.00	62,424.94	57,35,739.66	
India France Water Network							
Opening Balance	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	
Balance of Surplus Funds	5,07,300.00	13,889.69	15,92,918.00	(1,42,944.00)	-	(1,42,944.00)	
Total India France water Network	31,42,417.00	1,33,892.15	1,26,24,717.00	26,35,117.00	1,20,002.46	1,10,31,799.00	
Less: Programme Implementation & Overhead	-	-	-	-	-	-	
Foreign Currency fluctuation	-	-	16,04,706.43	-	-	(3,50,383.34)	
Balance for Project Releases	31,42,417.00	1,33,892.15	1,42,29,423.43	26,35,117.00	1,20,002.46	1,06,81,415.66	
TDB Programme							
Opening Balance	2,89,858.00	-	2,89,858.00	2,21,733.00	-	2,21,733.00	
Balance of Surplus Funds	(61,828.00)	-	(61,828.00)	68,125.00	-	68,125.00	
Total Programme Implementation and Overhead charges	2,28,030.00	-	2,28,030.00	2,89,858.00	-	2,89,858.00	



INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI Schedules forming part of Balance Sheet as At 31st March 2020							
	Amount as on 31.03.2020			Amount as on 31.03.2019			
Schduele B- Targetted Programmes	Amount (INR)	Amount (Euro)	Total Amount in INR	Amount (INR)	Amount (Euro)	Total Amount in INR	
Birac BPI France Programme	30,97,889.00	-	30,97,889.00	4,72,400.00	-	4,72,400.00	
Opening Balance	(1,888.00)	-	(1,888.00)	26,25,489.00	-	26,25,489.00	
Balance of Surplus Funds				30,97,889.00	-	30,97,889.00	
Total Birac French Embassy	30,96,001.00	-	30,96,001.00				
Less: Programme Implementation & Overhead							
Balance for Project Releases	30,96,001.00	-	30,96,001.00	30,97,889.00	-	30,97,889.00	
DST - ESONN Fellowship	3,906.00	-	3,906.00	30,32,455.00	-	30,32,455.00	
Opening Balance	1,962.00	-	1,962.00	(27,50,254.00)	-	(27,50,254.00)	
Balance of Surplus Funds	5,868.00	-	5,868.00	2,82,201.00	-	2,82,201.00	
Total Esson Fellowship				2,78,295.00		2,78,295.00	
Less: Prior Preiod items							
Less: Amount refunded to DST				3,906.00	-	3,906.00	
Balance for Project Releases	5,868.00	-	5,868.00				
DST - CNRS Fellowship							
Opening Balance				-	-	-	
Balance of Surplus Funds	20,59,620.00		20,59,620.00				
Total of DST ANR	20,59,620.00	-	20,59,620.00				



INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI Schedules forming part of Balance Sheet as At 31st March 2020						
	Amount as on 31.03.2020			Amount as on 31.03.2019		
	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						
Other Office expenses	5,002.00	-	5,002.00	39,448.00	-	39,448.00
Electronic Proposal Mangement Charges	5,59,220.00	-	5,59,220.00	1,38,678.00	-	1,38,678.00
Professional Expenses Payable	37,800.00	-	37,800.00	45,360.00	-	45,360.00
Communication Expenses	8,115.00	-	8,115.00	6,501.00	-	6,501.00
Books & Periodicals				1,990.00	-	1,990.00
Electricity Expenses				8,279.00	-	8,279.00
Total Salaries & Office Expense Payable	6,10,137.00	-	6,10,137.00	2,40,256.00	-	2,40,256.00
Duties & Taxes						
On Professional Services	23,600.00	-	23,600.00	60,500.00	-	60,500.00
On Contractors	1,566.00	-	1,566.00	24,700.00	-	24,700.00
On Salary				3,161.00	-	3,161.00
TDs on GST	11,362.00	-	11,362.00			
Total Duties & Taxes	36,528.00	-	36,528.00	88,361.00	-	88,361.00
Seminar & Workshops Liability						
Seminar on Medical Robotics (11-171)	1,08,510.00	-	1,08,510.00	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	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	5,91,717.00	2,75,400.00	3,820.00	5,72,223.00
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
Seminar on Evolutionary Developmental	-	1,320.00	1,09,303.00	-	1,320.00	1,02,567.00
Seminar on Metagenomic	-	3,288.00	2,72,264.00	-	3,288.00	2,55,485.00
Seminar on Airthmetic Geometry	-	3,188.00	2,63,984.00	-	3,188.00	2,47,715.00
Seminar on ocean Technology	14,00,000.00	-	14,00,000.00	14,00,000.00	-	14,00,000.00
Total Seminar & Workshop Liability	24,07,747.00	11,616.00	33,69,615.00	29,99,118.00	11,616.00	39,01,708.00

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI Schedules forming part of Balance Sheet as At 31st March 2020						
	Amount as on 31.03.2020			Amount as on 31.03.2019		
	Transaction in INR	Transaction in Euro	Total Amount in INR	Transaction in INR	Transaction in Euro	Total Amount in INR
Schdeule F- ADVANCES						
Seminar & Workshops						
Seminar on Application of Structured Biology						
Seminar on processing Registrar,Bharatnat University	8,05,200.00	-	8,05,200.00	8,05,200.00	-	8,05,200.00
Tata Institute of Fundamental Seminar on Catlysis by Design Using NMR	5,96,000.00	-	5,96,000.00	5,96,000.00	-	5,96,000.00
Seminar on Plasticity, Rheology and Nonlin	-	13,482.00	11,16,384.00	-	13,482.00	10,86,949.00
Total Seminar & Workshop Advances	14,01,200.00	25,802.00	35,37,748.00	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
GB/SC/RC Advance	22,820.00	8,993.60	7,67,540.00	-	-	
Internet Charges	74,098.00		74,098.00	74,098.00	-	74,098.00
Campus France	-	94,697.20	78,41,449.00	-	1,03,996.24	80,80,757.00
Cash Imprest	7,284.00	-	7,284.00	10,421.00	-	10,421.00
Total Other Deposit	1,32,668.91	1,03,690.80	87,18,838.00	1,12,985.91	1,03,996.24	81,93,743.00



INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
Schedules forming part of Balance Sheet as At 31st March 2020

				Amount as on 31.03.2019				
				Transaction (INR)	Total Amount (INR)	Transaction (INR)	Transaction (Euro)	Total Amount (INR)
Schedule A								
Reserve Fund-Core Programmes								
Opening Balance B/f		13,86,316.17		19,66,35,422.60		6,23,08,568.41	9,24,435.43	13,20,96,137.00
Balance of Surplus Funds		(5,28,95,379.40)		(1,36,60,638.00)		2,51,13,387.00	4,61,880.74	6,45,39,285.60
Adjustment for transfer of Funds		5,01,891.56		8,88,192.00		-	-	-
Interest refunded To DST		(5,83,427.00)		(25,50,395.00)		-	-	-
Transfer of Funds Current Year		-		(2,00,010.00)		-	-	-
Balance c/f to next year		9,21,63,147.01		11,04,770.73		8,74,21,955.41	13,86,316.17	19,66,35,422.60
				Amount as on 31.03.2020			Amount as on 31.03.2019	
Schedule D				Transaction (INR)	Total Amount (INR)	Transaction (INR)	Transaction	Total Amount (INR)
Foreign Currency Adjustment Account								
Opening Balance		-		66,23,853.00		-		83,80,464.00
Current year Adjustment		-		23,31,537.00		-		(17,56,611.00)
Balance carried forward to next year		-		89,55,390.00		-		66,23,853.00



Rupal

A. Gupta

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
SCHEDULES FORMING PART OF THE BALANCE SHEET AS AT 31ST MARCH 2020

Schedule- E Fixed Assets

S.No	Particulars	Rate	GROSS BLOCK			DEPRECIATION			NET BLOCK
			Opening Balance	Additions during the year upto 30.09.2019	Sold during the year	Closing balance	Depreciation for the year	Adjustment	
1	CAR	0.15	6,04,763.00	1,18,899.00	11,315.00	6,04,763.00	4,42,567.00	24,329.00	4,66,896.00
2	FURNITURE & FIXTURE	0.10	11,36,481.00	1,60,110.00	1,60,880.00	-	3,65,511.00	82,447.00	4,47,958.00
3	OFFICE EQUIPMENT	0.15	41,33,135.00	2,60,110.00	34,819.00	45,19,306.00	27,84,141.00	2,50,809.00	30,34,750.00
4	COMPUTER	0.40	23,53,436.00	10,900.00	5,739.00	23,58,597.00	20,72,978.00	1,12,929.00	21,85,907.00
5	LAND & BUILDING	0.10	1,47,71,284.00	1,47,71,284.00	1,39,061.00	1,33,80,676.00	1,35,19,737.00	1,39,061.00	13,90,608.00
6	PHOTOCOPIER	0.15	1,52,250.00	1,52,250.00	58,750.00	1,52,250.00	14,025.00	72,775.00	93,500.00
7	TELEPHONE SYSTEM	0.15	16,85,958.00	2,90,679.00	16,85,958.00	11,61,251.00	78,706.00	-	12,39,957.00
			2,48,37,307.00	2,60,110.00	51,873.00	2,55,36,223.00	2,02,65,874.00	7,02,106.00	2,09,67,980.00
									43,68,243.00
									45,71,433.00



Rupesh

A. Singh

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI
Schedules forming part of Income & Expenditure- Core Programme as At 31st March 2020

	Amount as on 31.03.2020			Amount as on 31.03.2019		
	Transaction (INR)	Transaction (Euro)	Total Amount (INR)	Transaction (INR)	Transaction (Euro)	Total Amount (INR)
Schedule G- Income Core Programme						
Grant in Aid						
Government of India	3,50,00,000.00	-		14,57,25,044.00	-	
Government of France	-	15,50,000.00	12,11,54,898.00	-	15,50,000.00	12,42,48,000.00
Total Grant in Aid	3,50,00,000.00	15,50,000.00	12,11,54,898.00	14,57,25,044.00	15,50,000.00	12,42,48,000.00
 Schedule H- Interest from Bank Accounts						
Union Bank of India Accumulated Reserve	21,32,433.00		21,32,433.00			
State Bank of India	-		-	25,50,395.00	-	25,50,395.00
UBI-Bank	18,720.00	-	18,720.00	11,328.00	-	11,328.00
Axis Bank	27,073.00	-	27,073.00	28,011.00	-	28,011.00
State Bank of Hyderabad-Gratuity Account	47,472.00	-	47,472.00	92,103.00	-	92,103.00
	22,25,698.00	-	22,25,698.00	26,81,837.00	-	26,81,837.00

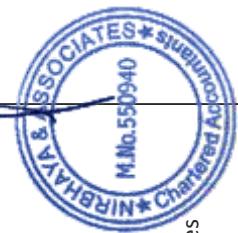


P. Rupesh

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Income & Expenditure- Core Programme as At 31st March 2020

Schedule -I Expenditure Core Programme	Amount as on 31.03.2019		
I. Running Expenditure of the Centre	Transaction (INR)	Transaction (EURO)	Transaction (INR)
	Amount as on 31.03.2020	Total Amount (INR)	Total Amount (INR)
Salaries and Office Expenses of the Centre			
(A) Salaries	1,14,04,511.00	-	1,14,04,511.00
Less: Salaries for Non Core	-	-	-
Total Salaries(A)	1,14,04,511.00	-	1,14,04,511.00
(B) Office Expenses			
Communication Expenses	3,21,640.00	3,21,640.00	5,61,543.00
Conveyance Expenses	47,015.00	47,015.00	25,123.00
Entertainment Expenses	-	-	1,236.00
Repair & Maintenance	1,22,510.00	1,22,510.00	53,212.00
Electricity Expenses	85,590.00	85,590.00	84,382.00
Security Charges	3,01,612.00	3,01,612.00	3,37,451.00
Other Office Expenses	1,65,675.00	1,65,675.00	64,095.00
Bank Charges	5,313.40	5,095.00	4,03,539.00
Books & Periodicals	16,048.00	-	16,048.00
Canteen Expenses	54,838.00	-	54,838.00
Festival Expenses	53,240.00	-	53,240.00
Management Service	3,05,303.00	-	3,05,303.00
Printing and Stationary	1,10,658.00	-	1,10,658.00
Staff Car Expenses	1,38,950.00	-	1,38,950.00
Professional & Legal Expenses	3,18,600.00	-	3,18,600.00
Audit Fees	82,600.00	-	82,600.00
Maintenance Charges IHC	11,14,767.00	-	11,14,767.00
Maintenance Charges-Office Premises	3,33,030.00	-	3,33,030.00
Computer Software	1,770.00	-	1,770.00
Employees Insurance Premium	1,41,178.00	-	1,41,178.00
			<i>Pruppal</i>



INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Income & Expenditure- Core Programme as At 31st March 2020

Schedule -I Expenditure Core Programme		Amount as on 31.03.2020		Amount as on 31.03.2019	
		Transaction (INR)	Transaction (EURO)	Transaction (INR)	Transaction (EURO)
Recruitment Expenses	22,949.00	-	22,949.00	1,69,789.00	-
Advertisement Expenses	63,000.00	-	63,000.00	86,420.00	-
IIC Membership	1,35,700.00	-	1,35,700.00	-	-
Website Maintenance	2,87,049.00	-	2,87,049.00	2,95,988.00	-
Gratuity	1,08,713.00	-	1,08,713.00	11,91,621.00	-
Prior Period Expenses	10,16,082.00	-	10,16,082.00	-	28,82,302.00
Property tax	4,66,658.00	-	4,66,658.00	-	-
Office Expenses(B)	58,20,488.40	5,095.00	62,18,714.00	86,23,862.00	4,842.50
Total Salaries and Office Expense(A+B)	1,72,24,999.40	5,095.00	1,76,23,225.00	2,40,72,374.00	4,842.50
(C) Travel Expenses					
Domestic Travel	2,62,193.00	-	2,62,193.00	1,50,362.00	-
International Travel	10,32,227.00	4,489.15	13,83,099.00	4,53,191.00	1,394.40
Total Travel Expenses (C')	12,94,420.00	4,489.15	16,45,292.00	6,03,553.00	1,394.40
(D) GB/SC/IRC/SEP/FSC Expenses					
Governing Body	19,893.00	1,776.42	1,58,738.00	11,04,341.00	7,268.20
Scientific Council	32,89,719.00	14,958.02	44,58,838.00	33,24,059.00	17,768.97
Industrial Research Council	9,75,365.00	7,258.73	15,42,707.00	16,09,012.00	8,461.32
Standard Expert Panel	70,985.00	-	70,985.00	1,23,485.00	1,078.80
Finance Sub-Committee	25,751.00	-	25,751.00	24,855.00	-
Total GB/SC/IRC/SEP/FSC Expenses (D)	43,81,713.00	23,993.17	62,57,019.00	61,85,752.00	34,577.29
<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>

Proposed



INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Income & Expenditure- Core Programme as At 31st March 2020

Schedule -I Expenditure Core Programme		Amount as on 31.03.2020		Amount as on 31.03.2019	
		Transaction (INR)	Transaction (EURO)	Transaction (INR)	Transaction (EURO)
(E) Office Expenses- Accumulated Reserve					
Group Farming Projects	-	-	-	3,50,436.00	35,323.00
Network Projects	-	-	-	15,51,933.00	2,026.84
Total Office Expenses- Accumulated Reserve (E)	-	-	-	19,02,369.00	37,349.84
II Scientific Expense of the Centre					
(A) General Scientific Expenses					
Electronic Project Proposal Management	16,48,218.00	-	16,48,218.00	18,03,885.00	18,03,885.00
Scientific Publication	1,13,650.00	-	1,13,650.00	5,98,030.00	5,98,030.00
Cefipra Lecture Series	3,80,206.00	-	3,80,206.00	19,794.00	19,794.00
Other Scientific Expenses	(1,85,412.00)	-	(1,85,412.00)	(3,27,552.00)	(3,27,552.00)
Total General Scientific Expenses (A)	19,56,662.00	-	19,56,662.00	20,94,157.00	20,94,157.00
(B) Research Projects/Seminar and Workshop					
Seminars & Workshops	36,05,680.00	26,408.84	56,69,795.00	58,94,160.00	59,588.82
Research Projects	5,07,37,396.00	8,24,726.21	11,51,97,997.00	7,09,09,212.00	8,43,203.50
Industrial Research Projects	1,02,26,581.00	1,63,396.07	2,29,97,618.00	1,11,76,714.00	1,08,773.48
Total Research Project/Seminar and workshop (B)	6,45,69,657.00	10,14,531.12	14,38,65,410.00	8,79,80,086.00	10,11,565.80



Ruppal

A. Gupta

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Income & Expenditure- Non Core Programme as At 31st March 2020

Schedule- J Income- Non Core Programme	Amount as on 31.03.2020			Amount as on 31.03.2019		
	Amount (INR)	Amount (Euro)	Total Amount in INR	Amount (INR)	Amount (Euro)	Total Amount in INR
IFCAM Projects						
Grant In Aid	1,69,00,000.00	65,214.00	2,19,97,126.00	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	1,00,000.00	-	1,00,000.00
Bank Interest	-	-	-	11,222.00	-	11,222.00
Total IFCAM Projects	1,70,00,000.00	65,214.00	2,20,97,126.00	1,73,11,222.00	54,197.00	2,16,64,005.00
DSt- ANR Projects						
Grant In Aid	-	-	-	-	-	-
Programme Implementation and Overhead	-	-	-	-	-	-
Bank Interest	29,775.00	-	29,775.00	1,17,560.00	-	1,17,560.00
Total DST-ANR Projects	29,775.00	-	29,775.00	1,17,560.00	-	1,17,560.00
DSt- INRA Projects						
Grant In Aid	-	-	-	-	-	-
Programme Implementation and Overhead	-	-	-	-	-	-
Bank Interest	23,416.00	-	23,416.00	23,658.00	-	23,658.00
Total DST-INRA Projects	23,416.00	-	23,416.00	23,658.00	-	23,658.00
DSt- INRIA Projects						
Grant In Aid	79,82,857.00	-	79,82,857.00	98,08,321.00	-	98,08,321.00
Programme Implementation and Overhead	6,50,000.00	-	6,50,000.00	8,84,942.00	-	8,84,942.00
Bank Interest	-	-	-	2,19,324.00	-	2,19,324.00
Total DST-INRIA Projects	86,32,857.00	-	86,32,857.00	1,09,12,587.00	-	1,09,12,587.00
Raman Charpak Fellowship						
Grant In Aid	1,40,00,000.00	1,40,000.00	2,49,42,400.00	2,33,33,334.00	1,40,000.00	3,45,77,308.00
Programme Implementation and Overhead	10,00,000.00	-	10,00,000.00	16,66,666.00	-	16,66,666.00
Bank Interest	-	-	-	2,91,346.00	-	2,91,346.00
Total Raman Charpak Fellowship	1,50,00,000.00	1,40,000.00	2,59,42,400.00	2,52,91,346.00	1,40,000.00	3,65,35,320.00
Birac French Embassy						
Grant In Aid	-	-	-	-	-	-
Programme Implementation and Overhead	-	-	-	-	-	-
Bank Interest	82,347.00	-	82,347.00	37,417.00	-	37,417.00
Total Birac French Embassy	82,347.00	-	82,347.00	37,417.00	-	37,417.00
Indo french Water network						
Grant In Aid	-	-	-	-	-	-
Programme Implementation and Overhead	-	-	-	-	-	-
Bank Interest	91,272.00	-	91,272.00	96,780.00	-	96,780.00
Total Indo French Water Network	91,272.00	-	91,272.00	96,780.00	-	96,780.00
TDB Programme						
Grant In Aid	-	-	-	-	-	-
Programme Implementation and Overhead	10,84,242.00	-	10,84,242.00	11,08,267.00	-	11,08,267.00
Bank Interest	38,252.00	-	38,252.00	19,999.00	-	19,999.00
Total TDB Programme	11,22,494.00	-	11,22,494.00	11,28,266.00	-	11,28,266.00



INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Income & Expenditure- Non Core Programme as At 31st March 2020

Schedule-J Income- Non Core Programme	Amount as on 31.03.2020			Amount as on 31.03.2019		
	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
Programme Implementation and Overhead	-	-	-	1,03,555.00	-	1,03,555.00
Bank Interest	-	-	-	-	-	-
Total BIRAC BPI France Programme	-	-	-	27,52,377.00	-	27,52,377.00
DST- ESONN Fellowship						
Grant In Aid	-	-	-	-	-	-
Programme Implementation and Overhead	-	-	-	-	-	-
Bank Interest	1,962.00	-	1,962.00	50,348.00	-	50,348.00
Total ESONN Fellowship	1,962.00	-	1,962.00	50,348.00	-	50,348.00
DST CNRS						
Grant In Aid	49,37,123.00	-	49,37,123.00	-	-	-
Programme Implementation and Overhead	3,00,000.00	-	3,00,000.00	-	-	-
Bank Interest	-	-	-	-	-	-
Total Birac French Embassy	52,37,123.00	-	52,37,123.00	-	-	-



Rupali

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI

Schedules forming part of Income & Expenditure- Non Core Programme as At 31st March 2020

Schedule-K Expenditure Non Core Programme	Amount as on 31.03.2020			Amount as on 31.03.2019		
	Amount (INR)	Amount (Euro)	Total Amount in INR	Amount (INR)	Amount (Euro)	Total Amount in INR
IFCAM Projects						
Project Expenses & Bank Charges	1,32,76,994.00	-	1,32,76,994.00	19,47,106.15	-	19,47,106.00
Programme Implementation and Overhead	1,00,000.00	-	1,00,000.00			
Total IFCAM Projects	1,33,76,994.00	-	1,33,76,994.00	19,47,106.15	-	19,47,106.00
DST- ANR Projects						
Project Expenses & Bank Charges	(16,73,060.00)	-	(16,73,060.00)	43,15,195.00	-	43,15,195.00
Programme Implementation and Overhead	-	-	-	3,61,788.00	-	3,61,788.00
Total DST-ANR Projects	(16,73,060.00)	-	(16,73,060.00)	46,76,983.00	-	46,76,983.00
DST- INRA Projects						
Project Expenses and Bank Charges	-	-	-	-	-	-
Programme Implementation and Overhead	-	-	-	-	-	-
Total DST-INRA Projects	-	-	-	-	-	-
DST- INRIA Projects						
Project Expenses & Bank Charges	40,18,383.00	-	40,18,383.00	1,09,53,172.74	-	1,09,53,173.00
Programme Implementation and Overhead	6,50,000.00	-	6,50,000.00	10,89,577.00	-	10,89,577.00
Total DST-INRIA Projects	46,68,383.00	-	46,68,383.00	1,20,42,749.74	-	1,20,42,750.00
Raman Charpak Fellowship						
Project Expenses & Bank Charges	81,97,581.00	1,96,463.00	2,35,53,129.00	71,67,849.00	1,89,772.01	2,06,26,746.00
Programme Implementation and Overhead	7,01,727.00	-	7,01,727.00	11,69,509.00	-	11,69,509.00
Total Raman Charpak Fellowship	88,99,308.00	1,96,463.00	2,42,54,856.00	83,37,358.00	1,89,772.01	2,17,96,255.00
Birac French Embassy						
Project Expenses	-	17,288.00	13,51,230.00	36,61,318.00	29,287.00	57,38,393.00
Programme Implementation and Overhead	-	-	-	1,96,563.00	-	1,96,563.00
Total Birac French Embassy	-	17,288.00	13,51,230.00	38,57,881.00	29,287.00	59,34,956.00
Indo french Water network						
Project Expenses & Bank Interest	(4,16,028.00)	(13,889.69)	(15,01,646.00)	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	(4,16,028.00)	(13,889.69)	(15,01,646.00)	9,54,644.00	16,894.00	21,52,790.00
TDB Programme						
Programme Implementation and Overhead	11,84,322.00	-	11,84,322.00	5,88,687.68	-	5,88,688.00
Total TDB Programme	11,84,322.00	-	11,84,322.00	5,88,687.68	-	5,88,688.00



S. Singh

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 2020

Schedule-K Expenditure Non Core Programme	Amount as on 31.03.2020			Amount as on 31.03.2019		
	Amount (INR)	Amount (Euro)	Total Amount in INR	Amount (INR)	Amount (Euro)	Total Amount in INR
BIRAC BPI France Programme						-
Project Expenses & Bank Charges	1,888.00		1,888.00	28,00,649.00		28,00,649.00
Programme Implementation and Overhead		-	-	1,03,234.00		1,03,234.00
Total BIRAC BPI France Programme	1,888.00	-	1,888.00	29,03,883.00	-	29,03,883.00
DST- ESONN Fellowship						-
Project Expenses & Bank Charges	-		-	-		-
Programme Implementation and Overhead	-	-	-	-		-
Total DST Esson Fellowship	-	-	-	-	-	-
DST CNRS						
Project Expenses & Bank Charges	28,77,503.00		28,77,503.00			
Programme Implementation and Overhead	3,00,000.00		3,00,000.00			
Total DST CNRS	31,77,503.00		31,77,503.00			
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



INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI						
Balance Sheet as at 31st March 2020						
				Conversion Rate Rs/Euro = 82.8055	Conversion Rate Rs/Euro = 77.7024	
I. Liabilities		SCH	Amount as on 31.03.2020		Amount as on 31.03.2019	
			Total Amount in INR		Total Amount in INR	
Reserve Fund	A		18,13,12,581.60	21,89,620.03	19,66,35,422.69	25,30,622.25
Current Liabilities	B					
Targeted Programmes						
IFCAM Project			1,63,07,882.43	1,96,942.02	32,63,076.81	41,994.54
DST-ANR Projects			-	-	11,23,886.00	14,463.98
DST-INRA Projects			14,17,874.00	17,122.94	8,04,722.54	10,356.47
DST-INRIA Projects			64,26,960.00	77,615.13	64,20,127.00	82,624.57
Raman Charpak Fellowship			1,85,47,521.97	2,23,989.01	1,74,94,488.26	2,25,147.33
BIRAC French Embassy			1,09,91,804.88	1,32,742.45	1,10,20,994.22	1,41,835.96
Economic Diplomacy R & D Programme			69,42,254.37	83,838.08	57,35,739.66	73,816.76
BIRAC BPI France			30,96,001.00	37,388.83	30,97,889.00	39,868.64
DST- ESONN Fellowship			5,868.00	70.86	3,906.00	50.27
DST-CNRS Fellowship			20,59,620.00	24,872.99	-	-
Indo French Water Network			1,42,29,423.43	1,71,841.53	1,06,81,415.82	1,37,465.71
			8,00,25,210.07	9,66,423.85	5,96,46,245.30	7,67,624.23
Programme Implementation & Overhead	B					
DST-ANR Projects			-	-	-	-
DST-INRA Projects			-	-	-	-
Raman Charpak Fellowship			2,98,273.00	3,602.09	-	-
BIRAC French Embassy			-	-	-	-
Indo French Water Network			-	-	-	-
TDB Programme			2,28,030.00	2,753.80	2,89,858.00	3,730.36
BIRAC BPI France			-	-	-	-
DST-ESSONN Fellowship			-	-	-	-
			5,26,303.00	6,355.89	2,89,858.00	3,730.36
Expenses Payable	C					
Salaries and Office Expenses Payable	C		6,10,137.00	7,368.31	1,01,578.00	1,307.27
TDS Payable	C		36,528.00	441.13	88,361.00	1,137.17
Seminar & Workshop	C		33,69,615.00	40,693.13	39,01,708.00	50,213.48
GB/SC Expenses Payable			-	-	2,088.00	26.87
Expenses on Publication			50,150.00	605.64	7,000.00	90.09
Interest Payable to DST						
Sbi Core			11,68,963.00	14,116.97	-	-
Raman Charpak Fellowship			8,85,911.00	10,698.70	-	-
DST CNRS Fellowship			42,208.00	509.72	-	-
DST Inria Fellowship			3,33,668.00	4,029.54	-	-
IFCAM			1,63,238.00	1,971.34	-	-
Scientific expenses payable			-	-	6,356.00	81.80
Travel Expenses Payable			-	-	5,277.00	67.91
			66,60,418.00	80,434.49	41,12,368.00	52,924.59
Group Farming	D		6,11,502.00	7,384.80	8,54,726.40	11,000.00
Grant-In Aid-2017-18			-	-	66,23,853.00	85,246.44
Foreign Currency Adjustment Account			89,55,390.00	1,08,149.70		
			27,80,91,404.67	33,58,368.76	26,81,62,473.39	34,51,147.88
Total Liabilities						

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.

(Ankesh)

Partner

Membership No.

Place : New Delhi

Date : 15.01.2021



(Simranjeet Singh)
Assistant Accounts Officer

(Dr. Purnima Rupal)
Director

INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH, NEW DELHI					
Balance Sheet as at 31st March 2020					
		Conversion Rate Rs/Euro = 82.8055		Conversion Rate Rs/Euro = 77.7024	
SCH		Amount as on 31.03.2020		Amount as on 31.03.2019	
		Total Amount in INR		Total Amount in INR	
				INR Version	
II. Assets					
Fixed Assets					
Cash & Cash Equivalents					
Core Bank Balances					
State Bank of Hyderabad Account		2,44,72,058.95		6,65,09,909.36	
Union Bank of India Accumulated Reserve		5,48,02,261.00		5,31,95,118.48	
Union Bank of India		4,52,198.00		4,37,139.00	
Axis Bank Account		-		8,17,916.00	
State Bank of India (GPF) Account		78,315.00		78,315.00	
State Bank of Hyderabad (Gratuity) Account		14,55,934.00		15,17,175.00	
CIC, Paris Account		10,50,38,528.33		7,46,68,737.46	
		43,68,243.00		52,753.05	
		Total Amount in INR		Total Amount in INR	
Non Core Bank Balances					
Union Bank of India - Raman Charpak Account		2,84,30,154.92		3,43,336.55	
Union Bank of India - DST INRIA Account		96,68,223.00		2,09,08,820.48	
Union Bank of India - DST INRA Account		7,08,458.00		1,16,758.22	
Union Bank of India - IFCAM Account		72,83,751.00		8,555.69	
Union Bank of India-DST ANR Account		48,287.73		87,962.16	
Union Bank of India-TDB Programme		12,05,242.90		583.15	
State Bank of Hyderabad-IFWN		31,42,417.00		17,04,535.73	
State Bank of Hyderabad-BIRAC		27,00,595.50		21,936.72	
State Bank Of India- BPI France		32,10,734.00		14,555.11	
Union Bank DST CNRS		23,80,521.58		7,82,660.16	
Union Bank Of India-ESONN		56,754.76		27,59,582.00	
		18,62,99,295.28		22,49,842.04	
Current Assets					
Seminars & Workshops		F		35,37,748.00	
Income Tax & TDS Receivable		1,91,225.00		42,723.59	
Other Deposits		F		2,309.33	
Tour Advances- Core		87,18,838.00		1,05,292.98	
Tour Advances-Non Core		78,54,879.00		94,859.39	
Accrued Interest-IFCAM		-		-	
Accrued Interest-ESSONN		66,432.00		802.27	
Accrued Interest-ANR		480.00		5.80	
Accrued Interest-TDB		392.00		4.73	
Accrued Interest-Raman Charpak		10,250.00		123.78	
Accrued Interest-INRIA		2,92,167.00		3,528.35	
Accrued Interest-CNRs		85,707.00		1,035.04	
Accrued Interest Accumulated Reserve		21,306.00		257.30	
Accrued Interest- INRA		5,25,291.00		6,343.67	
Accrued Interest-Core		5,735.00		69.26	
IIC Membership Fee Advance		3,661.00		44.21	
Electronic Project Proposal Management		1,59,300.00		1,923.79	
Cash -in-transit		4,90,875.00		5,928.05	
Security Deposit, Campus France, Paris		66,24,440.00		-	
		2,85,88,726.00		3,45,251.54	
Total Assets		27,80,91,404.67		33,58,368.76	

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. 010125N

(Ankesh)

Partner

Membership No.550940

Place : New Delhi

Date : 15.01.2021



(Simranjeet Singh)
Assistant Accounts Officer

Purnima Rupal

(Dr. Purnima Rupal)

Director

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 lenses and silica+Meniscus lenses	07.05.2016	49,35,500.00
		Precision XYZ, Nanopositioning system, recommended controller digital multi-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 infinity band network for data storage, 8 GPU cards	13.01.2017	40,00,000.00
7	5604-2	12.9" inch Ipad Pro WIFI256GB 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	Half 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 Unit, 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 temp 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, Photoreactor, 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 Toledo	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
30	62T4-1	Freezer	27.02.2020	70,000.00
31	62T5-1	CMOS Camera	11.05.2020	5,04,100.00
32	62T9-1	HPC Computer Cluster nodes, Workstation for PhD & Workstation for Post Doc	02.03.2020	15,19,583.00
		Total		9,56,98,916.00





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.



For further information, please contact:

Director

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