

# ENSEMBLE

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Newsletter of the Indo-French Centre for the Promotion of Advanced Research

Generating Knowledge for Solutions  
Focus on the  
**Future**



# editor's note

Greetings from CEFIPRA for the first edition of ENSEMBLE's journey of its second year!

At the outset we welcome Mme. Anne Grillo to the CEFIPRA family as the new Co-Chair from the French side.

The last year was exciting, with strengthening the core activities of the CEFIPRA and at the same time expanding the activities in response to the enhanced mandate of the Centre. During its existence of 26 years as probably the oldest bilateral S&T supporting organization of the world, CEFIPRA has always evolved in tune to the requirement of the global more specific Indo-French R&D.

In the same resolve, we are prepared to utilize the knowledge generated for providing solutions to the society. In this edition, we are bringing out stories of two such successful CEFIPRA supported projects for strengthening the solution pathway in the two sectors of Energy and Information Communication Technology (ICT).

During the period 13 new collaborative projects have been supported under the scientific programme of CEFIPRA and six projects have been selected for support under the DST-INRIA targeted programme on ICST. Indo-French S&T cooperation has been strengthened through supporting mobility of 37 scientists and students.

The 27th meeting of the Governing Body took place successfully on 6th of March 2014. The Governing Body has directed the Centre to catalyse across the knowledge innovation chain. So please keep an eye on our website for new announcements and kindly provide your ideas and feedback to be a part of this phase of our journey.

Thanking you all for your support!

**Merci Beaucoup!**



**Debapriya Dutta**  
Director, CEFIPRA



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## Advances in Communication Technologies

# New Directions for Wireless Networking

Wireless access networks became available for wide-spread public utilisation from the 1980s. Their most visible impact has been on mobile communication via the so-called cellular networks. In the mid-1990s, with the availability of low power electronics, miniature low power sensors, and energy efficient wireless communication, there emerged the idea of embedded sensing of the world around us, with the sensors and the computing connected by multi-hop wireless networks. This emerging technology now goes by the name of The Internet of Things (IoT).

While many of the basic challenges in cellular networks have been satisfactorily addressed, the increasing traffic demand on these networks has led to new questions related to the design, management, and control of these networks. Further, the emergence of the Internet of Things has motivated our work on multihop wireless networks (or the so-called ad hoc networks). The objective of this project has primarily been to explore various performance analysis, design, and control issues in cellular wireless networks, and multi-hop ad hoc wireless networks via mathematical modelling and analysis techniques such as stochastic processes, stochastic optimisation and control, competitive and cooperative game theory, and fluid limits of stochastic processes.

A significant part of the research effort has been in the application of noncooperative game models in the context

of wireless cellular systems. Stochastic control techniques have been applied to forwarding problems arising in delay tolerant networking (mobile opportunistic networks, and sensor networks with sleep-wake cycling). We have also explored the use of continuum or fluid limits of stochastic processes, in several problems of analysis and design of mobile opportunistic networks; the limits serve as useful approximations, and in some cases it has been found that an optimal control designed for the deterministic fluid limit model serves as a provably accurate control for the original stochastic process. In addition, we have aimed to contribute to the theory of such limits as well.

The following are some examples of the research problems studied in this project, and an outline of the approaches taken and the outcomes obtained.

## OPPORTUNISTIC SCHEDULING IN THE PRESENCE OF NON-COOPERATIVE USERS

A central problem in wireless communications is that of allocating resources to one of many mobile stations that have a common radio channel. Much attention has been given to the design of efficient and fair scheduling schemes that are centrally controlled by a base station (BS) whose decisions depend on the channel conditions reported by each mobile. The BS is the only entity taking decisions in this framework. The decisions are based on the reports of mobiles on their radio channel conditions. We studied the scheduling problem from a game-theoretic perspective in which some of the mobiles may be noncooperative or strategic, and may not necessarily report their true channel conditions. We modeled this situation as a signaling game and studied its equilibria. We demonstrated that the only Perfect Bayesian Equilibria (PBE) of the signaling game are of the babbling type: the noncooperative mobiles send signals independent of their channel states, the BS simply ignores them, and allocates channels based only on the prior information on the channel statistics. We then proposed various approaches to enforce truthful signaling of the radio channel conditions: a pricing approach, an approach based on some knowledge of the mobiles' policies, and an approach that replaces this knowledge by a stochastic approximation approach that combines estimation and control. We further identified other equilibria that involve non-truthful signaling.

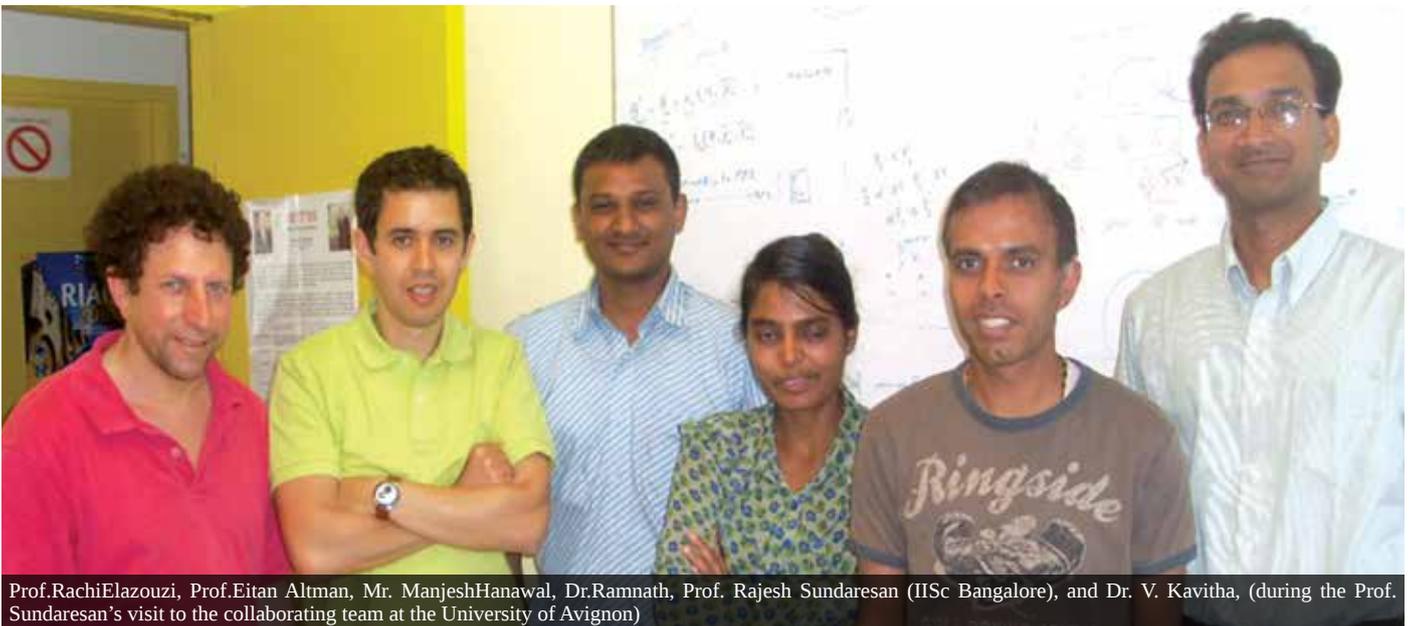
## CONTROLLED FORWARDING IN DELAY TOLERANT NETWORKS

We studied the trade-off between delivery delay and energy consumption in a delay tolerant network in which a message

(or a file) has to be delivered to each of several destinations by epidemic relaying. In addition to the destinations, there are several other nodes in the network that can assist in relaying the message. We first assumed that, at every instant, all the nodes know the number of relays carrying the packet and the number of destinations that have received the packet. We formulated the problem as a controlled continuous time Markov chain and derived the optimal closed loop control (i.e., forwarding policy). However, in practice, the intermittent connectivity in the network implies that the nodes may not have the required perfect knowledge of the system state. To address this issue, we obtained an ordinary differential equation (o.d.e.) (i.e., a deterministic fluid) approximation for the optimally controlled Markov chain. This fluid approximation also yields an asymptotically optimal open loop policy. Finally, we evaluated the performance of the deterministic policy over finite networks. Numerical results showed that this policy performs close to the optimal closed loop policy. Recently, we have extended this work to include a model for the spread of popularity of the message (or item of content, such as a song or video clip), i.e., the set of destinations grows as more nodes get interested in the content. Indeed, the relay nodes, that only carry the message between destinations, might also get interested in the content. This very interesting dynamics is modelled by taking its fluid limit and then using the resulting o.d.e. to derive a control from.

## GEOGRAPHICAL FORWARDING IN SLEEP-WAKE CYCLING WIRELESS SENSOR NETWORKS

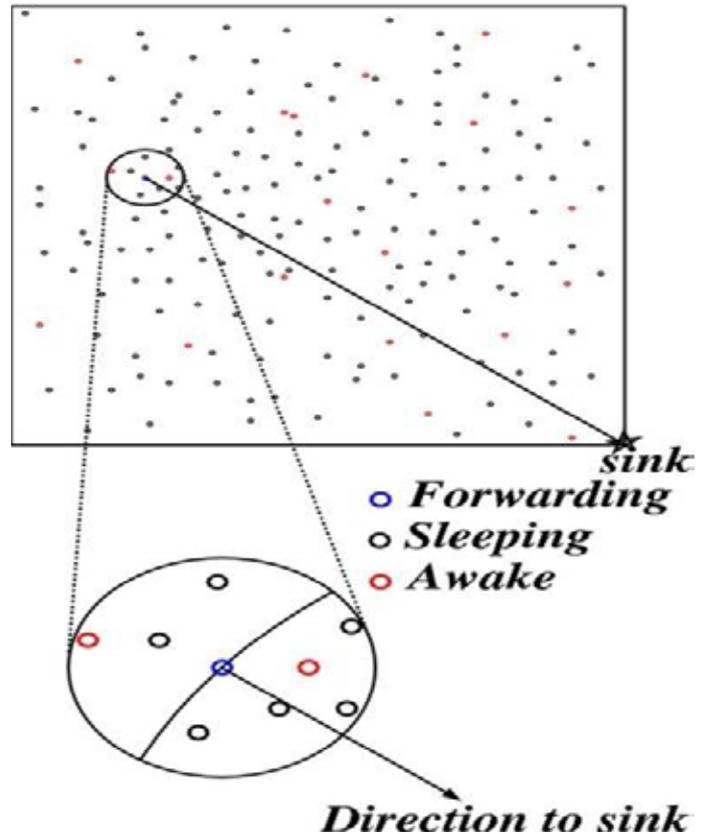
is motivated by geographical forwarding of sporadic alarm packets to a base station in a wireless sensor network (WSN),



Prof. Rachi Elazouzi, Prof. Eitan Altman, Mr. Manjesh Hanawal, Dr. Ramnath, Prof. Rajesh Sundaresan (IISc Bangalore), and Dr. V. Kavitha, (during the Prof. Sundaresan's visit to the collaborating team at the University of Avignon)

# leader

where the nodes are sleep-wake cycling periodically and asynchronously. We seek to develop local forwarding algorithms that can be tuned so as to trade-off the end-to-end delay against a total cost, such as the hop count or total energy. Our approach is to solve, at each forwarding node enroute to the sink, the local forwarding problem of minimizing one-hop waiting delay subject to a lower bound constraint on a suitable reward offered by the next-hop relay; the constraint serves to tune the trade-off. The reward metric used for the local problem is based on the end-to-end total cost objective (for instance, when the total cost is hop count, we choose to use the progress towards the sink made by a relay as the reward). We have first studied the case where the number of relays is exactly known. Next we have considered the model where the number of relays is not known leading to a partially observable Markov decision model. For this case we have obtained inner and outer bounds for the optimal policy. Finally we have considered the case where the relays, upon waking up, reveal only the probability distribution of their rewards. To know the exact reward value, the source has to send additional probe packets incurring additional cost. Our problem can be considered as a new variant of the asset selling problem studied in operations research literature. Very recently we have used the stochastic games setting to study optimal forwarding when nodes compete for relays. ●



**Anurag Kumar** obtained his B.Tech. degree from the Indian Institute of Technology at Kanpur, and the PhD degree from Cornell University, both in Electrical Engineering. He was then with Bell Laboratories, Holmdel, N.J., for over 6 years. Since 1988 he has been with the Indian Institute of Science (IISc), Bangalore, in the Department of Electrical Communication Engineering, where

he is now a Professor. He is currently also the Chair of the Electrical Sciences Division at IISc. From 1988 to 2003 he was the Coordinator at IISc of the Education and Research Network Project (ERNET), India's first wide-area packet switching network. His area of research is communication networking, specifically, modeling, analysis, control and optimisation problems arising in communication networks and distributed systems. Recently his research has focused primarily on wireless networking. He is a Fellow of the IEEE, of the Indian National Science Academy (INSA), of the Indian Academy of Science (IASc), of the Indian National Academy of Engineering (INAE), and of The World Academy of Sciences (TWAS). He is a recipient of the Indian Institute of Science Alumni Award for Engineering Research for 2008. He has been a J.C. Bose National Fellow since 2011.

**Eitan Altman** received the B.Sc. degree in electrical engineering (1984), the B.A. degree in physics (1984) and the Ph.D. degree in electrical engineering (1990), all from the Technion-Israel Institute, Haifa. In (1990) he further received his B.Mus. degree in music composition in Tel-Aviv university. Since 1990, Dr. Altman has been a researcher at INRIA (National research institute in



computer science and control) in Sophia-Antipolis, France. He has been in the editorial boards of several scientific journals: Wireless Networks (WINET), Computer Networks (COMNET), Computer Communications (Comcom), J. Discrete Event Dynamic Systems (JDEDS), SIAM J. of Control and Optimisation (SICON), Stochastic Models, and Journal of Economy Dynamic and Control (JEDC). He received the best paper award in the Networking 2006, in Globecom 2007, in IFIP Wireless Days 2009 and in CNSM 2011 conferences. His areas of interest include Network Engineering Games, social networks and their control. He received in 2012 the Grand Prix de France Telecom from the French Academy of Sciences. More information can be found at [www-sop.inria.fr/members/Eitan.Altman/](http://www-sop.inria.fr/members/Eitan.Altman/)



## Solid oxide fuel cells

# Powering the future

In the present scenario of energy crisis it is an utmost necessity to search for new efficient energy converting devices for long-term applications. Solid oxide fuel cells (SOFCs) are such electrochemical devices with high operating temperatures (800-900°C), in which fuel (hydrogen, hydrocarbon etc.) reacts with oxygen at the anode to produce direct electric current with high efficiency (45-50%) with relatively very low pollutants. However, there is a major challenge of developing a suitable sealant for avoiding the escape of fuel and which is chemically stable for several thousands of hours without degrading the interface.

On the basis of current understanding it was possible to design such materials in the form of glass and glass-ceramics (a kind of polycrystalline material) with proper choice of chemicals and processing. In this project we worked jointly exploiting the expertise and facilities available in India and France, first to optimise titanium-based phosphate and then Ba-Zn/Mg phosphor-silicate glass/glass-ceramic compositions through a series of processing experiments based on thermal data followed by structural (at molecular level and bulk) analysis using up to date analysis techniques such as X-ray diffraction, Nuclear magnetic resonance, scanning electron microscopy, Fourier transform infrared spectroscopy. We also studied their thermo-physical and electrical studies. Finally the challenge lies in demonstration of sealant material which could show long term vacuum/pressure endurance at the operating temperatures.

### OBJECTIVES

The aim of the project was to develop suitable high temperature sealants for solid oxide fuel cells (SOFCs) in planar configuration for higher power, based on phosphate-containing glass and glass-ceramics. Specific objectives were as given below:

- To investigate various alkaline earth oxide based silicate glass compositions with phosphorous pentoxide additive (e.g. RO-BaO- P<sub>2</sub>O<sub>5</sub>- SiO<sub>2</sub> where R=Magnesium (Mg), Zinc (Zn), ...) taking in advantage of phosphorous penta-oxide to reduce diffusion of chromium from interconnect material at operating temperature to degrade the interface and spoil the function of sealant.
- Establish the processing conditions for converting them into glass-ceramics, study different crystalline

## FUEL CELLS-AN UPDATE

A fuel cell is a device that generates electricity by way of a chemical reaction. The reactions that produce electricity take place at the two electrodes that every fuel cell has (negative and positive). A fuel cell also has an electrolyte, which carries electrically charged particles from one electrode to the other, and a catalyst, which speeds the reactions at the electrodes.

Fuel cells run on hydrogen and oxygen and generate electricity with very little pollution as the byproduct is nothing but water.

### FUEL CELL: HOW IT WORKS

The purpose of a fuel cell is to produce an electrical current that can be directed outside the cell and used for different needs. The chemical reactions that produce this current are the key to how a fuel cell works.

There are several kinds of fuel cells. But in general terms, hydrogen atoms enter a fuel cell at the anode where a chemical reaction removes their electrons. The ionized hydrogen atoms carry a positive electrical charge. The negatively charged electrons provide the current through wires to do work. Oxygen enters the fuel cell at the cathode to combine with electrons returning from the electrical circuit and hydrogen ions that have traveled through the electrolyte from the anode. In other cell types the oxygen picks up electrons and then travels through the electrolyte to the anode, where it combines with hydrogen ions.

The electrolyte plays a key role. It must permit only the appropriate ions to pass between the anode and cathode. If free electrons or other substances could travel through the electrolyte, they would disrupt the chemical reaction.

Whether they combine at anode or cathode, together hydrogen and oxygen form water, which drains from the cell. As long as a fuel cell is supplied with hydrogen and oxygen, it will generate electricity.

Even better, since fuel cells create electricity chemically, rather than by combustion, they are not subject to the thermodynamic laws that limit a conventional power plant. Therefore, fuel cells are more efficient in extracting energy from a fuel. Waste heat from some cells can also be harnessed, boosting system efficiency still further.

The basic workings of a fuel cell may not be difficult to illustrate. But building inexpensive, efficient, reliable fuel cells is a far more complicated business.

Scientists and inventors have designed many different types and sizes of fuel cells in the search for greater efficiency, and the technical details of each kind vary. Many of the choices facing fuel cell developers are constrained by the choice of electrolyte. The design of electrodes, for example, and the materials used to make them depend on the electrolyte. Today, the main electrolyte types are alkali, molten carbonate, phosphoric acid, proton exchange membrane (PEM) and solid oxide. The first three are liquid electrolytes; the last two are solids.

Each type of fuel cell has advantages and drawbacks compared to the others, and none is yet cheap and efficient enough to widely replace traditional ways of generating power, such as coal-fired, hydroelectric, or even nuclear power plants.

phase formation/separation, microstructure and their chemical reactivity at the operating conditions and to limit chromium diffusion.

- Develop suitable process for preparing seals
- Study the behaviour of the sealant with regard to chemical reactivity, degradation, structural-transformation in the long run.

### TECHNICAL APPROACH

The first core-part of the project was aimed at investigating the role of phosphorus penta-oxide in mitigating the formation of undesirable barium chromate layer at the sealing interface of barium calcium aluminium boro silicate glass sealant and joining alloy. For this, many glasses of various compositions were prepared and investigated for sintering, crystallization and sealing properties. Characterization by various methods like hot stage microscopy and thermo-mechanical analysis (TMA) studies along with multi-nuclear NMR, it was concluded that seals can be prepared with glasses containing upto 2 mol% P<sub>2</sub>O<sub>5</sub>, but desired results were obtained with glasses containing 1 mol% P<sub>2</sub>O<sub>5</sub>. We observed that the addition of P<sub>2</sub>O<sub>5</sub> improves crystallization behaviour and improves interaction between the glass and the metal leading to enhanced binding. The

glass-ceramics are found stable when heat treated for 500h at 800°C implying long term stability, and can be used as effective sealant for SOFCs.

In another signification work, a new glass composition was formulated by adding strontium oxide and lanthanum oxide and phosphorous penta-oxide in the combined manner using P<sub>2</sub>O<sub>5</sub> and barium phosphate to avoid the negative effect of P<sub>2</sub>O<sub>5</sub> on sealing properties of glass. The positive effect of barium phosphate incorporation on thermo-physical properties was demonstrated by the decrease in softening temperature, enabling the seal fabrication below 1000°C. Moreover, crystalline phases and thermal expansion coefficient were found stable and compatible for sealing applications. Interfaces of seals reveal good bonding.

A final series of tests has been carried out on glasses containing vanadium. In this case the glass composition was formulated by combined addition of V<sub>2</sub>O<sub>5</sub> and P<sub>2</sub>O<sub>5</sub> and the improved properties were found due to synergic effect of V<sub>2</sub>O<sub>5</sub> and P<sub>2</sub>O<sub>5</sub>. Vanadium oxide addition resulted in a decrease in glass-transition and softening temperature of glasses. This also reduced the glass surface tension, which may result in good sealing with metallic interconnect. The glass samples do not show major structural changes when P<sub>2</sub>O<sub>5</sub> is replaced with V<sub>2</sub>O<sub>5</sub>. The interfaces showed good



bonding when tested upto 1500 h at 800°C. The seals were also attempted with an innovative seal design using Haynes metal which permitted hermeticity test under high operating temperatures (800°C) using pressure difference technique.

The collaborative efforts resulted in several publications in high impact journals and participation in many national and international conferences.

### OUTCOMES/WAY FORWARD

Four glass/glass-ceramics systems namely Barium Calcium Aluminum Boro-Silicate, Barium Strontium-Lanthanum-Boro-Silicate with combined addition of P2O5 and Barium Phosphate, Barium-Alumino-Lanthanum-Boro-Silicate with TiO2, and Barium-Strontium-Alumino-Boro-Silicate with P2O5 and V2O5 to avoid the negative effect of P2O5 on sealing properties of glass were elaborated and applied as seals for high-temperature SOFC systems.

The glass-ceramic seals show excellent compatibility with interconnect alloy, for long term use at 800°C. They showed good tightness under vacuum and under pressure load. The effect of P2O5 has been investigated through detailed study by advanced analytical and characterization techniques and found that it promoted a better crystallization morphology through its nucleating effect. The limit of content has been determined as 2 mol%. A detailed structural study with solid-state nuclear magnetic resonance also enabled characterization of crystallization mechanism in complex multi-components glass-ceramics.

The importance of these studies will further enhance when we conduct long term chemical stability study also with other components of SOFC such as electrodes and electrolyte materials at higher temperatures. Structural characterization of these multi-component glass and glass-ceramic materials by using high resolution XRD and solid state NMR will produce reliable complementary information. ●



Dr G P Kothiyal served as Head, Glass and Advanced Ceramics Division, Bhabha Atomic Research Centre, and Professor of Physics at Homi Bhabha National Institute. With a PhD from Mumbai University, his research has focused on Glasses, Glass-ceramics & advanced Ceramics, Single crystal growth by vapour and melt growth, Thin film (crystalline and amorphous) growth by chemical deposition, conventional vapour phase as well as molecular beam epitaxy techniques, etc. He has published more than 150 research papers in peer reviewed journals.

Prof. Lionel Montagne, obtained his PhD in 1991 and carried out his Post Doctoral research work at the University of Nagoya. He is currently Head of Catalysis and Solid-State Chemistry Laboratory (CNRS affiliated) & Glass and Solid-State NMR Research Group, University of Lille, France. He is also Head of French Glass Network (CNRS affiliated). His Research areas are Glasses, Chemistry of phosphates, Solid state NMR. His prominent teaching areas are Chemistry of inorganic materials, and thermal analyses. He has published more than 95 research papers in peer reviewed journals and has 4 patents.



## CEFIPRA WELCOMES Mme. ANNE GRILLO

CEFIPRA is pleased to welcome Mme. Anne Grillo as the new Co-Chairperson of the Governing Body from the French side. She is the Directrice, Direction de la Coopération culturelle, universitaire et de la recherche, Ministère des Affaires Étrangères. of France.

Born in Marseille, France on May 30, 1967, Mme Grillo joined the Ministry of Infrastructure Transport & Housing, Govt. of France in 1993 where she headed its Legal Affairs Department.

In her long and distinguished career so far she has served in several important positions within France as well as represented her country in diplomatic positions across the world. Her overseas assignments include being the First Secretary, and later Deputy Counsellor, at Embassy of France in China (1993-1999). She has also served as Minister Counsellor,

Embassy of France in Morocco (2006- 2010) and Consul General of France at Barcelona, Spain (2010-2013). Her in-country assignments have been as Deputy Director of South Asia (2003-2006) and Officer In-charge of Development and Development Financing (2001-2003).

The team at CEFIPRA is looking forward to her stewardship and guidance in the times to come. ●



## 27th MEETING OF GOVERNING BODY OF CEFIPRA

March 6, 2014  
New Delhi

The 27th Meeting of Governing Body of CEFIPRA was held in New Delhi on 6th March 2014. The meeting was co-chaired by Dr. T. Ramasami, Secretary, Department of Science and Technology, Ministry of Science and Technology, New Delhi and Mme. Anne GRILLO, Directrice, Direction de la Coopération culturelle, universitaire et de la recherche, Ministère des Affaires Étrangères. of France

The meeting started with welcoming Mme. Anne Grillo, to the CEFIPRA family as the French Co-Chair. The Governing Body reiterated the unique role of CEFIPRA as an organization for the development of Indo-French Science and Technology cooperation. It was also noted that India is the only country with which France has such a mechanism. It was emphasized

that innovation through PPP mode of cooperation should form the focus of the enhanced activities of CEFIPRA, while retaining its core strengths of promoting collaborative research in advanced areas of science and technology. It was also emphasized that as a result of the existence of CEFIPRA over the last 25 years, a network of scientists has been established between the two nations. The collaborative networks between India and France need to be mobilized in the coming years for expanding the core activities of CEFIPRA. In this context, further efforts should be made to bring into the fold, research alliances and agencies, R & D clusters, companies, from both FRANCE and India, so as to have maximum benefits of the efforts being made by the two Governments. ●



Seminar on

## BIO-INORGANIC APPROACHES TO CURRENT HEALTH PROBLEMS

March 24-28, 2014  
Puducherry

CEFIPRA organized an Indo-French seminar on Bio-inorganic Approaches to Current Health Problems in association with Pondicherry University during March 24-28, 2014. The Seminar was attended by ten French, one Austrian, one German and around 50 Indian scientists. It was inaugurated by Professor V. Krishnan, who stressed the role of alkali, alkaline earth and transition metal ions in medicinal bioinorganic chemistry. A number of presentations by the younger faculty members and research scholars revealed that most of them are interested in designing metal (Cu, Zn, Ru) and organometallic Ru complexes, metal-curcumins and cyclophosphoramides as drugs for cancer treatment, their interaction with DNA and its cleavage. The seminar ended with an analysis of the thrusts made in treating diseases with metallo drugs, mainly cancer. Focus was made on the importance of bioinorganic chemistry in bioimaging and other non-cancerous diseases. One of the new ideas generated from this seminar is targeting telomerase enzyme, which

is responsible for cell growth and is over expressed in Cu-85% in cancer cell using Pt(II) and Ru(II) metal complexes. Interaction with many Senior Indian and French Scientists gave new exposure to young researchers. ●



Seminar on

## FUNCTIONAL METAL-ORGANICS: APPLICATIONS IN MATERIALS AND CATALYSIS

Feb 24 - 26, 2014  
Bhubaneswar

The Indo-French Seminar on “Functional Metal-Organics: Applications in Materials and Catalysis”, supported by CEFIPRA was held at the National Institute of Science Education and Research (NISER)-Bhubaneswar, Odisha, from February 24-26, 2014. About 80 participants drawn from India and France attended the Seminar.

The seminar was inaugurated by Dr. Anil Kakodkar, Chairman, Board of Governors of IIT-B and Solar Energy Corporation of India. The welcome addresses were delivered by Prof. V. Chandrasekhar, Director-NISER and Prof. Pierre H Dixneuf, Université de Rennes,.

The seminar covered advances and future trends in functional metal-organics and gathered scientists from France and India working in the areas ranging from molecular and nanomaterials for optic, photochemistry, magnetism and semiconductors to catalysis with the common basis of Organometallic, coordination and bioinorganic chemistry. The variety of presented topics has only competed with their quality. Some of the presented results were published in the best journals of the chemistry community, and the others were original recent unpublished works.

The presentations on various aspects of Functional Metal Organics included Molecular Magnetism, Photochemistry, Optical Materials, Organometallics and Catalysis.

The proposal to launch a spring/winter School in India on the Development of new molecular materials for energy related applications was discussed with Indian PhD students and post-docs as participants and French and Indian chemists as faculty. Discussions between participants from different fields allowed new fundamental questions to emerge that can form the basis of new research initiatives.

The participants opined that short research stays in France by Indian students should be encouraged. This could be funded by Charpak-Raman fellowships. Spring/Winter Schools in India should be organized – on subjects like development of new molecular materials for energy related applications: photocatalysis, solar cell and photovoltaics, photo activations of molecules, material and optical properties etc.

In view of the overwhelming success of this meeting it is suggested that a future meeting on this theme be held in India/France in about 2 years time. It was also suggested that another seminar should be planned and organized at the interface of molecules and materials. ●

## NEW PROJECTS SUPPORTED JANUARY-MARCH 2014

**Domain** | Life and Health Sciences

**Project Title** | Muscle SC self-renewal: A stressful matter

**Objective** | Selenoprotein N (SelN) is the only selenoprotein linked to a monogenic disease, SEPNI-related myopathy, presenting with severe muscle weakness and wasting. Using a combination of in vitro and ex vivo expertise and models, the project seeks to clarify the role of SelN, associated oxidative stress and epigenetic modifications in SC self-renewal, and their response to pharmacological intervention.



**Jyotsna Dhawan**  
Instem, National Centre for  
Biological Sciences



**Ana FERREIRO**  
Université Pierre Marie Curie,  
Institut of Myology, Paris

**Project Title** | Olfactory Modulation of Insect Flight

**Objective** | To draw the anatomo-functional map of the neural circuitry involved in the olfactory modulation of chemo-oriented walking and flight behaviours in the model species *Drosophila melanogaster*.



**Gaiti Hasan**  
National Centre for Biological  
Sciences, TIFR, Bangalore



**Jean-François FERVEUR**  
Université de Bourgogne, Dijon

**Project Title** | The Immuno-Psychiatry in South India Study: Immunogenetic and Immuno-phenotype Characterization of Major Psychoses

**Objective** | To characterize the nature and extent of dysimmunity associated with schizophrenia and bipolar disorders in two geographically distinct population groups (French Caucasians and South Indians) encountering distinct environmental factors.



**Vir Singh Negi**  
Jawaharlal Institute of Post-  
graduate Medical Education and  
Research, Puducherry



**Ryad TAMOUZA**  
Saint Louis Hospital. Paris-  
Diderot (P7) University of  
Paris, France

**Project Title** | Genome-scale analysis of differential propensities of different chromosomal domains for horizontal gene insertion in *Escherichia coli*

**Objective** | To address the contributions of the above factors in the insertion of acquired genetic loci in *Escherichia coli* using a combination of comparative genomics, systems biology, and novel applications of next-generation sequencing technologies.



**Aswin Sai Narain SESHASAYEE**  
National Centre for Biological  
Sciences, Bangalore.



**Marco Cosentino LAGOMARSINO**  
University Pierre and Marie  
Curie, Paris

**Project Title** | Decipher the symbiotic program in tropical legumes

**Objective** | To deepen our knowledge on the symbiotic mechanisms in tropical legumes by identifying the plant genes involved in the first steps of the symbiotic relationship in *A. hypogaea* and *A. evenia*.



**Maitrayee Das GUPTA**  
University of Calcutta,  
Kolkata, West Bengal



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

## NEW PROJECTS SUPPORTED JANUARY-MARCH 2014

### Domain | Pure and Applied Physics

#### Project Title | Magnetic nanoparticles for hyperthermia and spintronics

**Objective** | To combine experimental, theoretical and computational studies on assemblies of MNPs for two focused applications: magnetic hyperthermia and spintronics. In both these applications, the magnetic interactions between MNPs strongly influence the system properties (e.g., heat dissipation in the former and amplitude of the tunnel magnetoresistance in the latter).



**Varsha Banerjee**  
IIT Delhi



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

#### Project Title | Self-Similar Optical Patterns In Nonlinear Media

**Objective** | Self-similarity is one of the fundamental dynamics observed in many fields of science (optics, hydrodynamics, cosmology), as well as occurring in natural environment (plant growth, etc.). The project seeks to combine the theoretical and experimental expertise of both Indian and French groups to develop innovative applications of the self-similar concept and intent to solve some of the open questions in the above areas.



**K. Porsezian**  
Pondicherry University,  
Pondicherry



**Ph. Grellu**  
Laboratoire Interdisciplinaire Carnot de  
Bourgogne, Université de Bourgogne

### Domain | Pure and Applied Chemistry

#### Project Title | Molybdenum-containing enzymes: bioinspired peptidic catalysts for CO<sub>2</sub> reduction

**Objective** | To prepare peptido biomimetic/bioinspired Mo complexes in order to study and to decipher the molecular factors responsible for this remarkable reactivity to develop new biocatalysts Mo, robust and efficient for the reduction of CO<sub>2</sub>.



**Surajit Sinha**  
Indian Association for  
Cultivation of Science, Kolkata



**Marius Reglier**  
Institut des Sciences Moléculai-  
res de Marseille, Marseille

#### Project Title | Phosphorus-supported multisite coordinating ligands for the assembly of polynuclear heterometallic (3d-4f) and homonuclear (3d) ensembles: Towards a new generation of molecular magnetic materials

**Objective** | To introduce phosphorus-supported multisite coordination ligands for assembly of molecular magnetic materials. Proposed coordination platforms will be built by using acyclic/cyclic phosphorus compounds as scaffolds. The ligands will be modular, tunable having the capability to afford a diverse family of 3d-4f and 3d ensembles.



**Vadapalli Chandrasekhar**  
NISER, Bhubaneswar



**Hab. Rodolphe Clérac**  
University Bordeaux Pessac

### Domain | Pure and Applied Mathematics

#### Project Title | Hypergeometric functions: harmonic analysis and representation theory

**Objective** | To develop the Heckman-Opdam theory of hypergeometric functions in several directions. To continue the study of hypergeometric functions associated to root systems in a systematic manner and thus develop an Lp harmonic analysis.



**E. K. Narayanan**  
Indian Institute of Science,  
Bangalore



**Angela Pasquale**  
Université de Lorraine  
Metz

## NEW PROJECTS SUPPORTED JANUARY-MARCH 2014

**Domain** | Computer and Information Sciences & Materials Science

**Project Title** | eSynapse based on heterostructures of binary oxides

**Objective** | To develop electronic nanodevices that mimic the conductivity properties of biological synapses at the size and energy scale of biology. The effective conductance of biological synapses is determined by the time of arrival of pulses at its input and output terminals. Such a device can be developed based on memristive devices that can be programmed to multiple stable resistive states.



**Bipin Rajendran**  
IIT Bombay



**Catherine Dubourdieu**  
Institut des Nanotechnologies  
de Lyon, Ecully

**Domain** | Glycochemical Biology

**Project Title** | Glycochemical Studies on Mycobacterial Arabinomycolate

**Objective** | Ethambutol, a drug used for the treatment of TB, found to arrest the arabinan biosynthesis; glycolipids of MTb are currently under investigation as targets for drug discovery. Presence of xenobiotic furanosyl forms of arabinose, galactose and cyclopropanes in the lipids raise a few questions This proposal addresses them through physicochemical studies on a library of arabinofuranosyl lipids exploiting modern spectroscopic and microscopic techniques.



**Srinivas Hotha**  
Indian Institute of Science Education  
and Research, PUNE



**Thierry Benvegnu**  
Ecole Nationale Supérieure de  
Chimie de Rennes

**Domain** | Material Sciences

**Project Title** | Synthesis of Photocatalytic Porous Silicon-Containing Nitride and Oxynitride Nanocomposites

**Objective** | To accomplish the synthesis and characterization of porous silicon-containing (oxy) nitride nanocomposites as foams and membranes via the Polymer-Derived Ceramics (PDCs) route. Prepare nanocomposites in which titanium and/or zirconium oxide/oxynitride/nitride nanocrystals are formed during the synthesis of the silicon nitride & silicon oxynitride matrices with photocatalytic activity & adsorbent capacity concomitantly being stable in severe conditions.



**Ravi Kumar**  
N. V, IIT-Madras, Chennai



**Samuel Bernard**  
Institut Européen des  
Membranes, Montpellier

**Domain** | Earth and Planetary Sciences

**Project Title** | Survey of soil-Si pools and contribution of Si fertilization in a sustainable rice cultivation in South India

**Objective** | Si is generally not considered as an essential nutrient for crops but many studies have proven its benefits for improving their yields, specifically for rice. Integration of Si in agricultural practices is yet to be achieved in India. The project combines field & laboratory experiments to analyze Si speciation in water/soil/plant compartments of aerobic and wetland rice ecosystems in order to assess levels of bioavailable Si in South Indian soils.



**N.B. Prakash**  
UAS, Bangalore



**J.D. Meunier**  
Aix-Marseille University

**Domain** | Information Technology

**Project Title** | Monte Carlo and Learning Schemes for Network Analytics

**Objective** | To approach various computation problems in network analytics by means of Markov Chain Monte Carlo (MCMC) and related simulation techniques as well as machine learning algorithms such as reinforcement learning, ant colony optimisation, etc.



**Vivek S. Borkar**  
IIT Bombay



**Konstantin Avrachenkov**  
Inria Sophia Antipolis - Méditerranée

## DST-INRIA TARGETTED PROGRAMME ON ICST

Title	Indian PI	French PI	Title	Indian PI	French PI
Personalized Mobility Services for Urban Travelers	 <b>Pushendra Singh</b> Indraprastha Institute of Information Technology, Delhi	 <b>Animesh Pathak</b> Inria Paris Rocquencourt	Optimal inference in Complex and Turbulent data	 <b>D. Singh</b> IIT-Roorkee Roorkee	 <b>Hussein Yahia</b> INRIA
Basal Ganglia At Large	 <b>B.R Surampudi</b> Univ. of Hyderabad, Hyderabad	 <b>Frederic Alexandre</b> LaBRI, INRIA Bordeaux	Evolving Communities and Information Spreading	 <b>Bivas Mitra</b> IIT-Kharagpur Kharagpur	 <b>Jean-Loup Guillaume</b> Université Pierre et Marie Curie
Algorithmic Verification of Real-Time Systems	 <b>Krishna S</b> IIT-Bombay Mumbai	 <b>Frederic Herbreteau</b> Institut Polytechnique de Bordeaux	Evolving Communities and Information Spreading	 <b>Uttama Lahiri</b> IIT, Gandhinagar	 <b>Anirban Dutta</b> DEMAR, INRIA -Sophia Antipolis

The DST-INRIA programme could be put in place with the kind assistance from DST and INRIA during the year 2013. The agreement was signed after the ICST seminar held in April 2013. After the agreement, a call for proposals was launched. A total of 18 proposals were received under this call. A joint selection committee selected the following 6 project proposals through video-conference.

Seminar on

## NEW AVENUES FOR NETWORK MODELS

Jan. 13–15, 2014  
Bangalore

It is now well established that communication networks are amenable to mathematical modelling using a variety of tools, depending on the questions being asked. This was amply demonstrated in the workshop on New Avenues from Network Models organised with support from CEFIPRA at Department of Electrical Communication Engineering, IISc Bangalore from 13-15 January, 2014.

The primary aim of the workshop was to highlight that networks occur in several domains of human activity, and that a variety of mathematical techniques can be used to model these networks, so as to understand their performance, and derive insights into how to manage them.

Comprising of three tutorials and 12 seminars spread over three days, the workshop brought together several researchers from India and France, whose work had been funded by CEFIPRA

over the past 8-9 years, and several other researchers from the two countries, who work in related areas. The participants included students (including four from France), and several researchers from academia. Some of the new ideas discussed at the workshop included:

- Enforcement of fairness in the exchange of file fragments in a peer-to-peer network.
- The use of piecewise deterministic Markov processes to model the level of influence of the content on a user's social network timeline.
- A possible interpretation of the trial-and-error dynamics as a learning strategy that explores the strategy space according to the action functional predicted by the Freidlin-Wentzell theory, with the global minima of the action functional at pure strategy Nash equilibria.●

Workshop on

## FILAMENTOUS FUNGAL PATHOGENS: CURRENT TRENDS AND FUTURE PERSPECTIVES

Jan. 20-22, 2014  
Madurai

The workshop was hosted by Aravind Medical Research Foundation (AMRC) which has significant expertise in the study of ophthalmic fungal infections.

The workshop focused on an in depth analysis of the biology and pathogenesis of *Aspergillus* – the most ubiquitous fungal pathogen and the host response to fungal infection in the immuno-competent as well as in the immuno-compromised individuals. Fungal infection (mycoses) affects both immuno-competent (primary mycoses) and immuno compromised (opportunistic mycosis) and they are often fatal. With 12 French and 19 Indian participants the workshop themes included i) the “Omics” approaches to understand *Aspergillus* pathogenesis, ii) understanding the fungal biology, host-fungal interaction and host responses, iii) in developing a model system to study *Aspergillus* pathogenesis and iv) treatments to these fungal infections.

From the clinical side, complications of *Aspergillus* infection in haematopoietic stem cell/solid organ transplant

recipients and patients with long-term corticoid therapy, usage of combination of antifungal drug therapy and the need for the early diagnosis and treatment to prevent the occurrence of complications due to *Aspergillus* were discussed. Geological variation of the host response to fungi was pointed, which suggests differential therapeutic strategies depending on the location/kind of fungal infection. In addition, infection due to poly-microbes as during pulmonary infection in cystic fibrosis (CF) patients and the need to understand fungi in such context were emphasized.

AMRC highlighted to the participants the corneal infection due to *Aspergillus* and *Fusarium* spores, which is a cause of blindness of around 340000 Indian populations annually. Ineffectiveness of anti-fungal therapy in fungal keratitis patients causing loss of vision was discussed to underscore the need for early and effective intervention methods. ●

## INDO-FRENCH PHYSICS CONFERENCE

March 18-21, 2014  
Bangalore

Indo-French Centre for the Promotion of Advanced Research (CEFIPRA) in association with Centre national de la recherche scientifique (CNRS) organized an Indo-French Physics conference at IISc, Bangalore during March 18 - 21, 2014.

The objective of the conference is to foster collaboration between experts groups of two countries i.e. India & France in the important areas of physics. The conference was organized for four days in the areas of Optics, Nano-Sciences, Cold Atoms & Synchrotrons. Twenty eight French scientists from different institutes of France. and eighty Indian scientists from different leading institutes of India attended the conference. During four days of

conference, there were thirty five invited talks by the experts of both the countries followed by round table discussion. The presentation by French and Indian scientists covered various aspect of subject domains. There was an opportunity for Indian researchers to showcase their research before international community through poster session. There was an opportunity for French Researchers to visit Indian laboratories / Indian Institutes working in the areas of Physics.

Three definite collaborations are expected to emerge from this under the network programme of CEFIPRA. The conference concluded that researcher should be encouraged to submit proposals to CEFIPRA under its regular call for proposal. ●



## MOBILITY OF SCIENTISTS SUPPORTED UNDER CEFIPRA PROJECTS JANUARY - MARCH 2014

	Project Title	Name   Institutional Affiliation	Institute Visited
1	Studies of Spin Ladder and Heavy Fermion Systems in Extreme Conditions of Hydrostatic or Uniaxial Pressure and Low Temperature	<b>S. Arumugam</b> Bharathidasan University, Tiruchirappalli	Institut Nanosciences et Cryogenie INAC/SPSMS/IMAPEC CEA Grenoble
2	Correlated studies of response Properties of Open-shell Molecules in the Relativistic Framework	<b>Debasis Mukherjee</b> Indian Association for the Cultivation Sciences, Kolkata	Laboratoire de Chimie et Physique Quantiques, Toulouse
3	Computational studies of Frustrated Quantum Magnets	<b>Kedar Damle</b> Tata Institute of Fundamental Research, Mumbai	Laboratoire de Physique Theorique Toulouse
4	Hydrology and Water resources from Spaceover the Indian Continent	<b>V M Tiwari</b> National Geophysical Research Institute, Hyderabad	Laboratoire d'Etudes en Géophysique et Océanographie Spatiales, Toulouse
5	Emerging Strategies for Wireless Communication Networks	<b>Eitan Altman</b> INRIA Sophia, Atipolis	Indian Institute of Science Bangalore
6	Thermo-Hydrodynamics of Phase-Change Induced Oscillating Taylor Bubble Flows	<b>Frederic Leferve</b> Institute National des Sciences Appliquees de Lyon Centre de Thermique de Lyon, Villeurbanne	Indian Institute of Technology Kanpur
7	Studies of Spin Ladder and Heavy Fermion Systems in Extreme Conditions of Hydrostatic or Uniaxial Pressure and Low Temperature	<b>Daniel Braithwaite</b> Institute Nanosciences et Cryogenie, INAC/SPSMS/IMAPEC CEA, Grenoble	Bharathidasan University Tiruchirappalli
8	High Anisotropy Molecular Magnets: Synthesis & Modelling	<b>Jean-Pascal Sutter</b> Laboratoire de Chimie de Coordination du CNRS Toulouse	Indian Institute of Science Bangalore
9	Global Transcriptomics of Sex-Specific Splicing	<b>Rabinow Leonard</b> Centre de Neurosciences de Paris Sud Universite Paris-Sud 11, Orsay	Centre for DNA Fingerprinting & Diagnostics, Hyderabad
10	All Polymer Flexible Gas Sensors	<b>Mohamed M Chchimi</b> Interfaces, Traitements, Organisation et Dynamique des Systemes(ITODYS), Paris	Bhabha Atomic Research Centre Mumbai
11	Constraint-Based Design of Controllers and Prefilters	<b>Alexandre Goldsztejn</b> Laboratoire d'Informatique de Nantes- Atlantique LINA UMR CNRS 6241 Nantes	Indian Institute of Technology Mumbai
12	Constraint-Based Design of Controllers and Prefilters	<b>Christophe Jermann</b> Laboratoire d'Informatique de Nantes- Atlantique LINA UMR CNRS 6241 Nantes	Indian Institute of Technology Mumbai
13	Evaluation of Cellular and Immune Response in Mice and Patients with Acute Promyelocytic Leukemia Treated with Arsenic Trioxide	<b>Christine Chomienne</b> INSERM Hoopital Saint Louis Paris	Christian Medical College Vellore

## MOBILITY OF SCIENTISTS SUPPORTED UNDER CEFIPRA PROJECTS JANUARY - MARCH 2014

14	Kinetics and Spectroscopy in Extreme Environments: Applications to Astrophysics and Astrochemistry	<b>Robert Georges</b> Departement de Physique Moleculaire Universite de Rennes 1, Rennes	Indian Institute of Science Bangalore
15	Kinetics and Spectroscopy in Extreme Environments: Applications to Astrophysics and Astrochemistry	<b>Samir Kassi</b> Laboratoire Interdisciplinaire de Physique, Universite de Grenoble, Grenoble	Indian Institute of Science Bangalore
16	Kinetics and Spectroscopy in Extreme Environments: Applications to Astrophysics and Astrochemistry	<b>Ludovic Biener</b> Institut de Physique de Rennes, Universite de Rennes1, Rennes	Indian Institute of Science Bangalore
17	Distant obscured galaxies from GMRT and Herschel	<b>Alain Omont</b> Institut d'Astrophysique de Paris Paris	National Centre for Radio Astrophysics Pune
18	Tropical cyclones in the Bay of Bengal: Oceanic Response and Air-Sea Interactions	<b>Anicet Beauvais</b> Laboratoire d'Océanographie et de Climatologie: Experimentation et Analyses Numeriques, Paris	University of Delhi Delhi
19	Reversals of a Large Scale Field on a Turbulent Background	<b>Emmanuel Dormy</b> Laboratoire de Physique Statistique Ecole Normale Superieure Paris	Indian Institute of Technology Kanpur

### CALL FOR APPLICATIONS

### RAMAN-CHARPAK FELLOWSHIPS 2014

CEFIPRA has initiated a Call for Applications under the Raman-Charpak Fellowship for the year 2014. The aim is to facilitate the exchange of doctoral students between India and France, in order to broaden the scope and depth of future engagements in science, technology and innovation.

The Fellowship Programme is implemented by CEFIPRA with joint funding from the Department of Science and Technology (DST), Government of India and the Science & Technology Department of the French Embassy in India. Up to 15 fellowships each from India and France will be funded under this scheme, to attract the best of talent from India and France for the following themes:

- Atmospheric and Earth Sciences
- Life Sciences and Medicine
- Chemistry
- Material Sciences
- Engineering Sciences
- Mathematical and Computational Sciences
- Physical Sciences

For details regarding the application process and supporting documentation required please visit [www.cefipra.org](http://www.cefipra.org). Application should be addressed to:

**The Director**

Indo-French Centre for the Promotion of Advanced Research,  
5B Ground Floor, India Habitat Centre, Lodhi Road, New Delhi 110 003

Email: [director@cefipra.org](mailto:director@cefipra.org) • Website: [www.cefipra.org](http://www.cefipra.org)

Last date for submission is 7th May 2014.

## MOBILITY OF STUDENTS SUPPORTED BY CEFIPRA JANUARY - MARCH 2014

Domain	Name & Institute	Institute Visited	
Life Sciences	<b>Aditi Verma</b> Indian Institute of Science Bangalore	INSERM U 676, Hopital Robert Debrer Paris	
	<b>Deepak Pakalapati</b> Centre for Cellular and Molecular Biology, Hyderabad	Institut de Recherche en Cancérologie de Montpellier Montpellier	
	<b>Jaswinder Singh Maras</b> Institute of Liver and Biliary Science New Delhi	CEA, Batiment Le Ponant D Paris	
	<b>Esakki Muthu Sankaran</b> Bharathidasan University Tiruchirappalli	SPSMS/MAPEC, Commissariat a l'Energie Atomique-INAC Grenoble	
Physics	<b>Saumyadeep Roy</b> University of Assam Silchar	Universite Paris Sud Orsay	
Information Technology	<b>Arundhati Tarafdar</b> Indian Statistical Institute Kolkata	Universite Francois Rabelais Tours Tours	
Chemistry	<b>Vishwajeet Jha</b> National Chemical Laboratory Pune	Ecole Eurpeenne de Chimie, Polymeres et Materiaux, Universite de Strashourg Strasbourg	
Biotechnology	<b>Siddanagouda .S. Biradar</b> Smt. C. Munavalli Polytechnic Hubli	URGV Lab(INRA) Evry	
Chemical Sciences	<b>Sangeta Sen</b> Indian Association for the Cultivation of Science Kolkata	Laboratoire de Chimie et Physique Quantiques Universite de Toulouse-Toulouse	

## MOBILITY OF STUDENTS SUPPORTED BY CEFIPRA JANUARY - MARCH 2014

### RAMAN-CHARPAK FELLOWS

Domain	Name & Institute	Institute Visited	
Life Sciences	<b>Vivek Reddy Palicharla</b> Centre for DNA Fingerprinting and Diagnostics, Hyderabad	Institut de Génétique de Biologie Moléculaire et Cellulaire Illkirch	
Mathematical Sciences	<b>Bapan Ghosh</b> Bengal Engineering and Science University, Shibpur, Howrah	INRIA Sophia Antipolis Méditerranée Sophia Antipolis	
Chemical Sciences	<b>Kasireddy H. Vardhan Reddy</b> Indian Institute of Chemical Technology, Hyderabad	Laboratoire de Chimie Thérapeutique, BioCIS-CNRS UMR Châtenay-Malabry	
	<b>Konkala Karnakar</b> Indian Institute of Chemical Technology, Hyderabad	Laboratoire des Glucides UMR 6219 CNRS Amiens	
Atmospheric Sciences	<b>Sneha Chandrakant Sagarkar</b> Nagpur	INRA, UMR 1347 Agroecology Dijon	
Physical Sciences	<b>Purushottam Jha</b> Bhabha Atomic Research Centre Mumbai	Universite Paris Diderot-Paris 7 CNRS UMR 7086 Paris	
	<b>Joel Genet Marthelot</b> Université Pierre et Marie Curie	TIFR Centre for Interdisciplinary Sciences, Hyderabad	
	<b>Jonathan Anthony Freundlich</b> Université Pierre et Marie Curie	Indian Institute of Science Bangalore	

## BIRAC-SCIENCE & TECHNOLOGY DEPARTMENT OF THE FRENCH EMBASSY IN INDIA - CEFIPRA CALL FOR PROPOSALS

### INDO-FRENCH CHALLENGE-ORIENTED GRANTS 2014

Biotechnology Industry Research Assistance Council (BIRAC), The French Embassy in India, Ministry of Foreign Affairs, Government of France and Indo-French Centre for the Promotion of Advanced Research (CEFIPRA) request for proposals for Indo-French Challenge-Oriented Grants 2014. The proposals are invited with the objective of:

- Supporting high-quality bilateral research projects that combine innovative approaches towards new concepts and technological breakthroughs.
- Encouraging and enabling Indo-French collaboration between public and private research groups, industry, clinicians and end-users.

The focal topics of this Call for Proposals are:

- Molecular diagnostics for prediction of cardiac stroke.
- Rapid diagnostics for Alzheimers and /or dementia in elderly or molecular diagnostics for detection of neurological disorders inneonates especially related to cerebral palsy.
- Generation of new assistive technologies for mobility of physically challenged including elderly.

For proposal application format and other details please visit [www.cefipra.org](http://www.cefipra.org)

Last Date for Submission : 3rd May 2014

## CALL FOR APPLICATIONS FOR PARTICIPATION IN

### European School on Nanosciences and Nanotechnologies

August 24th - September 13th 2014 / Grenoble, France

CEFIPRA has joined hands with Université Joseph Fourier, Grenoble, France, to support the participation of Indian doctoral students in the European School on Nanosciences and Nanotechnologies (ESONN) training programme - Session 2014 (August 24th -September 13th, 2014). The expenses related to the participation of the selected students will be borne by CEFIPRA.

ESONN is a three-week course, the details of which is available on (<http://esonn.fr/>). The programme emphasizes the role of laboratory courses (half of the programme is devoted to practical work) and structured to highlight Nanoscience & Nanotechnologies in Physics, Biology & Chemistry. The academic and practical courses cover the elaborate functioning and characterisation of nano-objects. All the lectures and practicals are given IN ENGLISH, at the Maison des Magistères, 25 rue des Martyrs, Grenoble, France.

For details regarding the application process and supporting documentation required please visit [www.cefipra.org](http://www.cefipra.org). Application should be labelled on top as "Application for ESONN-CEFIPRA Fellowship" and should be sent by email to [submit@cefipra.org](mailto:submit@cefipra.org) and ALSO by post to:

#### The Director

Indo-French Centre for the Promotion of Advanced Research,  
5B Ground Floor, India Habitat Centre, Lodhi Road, New Delhi 110 003  
Email: [director@cefipra.org](mailto:director@cefipra.org) • Website: [www.cefipra.org](http://www.cefipra.org)

LAST DATE FOR RECEIPT OF COMPLETE APPLICATIONS: MAY 12, 2014



Indo-French Centre for the Promotion of Advanced Research (IFCPAR) is a model for international collaborative research in advanced areas of science and technology. The centre was established in 1987 with support from Department of Science & Technology, Government of India and the Ministry of Foreign Affairs, Government of France.



For further information please contact:

Pour toute information complémentaire, veuillez contacter:

#### Director

#### Indo-French Centre for the Promotion of Advanced Research

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