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# R&D Newsletter

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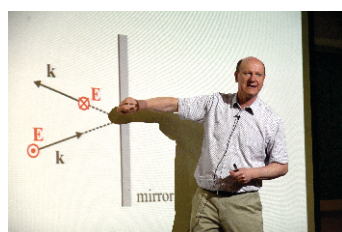
ROZI SIKSHA KENDRA

## CNR Rao Endowed Lecture 2019



On February 2019, Professor Animangsu Ghatak, Department of Chemical Engineering, IIT Kanpur delivered a lecture under CNR Rao Endowed lecture series. The title of his talk was 'Adhesion and Fracture of Soft Material.' This lecture series was made possible by a generous donation by Prof. C.N.R. Rao, Linus Pauling Professor at JNCASR, Bangalore. The objective is to give one faculty member of the IIT Kanpur, each year, the honor of delivering a lecture to the institute's community, sharing the excitement of his/her research with them.

## Institute Lecture (January-March, 2019)



### Prof. Olivier J F Martin

Swiss Federal Institute of Technology Lausanne (EPFL)

*Title: Plasmonics: From materials to metasurfaces and pure magnetic light*



### Prof. Mark E. Tuckerman

New York University, USA

*Title: Molecular simulation and Machine Learning as Routes to Exploring Structure and Phase*



### Prof. Michael Berry

University of Bristol, UK

*Title: Geometric phases and the separation of the world*



### Prof. Tahei Tahara

Molecular Spectroscopy Laboratory, RIKEN, Japan

*Title: Wonder world seen with light*



### Prof. Oleg A. Kabov

Kutateladze Institute of Thermophysics, Russia

*Evaporation, Levitation and Self-Organization of Liquid Micro-droplets over Solid and Liquid Surfaces and Contact Line Region*

# National Science Day Celebration

**N**ational Science Day is celebrated in our country with the objectives of commemorating the first Nobel prize in India on Science which was achieved by the discovery of Raman Effect by Sir C V Raman. It is also celebrated to emphasize on the culture of science and the application of science for the welfare of people.

To mark the celebration of National Science Day, the Cognitive Science Programme in coordination with the Dean, Research and Development Office has organized one-day symposium titled: **“Through the looking glass: Interdisciplinary Perceptions on Cognition”** on 26th February, 2019 at the Outreach Auditorium. Prof. Karandikar, Director, IIT Kanpur inaugurated the symposium. Prof. Narayanan Srinivasan, CBCS, Allahabad delivered the key note address which was followed by the technical disseminations from Profs Bishakh Bhattacharya, Debabrata Goswami, Nitin Gupta, Devpriya Kumar and Ark Verma on the subject theme. Subsequently, Prof. Philip Tseng, and Prof. Niall Duncan from Taipei Medical University have delivered expert talks in the same direction. The programme ended with a vote of thanks by Prof. S. Ganesh, Dean, Research and Development.



## Ranjit Singh Rozi Siksha Kendra

IIT Kanpur Alumni Dr. Ranjit Singh (BT/MME/1965), has pledged an amount of 1.9 Million Dollars to set up Ranjit Singh Rozi Siksha Kendra and Ranjit Singh Chair. The primary mission of Rozi Shiksha Kendra is to focus on achieving the objectives of

- Technology interventions for enabling education for upto two years of vocational training.
- Technology interventions for enabling job guarantees for the unemployed.

IIT Kanpur is already working with a cluster of five villages to improve the village life by creating a technology enabled model of sustainable development for rural community and subsequently creating a scalable model for cluster of villages.

The objectives of Ranjit Singh Rozi Siksha Kendra would be in line with IIT Kanpur's Centre for Technology for Sustainable Development and would strive towards enabling Equitable Prosperity for all.

## Center of Excellence for Defence Corridor



In February 2018, the Government of India announced setting up of a defense corridor in Uttar Pradesh. It was envisaged that a number of defense equipment manufacturing units will be set up along the corridor resulting in significant expansion of the industrial base in the state. At the time, IIT Kanpur and Government of UP had already agreed to collaborate in the technological domain with IIT Kanpur being declared as technological partner of the government. The government requested the institute to create a center of excellence in defense technologies

that can create new technologies to be transferred for manufacturing in the defense corridor.

After several rounds of discussions, In February 2019, a center of excellence for defense corridor was created at the institute with a budgetary outlay of Rs 50 Crores spread over three years. The institute has committed to develop relevant technologies in four domains: advanced materials (wound-healing material, stealth material etc), UAVs (vertical takeoff and landing drones of different weight classes), cyber security (hardened OS, malware protection etc), electronics and communications (long distance radars etc). Work on several specific projects has already started and first set of technologies are expected to be ready for manufacturing within a year.

It is perhaps the first time that a state government has made such a significant investment in an IIT for the development of technology. Most of the government officials involved with the project have been extremely cooperative and expect the institute to contribute in industrial development of the state.

## Recent Project

### Identifying the Molecular Mechanism(s) by which BMP Signalling Regulates the Migration and Polarity of Cortical Neurons

PI: Prof. Jonaki Sen (jonaki@iitk.ac.in)

Co-PI: Prof. Amitabha Bandyopadhyay (abandopa@iitk.ac.in)

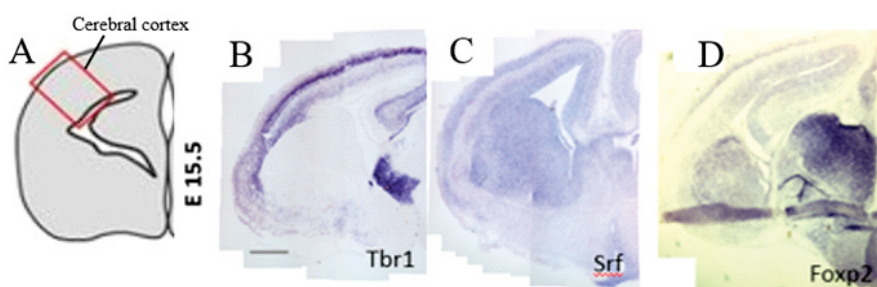
Department of Biological Sciences & Bioengineering

Sponsor: Science and Engineering Research Board



The mammalian cerebral cortex is the seat of various higher cognitive functions. It consists of a laminar arrangement of neurons in six layers. One interesting feature of neurons in the developing central nervous system is that they migrate away from their birthplaces at the ventricular zone to their final destinations.

Defects in migration and/or polarity of cortical neurons results in brain malformations and is linked to diverse psychiatric and neurological disorders including schizophrenia, epilepsy and autism. Hence, it becomes important to elucidate the molecular mechanism of neuronal migration, polarity and other aspects of cortical neurogenesis in order to understand not only the basic principles of brain development but also the pathological processes of these disorders.



Three candidate genes showing tissue restricted expression in the cross-section of the developing mouse cortex (Embryonic day 15.5): (A) schematic showing cross section of E 15.5 mouse cortex, (B) *Tbr1* (T-Box, Brain 1), (C) *Srf* (Serum response factor), (D) *Foxp2* (Forkhead box protein P2).

Recent work carried out in PI's laboratory has shown that canonical and non-canonical Bone Morphogenetic Protein (BMP) signaling differentially regulate radial migration and polarity of E15.5 born upper layer cortical neurons in mice.

This project intends to identify the molecules acting downstream of BMP signaling that specifically regulate radial migration and polarity of E15.5 born upper layer cortical neurons in the mouse through a transcriptomics based approach. This study is likely to provide insight into novel molecules and mechanisms regulating neuronal migration and establishment of polarity in mouse model.

## SNIPPETS



Prof. Mukesh Sharma was invited by the World Health Organization for consultation, 12-14 February 2019, at Geneva, Switzerland on risk communication and intervention to reduce exposure and to minimize

the health effects of outdoor air pollution (<https://www.who.int/airpollution/events/experconsult2019/en/>).

"Smart City" project led by Prof. Saikat Chakrabarti has won the ISGF innovation award 2019 under 'Smart Technology of the Year' category. India Smart Grid Forum (ISGF) has launched this award to recognize individuals and organizations who have set new benchmarks in Smart Grid and Smart City domains. The awards will showcase the globally growing smart ecosystem and foster global partnerships.



## Delhi Air Quality Experiment: A Paradigm Shift in Source Apportionment

PI: Prof. SN Tripathi (snt@iitk.ac.in)

Department of Civil Engineering / Centre for Environmental Sc. & Engineering

Sponsor: Central Pollution Control Board



Understanding the sources of ambient particulate matter (PM) is important for cost effective emission reduction. However, the mixing of the different source of emissions together with atmospheric dynamics and topographical conditions makes the understanding of source-receptor linkage complex especially in winter season. Currently, various air quality parameters are measured using offline filter based methods by collecting aerosols on filters using air samplers. Further, source apportionment of PM is performed using source-receptor modeling which needs prior information on the potential sources. However, filter based source apportionment

studies have limitations as variations in concentrations and composition of aerosols in atmosphere are captured in low temporal resolution. Studies employing these methods in the past have shown very low contribution (<30%) from secondary organic aerosols (SOA) in the total organic concentration levels.

Source apportionment by real-time measurements of particle phase organics using aerosol mass spectrometry has shown up to 60% contribution from SOA to the total OA mass<sup>1</sup> in India (Figure above). This significant difference in the calculated SOA fraction between filter based and real-time measurements may be due to the inability of the filter-based measurements to capture the real-time variation of SOA in the atmosphere. It is also important to understand the real-time variation of brown carbon aerosols along with primary and secondary OA, as they can significantly alter the absorptive properties of total aerosols<sup>2</sup>. Thus, it is important to characterize the gases and aerosols using the real-time instruments to understand their sources and evolution pathways<sup>3</sup>.

Considering the fast physical and chemical transformation and transportation of the emissions in the atmosphere, our study couples the real-time PM<sub>2.5</sub> measurements from advanced online mass spectrometry instruments and offline analysis of filter samples (for more time and spatial coverage) using mass spectrometry techniques to understand the sources of aerosols in detail.

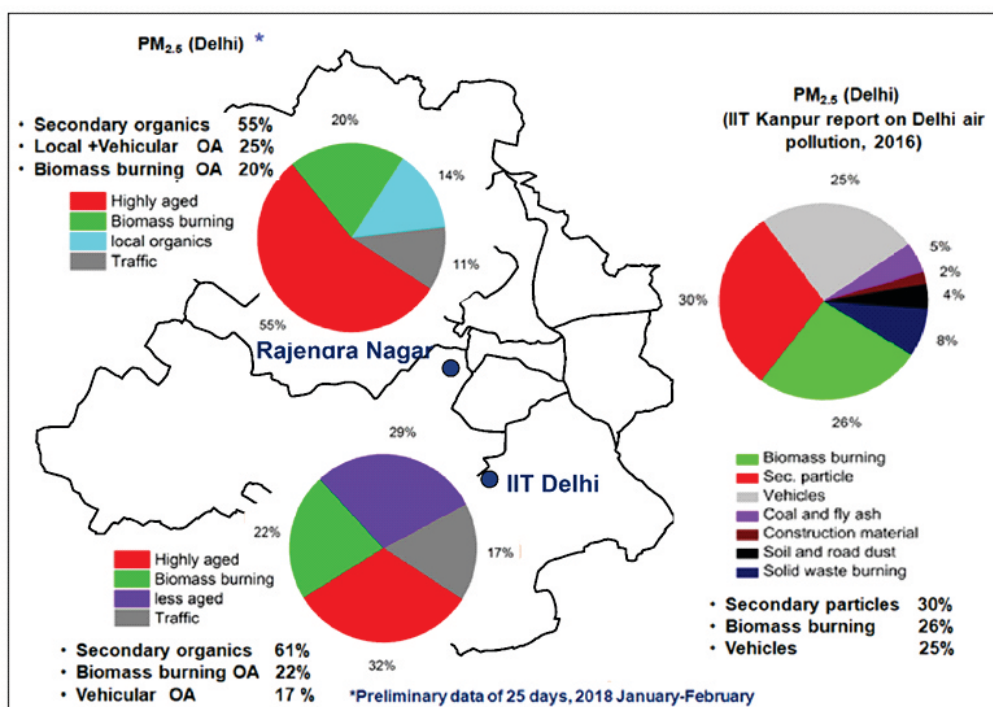


Figure : Sources of winter aerosols in Delhi. The figures on the left indicate the real-time source identification (unpublished data). The right hand side shows the source identification in Delhi using offline analysis.

<sup>1</sup>Chakraborty et al, Journal of Geophysical Research: Atmospheres, **2015**, 120(17), 9006-9019; Prevot et al, Nature, **2014**, 514, 218-222

<sup>2</sup>Shamjad et al, Environ. Sci. Technol. **2015**, 49 (17), 10474-10481; Satish et al, Environ. Sci. Technol. **2017**, 51 (12), 6765-6772.

<sup>3</sup>Thamban et al, Atmospheric Research, **2017**, 197, 211-223; Kumar et al, Environmental Science: Processes & Impacts, **2016**, 18, 1285-1296.

## Recent Project

### Developing a Compact Graphene based Sensor for Monitoring Steel Structure under Stress

PI: Prof. Satyajit Banerjee (satyajit@iitk.ac.in)

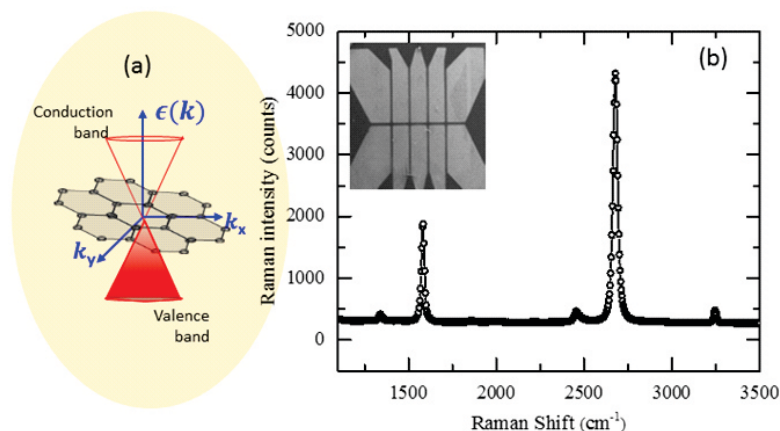
Department of Physics

Sponsor: Science and Engineering Research Board, DST (Imprint-II)



**I**ron is easily magnetized but its ability to retain magnetization after the applied magnetic field is removed is low. Steel however has relatively low susceptibility but it retains the acquired magnetism for a longer time. The magneto-elastic properties of steel are such that they are sensitive to stress acting on it.

The project aims to develop a sensor which will be directly mounted onto the steel structure in order to evaluate stresses and dynamically monitor the strain fluctuations. The sensor will aid in evaluating the structures stability as well as help in anticipating the possible development of faults which can compromise its stability. Graphene, a wonder material, is a monolayer sheet of carbon atoms with unique linear energy momentum dispersion around its fermi energy. Its high electrical mobility and mechanical rigidity will be utilized to make these sensors.



\*Data and image are a part of the thesis and a submitted paper of Ms. Kamalika Nath, Phd student Dept. of Physics 2019

Figure(a) An artistic impression of the linear energy – momentum dispersion, overlaid on a monoatomic view of Carbon atoms in Graphene  
Figure(b) Insets shows a Graphene sensor fabricated in our lab and the Raman spectra of Graphene from the smallest patterned structure.

### Electric Field Controlled Spin Dynamics in Nanomagnets

PI: Prof. Soumik Mukhopadhyay (soumikm@iitk.ac.in)

Co-PI: Prof. Amit K. Agarwal (amitag@iitk.ac.in)

Department of Physics

Sponsor: Department of Science & Technology



**H**ow do magnetic moments order in a two-dimensional solid? This question lies at the heart of fundamental physics with implications beyond its realm such as in the study of topology, device applications, etc. The well-known Mermin-Wagner theorem rules out the possibility of long range ordering in 2D Heisenberg ferromagnets with continuous rotation symmetry and short range interaction. However introduction of anisotropy could gap out the long wavelength excitations and stabilize magnetic ordering. Restricting the spin dimensionality to two as

in Heisenberg XY model systems opens up possibility of topological phase transition without any symmetry breaking. Enhanced fluctuations in such systems can potentially lead to novel ordered phases. Recent discovery of 2D magnetism in van-der Waals materials has created opportunity of addressing these questions using controlled experiments.

The objective of this project is to study spin dynamics in magnetic systems close to monolayer limit using FMR broadband spectroscopy.

# Success Stories of Incubated Companies

## Urinalytics Health

Founder Nikky Jha is selected for Young Social Entrepreneurs 2019 Workshop by Singapore International Foundation

## Ignis Career

USD 150,000 fund raise from Grey Matter Capital

## Aquafront Infrastructure

NRDC National Meritious Innovation Awards 2018

## Delmos Research Pvt Ltd

Eat Right Startup Awards from FSSAI

## Ficting

Founder Abhay Gupta is Selected for Draper University's Pre-Accelerator Program 2019 in Silicon Valley with scholarship

## BioScan Research

Winner of Social Alpha Quest for Healthcare Innovation 2018

## Promorph Solutions Pvt Ltd

Top 100 Finalists in Maharashtra Startup Week 2019

## Kritsnam Technologies

Best Startup Award (Social Impact) in MeltingPot2020



## HelpUsGreen

Won National Bio Entrepreneurship competition organised by C-CAMP, Bangalore

2018 GSC Millennial Honors

UN Young Global Leader Award 2018

## OxenFarm Solutions

Awaaz Entrepreneur Viewer's Choice Award from CNBC AWAAZ

## KrishiHub (JB Infolabs Pvt Ltd)

NASSCOM Emerge 50 Awards

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## Feedback/Suggestions

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