"We explore the Universe, literally, from the smallest to the largest scales, not just in terms of length but also in energy and time. We spy on exotic particles whizzing inside colliders. We study how a collection of particles behave at low temperatures, normal temperatures, high magnetic fields and other extremes of nature. We venture into the basis of life and evolution, order and chaos. We care about the Sun's magnetic fields and worry about the weather in space. We flirt with black holes and swim in space-time ripples. Yes, we are physicists. Come join us, there is a Universe to fathom..."

Physicists at IISER Kolkata have published in leading international journals such as Nature, Science and Physical Review Letters and they have produced students who are now at the leading institutions of the world such as Cambridge, Cornell, IISc, JNCASR, Maryland, Oxford and Rutgers. They have won awards for their work, both within and outside the country, and their research and interviews have been highlighted in forums as diverse as the Times of India to the New York Times Dot Earth Blogs. Here is the story of this merry bunch of physicists and the Department they nurture.

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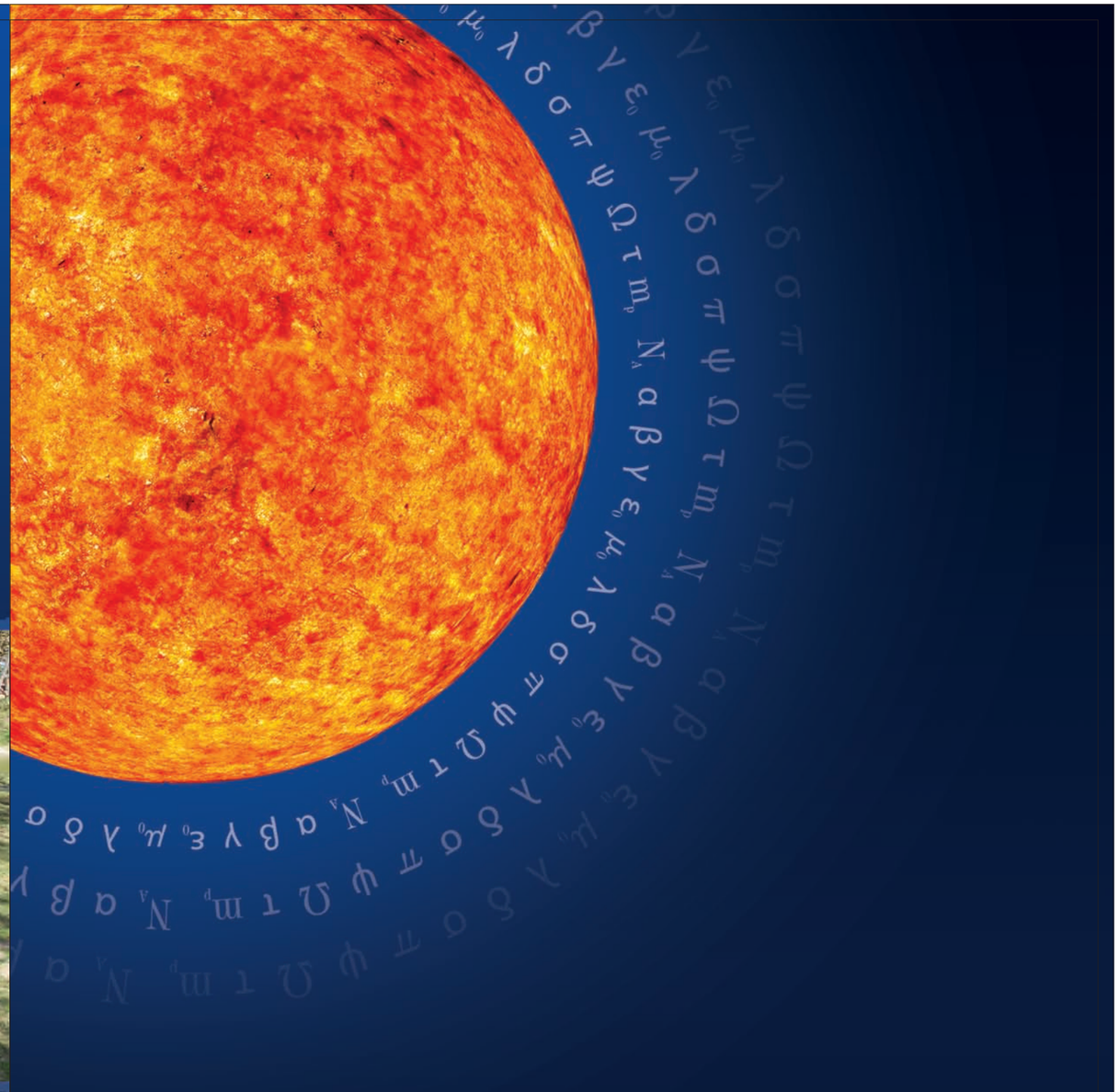
Website (Physical Sciences): http://phys.iiserkol.ac.in/
Website (Institute): http://www.iiserkol.ac.in/



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Department of Physical Sciences

IISER KOLKATA
2013

Indian Institute of Science Education and Research Kolkata

IISER KOLKATA

Department of Physical Sciences 2013

If you want to build a ship, don't drum up people together to collect wood and don't assign them tasks and work, but rather teach them to long for the endless immensity of the sea.

Antoine de Saint-Exupéry

Department Brochure 2013

Department of Physical Sciences

Indian Institute of Science Education and Research Kolkata

Foreword

Despite the long hours, many sleepless nights and numerous cups of tea that were invested on this book, it has been a pleasure putting this together for the Department of Physical Sciences at the Indian Institute of Science Education and Research (IISER), Kolkata. We envisage this book as a window – albeit an abstract one – between the outside world and us. On the one hand, this window allows you – the reader – to peer into our domain and on the other hand, this window provides us with a frame to showcase our creations.

IISERs are new institutes, fledgling but ambitious. We believe that IISERs are possibly the greatest endeavour in Indian science in recent years and we nurture this dream and toil to turn this into reality. This belief is our inspiration for reaching out to the outside world to tell our story.

Our Department is relatively young, but what we have achieved in these few years would be evident to anyone reading this book. If you like our story, share this with others. If you are a student and you are interested in what we do, write to us. If you are a colleague and respect our work, well, it simply takes an extended hand to be a collaborator. So, welcome to our world...

Arindam Kundagrami

Editorial Coordinator, Department of Physical Sciences

Dibyendu Nandi

Editorial Coordinator, IISER Kolkata

Table of Contents

Message from the Director

This book contains academic profiles of faculty members of the Department of Physical Sciences, Indian Institute of Science Education and Research, Kolkata and details of their teaching and research activities.

The Indian Institutes of Science Education and Research (IISERs) were established by the Ministry of Human Resource Development (MHRD), Government of India, based on the recommendation of the Scientific Advisory Council to the Prime Minister. The first two Institutes established under this initiative were IISER Kolkata and IISER Pune in 2006, followed by IISER Mohali in 2007, and IISER Bhopal and IISER Thiruvananthapuram in 2008. Each IISER is an autonomous institution and awards its own degrees. The basic mandate of the IISERs is to provide quality science education and to carry out research in basic and frontier areas of science involving both undergraduate and postgraduate students. Through borderless and flexible education programs, IISERs provide an opportunity for young students to experience the excitements of research in the sciences. In essence, IISERs are devoted to both teaching and research in an integrated manner – thus nurturing both curiosity and creativity.

IISER Kolkata's fully residential campus is coming up on 201 acres of land at Haringhata (Mohanpur). We expect the years 2013-2014 to be exciting and eventful for the growth of IISER Kolkata. The coming years would be an important landmark for us, as the Institute is planning to shift a major part of its activities to the permanent campus.

The first two batches of students who joined in 2006 and 2007 successfully completed their academic requirements for the award of BS-MS dual degree. Notably, about 80% of our first and second-batch BS-MS students, totalling 103, have booked their places in some of the world's best research institutes, including top-notch North American and European Universities, in addition to joining premier research institutes in India. The third batch of students who joined in 2008 is on the verge of completion in May 2013. We are proud of the fact that, as of March 2013, a total of 14 students have completed their PhD research working at IISER Kolkata. We are excited and looking forward to awarding degrees to all three batches of BS-MS students and PhD students during the First Convocation of IISER Kolkata, scheduled in June 2013.

IISER Kolkata offers students a unique educational experience, which is comprehensive in character and rounded in nature. It also offers faculty members and students a modern and flexible environment to grow intellectually through an informal and formal exchange of ideas both within and outside the classrooms. To support continuing growth in interdisciplinary research and teaching, it is understandable that creation of an efficient academic environment is a must. Accordingly, IISER Kolkata strives to train students to become part of this dynamic and evolving scenario. Creating research infrastructure is one of our top-notch priorities. And hence we are continuing to add on to the already existing and impressive experimental facilities.

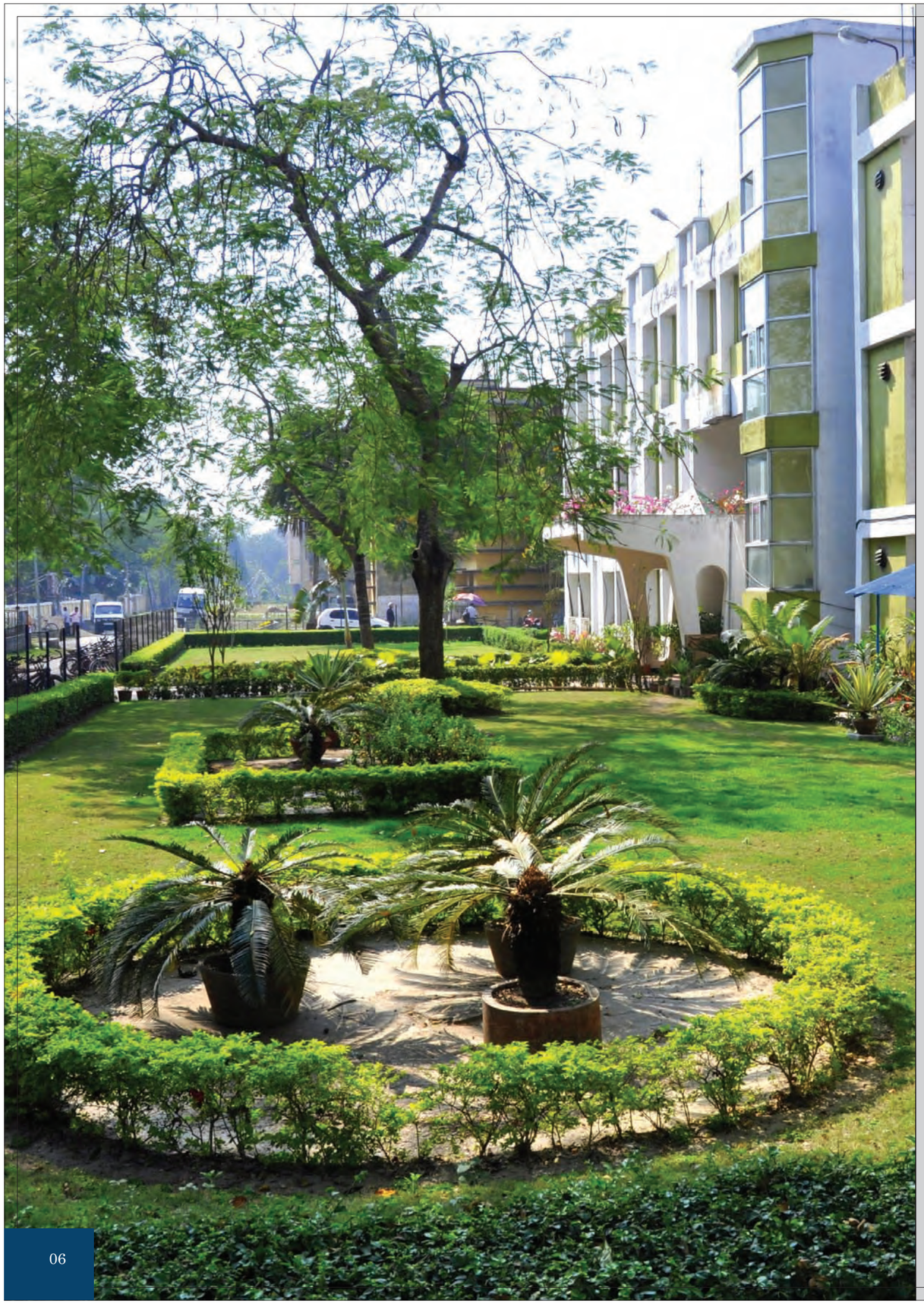
IISER Kolkata has well-trained, committed, and dedicated faculty members to take the Institute to greater heights in the coming years. Our faculty members are supported by attractive start up and matching research grants. With 76 regular faculty, 407 BS-MS students, 57 Integrated PhD students, 177 PhD students, and 2 Post-Doctoral Fellows, IISER Kolkata is vibrant with academic activities. It is a matter of great satisfaction that faculty members have been publishing their research papers in journals of international repute, based on work done at IISER Kolkata. Some of our young faculty members have excelled in research and have been recognized with national and international fellowships and awards. It is very satisfying to put on record that our colleagues have attracted funding through 76 sponsored research projects amounting to about Rs. 32 Crores. Moreover, the academic activities of IISER Kolkata are supported by 53 non-teaching staff members.

Apart from engaging in scientific activities, students and faculty of IISER Kolkata are also involved in various social and outreach activities. We are trying our best to fulfil our social commitment through various outreach programs. The Institute plans to develop a synergetic network with other academic institutions both in India and abroad, addressing fundamental issues related to science education in India.

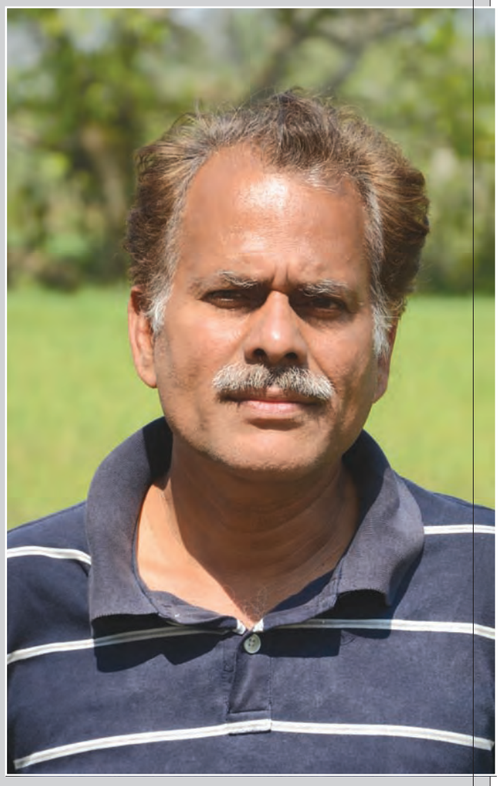
To conclude, for inquisitive young minds looking for a platform to experience a fine blend of quality teaching and world-class research in basic sciences and for young faculty candidates keen to get an opportunity to make a name in teaching and cutting-edge research, IISER Kolkata is one of the best institutions in India to reckon with. As I believe in collective responsibility and team efforts, I find IISER Kolkata is an ideal place to take quality faculty members and students, and non-teaching staff members along with me in this educative and satisfying journey to build, to nurture, and to see the fruits of a budding academic institute of substantial promise. Personally, I am humbled and grateful to be a part of this challenging and exciting environment of IISER Kolkata.

R.N. Mukherjee

Prof. R. N. Mukherjee
Director



Message from the Head of the Department



Prasanta K. Panigrahi

The Department of Physical Sciences (DPS) at IISER Kolkata devotes itself to the study of Physics and its applications towards understanding the world around us. The research areas of specialization broadly include astrophysics and space science, atomic, molecular, and optical physics, biophysics, complex systems, condensed matter physics (including soft matter physics), gravitation and cosmology, high energy physics, mathematical physics, and nonlinear dynamics. The present DPS strength includes 27 faculty, 1 senior scientific officer, and 1 IISER Fellow of whom there are 13 experimentalists, and 16 theorists. The DPS family includes 50 doctoral students (both Integrated PhD and regular PhD), whose strength is being gradually increased keeping in mind the strong commitment of the IISER system towards research with quality teaching. The rigorous teaching program of the department integrates the requirements for the Integrated BS-MS, Integrated PhD and PhD courses that are offered here.

The BS-MS students specialize in physics from 3rd year onwards and subsequently carry out a year-long research project in their fifth year. The IPhD students start research early through a project in their 2nd year as part of their course work. Emphasis on problem solving with the active help of teaching assistants and carrying out research projects in their spare time keep the students engrossed in the academic program. A number of students are authors of high quality research papers published in peer reviewed international journals. The research activities range from the highly specialized to the highly interdisciplinary, in line with the spirit of interdisciplinary research at IISER Kolkata. The doctoral students (both IPhD and PhD) and members of faculty carry out journal club activity, weekly seminars, as well as hosting distinguished visitors from India and abroad. The department regularly conducts national and international workshops and encourages its faculty to participate in academic meets of repute. Departmental faculty have received global recognition for their research and are leading new initiatives such as the Centre for Study of Materials under High Pressure and the MHRD Centre of Excellence in Space Sciences. All of the above give us good reason to eagerly look forward to the exciting times that await. Do join us on this journey.

PEOPLE

Faculty

Ayan Banerjee (Optical Spectroscopy experiments)
Narayan Banerjee (Gravitation & Cosmology theory)
Soumitra Banerjee (Nonliner Dynamics theory)
Bhavtosh Bansal (Condensed Matter experiments)
Rangeet Bhattacharyya (Nuclear Magnetic Resonance)
Ananda Dasgupta (Quantum Phenomena theory)
Amitava Datta (High Energy theory)
Rumi De (Nonlinear Dynamics &Biophysics theory)
Amit Ghosal (Condensed Matter theory)
Anandamohan Ghosh (Nonlinear Dynamics & Biophysics theory)
Nirmalya Ghosh (Optics, Spectroscopy, & Biophotonics experiments)
Golam Mortuza Hossain (Gravitation & Cosmology theory)
Arindam Kundagrami (Soft Condensed Matter theory)
Siddhartha Lal (Quantum Condensed Matter theory)
Chiranjib Mitra (Quantum Condensed Matter)
Partha Mitra (Condensed Matter experiments)
Goutam Dev Mukherjee (Condensed Matter experiments)
Dhananjay Nandi (Molecular Dynamics experiments)
Dibyendu Nandi (Astrophysical Space Sciences)
Rajesh Kumble Nayak (Astrophysics & Gravitation)
Bipul Pal (Ultrafast Spectroscopy in Semiconductor experiments)
Prasanta Panigrahi (Field theory)
Satyabrata Raj (Condensed Matter experiments)
Supratim Sengupta (Complex Systems & Biophysics theory)
Ritesh Singh (High Energy theory)
Subhasis Sinha (Condensed Matter theory)
Prashanth Upadhya (Condensed Matter experiments)

IISER Fellows

Pradip Khatua (Condensed Matter experiments)

Senior Scientific Officers

Uday Kumar (Condensed Matter experiments)

Staff

Indrajit Chatterjee
Scientific Officer (indra.chatterjee)
Physics Laboratories

Pintu Das
Laboratory Assistant and Department Secretary (pintudas)
Mechanical Workshop

Subhash Malo
Attendant (subhas.malo)
Physics/Electronics Laboratory

Rajni Marrick
Scientific/Technical Assistant (rajni)
Physics/Electronics Laboratory

Gour Gopal Paul
Lab Technician (gour.gopalpal)
Physics Laboratories

Ananda Mohan Saha
Attendant (anandasaha)
Physics/Electronics Laboratory

We gratefully acknowledge the support of the staff of the Administration & the Computer Section.

PhD (RS) Students of DPS (37)
Integrated PhD students of DPS (15)
MS students of DPS (65)

Webpages:
Faculty:
http://phys.iiserkol.ac.in/faculties.html
Staff:
http://phys.iiserkol.ac.in/staff.html
Students:
http://phys.iiserkol.ac.in/students.html

ACADEMIC PROGRAMMES

INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH KOLKATA was established in 2006 by the Ministry of Human Resource Development (MHRD), Government of India. IISER Kolkata is an autonomous institution awarding its own degrees. Department of Physical Sciences (DPS) in IISER Kolkata offers four academic programmes with varying degree of emphasis on teaching and research as follows.

Integrated Dual-degree BS-MS Programme

[Current student strength: 410 (Institute), 65 (Physics)]

This remains the flagship teaching programme of DPS. Students are admitted through institute level procedures (see below) after their higher secondary level schooling.

ADMISSIONS: Students must qualify in one of the following examinations for consideration for admission. The programme starts in August.

Kishore Vaigyanik Protsahan Yojana (KVPY) Fellowship: KVPY is one of the most prestigious fellowships for students who have completed their secondary level schooling. The fellowship is offered by the Department of Science and Technology (DST), Govt. of India, to candidates with exceptional aptitude in science, after a written exam and an interview (Web: www.iisc.ernet.in/kvpy).

National Olympiads: The Olympiad examinations, the science equivalent of the International Olympics, are conducted at regional, national and international levels, and are considered to be the toughest and the most challenging exams at the pre-college level. Participation in the National Olympiad Camp remains rare honor, and students representing India in the International Olympiads are eligible for applying.

IIT-JEE: The students qualifying the IIT-JEE are eligible to apply for admission in IISER-K. (Web: www.jee.iitk.ac.in and other IIT websites).

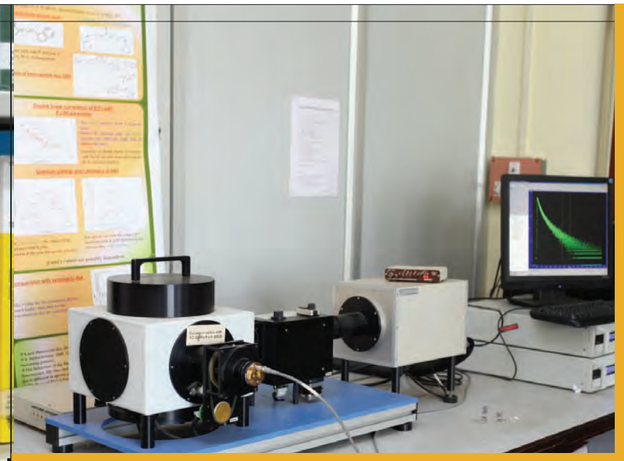
State & National Board exams: Students who stand among the top layer (currently top 1% - as per DST or board cut-off tables) of their respective boards in higher secondary or equivalent exams, may apply to appear in an IISER aptitude test, qualifying which they are offered admission. (Web:http://www.iiser-admissions.in/)

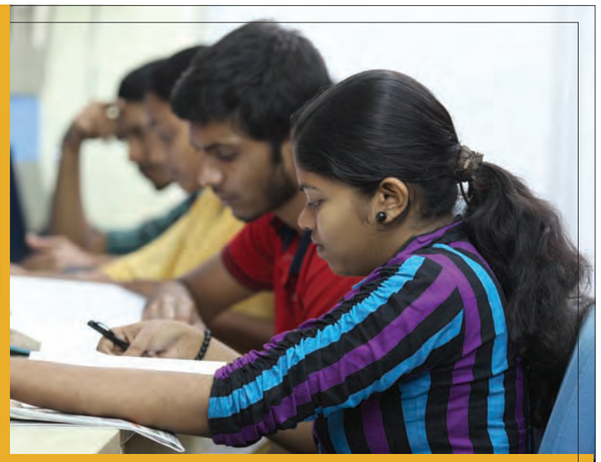
Students admitted in the BS-MS programme in IISER Kolkata are automatically eligible for the INSPIRE fellowship awarded by DST.

Integrated Ph.D Programme

[Current student strength: 62 (Institute), 15 (Physics)]

This is our flagship research programme. Students are admitted through a department level selection procedure





comprising of screening, a written test, followed by a thorough interview. This is a PhD programme in Physics in which outstanding undergraduates (after B.Sc. or B.Tech.) are drafted early, and then go through a rigorous and specialized coursework for two years before they start their research in the frontiers in physics. The programme starts in August.

PhD Programme

[Current student strength: 158 (Institute), 37 (Physics)]

This is our regular Ph.D programme in which bright and motivated Physics graduates are admitted (after M.Sc) through a department level selection procedure comprising of screening followed by a rigorous interview.

ADMISSIONS (for both IPhD and PhD):

The advertisements for IPhD & PhD programmes appear in the Institute website in March-April. The written test and interviews are taken sometime between May-July.

(Web: http://www.iiserkol.ac.in/academics/programmes/)

Students admitted in the IPhD programme in Physics in IISER Kolkata are awared a healthy stipend by the institute in their first two years before they are elevated to the scale of regular PhD students (CSIR-UGC JRF).

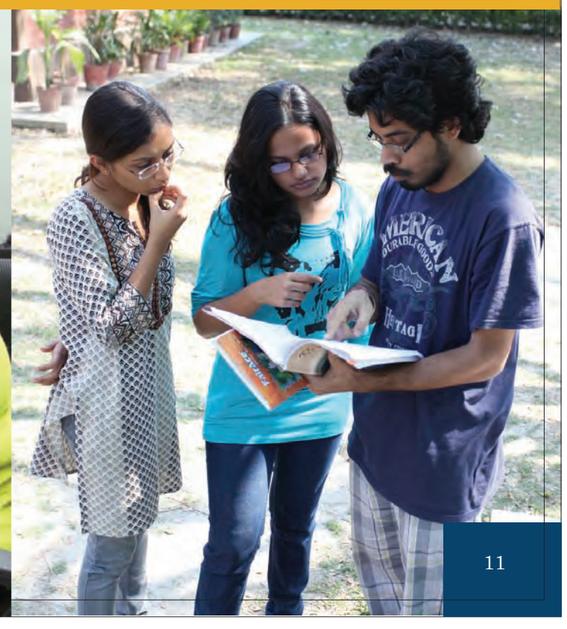
Postdoctoral Programme

A few PhDs with outstanding academic records are hired as postdoctoral fellows in DPS every year. The fellows are expected to collaborate with the DPS faculty on challenging problems in physics and related disciplines.

HIRING: Postdoctoral fellows are hired through DPS advertisements (in the Institute website) anytime during the year. The screened candidates may be invited to present his work in person or through web which will constitute the candidate's interview.

(Web:http://www.iiserkol.ac.in/academics/programmes/)

PhDs hired in the Postdoctoral programme in Physics in IISER Kolkata will receive stipend and benefits commensurate with Government of India regulations.



RESEARCH & FACILITIES

Research Activities

We explore the Universe, literally, from the smallest to the largest scales, not just in terms of length but also in energy and time. We spy on exotic particles whizzing inside colliders. We worry about how a collection of particles behave at extreme temperatures, pressures and magnetic fields. We try to understand the basis of life and evolution, order and chaos. We flirt with black holes and swim in space-time ripples. We care about the fact that the Sun has magnetic fields and worry about the weather in space. Our research portfolio encompasses almost all major areas of physics, areas whose boundaries we try to stretch every day, working with our minds, pen, paper, computers and instruments mixed with a healthy dose of romance for our subject.

Theoretical Physics

Understanding the origin, dynamics, large-scale structure and fate of the Universe requires delving into the fields of gravitation, cosmology and general relativity. Dr. Rajesh Kumble Nayak works on testing theories of gravity and is involved in the hunt for gravitation waves. He also investigates the properties of the Black Holes in non-flat backgrounds. Dr. Narayan Banerjee's current interests are focussed on Dark Energy, which is believed to be the driver of the accelerated expansion of the Universe. While, general relativity is an amazingly successful theory of gravitation, it predicts the existence of singularities in regions of extreme densities where it is thought to become unreliable. It is believed that a suitable reconciliation of general relativity with quantum theory, another tenet of modern physics, is needed to address this issue. Dr. Golam Mortuza Hussain is involved in the quest for a quantum theory of gravity which is expected to supersede general relativity in describing physics near extreme gravitational situations. In particular his research is focussed on loop quantum cosmology (LQC) and loop quantum gravity (LQG).

Closing in on our immediate neighbourhood, the most dynamically active astrophysical object in the solar system is our parent star – the Sun. The energy and particulate output of the Sun varies, primary driven by its magnetic fields. On the one hand, the slow long-term variation of solar output is relevant for planetary climates such as that of the Earth's, especially in the context of global climate change. On the other hand, transient, energetic events such as solar storms create hazardous space weather that impacts Space and Earth-based technologies. Dr. Dibyendu Nandi uses theoretical and computational approaches and data from satellites to explore the origin and impact of the Sun's activity on our Space environment. In particular, he is interested in developing physics-based models for space weather forecasting.

At the smallest lengthscales in nature, we are confronted with fundamental questions regarding its building blocks, i.e., matter and radiation. Particle physics seeks to answer those questions at the theoretical level, and at the experimental level, hunt for exotic particles that are keys to understanding the world. Dr. Amitava Datta and Dr. Ritesh K. Singh are engaged in assessing the prospect of discovering physics beyond the standard model of particle physics at the Large Hadron Collider (LHC). Dr. Datta has used the existing LHC data to constrain new physics models like supersymmetry. Dr. Ritesh Singh is interested in measurement of Charge-Parity (CP) violation and top quark polarization at the LHC. He is also involved in studying the physics potentials of the proposed International Linear Collider.

Condensed matter physics takes the route of emergence in exploring the universe: here, a system is always more than just the sum of its parts. The enormous diversity in our physical world that ranges from the atom to the planet is testimony to the power of emergent phenomena. In keeping with this, the condensed matter theory group at DPS works on areas as diverse as self-assembly of soft matter and high-temperature superconductivity. For instance, Dr. Subhasis Sinha probes the many ways that lead from a superconducting state of Cooper pairs to a Bose-Einstein condensate. Dr. Amit Ghosal, on the other hand, explores how quantum fluctuations can melt a correlated state of electrons (the Wigner molecule) formed in a quantum dot. Dr.Arindam Kundagrami investigates the equilibrium and dynamics of classical systems ranging from liquid crystals to charged polymers in aqueous background. Can one transport electrons from a quantum dot in a sheet of graphene into a superconductor, wonders Dr. Siddhartha Lal? Dr. Prasanta K. Panigrahi studies the dynamics of topological excitations in Bose-Einstein condensates, cold fermions and many body physics.

These studies use knowledge gleaned from the full spectrum of physical sciences and are highly relevant for understanding the world of materials sciences and driving emerging technologies.

The research of the members of the nonlinear dynamics and biophysics group ranges from pure dynamical systems to various problems in biological physics spanning systems from the genome to cells and tissues to complete organisms. Dr. Supratim Sengupta explores what kind of building blocks is necessary for sustaining life? He also seeks to understand how individual human behavioural impulses lead to the emergence of cooperative social dynamics. Dr. Anandamohan Ghosh uses tools of statistical physics and dynamical systems to understand important issues in biophysics such as how cells regulate gene expression in the presence of noise and how a group of neurons respond coherently to some sensory stimuli. Dr. Rumi De investigates how cells and tissues respond to mechanical forces and the dynamics of cells in response to environmental cues. These are some of the interesting questions in the biological context that motivate the biophysics

group. These problems are tackled using tools and methods developed in mathematical physics, statistical physics, elasticity, soft condensed matter theory, evolutionary game theory and bioinformatics.

In the context of dynamical systems, understanding how coupled phase oscillators show peculiar behaviour like quasi-periodicity and chaos is also a focus of this group. In particular, Dr. Soumitro Banerjee analyzes non-linear dynamical systems such as switching electronic circuits and their special behaviours such as bifurcations.

Much of our understanding of the physical world depends on mathematics, on theoretical constructions that perhaps sometimes appear abstract, but which are immensely useful in understanding the vagaries of nature. In keeping with this, Dr. Ananda Dasgupta is interested in Lie-algebraic techniques in the field of quantum optics, especially in squeezed states and matter radiation interaction, and also on fundamentals of quantum and statistical mechanics.

Dr. Prasanta K. Panigrahi works on non-commutative field theory, quantum computation, and applications of wavelet transforms.

Should theorists worry about data, especially large volumes of data? Our answer to that question is an absolute yes! There is an emerging thought amongst scientists that making sense of large volumes of data will drive our scientific breakthroughs in the coming century. Whether this be hunting for gravitational waves, or for exotic particles in colliders, creating algorithms for satellite data-based space weather predictions, looking for trends in global and regional climate, or mining the genomic database – the power of intelligent data analysis and modelling is here to stay. Dr. Rajesh Kumble Nayak, Dr. Dibyendu Nandi and Dr. Prasanta K. Panigrahi are all involved in large volume data analysis. This activity encompasses creation of new statistical and wavelet based data mining tools and development of data modelling techniques with the aim of constraining theories and to glean out mysteries of nature buried in data.

Experimental Physics

Experiments provide the foundation on which the theoreticians build their models. Therefore, the Department aims to establish a set of state-of-the-art experimental facilities which can broadly be classified into two nearly equally populated segments, namely, experimental condensed matter group, the optics and spectroscopy group.

The experimental condensed matter group is primarily interested in studying manifestation of quantum effects in matter under extreme experimental conditions such as low temperatures, high magnetic fields, high pressures, reduced dimensions or combinations of these. The group boasts of one of the finest experimental facilities in the country capable of studying a wide range of materials of current interest like topological insulators, multiferroics, diluted magnetic semiconductors, organic semiconductors, manganites, high-Tc superconductors and semiconductor quantum dots and wells. The magnetism group led by Dr. Chiranjib Mitra aims to understand the fundamentals of quantum magnetism and possible application in quantum computing using sensitive magnetometry and magneto-optical techniques. The spintronics group led by Dr. Partha Mitra focuses on possible mechanisms to generate, detect and manipulate spin polarized currents in semiconductors. The high pressure physics lab led by Dr. Goutam Dev Mukherjee seeks to simulate conditions of various geological processes with the aim of understanding the fundamentals of phase transitions under these conditions. Dr. Satyabrata Raj is an expert on the technique of angle resolved photoemission spectroscopy (ARPES) which is an indispensible tool for determination of electronic structures of materials. The high magnetic field group led by Dr. Bhavtosh Bansal has indigenously developed a pulsed magnet facility that is currently being used to study exotic effects in semiconductors. Dr. Prashanth C. Upadhya specializes in Terahertz spectroscopy, and the use of ultra-fast spectroscopy techniques to probe the physics of lower dimensional structures.

The optics and spectroscopy group is involved in many interesting and intriguing research activities probing the diverse aspects of light itself as well as light matter interactions at different spatial and temporal scales. The Semiconductor Spectroscopy Group led by Dr. Bipul Pal and Dr. Bhavtosh Bansal is interested in understanding the basics of light-matter interaction in novel semiconductor nanostructures using steady-state and femtosecond

time-resolved spectroscopy at low temperatures. The optical micromanipulation lab set up by Dr. Ayan Banerjee uses optical tweezers to confine mesoscopic particles ranging from nano-particles to biological cells and perform diverse experiments to reveal fundamental properties of the particles as well as that of the light used for trapping. Dr. Nirmalya Ghosh has set up a bio-optics and nano-photonics lab (BioNap) where the main emphasis is on understanding the light-matter interaction by exciting localized surface plasmon resonances in metal nano-structures or morphology dependent resonances (whispering gallery modes) of microscopic dielectric structures, as well as using various optical spectroscopic approaches (elastic scattering, fluorescence, Raman) for probing biological and other complex systems. Dr Dhananjay Nandi studies various interesting experiments with generation of supersonic molecular beams to create cold molecules and clusters towards understanding the quantum mechanics of gas phase molecular reactions using indigenously developed novel techniques. Dr Rangeet Bhattacharya's interests are in developing novel experimental techniques in solid and liquid state Nuclear Magnetic Resonance (NMR) with the goal of studying dynamics of liquid molecules and solids, thus exploring phenomena such as the nonlinear effects of excitation schemes on the spin dynamics or the nature of quantum decoherence in various entangled states.

Research Areas

Astrophysics and Space Sciences
Solar and stellar magnetism
Magnetohydrodynamic dynamo theory
Space weather predictions
Space mission support and satellite data analysis

Biophysics and Complex Systems
Evolutionary game theory
Dynamics of social cooperation
Gene expression
Computational neuroscience
Biophotonics
Biopolymers
Bioinformatics
Mechanobiology

Condensed Matter Physics
Semiconductor nanostructures
Physics in high magnetic fields
Nuclear Magnetic Resonance
Giant Magnetoresistance
High temperature superconductivity
Strongly correlated systems
Low-dimensional quantum systems
Quantum computation and information processing
Spintronics
Nanotechnology
Physics at high pressure
Physics at high magnetic fields and low temperatures
Many body physics
Bose-Einstein condensates
Quantum phase transitions
Atomic force microscopy

Data Analysis and Computation
Statistical and wavelet techniques
Algorithm development
Data modelling
Global climate reconstruction and trends
Satellite data analysis
Ground-based observatory data analysis

Gravitation and Cosmology
Physics of Black Holes
Gravitational waves
Quantum gravity
Quantum cosmology
General theory of relativity

Mathematical Physics
Lie-algebraic techniques in quantum optics
Foundations of quantum and statistical mechanics
Group theory
Non-commutative field theory

Non-Linear Dynamics
Dynamical systems
Quasi periodicity and chaos

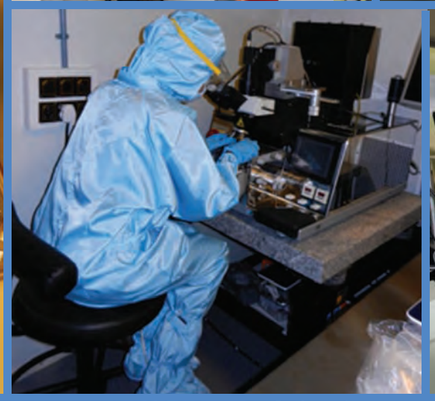
Optics and Spectroscopy
Precision optical spectroscopy
Ultrafast spectroscopy
Photoemission spectroscopy
Nanophotonics

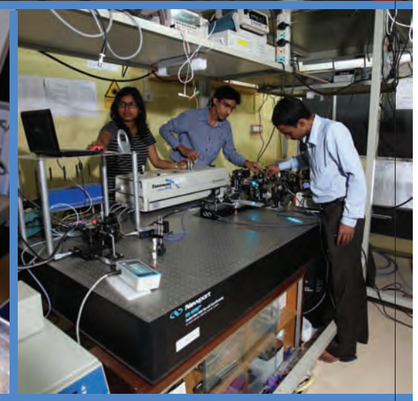
Particle Physics and High Energy Physics
Collider phenomenology
Super-symmetry

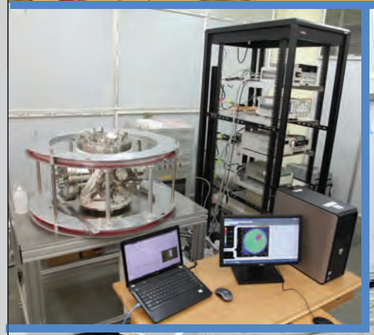
Soft Matter Physics
Physics of liquid crystals, colloids, & polymers
Diffusive systems

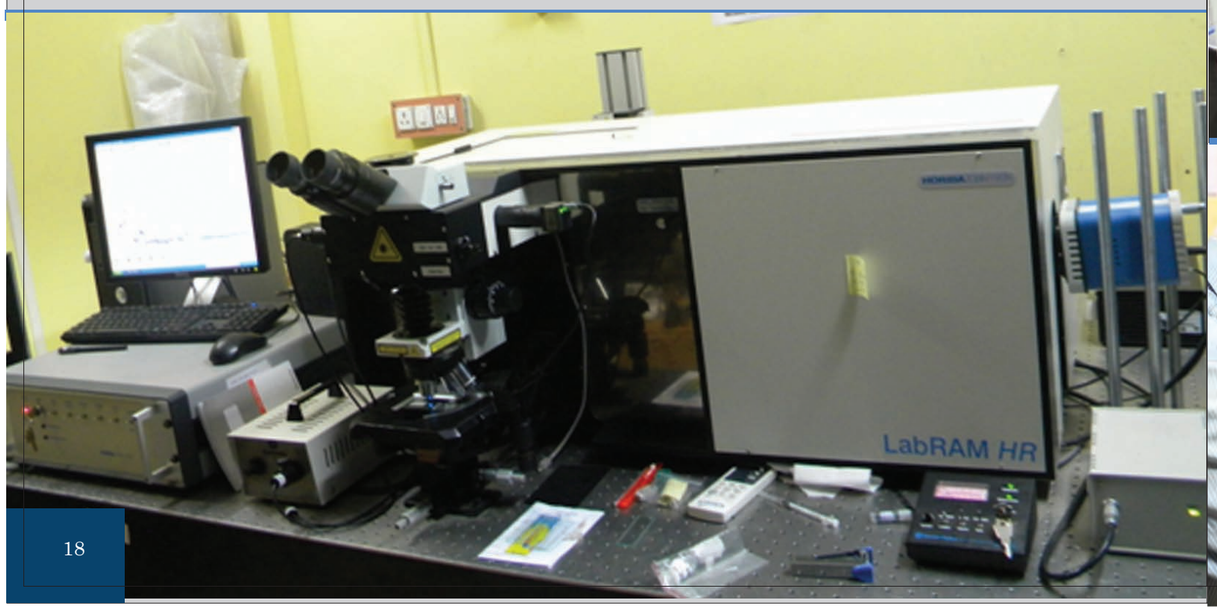
Experimental Facilities

Magnetic Properties Measurement System (MPMS) (Chiranjib Mitra, Partha Mitra)
Cryogen-free Transport Properties Measurement System (Chiranjib Mitra, Partha Mitra)
Magneto Optic Kerr Effect (MOKE) measurement setup (Chiranjib Mitra)
Class-100 clean room (Partha Mitra)
Mask Aligner for photolithography (Partha Mitra)
Spin Process Station (Partha Mitra)
Profilometer (Partha Mitra)
Thin film workstation (Partha Mitra)
Atomic Force Microscope (AFM) (Partha Mitra)
Field Emission Scanning Electron Microscope (FESEM) and e-beam lithography (Partha Mitra)
Pulsed Laser Deposition System (Chiranjib Mitra)
Micro-Raman measurement facility (Goutam Dev Mukherjee)
High Temperature Arc Melting Furnace (Satyabrata Raj)
High field pulsed magnet facility (Bhavtosh Bansal, Pradip Khatua)
Semiconductor spectroscopy facility (Bipul Pal, Bhavtosh Bansal)
Optical micro manipulation Lab (Ayan Banerjee)
Multimodal spectroscopic imaging system (Nirmalya Ghosh)
Tunable wavelength ultrafast laser spectroscopy facility (Prashanth C Upadhya)
Velocity Map Imaging spectrometer (Dhananjay Nandi)
Nuclear Magnetic Resonance (NMR) spectrometer (Rangeet Bhattacharya)
Mechanical Workshop (Satyabrata Raj, Pintu Das (Technician))
i) All geared Bench lathe Machine ii) Heavy Duty Universal Milling Machine iii) Heavy Duty High Precession Pillar Drill Machine iv) Heavy Duty hydraulic Metal Cutting Hacksaw Machine v) Bench Grinding Machine









Computational Facilities in DPS

High performance computation is the part of modern physics research. Members of the physics department are actively taking part in developing state of the art computational facility in the institute. Presently, the department has a few high-end workstations and a couple of small clusters. Smaller clusters are mainly used for developing parallel codes, training students, and to run small simulations. We have a cluster *Meghnad* which is developed by putting together teaching lab desktops. It has nearly 40 nodes and can be used for low memory but high CPU jobs.

In addition to the hardware, softwares such as Mathematica, Matlab, and Labview are available for both research and teaching labs.

GPU based computation is considered as the future of high-performance computing. In addition to standard CPU based workstations, our department is also exploring possibilities for GPU based systems for cost effective high-end computing. Some of the currently available systems are being used for developing efficient codes for running on GPU based systems to explore future GPU based high-end computing.

National Knowledge Network

The National Knowledge Commission under the Government of India has initiated an effort to inter-connect all institutions of higher learning in the country. As a part of this effort, IISER Kolkata has been connected to National Knowledge Network (NKN) through optical fibre link since July 2011. This connectivity has become the core internet link of IISER Kolkata to the world at large. The provisioned bandwidth of this link is 100 Mbps at present.

Virtual Classroom at IISER Kolkata: As an application to use the high-speed connection provided through National Knowledge Network, a Virtual Classroom has been set up at IISER Kolkata. This Virtual Classroom facility is meant to bridge the physical distance between teachers and students who are at different physical locations. For example, students at IISER Kolkata can attend a class that is being held at IISER Pune and ask live questions (picture below) to the teacher there and vice-versa. The Virtual Classroom facility, which is capable of transmitting and receiving interactive high-definition video classes across the globe through internet, was inaugurated on 16th February 2012 at IISER Kolkata by Prof. R. N. Mukherjee, the Director of the institute.

Library

The IISER Kolkata Library is fast moving towards becoming an important science library in the country. Started in 2006 as one of its first centres, it has become an important information resource centre for the whole institute. The rich and valuable collection built through these years has many important reference materials as well as archival volumes of several important journals. Apart from its print collection, the Library also subscribes to thousands of e-journals, e-books, and several databases. The focus of the Library is to act as the backbone of the information support system of the whole Institute.

Presently, the Library has a collection of around 16,000 print documents, more than 12,000 e-books. It subscribes around 2,300 online and few print journals. The Library has a sizable collection of audio-visual materials to support the teaching and research activities of the Institute. It also has an important collection on Indian heritage in Science, Technology, Arts and Literature. One of the remarkable aspects of our print collection is the books from several renowned series published by some of the best publishers around the world. Apart from the current subscription of journals from eminent publishers like American Chemical Society (ACS), American Mathematical Society (AMS), American Physical Society (APS), Cambridge University Press (CUP), Elsevier, Nature Publishing Group (NPG), Oxford University Press (OUP), Royal Society of Chemistry (RSC), Springer, Taylor and Francis, Wiley, World Scientific etc., the Library had already purchased several important journal archives from many of these publishers on Biological Sciences, Chemical Sciences, Earth Sciences, Mathematical Sciences and Physical Sciences. As a core member of INDEST Consortium, the Library has played a very active role in obtaining several important online resources from it as well. Apart from subscribing to various full-text databases like Annual Reviews, OpticsInfobase, JSTOR, IEEE Electronic Library, ACM Digital Library, the Library also subscribes to several important bibliographic databases like Faculty of 1000, MathSciNet, Project Muse, SciFinder, SCOPUS etc. Recently it has also started to subscribe to the Web of Science database.

To help its users to search and locate the documents, the Library has procured the Virtual Library Management System from VTLS, Inc. USA. The online Public Access Catalogue (OPAC) is available on the Internet <http://lib.iiserkol.ac.in:8000/cgi-bin/gw/chameleon/>. Anyone can search, locate, and identify print documents available using this OPAC. In addition, bona fide users of IISER Kolkata can place reservation and renew books online using this portal. Wi-Fi facility is available inside the Library. The Library also extends the VPN facility to faculty level users to access its subscribed online resources from anywhere. Interested users from other academic Institutions are welcome to use it as a reference library.

Library Hours:
IISER-K Library, Mohanpur Campus
Weekdays: 9.00 to 23.00 hrs.
Saturdays and Sundays: 10.00 to 23.00 hrs.
IISER-K Library, Main Campus
Weekdays: 9:00 to 17:00 hrs.

TEACHING

"Quand tu veux construire un bateau, ne commence pas par rassembler du bois, couper des planches et distribuer du travail, mais reveille au sein des hommes le desir de la mer grande et large.

If you want to build a ship, don't drum up people together to collect wood and don't assign them tasks and work, but rather teach them to long for the endless immensity of the sea."

—Antoine de Saint-Exupéry

In the physics department of IISER Kolkata, we have undertaken the task of teaching our students to long for the immensity of our sea – the vast and wonderful realm of science in general and physics in particular. In addition our aim is to ensure that, when our students graduate, they have in their arsenal the theoretical and experimental tools that will enable them to become successful researchers as well as teachers in their own right. It is also our endeavour to expose our students to the best of current research, in physics as well as related interdisciplinary fields.

Teaching Programme

The IISER system evolved out of a concerted attempt at improving the state of higher education in India. It had been felt for a long time that despite the presence of extremely talented students and faculty, the higher education and research sectors of our country were languishing behind other developed and emerging nations. One reason behind this was felt to be the disconnect between textbook studies and active research, with the traditional universities primarily catering to the former and specialized research institutions focussing on the latter. The need of the hour, it was realized, is to create new institutions that will treat teaching and research on the same footing – and will expose the students to the world of research as an integral part of their study right from the very beginning. So the IISERs were born.

The BS-MS programme

IISER Kolkata began its journey in the August of 2006 with thirty-eight students in its flagship teaching program. This is what is today called the five year integrated BS-MS dual degree program. Since then, we have had two batches of students who have passed out with one more batch almost ready to venture out into the world.

One prevalent trait in current educational methods which is proving counterproductive in today's research scenario is the compartmentalization of science into rigid boundaries of separate disciplines. It is a guiding principle in the IISERs that these boundaries should be dispensed with to the extent possible. At the same time, a balance has to be drawn between too wide a curriculum that will teach a little bit of everything and a restricted curriculum which will allow the students to master some essential topics. With these aims in mind, students study all of the major science streams (Biology, Chemistry, Earth Sciences, Mathematics and Physics) in the first year of the BS-MS course, all at the same level. In addition to the regular theoretical and experimental courses in these major subjects the students are also exposed to a year long course on the applications of computer methods in science. In the second year, the student is expected to choose three of these subjects as pre-majors, and from these he must choose his major subject in the third year. Even after he has chosen a major, a student is required to take minor courses from other subjects in which he has the necessary pre-requisites. In the fourth year and above, the student can take a few inter-disciplinary courses that will broaden his scientific base over and above the core and elective courses from her chosen discipline. Our experience so far has been that this exposure to other subjects has been really beneficial to the growth of a student, both as a scientist and as a person. Moreover, exposure to computer usage and advanced mathematics proves highly helpful for the students in the course of their studies in physics.

Physics is above all an experimental subject. Keeping this in mind, we at IISER Kolkata have developed a mixture of traditional and innovative experiments whose aim is to both impart essential laboratory skills and challenge the students' intellectual curiosity. In advanced classes students get an opportunity to work directly in research labs where they get a feel for real life research.

In the final year of the course a student has to carry out a year long project which is the perfect launching pad for a future research career. Indeed, a student can get exposed to real life research even earlier by choosing to do projects either within IISER Kolkata or elsewhere during the summer break. Here in the physics department we have had several students who had published their work in reputed journals even before completing their coursework. The students also have the option of joining a fast-track research program from their fifth year itself – which will lead to a comparatively early PhD.

We in the physics department take great pride in the fact that our outgoing students have fared very well in the national scale. From our very first batch one student won the coveted Rhodes Fellowship - and what's more, he was the only one from the sciences to win it that year

from India. On the national front, several of our students have qualified in the NET examination. In addition, two of our students have won the prestigious “Shyamaprasad Mukherjee fellowship”. Our students have, by and large, continued to do research in physics both within India and abroad.

The Integrated PhD programme

PhD students are the backbone of research in an institution. In the last twenty years renowned science departments in India have seen unprecedented success in the post-bachelors Integrated PhD programme which produced world-class PhD graduates, a majority of whom are now, in the capacity of faculty, part of the so-called “second wave of science” in IISERs, NISER, and other institutes in India. Keeping in line with this success story, IISER Kolkata has initiated the Integrated PhD (IPhD) programme in the year 2009 for students completing their bachelors in science and engineering. The aim of this endeavour is to attract outstanding and innovative undergraduates to research in basic sciences, and to motivate them to begin cutting-edge research at an early stage of their higher studies.

In the Physics department, we consider our IPhD program as our flagship research program, and we have devised a specialized course work that will best prepare the students to pursue doctoral research in our department. Maintaining the fundamental spirit of an interdisciplinary approach of IISERs, the IPhD students in physics are given more freedom in their choice of courses. Despite giving options for a reasonable exposure to different aspects of basic sciences, the IPhD program emphasizes early focus on major topics in physics. In their 1st year, the IPhD students take, along with 3rd year MS students, 5 core courses each semester. For the additional two electives each semester, however, they are allowed to take physics courses at various levels based on their diverse background. In the 2nd year too, there are specialized courses carefully designed to IPhD students who would begin their research work simultaneously. At this level itself, they start their curriculum project consisting of challenging (and possibly long-term) problems which, in most likelihood, would from the basis of their doctoral work. A departmental advisory committee actively counsels the students to choose elective courses, and encourages them to interact with faculty members to gain a broad perspective on research in different areas in physics. Although IPhD students get to take less number of electives than MS students in their first two years, they are allowed to exchange a few credits between the project and the elective courses. In addition, they can always make it up in their later years of stay as the doctoral student, preferably choosing electives suitable to their ongoing research interest and beyond. During the later part of the IPhD course work a comprehensive test ensures the student's worthiness to continue the doctoral work.

The research project, in conjunction with the specially designed courses suitable for a doctoral programme, brings the IPhD students quickly but steadily to a level where they can be confident of carrying out research on their own. Direct and dedicated contact to a competitive research environment is the key in preparing them for the world of research and eventually launching them towards a world-class doctoral work. Therefore, it is expected that IPhD students would complete their PhD earlier than conventional PhD students. However, we strongly feel that the quality of a PhD is more important than its duration. The rigorous course work we have in place for IPhD students assures a very conducive environment for the students to pursue a well-rounded doctoral degree of high quality. The IPhD program in DPS is in its nascent stage, but gaining momentum in leaps and bounds, and we are confident it will soon deliver excellent results similar to other renowned physics departments in India.

The Institute invites applications for IPhD programme in the fields of Biological, Chemical, Mathematical, Physical and Earth Sciences. In Physics we invite applications from students who have completed a Bachelors degree in physics or engineering from any recognised university. The deserving candidates are selected from the pool of applicants first by a screening based on their academic background, then a rigorous aptitude test, and finally a thorough interview. The selection is in place once a year (advertised tentatively in March). The selected candidates are offered a healthy monthly stipend commensurate with their academic level. Once the students become JRF, their stipend and benefits are raised to the CSIR-NET level.

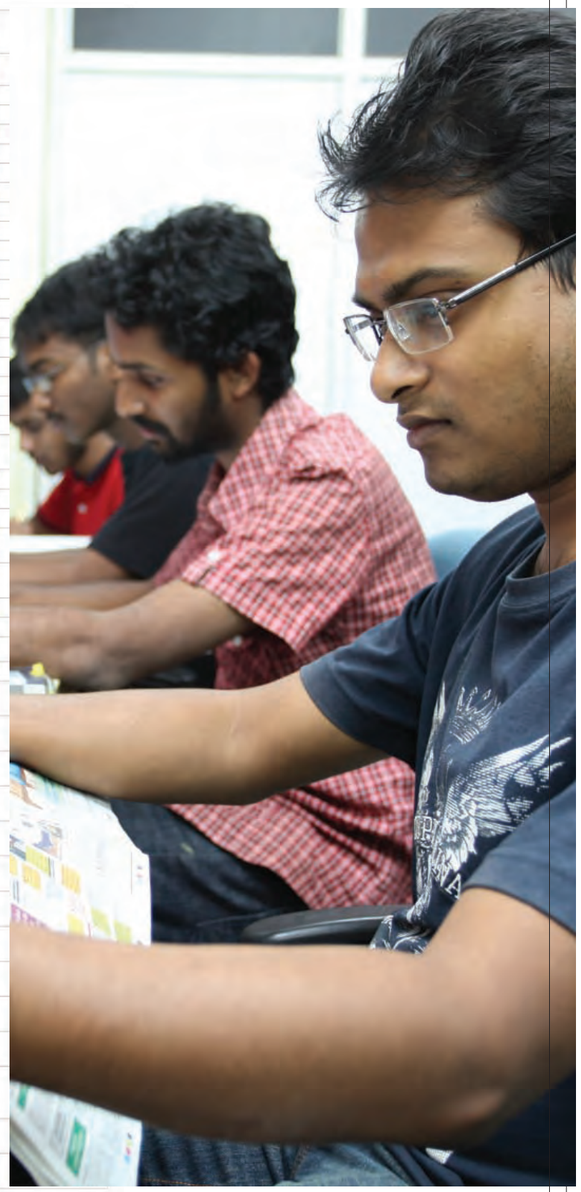
The PhD Programme

The traditional regular PhD programme, like many other leading institutes in India, is also a stronghold in our department to admit and train brilliant graduates (after their Masters) to pursue doctoral research. As we have emphasised before, the IISERs are institutes where research and teaching happen with equal emphasis and passion. This is highlighted by our thriving PhD program where we aim to equal the best in the world. Although the regular PhD students go through a mandatory course work relatively shorter than IPhDs, the syllabus still provides rigour and ample opportunity to a willing student to best prepare for top-flight research. The PhD students have a full one year course work comprising of four courses from levels 3 to 5. The department counsels the students, much in the same way as the IPhDs, in their course choices to help them reap the maximum synergistic benefit from their research and course work.

We admit PhD students twice a year through a process of screening, based on their academic background, followed by a rigorous interview. Exceptional students can be drafted out of turn through a rolling selection process (screening and interview).

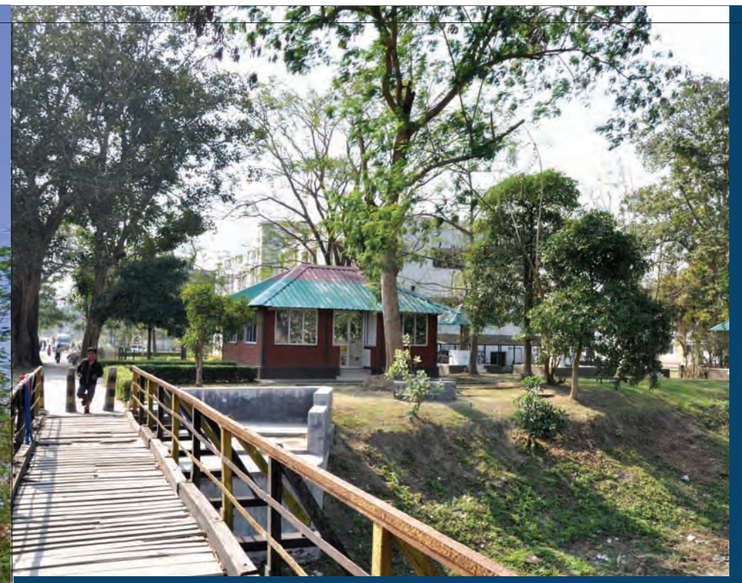
Proposed Course Structure for BS-MS/IPhD/RS programmes in Physics

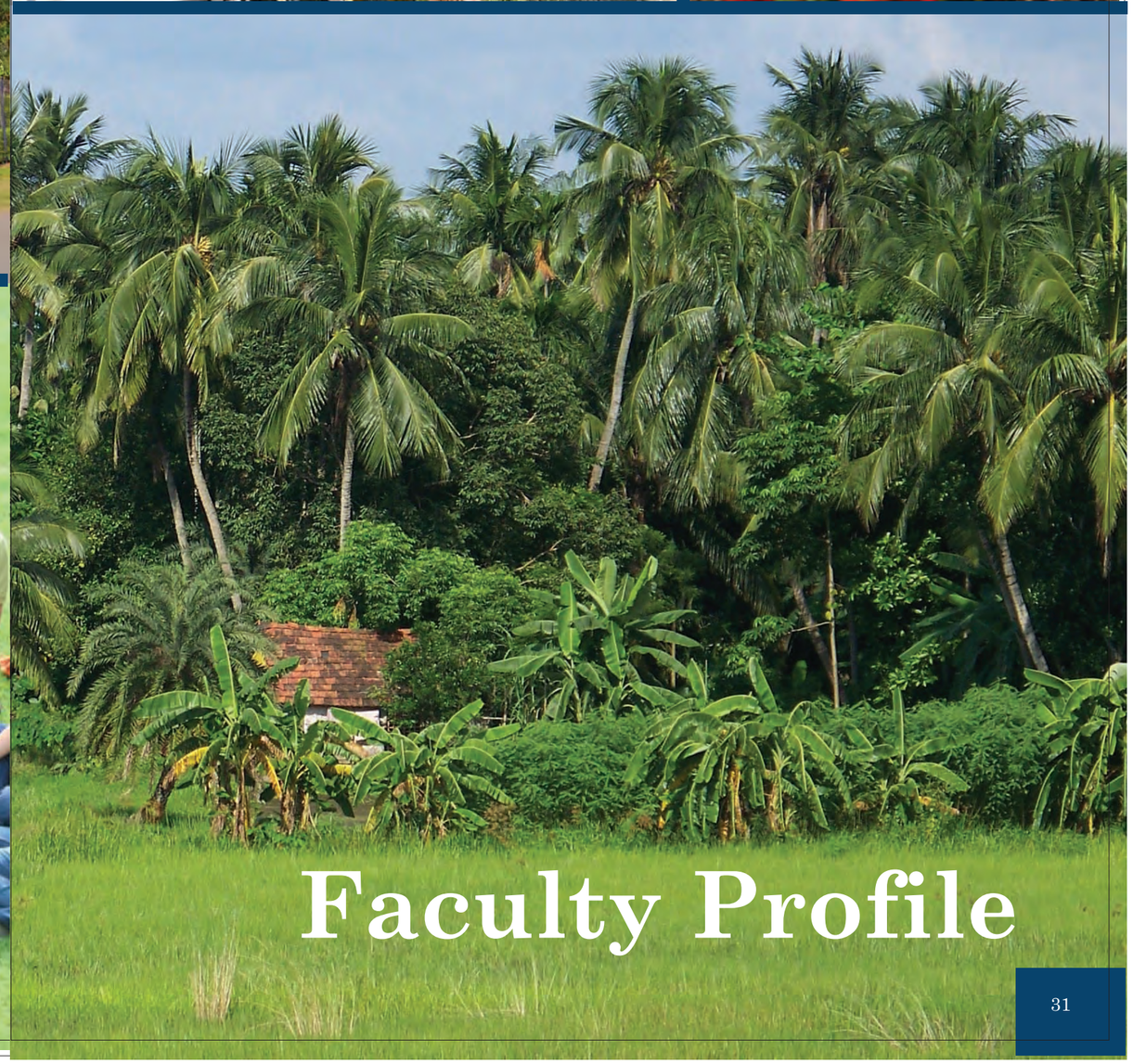
	Autumn Semester		Spring Semester	
Level 1	PH1101	Physics 1 [Mechanics, Optics, Quantum Mechanics] (3)	PH1201	Physics 2 [Thermal Physics, Electricity & Magnetism, STR] (3)
	PH1102	**Physics Lab 1 [Mechanics,Heat] (3)**	PH1202	**Physics Lab 2 [Electricity & Magnetism, Properties of Matter] (3)**
Level 2	PH2101	Physics 3 [Waves, Optics, Electricity & Magnetism] (3)	PH2201	Physics 4 [Mechanics, Quantum Mechanics, Particle Physics] (3)
	PH2102	Electricity and Electronics (2)	PH2202	Thermal Physics (2)
	PH2103	**Physics Lab 3 [Modern Physics, Electrical] (3)**	PH2203	**Physics Lab 4 [Electronics, Optics] (3)**
Level 3 (IPhD 1)	PH3101	Intermediate Classical Mechanics (3)	PH3201	Basic Statistical Mechanics (3)
	PH3102	Intermediate Quantum Mechanics (3)	PH3202	Intermediate Electricity and Magnetism (3)
	PH3103	Mathematical Methods of Physics (3)	PH3203	Advanced Quantum Mechanics (3)
	PH3104	**Electronics Lab (3)**	PH3204	**Advanced Optics Lab (3)**
	PH3105	**Computational physics (3)**	PH3205	**Basic Nuclear Physics - Theory & Lab (3)**
		Minor (BS-MS) / Minor or Elective from below or Levels 1,2 (IPhD) (3)		Minor (BS-MS) / Minor or Elective from below or Levels 1,2 (IPhD) (3)
		Minor (BS-MS) / Minor or Elective from below or Levels 1,2 (IPhD) (3)		Minor (BS-MS) / Minor or Elective from below or Levels 1,2 (IPhD) (3)
Level 4 (IPhD 2)	PH4101	Basic Condensed Matter Physics (3)	PH4201	**Introduction to Experimental Research (3)**
	PH4102	Basics of Field Theory and Relativistic QM (3)	PH4202	Seminar Course (3)
	PH4103	Introductory Astrophysics (3)	Elective1	Choose from below (both BS-MS and IPhD) (3)
	PH4104	**Condensed Matter Laboratory (3)**	Elective2	Only for BS-MS, choose from below (3)
	Elective1	Only for BS-MS, choose from below (3)	Elective3	Only for BS-MS, choose from below (3)
	Elective2	Only for BS-MS, choose from below (3)	Elective4	Only for BS-MS, choose from below (3)
			PH4203/ PH5203	Advanced Statistical Mechanics (IPhD Compulsory) (3)
		IP Project (9 credits)		IP Project (9 credits)
				Comprehensive Examination for IPhD
Level 5 (IPhD 3/ RS 1)	PH5101	BS-MS Project (9)	PH5201	BS-MS Project (12)
	Elective1	Choose from below (BS-MS/IPhD only)/Choose from below and Levels 3,4 (RS only) (3)	Elective 1	Choose from below (BS-MS/IPhD only)/Choose from below and Levels 3,4 (RS only) (3)
	Elective2	Choose from below (BS-MS only)/Choose from below and Levels 3,4 (RS only) (3)	Elective 2	Choose from below and Levels 3,4 (RS only) (3)
	PH5102	Faculty rotation (RS only - Autumn entry) (3)	PH5202	Faculty Rotation (RS only - Spring entry) (3)
		Comprehensive Examination for RS - Spring entry.		Comprehensive Examination for RS - Autumn entry
		Autumn (Aug-Nov) Electives		**Spring (Jan-Apr) Electives**
Electives	PH3106	Reading Project (3) (IPhD 1st year only)	PH3206	Reading Project (3) (IPhD 1st year only)
	ID4105/ ID5105	Evolutionary Dynamics (3)	PH4203/ PH5203	Advanced Statistical Mechanics (IPhD Compulsory/ BS-MS, RS elective) (3)
	PH4106/ PH5106	**Workshop and Vacuum Techniques (3)**	ID4204/ ID5204	Nonlinear Dynamics (3)
	PH4107/ PH5107	Non-equilibrium Statistical Mechanics & Diffusion (3) (Prereq: Basic Statistical Mechanics)	ID4205/ ID5205	Continuum Mechanics (3)
	PH4108/ PH5108	Advanced Condensed Matter Physics (3) (Prereq: Advanced Statistical Mechanics)	PH4206/ PH5206	General Theory of Relativity & Cosmology (3) (Prereq: Advisory committee guidance)
	PH4109/ PH5109	Quantum Field Theory (3) (Prereq: Basics of Field Theory and Relativistic Quantum Mechanics)	PH4207/ PH5207	High Energy Physics (3) (Prereq: Basics of Field Theory and Relativistic Quantum Mechanics)
	PH4110/ PH5110	**Advanced Physics Laboratory-I (3)**	ID4208/ ID5208	Biological Physics (3)
	PH4111/ PH5111	Advanced Mathematical Methods (3) (Prereq: Mathematical Methods of Physics)	PH4209/ PH5209	**Simulation Techniques and Data Analysis in Physics (3) (Prereq: Computational Physics)**
	PH4112/ PH5112	Quantum Optics & Computation (3) (Prereq: Advanced Quantum Mechanics)	PH4210/ PH5210	**Advanced Physics Laboratory-II (3)**
	PH4113/ PH5113	Quantum Magnetism (3) (Prereq: Advanced Quantum Mechanics)	PH4211/ PH5211	Nuclear Magnetic Resonance (3) (Prereq: Intermediate Quantum Mechanics and Basics of Condensed Matter Physics)
	PH4114/ PH5114	Advanced Electricity, Magnetism, and Optics (3) (Prereq: Intermediate Electricity & Magnetism)	PH4212/ PH5212	Advanced Soft Condensed Matter Physics (3) (Prereq: Advanced Statistical Mechanics)
	PH4115/ PH5115	Advanced Atomic & Molecular Physics (3) (Prereq: Advanced Quantum Mechanics)	PH4213/ PH5213	Advanced Astrophysics (3) (Prereq: Introductory Astrophysics)
	PH4116/ PH5116	Quantum Gravity and String Theory (3) (Prereq: General Theory of Relativity AND Basics of Field Theory and Relativistic Quantum Mechanics)	PH4214/ PH5214	Field Theories in Condensed Matter Physics (previously Many Body Theory) (3) (Prereq: Basic Condensed Matter Physics)
	PH4117/ PH5117	Quantum Transport (NKN course) (3)	PH4215/ PH5215	Fluid Dynamics (NKN course) (3)
	PH5120	Independent Study (3) (Every year) (RS/IPhD 3rd yr+ only)	PH5220	Independent Study (3) (Every year) (RS/BS-MS 10th sem/IPhD 3rd yr+ only)



Explanation of the course structure:

This is the proposed consolidated course structure for all three programs (BS-MS, IPhD, &PhD) in the Department of Physical Sciences, IISER Kolkata. The structure in this form is expected to be in effect from August, 2013. Levels 1 to 5 correspond to the years 1 to 5 for the BS-MS course work. BS-MS students study all 5 disciplines in level 1, and 3 pre-major disciplines in level 2 (of which only the physics courses are listed here) before continuing as physics majors in level 3 onwards. 1st year IPhD students start their course work concurrently with 3rd year physics major students (BS-MS) at level 3. However, for the optional 4 courses in level 3, the IPhD students may opt, in addition to minors, for physics courses at *any* level. For both BS-MS and IPhd projects, some credits can be commuted to take regular courses at the discretion of the department. The research scholars (RS) are regular PhD students who take courses with 3rd year IPhD or 5th year MS students. However, in consultation with the advisors, they are allowed to choose courses from level 3 as well. Most electives are suitable for both levels 4 & 5. Some of them, however, require prerequisites, and are offered at only level 5. Almost all courses are of three credits, requiring, for example, three lecture hours per week. The experimental courses are depicted in bold. All the elective courses are listed separately (in dark green). Only a few of them are offered on a regular basis, and we may switch allotted semesters for one to make it suitable for a certain batch of students. The BS-MS and IPhD students are admitted only in autumn, whereas the research scholars (RS) are admitted both in autumn and spring.





Faculty Profile

Ayan Banerjee
Assistant Professor
ayan@iiserkol.ac.in

Experimental studies of mesoscopic systems in optical tweezers and optical micromanipulation of matter

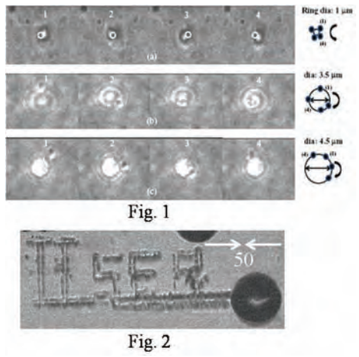


Fig. 1

Fig. 2

Fig. 1. Controlled transport of a soft oxo metalate (SOM) peapod due to enhanced SOI in optical tweezers.
Fig. 2. Pattern formation by controlled nucleation of a SOM in optical tweezers. Dimensions in μm.

Optical tweezers facilitate controlled experiments with mesoscopic matter ranging from nanoparticles to biological cells – the species being confined using light in a well-characterized fluid environment. Ayan's group has a working optical tweezers system in their lab to study diverse problems in a truly interdisciplinary mode of research. On the physics front, the group is probing the spin-orbit interaction (SOI) in tightly focused light that is used to trap particles in optical tweezers, and the manifestation of SOI in mesoscopic systems (Fig. 1). Other than this, studies are also underway on Brownian motion of trapped particles and interaction of different trapped soft matter species with light. The group has collaborations with Chemistry and Biology departments of IISER-K, and has interesting results in controlled photo-nucleation in optical tweezers using which they have written permanent patterns on glass substrates (Fig. 2). Studies are also underway on elasticity properties of biological cells in normal and stressed conditions so as to develop novel diagnostic techniques at the single cell level.

Selected Publications:

Self-assembly of microparticles in stable ring structures in an optical trap, Haldar, A., Pal, S. B., Roy, B., Dutta Gupta, S., and Banerjee, A., 2012, Physical Review A, 85, 033832

Measurement of probe displacement to the thermal resolution limit in photonic force microscopy using a miniature quadrant photodetector, Pal, S. B., Haldar, A., Roy, B., and Banerjee, A., 2012, Review of Scientific Instruments, 83, 023108

Probing the dynamics of an optically trapped particle by phase sensitive back focal plane interferometry, Roy, B., Pal, S. B., Haldar, A., Gupta, R. K., Ghosh, N., and Banerjee, A., 2012, Optics Express, 20, 8317

Saturated-absorption spectroscopy: eliminating crossover resonances by use of copropagating beams, Banerjee, A. and Natarajan, V., 2003, Optics Letters, 28, 1912

Precise frequency measurements of atomic transitions by use of a Rb-stabilized resonator, Banerjee, A., Das, D., and Natarajan, V., 2003, Optics Letters, 28, 1579

PhD Students:

Basudev Roy, Sudipta Bera

Ayan Banerjee obtained his PhD in Physics from the Indian Institute of Science in 2005. Subsequently he was a Research Scientist at General Electric Global Research, Bengaluru. He won the 'Innovation Award' in GE in the years 2007 and 2008. Ayan joined IISER-K in 2009 as Assistant Professor in Physics.

Narayan Banerjee
Professor
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General Relativity and Cosmology

Recent observations tell us that the Universe at present is undergoing an accelerated expansion. This is counterintuitive as the dynamics of the Universe is governed by gravity, which is always attractive. In general relativity the pressure of the matter distribution also plays a role in the gravitational interaction. There is therefore a search for some matter, dubbed as Dark Energy, which yields an effective negative pressure sufficient to give rise to a repulsive gravity. Narayan Banerjee at present is involved in this search for a suitable Dark Energy.

Narayan is also interested in gravitational collapse to check whether the end of a star is in a black hole or in a naked singularity. Recently he is also working on quantizing cosmological models.

Selected Publications:

Brans-Dicke scalar field as a chameleon, Das, S., Banerjee, N., 2008, Phys. Rev. D, 78, 043512

Generalized scalar tensor theory and the cosmic acceleration, Banerjee, N., Ganguly, K., 2009, Int. J. Mod. Phys. D, 18, 445

Collapse of non-spherically symmetric scalar field distribution, Ganguly, K., Banerjee, N., 2011, Gen. Relativ. Gravit., 43, 21

Perfect Fluid Quantum Anisotropic Universe: Merits and Challenges, Majumder, B., Banerjee, N., 2013, Gen. Relativ. Gravit., 45, 1

Modified Ricci flow and asymptotically non-flat spaces, Chatterjee, S., Banerjee, N., 2013, Canadian Journal of Physics (in press)

PhD Students:

Anjan Ananda Sen, Somasri Sen, Sudipta Das, Supratik Pal, Koyel Ganguly, Manjari Bagchi, Barun Majumder, Nandan Ray, Ankan Mukherjee, Soumya Chakraborty

Narayan Banerjee obtained his Ph.D. from Jadavpur University in 1986. Subsequently he taught at Sripat Singh College in Murshidabad. He Joined Jadavpur University in 1991 and moved to IISER Kolkata in 2008.

Soumitro Banerjee
Professor
soumitro@iiserkol.ac.in

Bifurcation theory for non-smooth systems

In many dynamical systems it has been found that a small variation in a parameter may result in a *qualitative change* in the steady state behaviour. Such events are called bifurcations --- which have been the subject of investigation of Dr. Banerjee. He has mainly concentrated on "hybrid dynamical systems" like switching electronic circuits and mechanical systems with impacts or stick-slip motion, which involve continuous-time evolution as well as discrete switching action between two or more different types of dynamical behaviour. Dr. Banerjee's pioneering contribution has been in demonstrating that such systems undergo a special kind of qualitative change, known as "border collision bifurcation." He has been instrumental in developing the mathematical theory of border-collision bifurcations, which has been widely used in various application areas to understand why certain abrupt and drastic changes occur in the dynamical state of a system. He has also been in the forefront of the investigations on the nonlinear phenomena in power electronics.

Selected Publications:

Robust Chaos, Banerjee, S., Yorke, J. A., and Grebogi, C., 1998, Physical Review Letters, 80, 3049

Border Collision Bifurcations in Two-Dimensional Piecewise Smooth Maps, Banerjee, S., Grebogi, C., 1999, Physical Review E, 59, 4052

Invisible Grazings and Dangerous Bifurcations in Impacting Systems: the Problem of Narrow-band Chaos, Banerjee, S., Ing, J., Pavlovskaia, E., Wiercigroch, M., Reddy, R. K., 2009, Physical Review E, 79, 037201

Books: "Nonlinear Phenomena in Power Electronics" (Ed: Banerjee and Verghese, IEEE Press, 2001), "Dynamics for Engineers" (Wiley, London, 2005), and "Wind Electrical Systems" (Oxford University Press, New Delhi, 2005)

Dr. Soumitro Banerjee did his B.E. from the Bengal Engineering College in 1981. Further, he did his M.Tech. in 1983, and Ph.D in 1987 from IIT Delhi. He was in the faculty of the IIT, Kharagpur, since 1986, and has moved to the IISER Kolkata, in 2009. He is a recipient of the S. S. Bhatnagar Prize (2003), and is recognized as a "Highly Cited Author" by Thomson Reuters. He is a Fellow of the Indian Academy of Sciences, the Indian National Academy of Engineering, the Indian National Science Academy, and the Third World Academy of Sciences.
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Bhavtosh Bansal
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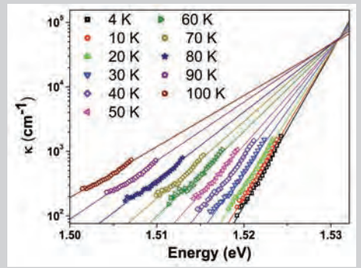
Physics of excitons: Understanding light emission from semiconductors

While semiconductor-based light emitting devices are already ubiquitous, many specific aspects of the physics of light-matter interaction are ill-understood. This is especially true in novel materials where disorder is significant, the role of the band structure in the optical properties is not well understood, or if one wants to understand the dynamics on the (sub-) picosecond time scales. A deeper understanding of these issues is important for gauging the viability of different ideas and materials for next generation optoelectronic devices, and fun because semiconductors often manifest as clean examples of text-book quantum mechanics at play.



Urbach tail in GaAs quantum well seen in their optical absorption spectrum. Understanding the origin of these, universally observed exponential slopes of the absorption edge below the fundamental gap which meet at a focus, is a 60-year old problem that the Semiconductor Spectroscopy group has tried to address.

Bhavtosh is an experimentalist interested in spectroscopic investigations of semiconductor nanostructures (quantum wells and quantum dots) and mismatched semiconductor alloys. The primary technique he uses is low-temperature photoluminescence, in steady state and in the form of picosecond excitation-correlation spectroscopy. The development of a pulsed magnet set up for studying optics of semiconductor nanostructures in high magnetic fields is another current activity of his group.

Selected Publications:

On Conversion of Luminescence into Absorption and the van Roosbroeck-Shockley Relation, Bhattacharya, R., Pal, B., Bansal, B., 2012, Applied Physics Letters, 100, 222103

High-field Magneto-photoluminescence of Semiconductor Nanostructures (Review), Hayne, M., Bansal, B., 2012, Luminescence, 27, 179

Charge Separation and Temperature-Induced Carrier Migration in $Ga_{1-x}In_xN_yAs_{1-y}$ Multiple Quantum Wells, Nuytten, T., Hayne, M., Bansal, B., Liu, H.Y., Hopkinson, M., Moshchalkov, V.V., 2011, Physical Review B, 84, 045302

Extended excitons and compact heliumlike biexcitons in type-II quantum dots, Bansal, B., Godefroo, S., Hayne, M., Medeiros-Ribeiro, G., Moshchalkov, V.V., 2009, Physical Review B, 80, 205317

Excitonic Mott transition in type-II quantum dots, Bansal, B., Hayne, M., Geller, M., Bimberg, D., Moshchalkov, V.V., 2008, Physical Review B, 77, 241304

PhD Students:

Sumi Bhuyan, Arka Roy

Bhavtosh Bansal did his PhD in Physics from the Indian Institute of Science, Bangalore, India in 2005. Before moving to IISER Kolkata in 2010, he was a postdoctoral fellow at Tata Institute of Fundamental Research, Mumbai, India, Catholic University Leuven, Belgium, and High Field Magnet Laboratory, Nijmegen, the Netherlands.

Rangeet Bhattacharyya

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Methodological development in Nuclear Magnetic Resonance and Quantum Information Processing

Our main interest is in developing novel experimental techniques in solid and liquid state NMR with primary interest lying in studying dynamics of liquid molecules and solids. Solid state NMR often shows signatures of non-linearity (departure from linear response theory), which, if taken into consideration, can provide wealth of information about the system under study. At the moment we are investigating the non-linear effects both from theoretical and experimental stand points. We also investigate the nature of decoherence and quantum evolution using coupled spin systems as model qubit network.

Selected Publications:

Diversity of carboxylate binding in a new tetranuclear zinc cluster: correlation between spectroscopic investigations and carboxylate binding modes, Patra, A., Sen T. K., Bhattacharyya , R., Mandal, S. K., and Bera, M., 2012, RSC Adv., 2, 1774

In situ NMR observation of the formation of metallic lithium microstructures in lithium batteries, Bhattacharyya, R., Key, B., Chen, H., Best, A. S., Hollenkamp, A. F., Grey, C. P., 2010, Nature Materials, 9, 504

Real-time NMR investigations of structural changes in silicon electrodes for lithium-ion batteries, Key, B., Bhattacharyya, R., Morcrette, M., Seznéc, V., Tarascon, J. M., Grey, C. P., 2009, Journal of the American Chemical Society, 131, 9239

Quadrupolar nuclear magnetic resonance spectroscopy in solids using frequency-swept echoing pulses, Bhattacharyya, R., Frydman, L., 2007, Journal of Chemical Physics, 127, 194503

Implementation of parallel search algorithms using spatial encoding by nuclear magnetic resonance, Bhattacharyya, R., Das, R., Ramanathan, K. V., Kumar, A., 2005, Physical Review A, 71, 052313

PhD Students:

Ipsita Chakraborty, Arnab Chakrabarti

Rangeet Bhattacharyya obtained his PhD in Physics from the Indian Institute of Science in 2005. Subsequently he was a postdoctoral fellow at Weizmann Institute of Science (Israel), Stony Brook University (USA) and at Southampton University (UK). Rangeet joined IISER Kolkata in 2010 and is serving as an Assistant Professor. He has received University Gold Medal from Jadavpur University and later Laura Marinelli award for his work on methodological developments in NMR in 2008.

Ananda Dasgupta

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Exploring the interface of physics and mathematics

The connection between physics and mathematics is an age-old one. Given the antiquity of this connection there seems to be little in store in terms of fundamental new themes to explore. However, the recent surge of interest in the techniques of Geometric Algebra and its connection to physics seems to show a great deal of promise. Ananda is fascinated by this rather recent rediscovery of old works by Grassmann and Clifford and is trying to adapt the technique to his area of expertise – which is the application of Lie algebraic techniques to study quantum phenomena. He is also deeply interested in physics pedagogy and is exploring the use of computer enabled methods in the teaching-learning process.

Selected Publications:

Gnuplot animations as a Physics teaching tool, Dasgupta A., 2012, Lat. Am. J. Phys. Educ., 6 , 252

Simple systematics in the energy eigenvalues of quantum anharmonic oscillators, Dasgupta A., Roy D., and Bhattacharya R., 2007, J. Phys. A: Math. Theor., 40, 773

A new look at two old problems in electrostatics, or much ado with hemispheres, Dasgupta A., 2007, Eur. J. Phys., 28, 705

Relativistic kinetics from the Bondi K-calculus, Dasgupta A., 2007, Eur. J. Phys., 28, 817

PhD Student:

Tapas Das

Ananda Dasgupta did his PhD work at the Saha Institute of Nuclear Physics, Kolkata. He obtained his PhD in Physics in 2001. He joined St. Xavier's College, Kolkata as a lecturer in Physics in 1999. In 2005 he joined the faculty of Jadavpur University and finally moved to IISER Kolkata in 2007.

Amitava Datta
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The Large Hadron Collider confronts physics beyond the Standard Model

The Large Hadron Collider (LHC) at CERN has produced a large volume of data during the last two years. No compelling evidence of physics beyond the standard model (SM) has been found. This constrains many theoretically well-motivated extensions of the SM. We have examined such constraints in the minimal supersymmetric SM (MSSM) which contains a viable candidate for the observed dark matter (DM) in the universe. We have argued that while the current LHC data at 7-8 TeV , severely constrains the strongly interacting sector of the MSSM, the electroweak sector is rather mildly constrained. On the other hand the electroweak sector by itself can produce the observed DM relic density. Thus supersymmetric DM is very much allowed by the LHC experiments. We are also working on the possible signatures of supersymmetric DM at the upgraded LHC experiments at 14 TeV which is expected to be operational in 2016.

Selected Publications:

Many Faces of Low Mass Neutralino Dark Matter in the Unconstrained MSSM, LHC Data and New Signals, Choudhury, Arghya, and Datta, Amitava, 2012, Journal of High Energy Physics, 1206, 006

Revealing the Footprints of Squark Gluino Production through Higgs Search Experiments at the Large Hadron Collider at 7 TeV and 14 TeV, Bhattacherjee, Biplob, and Datta, Amitava, 2012, Journal of High Energy Physics, 1203, 006

Enriching the Exploration of the mUED Model with Event Shape Variables at the CERN LHC, Datta, Amitava, Datta, Anindya, and Poddar, Sujoy, 2012, Physics Letters, B712, 219

Low Mass Neutralino Dark Matter in mSUGRA and More General Models in the Light of LHC Data, Bhattacharyya, Nabanita, Choudhury, Arghya, and Datta, Amitava, 2011, Physical Review, D84, 095006

Probing R-parity Violating Models of Neutrino Mass at the LHC via Top Squark Decays, Datta, Amitava, and Poddar, Sujoy, 2009, Physical Review, D79, 075021

PhD Students:

Sujoy Poddar, Nabanita Bhattacharyya, Arghya Choudhury

Amitava Datta obtained his PhD in Physics from Visva - Bharati University in 1977. Subsequently he joined Jadavpur University in 1981. He was a Fellow of the Alexander von Humboldt Foundation, an Associate Member of the International Centre for Theoretical Physics, Trieste. He has been a fellow of the Indian National Science Academy since 2004.

Rumi De
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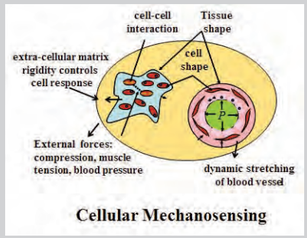
Physics of Living Matter

Our main interest is in theoretical biological physics specifically to understand the nonlinear dynamics and the mechano-sensitive behavior of active cells. Understanding the active response of cells to mechanical forces is important in the context of many biological processes -- such as wound healing, muscle growth, tissue organization and development -- that have wide implication in cell biology and even in biomedical applications. Some of the areas that we are interested in include cell adhesion, orientation, actin cytoskeletal dynamics, collective cell migration, fingering instability during wound healing, and other stretch induced cellular functionality and its consequences in embryonic development. We are also interested in stick-slip dynamics of living matter such as saltatory motion of white blood cells and actin dynamics. We study the underlying physics of the concerted active responses of the cell by using the approaches of statistical physics, soft condensed matter theory, theory of elasticity, and non linear dynamics. Our group is developing suitable theoretical models as well as carrying out simulations to understand the underlying dynamics of living system.



Cellular Mechanosensing

Selected Publications:

Mechanical consequences of cellular force generation, Zemel, A., De, R., and Safran, S. A., 2011, Curr. Opin. in Mat. Sci. Solid State Phys., 15, 169

Theoretical concepts and models of cellular mechanosensing, De, R., Zemel, A., and Safran, S., 2010, Methods in Cell Biology, 98, 143

Do cells sense stress or strain? Measurement of cellular orientation can provide a clue, De, R., Zemel, A., and Safran, S., 2008, Biophysical Journal Lett., 94, L29

Dynamics of cell orientation, De, R., Zemel, A., and Safran, S., 2007, Nature Physics, 3, 655 (Appeared in News and Views of Nature Physics)

Dynamics of the peel front and the nature of the acoustic emission during peeling of an adhesive tape, De. R., and Ananthakrishna, G., 2006, Physical Review Letters, 97, 165503

Dr. Rumi De obtained her PhD in 'Nonlinear Dynamical Systems' from the Indian Institute of Science in 2006. Subsequently she was a postdoctoral fellow at Weizmann Institute of Science in Israel and a postdoctoral research associate at Brown University in USA. She moved back to India and joined IISER Kolkata in 2010. She was a recipient of 'Young Investigator Award' at 6th World Congress of Biomechanics in Singapore in 2010.

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Amit Ghosal

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Interplay of electronic correlations and disorder: From quantum dots to superconductivity

Amit's research focuses on the understanding of the complex phases, in which the interplay of strong interactions and irregularities lead to new emergent phenomena. Some research being carried out in his group are:

(a) Melting of an amorphous solid ("Wigner molecules"), made out of Coulomb-interacting electrons, in an irregularly confined geometry. Melting driven by both the thermal and quantum fluctuations are being studied using advanced numerical techniques.

(b) The effect of impurities on high Tc cuprates. Much of their novel properties arise from the complex interplay of strong correlations between electrons and the doping. Amit is developing an inhomogeneous mean-field theory augmented with Gutzwiller techniques to uncover several interesting features of these systems.

(c) Disorder effects on the low Tc superconductors. The repulsion between electrons forming Cooper pairs has been typically neglected in the literature of disordered CS superconductors. On the other hand, such repulsion is known to produce local moments through the interplay with disorder. Amit hopes to uncover the roles of these moments in the demise of superconductivity.

Selected Publications:

Interaction-induced Strong Localization in Quantum Dots, Guclu, A. D., Ghosal, Amit, Umrigar, C.J., and Baranger, H.U., 2008, Physical Review B, 77, 41301(R)

Competing Ferromagnetism in the Overdoped High Temperature Copper Oxide Superconductors Kopp, A., Ghosal, Amit, and Chakravarty, S., 2007, Proceedings of the National Academy of Sciences, 104, 6123

Incipient Wigner Localization in Circular Quantum Dots, Ghosal, Amit, A.D. Guclu, A.D., Umrigar, C.J., Ullmo, D., and Baranger, H.U., 2007, Physical Review B, 76, 85341

Towards Strong Interaction in Circular Quantum Dots: Correlation Induced Inhomogeneity, Ghosal, Amit, A.D. Guclu, A.D., Umrigar, C.J., Ullmo, D., and Baranger, H.U., 2006, Nature Physics, 2, 336. (See also the Cover Story, *ibid.*).

PhD Students:

Dyuti Bhattacharya, Debmalya Chakraborty, Biswarup Ash

Amit Ghosal obtained his PhD in Physics in 2001 from the Tata Institute of Fundamental Research. Subsequently he was a Postdoctoral Fellow at McMaster University, funded by the SHARCNet Fellowship. He then moved to Duke University, USA with a Research Associate position. Finally, he spent two years at University of California, Los Angeles, USA as a Postdoctoral Scholar funded by the David Saxon Chair Fellowship.

Anandamohan Ghosh

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Nonlinear Dynamics; Mathematical and Theoretical Biology

I work on understanding the biological systems from a nonlinear dynamics and a statistical physics perspective. Dynamics of a neuron is highly non-linear and the methods of dynamical systems often reveal the underlying mechanism. Again, the emergence of the coherent behavior in a population of neurons can be studied using the tools of statistical physics. Identifying the features of the neural dynamics necessary for the emergent sensory adaptation is one of my present research interests. The mathematical analysis used in the above studies are quite generic in the sense that they can be used to study many biological systems. I also study the role of intrinsic noise in the transcription dynamics and how a cell responds and adapts to changes in the environment.

Selected Publications:

General properties of transcriptional time-series in Escheria coli, So, L., Ghosh, A., Zong, C., Sepulveda, L., Segev, R. and Golding, I., 2011, Nature Genetics, 43, 554

Phase description of spiking neuron networks with global electric and synaptic coupling, Roy, D., Ghosh, A. and Jirsa, V., 2011, Physical Review E, 83, 051909

Simple model for bursting dynamics of neurons, Ghosh, A., Roy, D. and Jirsa, V., 2009, Physical Review E, 80, 041930

PhD Student:

Soumen Kumar Patra

Anandamohan Ghosh obtained his PhD in Physics from National Chemical Laboratory, Pune in 2004.

Nirmalya Ghosh

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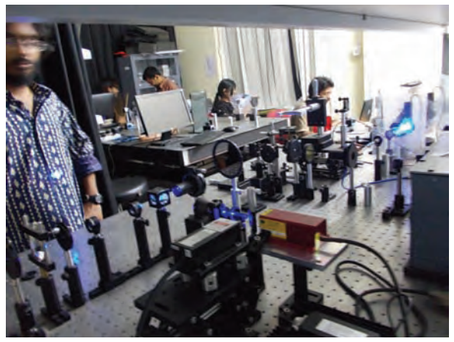
Biophotonics – Nano-Optics: Novel optical modalities for probing biological and other complex systems



Investigation of light-matter interactions at nano (or mesoscopic) scale has received considerable recent attention owing to fundamental interests and diverse potential applications. Nirmalya (and his group) investigates various aspects of light matter interaction and explores its applications in ultra-high sensitive sensing and optical nano-probing. These include studies on localized / surface plasmon resonances in metal nano-structures, plasmonic Fano resonances, spin orbit interaction of light in micro / nano systems, morphology dependent resonances (whispering gallery modes) in dielectric micro-particles, etc. The research activity of the group is also centered on developing novel optical imaging and spectroscopic modalities for probing biological and other complex systems. 'Random medium polarimetry' is the other actively pursued research area of the group. The studies involve (a) Development of novel polarimetry measurements / analysis methods (based on Jones, Stokes-Mueller formalisms) (b) Modeling polarized light transport (Monte Carlo simulations, radiative transport theory, diffusion approximation) in complex random medium and (c) explore its applications in biomedical diagnosis / imaging.

Selected Publications:

Probing multifractality in tissue refractive index: prospects for precancer detection, Das, N., Chatterjee, S., Soni, J., Jagtap, J., Pradhan, A., Sengupta, T.K., Panigrahi, P.K., Vitkin, I. A., and Ghosh, N., 2013, Optics Letters, 38, 211

Comparative study of differential matrix and extended polar decomposition formalisms for polarimetric characterization of complex tissue-like turbid media, Kumar, S., Purwar, H., Ossikovski, R., Vitkin, I. A., and Ghosh, N., 2012, Journal of Biomedical Optics, 17, 105006

Tissue polarimetry: concepts, challenges, applications and outlook, Ghosh, N. and Vitkin, I. A., 2011, Journal of Biomedical Optics, 16, 110801

Differing self-similarity in light scattering spectra: a potential tool for pre-cancer detection, Ghosh, S., Soni, J., Purwar, H., Jagtap, J., Pradhan, A., Ghosh, N., Panigrahi, P. K., 2011, Optics Express, 19, 19717

Quantitative polarimetry of plasmon resonant spheroidal metal nanoparticles: A Mueller matrix decomposition study, Soni, J., Purwar, H. and Ghosh, N., 2011, Optics Communications, 285, 1599

PhD Students:

Jalpa Soni, Nandan K. Das

Nirmalya Ghosh obtained his PhD in Physics from Raja Ramanna Centre for Advanced Technology (RRCAT), Indore, India in 2006. Subsequently he was a postdoctoral fellow at Department of Medical Biophysics, University of Toronto, Canada. He has also held a position of Scientist at RRCAT, Department of Atomic Energy, India during the period 1998 – 2007. Nirmalya joined IISER Kolkata in 2009.

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Golam Mortuza Hossain

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The quantum universe at the Planck scale and its implications at large scale

General relativity is an amazingly successful theory of gravitation. However, it predicts existence of singularities in regions of extreme densities where it becomes unreliable. It is believed that a suitable reconciliation of general relativity with quantum theory, another tenet of modern physics, is needed to address this issue. The quest for a "quantum theory of gravity" which is expected to supersede general relativity in describing physics near extreme gravitational situations has led to several approaches. Golam's research interests concern primarily in the field of the so-called Loop Quantum Cosmology which is a mini-superspace approach using techniques of Loop Quantum Gravity, a proposed theory of quantum gravity. The quantization method used in this theory is often referred as polymer or loop quantization. Recently Golam has been exploring the physical implications of polymer quantization of matter fields.

Selected Publications:

Primordial polymer perturbations, Seahra, S. S., Brown, I. A., Hossain, G. M., and Husain, V., 2012, Journal of Cosmology and Astroparticle Physics, 1210, 041

The Propagator in polymer quantum field theory, Hossain, G. M., Husain, V., and Seahra, S. S., 2010, Physical Review D, 82, 124032

Loop quantum gravity corrections to gravitational wave dispersion, Bojowald, M., and Hossain, G. M., 2008, Physical Review D, 77, 023508

Genericness of a Big Bounce in Isotropic Loop Quantum Cosmology, Date, G., and Hossain, G. M., 2005, Physical Review Letters, 94, 011302

Primordial density perturbation in effective loop quantum cosmology, Hossain, G. M., 2005, Classical and Quantum Gravity, 22, 2511

PhD Student:

Gopal Chandra Sardar

Golam Mortuza Hossain obtained his PhD in Theoretical Physics from the Institute of Mathematical Sciences, Chennai in 2006. Subsequently he was a postdoctoral fellow at the Institute for Gravitation and the Cosmos, Pennsylvania State University and University of New Brunswick, Canada. He was awarded INSA Medal for Young Scientists in 2006. Golam moved back to India in 2010 to join IISER Kolkata as an Assistant Professor.

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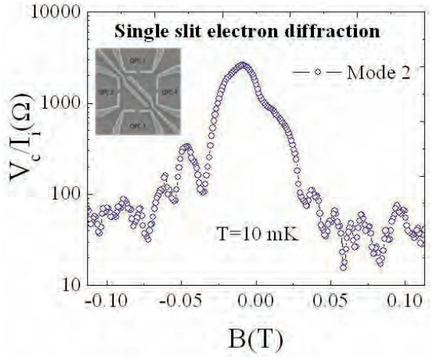
Mesoscopic physics in semiconductor at ultra-low temperature



Variation of detector signal with magnetic field. The curve is the electronic analog of single slit diffraction in optics.

Many interesting and sometimes unexpected effects appear due to the phase coherence of electronic wave-functions in the mesoscopic regime. Some of these effects are very promising for applications in nano-electronic devices. Mesoscopic system, on the other hand, provides a possibility to understand the basic features of quantum mechanics in a very controlled way. Currently, I am working on one such problem, where electronic phase coherence plays a very crucial role, the phenomenon called electron diffraction (a thought experiment of Feynman), using high mobility two dimensional electron gas at 10 mK temperature. I have also been studying weak localization (WL) and universal conductance fluctuations (UCF) through magneto-transport measurements on silicon nano-wires at very low temperature, where quantum interference plays a key role to understand the process of de-coherence caused by electron-electron interaction. The feasibility of one parameter scaling theory in such low dimensional quantum wires is also under investigation.

Selected Publications:

Indigenous design and fabrication of a 6.5 tesla superconducting magnet and a magneto-transport measurement set-up, Khatua P., and Majumdar, A. K., 2009, Pramana, 72, 629

Competition between interlayer exchange and Zeeman energies on the way to saturation of magnetization in Fe/Cr multilayers, Khatua, P., and Majumdar, A. K., 2009, Journal of Applied Physics, 105, 013920

Correlation between giant magnetoresistance and anomalous Hall effect: A realization of the existence of quantum well in giant magnetoresistive Fe/Cr multilayers, Khatua, P., and Majumdar, A. K., 2006, Physical Review B, 74, 092405

Scaling law and its universality in the anomalous Hall effect of giant magnetoresistive Fe/Cr multilayers, Khatua, P., Majumdar, A. K., Temple, D., and Pace, C., 2006, Physical Review B, 73, 094421

Pradip Khatua obtained his PhD in Physics from the Indian Institute of Technology Kanpur in 2006. Subsequently he was a postdoctoral fellow at Weizman Institute of Science, Israel.

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Experimental Condensed Matter Physics & Spectroscopy: Magnetism, superconductivity, transport properties and spectroscopy

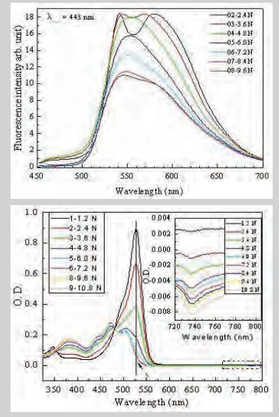
We basically study Magnetic mechanism in bulk and low dimensional systems (Intermetalic alloys, oxides etc.) which do include nanomaterials too. Phase transition and criticality are important aspects to be studied.

In superconductivity, we are basically focusing on magnetic mechanism of superconductivity and sample is being prepared by chemical route. Organic superconductor is our one of the recent interest in which mechanism looks to be very interesting due to localized nature of electron.

Transport property of strongly correlated systems is very interesting due to complicated nature of basic mechanism.

Spectroscopy of organic molecules and low dimensional systems (quantum dots) is our interest. The dynamics of coupled system (quantum dot and organic molecule) is quit fascinating. Recently we observed Fano resonance with organic laser dye which is quite novel results.

More importantly, we are developing high magnetic filed pulse magnet a state of the art facility for the study of magnetoresistance (MR) and photoluminescence with Dr. Bhavtosh Bansal and Dr. Pradip Khatua. As the first stage of development, the highest pulse magnetic field achieved is 22 Tesla with working temperature range for MR measurement from room temperature down to liquid nitrogen.



The graphic shows one of the most fascinating phenomena of Fano Resonance in absorption and fluorescence spectra of Rhodamine-6G laser dye in the aqueous medium with relative change in the hydrochloric acid concentration

Selected Publications:

Glassy behaviorinthelayeredperovskites$La_{(2-x)}Sr_xCoO_4$ (1:1⩽x⩽1:3), Mukherjee, S., Mukherjee, Rajarshi, Banerjee, S., Ranganathan, R., and Kumar, Uday, 2012, Journal of Magnetism and Magnetic Materials, 324, 928

Efficient lasing action from Rhodamine-110 (Rh-110) impregnated sol–gel silica samples prepared by dip method, Deshpande, Aparna V., and Kumar, Uday, 2010, Journal of Luminescence 130, 839

An automated autocorrelator for the measurement of high-frequency femtosecond pulses, Benocc, R., Batani, D., Jawad, H., Carpeggiani, P., Kumar, Uday, Levchenko, A., Venkatakrishanan, N., 2010, Radiation Effects & Defects in Solids, 165, 681

Effect of higher protonation on lasing performance of Rhodamine-B in sol-gel glasses, Deshpande, A. V., and Kumar, Uday, 2009, Journal of Non-Crystalline Solids, 355, 501

(Invited Book Chapter) Kumar, Uday, In: "The Sol-Gel Process: Uniformity, Polymers and Applications"; Editors: Rachel E. Morris; Sol-Gel based solid state dye-laser—Past, Present and Future, Nova Science Publishers 2010, ISBN: 978-1-61761-321-0

Uday Kumar obtained his PhD in Physics from the Institute of Chemical Technology, University of Mumbai in 2003. Subsequently he was a Research Associate at S. N. Bose National Centre for Basic Sciences, Kolkata, India and a visiting scientist at Milano Biccoca University, Itally. Uday Kumar moved back to India in IISER Kolkata in July 2007 as Senior Scientiffic Officer.

Arindam Kundagrami
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Physics of soft matter: Liquid crystals to charged polymers

My research interests centre on soft condensed matter physics which uses the language and tools of statistical physics. Soft matter physics deals with soft materials like colloids, liquid crystals, polymers, and complex fluids that are “soft” to touch as their elastic modulus is much lower compared to “hard” materials. Soft materials provide an ideal testing ground for many fundamental ideas of physics such as the relation between elasticity, long-wavelength dynamics, topological defects and broken symmetry, critical phase behaviour, and cooperative phenomena and self assembly of particles.

The major topics currently I am working on include equilibrium phase behaviour of polyelectrolytes (charged polymers) in diverse forms (such as isolated ionizable polymers, gels, brushes, or semi-flexible polymers), various phenomena in polymer physics (such as polymer complex formation, coil-globule transition, and stability of novel phases (e.g.,"pearl-necklace" phase), dynamics of phase transitions (such as swelling in polyelectrolyte gels), moving boundary problems in diffusive systems, and its application to soft-matter and biological processes.

The “pearl-necklace” phase of a single charged polymer chain

Selected Publications:

Effective charge and coil-globule transition of a polyelectrolyte chain, Kundagrami, A., and Muthukumar, M., 2010, Macromolecules, 43, 2574

Charge regularization in phase separating polyelectrolyte solutions, Muthukumar, M., Hua, J., and Kundagrami, A.,2010, The Journal of Chemical Physics, 132, 084901

The collapse of linear polyelectrolyte chains in a poor solvent: When does a collapsing polyelectrolyte collect its counter ions?, Loh, P.,Deen, R.,Vollmer, D., Fischer, K., Schmidt, M., Kundagrami, A., and Muthukumar, M., 2008, Macromolecules, 41, 9352

Theory of competitive counterion adsorption on flexible polyelectrolytes : Divalent salts, Kundagrami, A., and Muthukumar, M., 2008, The Journal of Chemical Physics, 128, 244901

The Structure of twist-grain-boundary-C Phases, Kundagrami, A., and Lubensky., T., 2003, Physical Review E (Rapid Communications), 68, 060703

PhD Student:

Swati Sen

After doing his B.Sc. from Presidency College, Kolkata, and M.S. from IISc, Bangalore, Arindam worked with Tom Lubensky on phase behaviours of smectic liquid crystals during his Ph.D from University of Pennsylvania (2003). In his only postdoctoral job with M. Muthukumar in University of Massachusetts, Amherst, he worked on the physics of charged polymers. Additionally, Arindam had been a consultant from UMass to Johnson & Johnson. Arindam joined DPS, IISER Kolkata in 2010.

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Siddhartha Lal
Assistant Professor
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Less is Different: Emergence of complexity in low-dimensional quantum systems

Lowered dimensionality, strong correlations and quantum fluctuations often conspire to give rise to novel emergent states of matter in quantum condensed matter systems. Emergence refers to the complex behaviour of a many-body system that is qualitatively different from that of its constituent parts. The theoretical analysis of such phenomena is made challenging by the lack of any obvious small coupling constant in the problem. In addition, critical phenomena in low-dimensional systems are often at zero-temperature and driven by quantum fluctuations arising from the competition between different quantum orders. Siddhartha has investigated emergent phenomena in a variety of systems, including those that display the quantum Hall effect, superconductivity at high temperatures and orbital-spin liquid states. He is also keenly interested in understanding how correlations and connectivity modify our understanding of circuitry at the quantum level. As a condensed matter theorist, he hopes that uncovering the mechanisms responsible for such emergent phenomena can provide proof-of-concept demonstrations that impact future quantum technologies.

Selected Publications:

Charge Fractionalisation in a Mesoscopic Ring, deGottardi, W., Lal, S., and Vishveshwara, S., 2013, Phys. Rev. Lett., 110, 026402

Inelastic light scattering measurements of a pressure-induced quantum liquid in $KCuF_3$, Yuan, S., Kim, M., Seeley, J. T., Lee, J. C. T., Lal, S., Abbamonte, P., and Cooper, S. L., 2012, Phys. Rev. Lett., 109, 217402

Two-step stabilization of orbital order and the dynamical frustration of spin in the model charge-transfer insulator $KCuF_3$, Lee, J. C. T., Yuan, S., Lal, S., Joe, Y. I., Gan, Y., Smadici, S., Finkelstein, K., Feng, Y., Rusydi, A., Goldbart, P. M., Cooper, S. L., Abbamonte, P., 2012, Nature Physics, 8, 63

Andreev Bound State Spectroscopy in a Graphene Quantum Dot, Dirks, T., Hughes, T. L., Lal, S., Uchoa, B., Chen, Yung-Fu, Chialvo, C., Goldbart, P. M., Mason, N., 2011, Nature Physics, 7, 386

Charge-Density-Wave and Superconductor Competition in Stripe Phases of High Temperature Superconductors, Jaefari, A., Lal S., and Fradkin, E., 2010, Phys. Rev. B, 82, 144531

PhD Students:

Nivedita Bhadra, Dinesh Sarkar

Siddhartha Lal obtained his Ph.D. in Physics from the Indian Institute of Science, Bangalore in 2003. With postdoctoral tenures at the Institute for Theoretical Physics (University of Cologne), the Abdus Salam International Center for Theoretical Physics (Trieste) and the Institute for Condensed Matter Theory at the University of Illinois at Urbana-Champaign, he joined the Indian Institute for Science Education and Research, Kolkata as an Assistant Professor in July 2010. He started his Ramanujan Fellowship in December 2010.

Chiranjib Mitra
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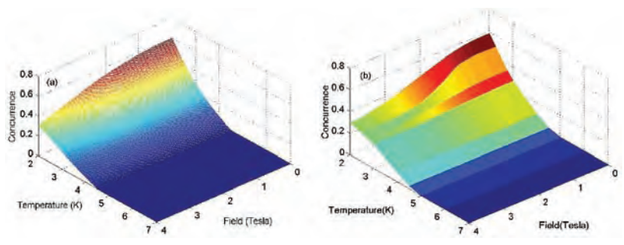
Physics of correlated electron systems

I work on Strongly Correlated Electron systems, probing certain aspects of Magnetism and Transport in localized moments as well as itinerant electron moments based compounds, which include both intermetallic and oxide compounds in addition to some molecular magnets, which are essentially low-dimensional systems. I study Kondo Lattices (Heavy Fermions), dilute Kondo Systems, Non-Fermi liquid like behavior in the localized moment systems where as doped manganites and spin polarized tunneling in granular materials as well as artificially fabricated tunnel junctions in the itinerant moment magnetic systems. In the molecular magnets, I am interested in studying low dimensional, low spin systems where the system will behave like quantum mechanical system at low temperatures and the ensuing spin system will be like a Heisenberg chain. One can probe the quantum nature of the ground state in an antiferromagnetic ground state; the system will be in an entangled state. This entangled nature of the ground state can be used in Quantum Information Processing and quantum communication through spin chains. In addition to these I also work on Topological Insulators, where, the surface is conducting but the bulk is insulating. These surface states are topologically protected and can be used to encode quantum information, which is resistant to decoherence and can be used for fault tolerant quantum computation.



Theoretical value of concurrence as a function of magnetic field and temperature for a dimer model. (b) Experimental value of concurrence as a function of magnetic field and temperature for $Cu(NO_3)_2$ x 2.5 H_2O. The magnetic field values are in Tesla and the temperature is in Kelvin.

Selected Publications:

Experimental detection of quantum information sharing and its quantification in quantum spin systems, Das, D., Singh, H., Chakraborty, T., Gopal, R. K., and Mitra C., 2013, New Journal of Physics, 15, 013047

Quantification of entanglement from magnetic susceptibility for a Heisenberg spin 1/2 system, Chakraborty, T., Singh, H., Das, D., Sen, T.K., and Mitra, C., 2012, Physics Letters A, 376, 2967

Teleportation in the presence of common bath decoherence at the transmitting station, Rao D.D.B., Panigrahi P.K., Mitra C., 2008, Physical Review A, 78, 022336

Molecular thin films: A new type of magnetic switch; Heutz S., Mitra C., Wu W., Fisher A.J., Kerridge A., Stoneham A.M., Harker A.H., 2007, Advanced Materials, 19, 3618

Observation of Minority Spin Character of the New Electron Doped Manganite La0.7Ce0.3 MnO3 from Tunneling Magnetoresistance, Mitra, C., Raychaudhuri, P., Dörr, K., Müller, K.H., Schultz, L., Oppeneer, P.M., Wirth, S., 2003, Physical Review letters, 90, 17202

PhD Students:

Harkirat Singh, Tanmoy Chakraborty, Radha Krishna Gopal, Sourabh Singh, Jit Sarkar

Chiranjib Mitra did his PhD in Physics from the Tata Institute of Fundamental Research, Mumbai, India in 2001. Before moving to IISER Kolkata in 2007, he was a postdoctoral fellow jointly at the Max Planck Institute for the Chemical Physics of Solids, Dresden, Germany and Institut für Festkörper-und Werkstofforschung Dresden, Germany (2001-2002), University of Cambridge, Cambridge, U.K. (2002-2004) and London Centre for Nanotechnology, University College London, U.K. (2004-2007).

Partha Mitra
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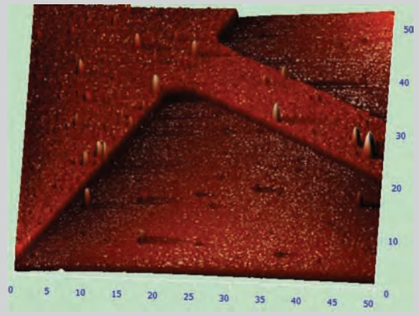
Spin dependent transport phenomenon and application

The signatures of the spin degree of freedom of the free carriers in a solid material often get masked by the large classical electromagnetic forces on its charge and also due to 'relaxation' effect that makes spin current non conservative. With the recent advancement in nanotechnology and ultra fast measurement techniques, it is now possible to design novel experimental schemes to overcome these challenges. This has led to a very active multidisciplinary field of research that aims at understanding the fundamentals of the spin dependent transport phenomenon that can eventually find application in the form of 'spintronic' devices.



A lithographically patterned topological insulator film imaged by Atomic Force Microscope

Our group explores wide range of materials with potential for spintronic applications due to longer spin coherence lengths and spin-orbit interaction. Currently we are investigating new classes of radical based organic semiconductors and topological insulators for quantum effects in transport properties using our low temperature and high magnetic field facility. Subsequently we aim to use these materials to attempt several challenges like electrical detection of spin hall effect, detection of spin currents using superconductive and ferromagnetic interfaces and manipulation of nanomagnets using spin torque. We have developed state-of-the -art facilities for synthesis of the thin films and multilayer samples and fabrication of nano and micro devices.

Selected Publications:

Magnetic ordering in Ni-rich NiMn alloys around multicritical point: Experiment and theory, Pal, P., Banerjee, R., Banerjee, R., Mookerjee, A., Khaple, G. C., Sanyal, B., Hellsvik, J., Eriksson, O., Mitra, P., Majumdar, A. K., and Nigam, A.K., 2012, Physical Review B, 85, 174405

Magnetostructural studies on tetranuclear Manganese [$Mn^{III}_2Mn^{II}_2$] complexes of 9-Hydroxyphenalenone with Weak π···π Interactions, Dey, K., Honecker, A., Mitra, P., Mandal, S. K., and Mukherjee, A., 2012, European Journal of Inorganic Chemistry , 35, 5814

Quasi-reversible magnetoresistance in exchange-spring tunnel junctions, Zhu, M., Wilson, M. J., Mitra, P., Schiffer, P., and Samarth, N., 2008, Physical Review B, 78, 195307

Spin valve effect in self exchanged biased ferromagnetic metal/semiconductor bilayers, Zhu, M., Wilson, M. J., Sheu, B. L., Mitra, P., Schiffer P., and Samarth, N., 2007, Applied Physics Letters, 91, 192503

Weak localization correction to the anomalous Hall effect in polycrystalline Fe films, Mitra, P., Misra, R., Hebard, A. F., Muttalib, K. A., and Woelfle, P., 2007, Physical Review Letters, 99, 046804

PhD Student:

Arpita Mandal

Dr Mitra pursued graduate studies at the University of Florida and obtained Doctoral degree in Physics in May 2006 for his thesis on experiments done on ultra thin films of magnetic materials at low temperatures. He continued postdoctoral research in the field of semiconductor spintronics at The Pennsylvania State University from 2006-2009. Subsequently, he joined IISER-Kolkata in 2009.

Goutam Dev Mukherjee

Assistant Professor
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Studies at extreme conditions of pressure

Experimental investigations of condensed states generally deal with studying their physical properties by changing the physical parameters, like, pressure, temperature, and magnetic field. Suitable theoretical models are then used for analytical and computational studies to understand the fundamental mechanisms responsible for the unique physical properties exhibited by the condensed states of matter. Among all the physical parameters, pressure perhaps has the greatest range. Applying external pressure one can tune the interatomic spacing of any material by considerable amount with a very high precision. This can produce new high density phases of matter with novel physical properties, like, novel-superconductivity, multiferroic-behaviour, re-entrant ferroelectricity, collapse of magnetism etc. In this large canvas, strongly correlated-electron systems provide us with very unique and interesting problems, most of which are not understood yet. We squeeze our specimens under (quasai-)hydrostatic conditions using diamond anvil cells to pressures above 150 GPa and study their response using different spectroscopic techniques and also X-ray diffraction measurements in synchrotron sources. We also study the electrical transport behavior under pressure to complement the above optical and structural investigations.

Selected Publications:

Reappearance of Ferroelectric Soft Modes in the Paraelectric Phase of Pb1-xCaxTiO3 at High Pressures: Raman and x-ray diffraction studies, Basu A., Chandra A., Tyagi A.K., and Mukherjee G. D., 2012, Journal of Physics: Condensed Matter, 24, 115404

High Pressure Investigations of Na0.025WO3: X-ray diffraction and Raman spectroscopy studie, Basu, A., Paul, S., Pollentarutti, M., Bais, G., Oishi, S., Raj, S., and Mukherjee, G. D., 2011, Journal of Physics: Condensed Matter, 23, 365401

High Pressure Melting Curve of He and Ne: Deviations from theory of corresponding states, Santamaria-Perez, D., Mukherjee, G. D., Schwager, B. and Boehler, R., 2010, Physical Review. B, 81, 214101

X-ray Diffraction Measurements of Mo Melting to 119 GPa and the High Pressure Phase Diagram, Santamaria Perez, D., Ross, M., Errandonea, D., Mukherjee, G. D., Mezouar, M., and Boehler, R., 2009, Journal of Chemical Physics, 130, 124509

High Pressure Melting Curve of Nitrogen and Liquid-Liquid Phase Transition, Mukherjee, G. D., and Boehler, R., 2007, Physical Review Letter, 99, 225701

PhD Students:

Abhisek Basu, Rajesh Jana, Guruprasad Mandal, Susanta Das

Goutam Dev Mukherjee obtained his PhD in Physics from the University of Hyderabad in 1997. Subsequently he was a postdoctoral fellow in IIT Kanpur, Scientist D and E in Bhabha Atomic Research Centre, and visiting scientist in High Pressure Group, Max Plank Institute for Chemistry in Mainz. He has received the N.S. Satyamurthy Best Young Scientist Award in 2002 from Indian Physics Association and 3rd best prize in the Young Scientist Colloquium in 2000 from Indian Physical Society. He is also recipient of Senior Fulbright Fellowship and visited Harvard University to work on high pressure investigations in hydrogen. He joined IISER Kolkata in 2008.

Dhananjay Nandi

Assistant Professor
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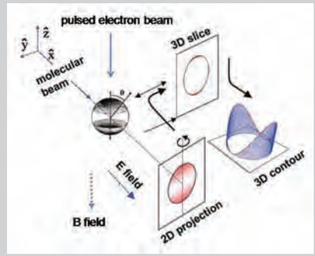
Gas Phase Molecular Dynamics: Low energy electron-molecule collisions

The main interest of Dhananjay is to understand the detailed gas phase molecular dynamics probed by *novel* Velocity Map Imaging (VMI) technique with Time Slicing (see accompanying figure). This includes fundamental aspects of electron attachment phenomena and dissociation dynamics in isolated molecules and clusters. The low energy electron interacts with molecule forming transient molecular anion that subsequently dissociates into fragment anion and neutrals (DEA). Dhananjay is developing a custom design VMI spectrometer for the studies of Dissociative Electron Attachment (DEA) and Polar Dissociation (PD). VMI is a recent variant of charge particle imaging, the heart of the spectrometer is a two dimensional Position Sensitive Detector (PSD). From the time and position information one can extract all three momentum component enabling kinematically complete measurement. From the time sliced image one can determine the kinetic energy and the angular distribution with unprecedented sensitivity.



This figure shows the schematic of the velocity map imaging for low energy electron-molecule collision

Selected Publications:

Dissociative electron attachment to NO probed by Velocity Map Imaging, Nandi, D., Prabhudesai, V. S., Nestman, B. M., and Krishnakumar, E., 2011, Phys. Chem. Chem. Phys., 13, 1542

Photoionization of 2-Pyridone and 2-Hydroxypyridine, Poully, J. C., Schermann, J. P., Nieuwjaer, N., Lecomte, F., Grégoire, G., Desfrançois, C., Garcia,G. A., Nahon, L., Nandi, D., Poisson, L., and Hochlaf, M., 2010, Phys. Chem. Chem. Phys., 12, 3566

Dissociative Electron Attachment to Poly-atomic Molecules: Ion Kinetic Energy Measurements, Nandi, D., and Krishnakumar, E., 2010, Int. J. Mass Spectrom., 289, 39

PhD Students:

Pamir Nag, Atanu Nandy

Dhananjay Nandi obtained his PhD in Physics from the Tata Institute of Fundamental Research in 2004. Following this he was postdoctoral fellow at Max-Planck-Institüt für Kernphysik, Heidelberg, Germany; Guest Scientist at Freie Universität, Berlin, Germany; Research Professor at Seoul National University, Korea; and Research Associate at Laboratoire Francis PERRIN, CEA Saclay, France. Dhananjay received INSA Medal for Young Scientist in 2010.

Dibyendu Nandi

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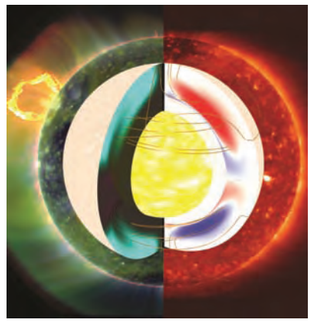
Astrophysical Space Sciences: Exploring the Sun-Earth system



This collage shows magnetic fields in the interior of the Sun simulated using a solar dynamo model (center) and the observed solar corona at two different phases of solar activity; a quiescent phase during the recent, unusually long minimum in solar activity (right) and a comparatively active phase following the minimum (left) – during which a solar storm is seen to originate (upper-left corner). The dynamo simulated toroidal and poloidal components of the Sun's magnetic field are depicted in color within the Sun in this image. Sunspots originate from this internal magnetic field and are the seats of solar storms that generate beautiful auroras but are also hazardous to our space-based technologies. This simulation is from Nandy et al. 2011 (Nature, 3rd March issue)

The Sun is a variable star, with its radiative, magnetic and particulate output varying on timescales ranging from minutes to planetary evolutionary timescales. The short term variability is primarily manifested through solar magnetic storms which contribute to severe space weather affecting space-based technologies. The long term solar radiative variability, which is coupled to the Sun's magnetic output, is the primary natural driver of the Earth's climate system. This rich diversity of solar activity ultimately originates in a magnetohydrodynamic dynamo mechanism in the solar interior that generates magnetic fields feeding on solar plasma flows. Dibyendu explores this Sun-Earth system – through dynamo simulations of solar magnetic fields, developing theoretical and satellite data analysis-based techniques for severe space weather forecasting, and investigating the solar contribution to global climate change. Dibyendu leads the MHRD Center of Excellence in Space Sciences, is involved with India's first solar space mission, holds vice-chairmanship of the space weather panel of the international Committee on Space Research and is a working group chairman of the International Astronomical Union.

Selected Publications:

Kinematic Properties of Solar Coronal Mass Ejections: Correction for Projection Effects in Catalogued Satellite Measurements, Howard, T.A., Nandy, D., and Koepke, A., 2008, Journal of Geophysical Research, 113, A01104

The Unusual Minimum of Solar Cycle 23 Caused by Changes in the Sun's Meridional Plasma Flows, Nandy, D., Munoz-Jaramillo, A., & Martens, P.C.H. 2011, Nature, 471, 80

Space Climate, Editors: Mursula, K., Usoskin, I., Nandy, D, and Marsh, D. 2011, a special issue of the Journal of Atmospheric and Solar-Terrestrial Physics, Elsevier (Amsterdam), Volume 73, Issues 2-3

Modeling the Solar Cycle: What the Future Holds, Nandy, D. 2012, in the book "Comparative Magnetic Minima: Characterizing quiet times in the Sun and Stars", Cambridge University Press, page 54, ISBN-13: 9781107019867

Turbulent Pumping of Magnetic Flux Reduces Solar Cycle Memory and thus Impacts Predictability of the Sun's Activity, Karak, B.B., and Nandy, D., 2012, Astrophysical Journal Letters, 761, L13

PhD Students:

Antonia Wilmot-Smith, Anthony Yeates, Andres Munoz-Jaramillo, Dario Passos, Soumitra Hazra

Dibyendu obtained his PhD in Physics in 2003 from IISc following which he was Postdoctoral Fellow and Assistant Research Professor at Montana State University and a Visiting Scientist at Harvard-Smithsonian Center for Astrophysics. He moved back to India in 2008. Dibyendu's honours include the Martin Forster Gold Medal from IISc, the Ramanujan Fellowship of the Government of India and the Harvey Prize of the American Astronomical Society.
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Rajesh Kumble Nayak

Assistant Professor
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Black holes and gravitational waves

Almost all the studies on blackholes have focused on isolated blackholes possessing two basic properties, namely time-independence and asymptotic flatness. On the other hand, one cannot rule out the important and, perhaps, realistic situation in which the black hole is associated with a non-flat background. Very little has been done in this direction. We investigate the physical effects near asymptotically non-flat blackholes.

Breakthroughs in modern technology have made possible the construction of extremely large interferometers both on ground and in space for the detection and observation of gravitational waves. Several ground based detectors are being constructed around the globe; these are the projects, LIGO, VIRGO, GEO, TAMA and AIGO of building interferometers whose arm-lengths will be of the order of kilometers. LISA - Laser Interferometric Space Antenna - is a proposed mission consisting of three identical spacecrafts forming a giant equilateral triangle of side 5 Million kilometers to observe and detect low frequency cosmic gravitational waves. Data analysis is an important component of gravitational wave detection, we develop and implement various algorithms for identifying and analyzing astrophysical gravitational wave signatures from the detectors output.

Selected Publications:

Inertial forces and Einstein's Equations in axially symmetric stationary spacetimes, Nayak, K. Rajesh, 2009, Gen. Rel. and Gravitation, 1572-9532 (Online)

General relativistic treatment of LISA optical links, Dhurandhar, S. V., Vinet, J-Y., and Nayak, K. Rajesh, 2008, Class. Quantum Grav. 25, 245002

The tomographic method for LISA binaries: application to MLDC data, Nayak, K. Rajesh, Mohanty, Soumya D., and Hayama, Kazuhiro, 2007, Class. Quantum Grav. 24, S587

On the minimum flexing of LISA's arms, Nayak, K. Rajesh, Koshti, S., Dhurandhar, S. V., and Vinet, J-Y., 2006, Class. Quantum Grav., 23, 1763

Tomographic reconstruction of LISA Galactic binary distribution, Mohanty, Soumya D., and Nayak, K. Rajesh, 2006, Phys. Rev. D, 73, 083006

PhD Students:

Basabendu Barman, Santanu Tripathy

Dr Rajesh Nayak obtained his PhD in Physics in 2002 from the Indian Institute of Astrophsyics, Banglaore. He was a Postdoctoral Fellow at IUCAA and Pune and Henri Poincare post doctoral Fellow at Observatoire de la Cote d'Azur, Nice France. Following this he was a Postdoctoral Fellow at Center for Gravitational Wave Astronomy, Dept. Physics and Astronomy, University of Texas At Brownsville.

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Nanoscience in femtosecond domain: Probing nanomaterials with ultrafast laser spectroscopy

A PhD student is working on time-resolved spectroscopy setup using femtosecond laser system in the laboratory

Probing science at the extreme length and time scales has been a never ending endeavor of human society. At one extreme, there is astrophysical research involving stars and galaxies and on the other end lies the 'small is beautiful' domain of nanoscience and ultrafast phenomena. Bipul is fascinated by the 'ultra-small – ultra-fast' world of semiconductor nanostructures. His research involves study of interactions of electrons and holes with phonons, defects and disorder in semiconductors using state-of-the-art linear and nonlinear laser spectroscopy in the femtosecond to millisecond time scales. These studies aim at clarifying various issues related to fundamental quantum mechanical processes and many-body phenomena in nanoscience. Results of such studies are relevant in solving problems related design of improved semiconductor optoelectronic devices.

Selected Publications:

On conversion of photoluminescence into absorption and the van Roosbroeck-Shockley relation, Bhattacharya, R., Pal, B., and Bansal, B., 2012, Applied Physics Letters, 100, 222103

Self-assembly and nonlinear optical property of a synthetic dipeptide, Maity, S.K., Kumar, R., Ambast, D.K.S., Pal, B., and Haldar, D., 2012, Journal of Materials Chemistry, 22, 22198

Spin relaxation in charge-tunable InP quantum dots, Pal, B. and Masumoto, Y., 2009, Physical Review B, 80, 125334

Spectral diffusion of type-II excitons in wurtzite InP/InAs/InP core-multishell nanowires, Pal, B., Goto, K., Ikezawa, M., Masumoto, Y., Mohan, P., Motohisa, J., and Fukui, T., 2009, Journal of Luminescence, 129, 1941

Type-II behavior in wurtzite InP/InAs/InP core-multishell nanowires, Pal, B., Goto, K., Ikezawa, M., Masumoto, Y., Mohan, P., Motohisa, J., and Fukui, T., 2008, Applied Physics Letters, 93, 073105

PhD Students:

Richarj Mondal, Deepak Kumar Sinha Ambast, Rupak Bhattacharya

Bipul Pal completed M. Sc. in Physics (university topper) in 1998 from University of Kalyani, WB, and Ph. D. in Physics (best thesis awardee) in 2004 from the Tata Institute of Fundamental Research, Mumbai. Following this, he was involved in postdoctoral research as an INOUE Fellow (1 year) and a JSPS Fellow (2 years) at University of Tsukuba, Japan. Subsequently, he returned to India to join as an assistant professor in the Indian Institute of Science Education and Research, Kolkata, in 2007. He is an Associate of the Indian Academy of Sciences and an INSA Young Scientist awardee.

Prasanta K. Panigrahi
Professor
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Quantum Computation, Field Theory

Although Quantum Mechanics is a well studied subject, Quantum computation has currently attracted significant attention, because of its possible practical applicability as also due to the counter-intuitive aspects of the quantum world. Prasanta explores various aspects of quantum communication like teleportation, dense-coding and secure direct communication in different quantum channels. Non-destructive discrimination of quantum states and quantum error correction are other areas of his interest.

In many-body physics, his interests lie in cold atoms, soliton dynamics in Bose-Einstien condensates and optical fibers. The electromagnetic response of graphene and topological insulators are the field theoretical systems under investigation by his research group. The fact that, these systems are well described by relativistic field theories makes them interesting to realize exotic relativistic phenomena, as well as subtle field theoretical effects like anomalies and their physical manifestations. Light matter interaction and Bio-photonics are also areas of great interest to him.

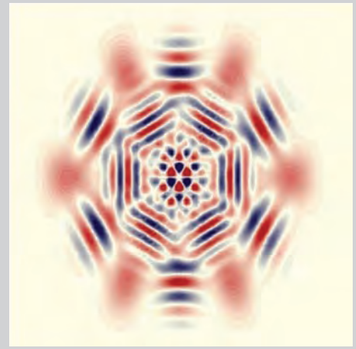

Image from "Sub-Planck-scale structures in the Pöschl-Teller potential and their sensitivity to perturbations"

Selected Publications:

Quantum violation of entropic non-contextual inequality in four dimensions, Pan, Alok K., Sumanth, M., and Panigrahi, Prasanta K., 2013, Phys. Rev. A, 87, 014104

Modulational instability of co-propagating light beams induced by cubic–quintic nonlinearity in nonlinear negative-index material, Gupta, Rama, Raju, Thokala Soloman, Kumar, Choragudi Nagaraja, Panigrahi, Prasanta K., 2012, JOSA B., 29, 3360

Distinguishing cancer and normal breast tissue auto-fluorescence using continuous wavelet transform, Gharekhan, Anita H., Arora, Siddharth, Pradhan, Asima, Panigrahi, Prasanta K., 2010, IEEE Journal of Selected Topics in Quantum Electronics, 16, 893

Perfect teleportation, quantum-state sharing, and superdense coding through a genuinely entangled five-qubit state, Muralidharan, Sreeraman, and Panigrahi, Prasanta K., 2008, Phys. Rev. A. 77, 032321

Loss of super-fluidity in the BoseEinstein condensate in an optical lattice with cubic and quintic nonlinearity, Das, Priyam, Vyas, Manan, and Panigrahi, Prasanta K., 2009 , J. Phys. B: At. Mol. Opt. Phys. 42, 245304

PhD Students:

Vivek M. Vyas, Kumar Abhinav, Priyam Das, S. Modak

After obtaining his PhD in Physics from the University of Rochester in 1988, Prasanta K. Panigrahi was a postdoctoral fellow at University of Illinois, Chicago and then at the University of Montreal. Prasanta moved back as a faculty in School of Physics, University of Hyderabad in 1993. He then joined Physical Research Laboratory, Ahmedabad in 2002. Since 2007 he has been with IISER Kolkata. He was an Elected Fellow, Gujarat academy of science, Gujarat and is also the referee for PRL, PRB, Journal of Physics, Pattern Recognition Letters, Physics Letter A, Pramana, and EPL etc. Recently, he has become a fellow of NASI, Allahabad.

Satyabrata Raj

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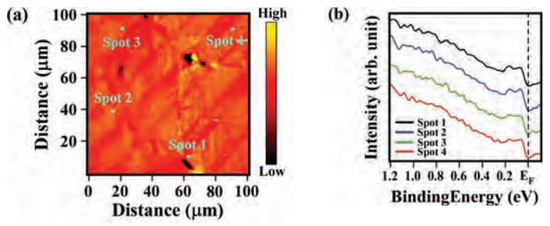
Experimental Condensed Matter

We investigate the electronic structure of strongly correlated systems by angle-resolved photoemission spectroscopy (ARPES). We study (i) Metal-Insulator Transition (MIT) in transition metal oxides (ii) Electronic structure of manganites showing CMR (iii) Superconductivity in Heavy Fermions (iv) Low-dimensional systems showing charge-density wave (CDW), (v) Electronic structure of the novel nano materials, super-ultra-thin films and/or one-dimensional chains etc.. We investigate to understand the luminescence, electronic and magnetic properties of various II-VI group nanoparticles. We synthesize such nanoparticles which can emit light when excited by a suitable source. The evolution of ferromagnetism in such dilute magnetic semiconductors is studied by measuring its magnetic properties with temperature.



(a) Spectromicroscopic image collected over 100 × 100 μm^2 area and (b) photoemission spectra of insulating $Na_{0.025}WO_3$ sample surface close to the Fermi level, E_F .

Selected Publications:

Electronic band structure and Fermi surface of low-dimensional $La_2Mo_2O_7$, Paul, S., Ghosh, A., and Raj, S., 2013, J. Phys. Chem. Solids, 74, 579

Structural phase transformation from wurtzite to zinc-blende in uncapped CdS nanoparticles, Ghosh, A., Paul, S., and Raj, S., 2013, Solid State Commun., 154, 25

Temperature dependent photoemission spectroscopy on lightly-doped sodium tungsten bronze, Paul, S., Ghosh, A., Chakraborty, A., Petaccia, L., Topwal, D., Sarma, D. D., Oishi, S., and Raj, S., 2012, Solid. State Commun., 152, 493

High-pressure investigations of $Na_{0.025}WO_3$: *x*-ray diffraction and Raman spectroscopy studies, Basu, A., Paul, S., Polentarutti, M., Bais, G., Oishi, S., Raj, S., and Mukherjee, G. D., 2011, J. Phys. : Condens. Matter, 23, 365401

Temperature dependent x-ray diffraction study of lightly doped Na_xWO_3, Paul, S., Mukherjee, G. D., Ghosh, A., Oishi, S., and Raj, S., 2011, Appl. Phys. Lett. 98, 121910

PhD Students:

Anirudha Ghosh, Sanhita Paul

Satyabrata Raj obtained his PhD in Physics from the Utkal University in 2001. He was a Research Associate at Indian Institute of Science and COE and JSPS Fellow at Tohoku University, Japan. He joined IISER-K in 2008.

Supratim Sengupta

Associate Professor
supratim.sen@iiserkol.ac.in

RNA, Origins and Complexity

Reaction-diffusion driven spatio-temporal oscillatory dynamics of proteins like *MinD* (blue) and *MinE* (red) ensure that the *E.coli* cell divides in the middle.

Our research deals with various aspects of the Origin and Evolution of Life as they pertain to regulatory RNA, Genetic Code and Biological Complexity at sub-cellular scales. We are specifically interested in the origin and evolution of the genetic code and whether regulatory RNA like riboswitches can be considered to have a primordial origin that can be traced back to the root of the tree of life. We also study how the oscillatory dynamics of some proteins at the sub-cellular level can lead to accurate regulation of mid-cell division in E.coli. We use computational modelling and bioinformatics tools to get insights into these topics.

We are also interested in understanding other types of complex systems like economic and social systems. We use evolutionary game theory techniques to understand how the costs and benefits associated with strategies employed by different individuals during their interactions with each other affect the frequencies of individuals in the population employing different strategies.

Selected Publications:

The Mechanisms of Codon Reassignments in Mitochondrial Genetic Codes, Sengupta, S., Yang, X., and Higgs, P.G., 2007, Journal of Molecular Evolution, 64, 662

Riboswitch Detection using Profile Hidden Markov Models, Singh, P., Bandyopadhyay, P., Bhattacharya, S., Krishnamachari, A., and Sengupta, S., 2009, BMC Bioinformatics, 10, 325

Classification of HIV-1 sequences using profile Hidden Markov Models, Dwivedi, S.K., and Sengupta, S., 2012, PLoS One, 7(5), e36566

Stuttering Min oscillations within E. coli bacteria: A stochastic polymerization model, Sengupta, S., Derr, J., Sain, A., and Rutenberg, A.D., 2012, Physical Biology, 9 , 056003

Phylogenetic analysis and comparative genomics of Purine riboswitch distribution in prokaryotes, Singh, P., and Sengupta, S., 2012, Evolutionary Bioinformatics, 8, 589

PhD Students:

Payal Singh, Ashutosh Vishwabandhu, Neha Aggarwal

Supratim Sengupta obtained his PhD in Physics from the Institute of Physics, Bhubaneswar in 2000. Subsequently he was a postdoctoral fellow at the University of Alberta, McMaster University and Dalhousie University. Supratim moved back to India in 2007 and joined the faculty of the School of Computational & Integrative Sciences, Jawaharlal Nehru University, New Delhi. After spending nearly 5 years in JNU, he joined IISER, Kolkata in December, 2011.

Ritesh K Singh
Assistant Professor
ritesh.singh@iiserkol.ac.in

High Energy Physics phenomenology and Quantum Field Theory

The world of sub-atomic entities are understood in terms of some fundamental particles and their interactions. These are described by quantum field theory (QFT) which is designed for such a purpose. This allows one to study the scattering experiments and production of new particles at various colliders. Ritesh studies the use of particle's spin and its polarization to probe the interactions among fundamental particles. To this end, he fabricates (proposes) various correlators that can be measured at the colliders and provide a clear probe to understand the interactions quantitatively. Further, he also appreciates that QFT is designed to cast sub-atomic entities as free particles and the forces are understood as instantaneous exchange of force carrying particles. This picture is unable to encompass gravitational force and thus a realm beyond the standard QFT is acknowledged. To this end also works on automatizing standard perturbative QFT calculations and exploring the ways to go beyond.

Selected Publications:

New physics contributions to the forward-backward asymmetry at the Tevatron, Biswal, S. S., Mitra, S., Santos, R., Sharma, P., Singh, Ritesh K., Won, M., 2012, Physical Review D, 86, 014016

On measurement of top polarization as a probe of $t\bar{t}$ production mechanisms at the LHC, Godbole,, R. M., Rao, K., Rindani, S. D., Singh, Ritesh K., 2010, Journal of High Energy Physics, 1011, 144

The Forward-backward asymmetry of top quark production at the Tevatron in warped extra dimensional models, Djouadi, A., Moreau, G., Richard, F., Singh, Ritesh K., 2010, Physical Review D, 82, 071702

A Model independent spin analysis of fundamental particles using azimuthal asymmetries, Boudjema, F., Singh, Ritesh K., 2009, Journal of High Energy Physics, 0907, 028

Kaluza-Klein excitations of gauge bosons at the LHC, Djouadi, A., Moreau, G., Singh, Ritesh K., 2008, Nuclear Physics B, 797, 1

PhD Students:

Lisa Edelhauser, Priyashri Kar

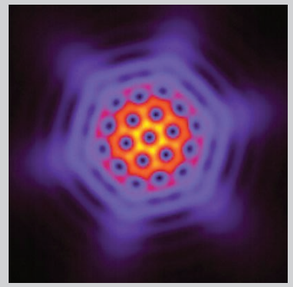
Ritesh Singh obtained his PhD in Physics from the Indian Institute of Science in 2006. Subsequently he was a postdoctoral fellow at LPT Orsay & LAPTH, Annecy in France and Wuerzburg University in Germany before joining IISER-Kolkata. He is young associate of Indian Academy of Sciences for 2011-2014.

Subhasis Sinha
Associate Professor
subhasis@iiserkol.ac.in

Theory of ultracold quantum gases and quantum dissipative dynamics

Research interests:

- Hydrodynamic and phase coherent collective properties of trapped Bose condensates: (e.g. rotating condensate, vortices and solitons in BEC, collective excitations of condensate with long range interaction, Josephson dynamics)
- Quantum Phase Transition of ultracold Bosons and Fermions in an optical lattice and correlated phases of cold atoms (e.g. Supersolid phase, density waves, paired supersolid etc.).
- BCS-BEC crossover
- Dissipative dynamics of quantum systems (Quantum Brownian motion, effect of dissipation on quantum phase transitions, quantum quench)



This graphics shows hexagonal lattice structure of a trapped condensate coupled to a synthetic gauge field.

Selected Publications:

Phases and collective modes of a hardcore Bose-Fermi mixture in an optical lattice,
Sinha, S. and Sengupta, K., 2009, Phys. Rev. B, 79, 115124

Nonperturbative approach to quantum Brownian motion, Sinha, S., and Sreeram, P. A., 2009, Phys. Rev. E, 79, 051111

Dissipative quantum systems and the heat capacity , Dattagupta, S., Kumar, J., Sinha, S., and Sreeram, P. A., 2010, Phys. Rev. E, 81, 031136

Superfluid-insulator transition of ultracold bosons in an optical lattice in the presence of a synthetic magnetic field, Sinha, S., and Sengupta, K., 2011, Europhys. Lett., 93, 30005

Trapped Two-Dimensional Condensates with Synthetic Spin-Orbit Coupling, Sinha, S., Nath, R., and Santos, L., 2011, Phys. Rev. Lett., 107, 270401

PhD Students:

Arpita Sen, N. Linga Murthy

Subhasis Sinha obtained his PhD in Physics from the Institute of Mathematical Sciences in 2001. He was a postdoctoral fellow at Ecole Normale Superieure (Paris), Max Planck Institute for complex systems (Dresden), Stuttgart University and visiting scientist at Laboratoire de Physique Theorique et Modeles Statistiques (Orsay). He was 'Faculty fellow' at S. N. Bose National Centre for Basic Sciences (Kolkata) from 2006 to 2008. Subhasis joined IISER-Kolkata in 2008.

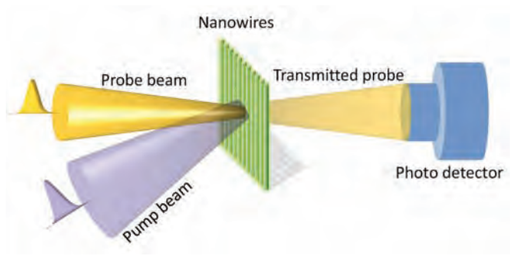
Prashanth Upadhya

Assistant Professor
pupadhya@iiserkol.ac.in

Exploring the light-matter interaction in minuscule space and time scales

The objective of our research is to develop and apply ultrafast optical tools that can temporally (at the fundamental timescale) as well as spatially resolve light-matter interaction over a broad wavelength range from the visible to the far infrared (Terahertz). We employ tunable ultrafast lasers to develop novel ultrafast spectroscopy systems that can probe both static and non-equilibrium dynamics in variety of systems.

One of our research interests is in the area of terahertz science since terahertz (10^{12} Hz) radiation has immense scientific and technological importance because it embraces the fundamental interface between electronics and photonics. Our efforts are aimed at developing ultrafast terahertz sources and detectors, and implement them for variety of applications including spectroscopy, imaging and sensing.



Further, by employing variants of ultrafast techniques (for example, ultrafast microscopy) we study ultrafast carrier dynamics in nanostructured materials and explore new approaches to realize optimized functionalities of nanodevices for their application in nanophotonics and energy harvesting.

Selected Publications:

Understanding ultrafast carrier dynamics in single quasi-one-dimensional Si nanowires, Seo M. A., Dayeh S. A., Upadhya P. C., Martinez J.A., Swartzentruber B. S., Picraux S. T., Taylor A. J., and Prasankumar R. P., 2012, Applied Physics Letters, 100, 071104

Influence of surface states on the transient photoconductivity in Si nanowires, Kar A., Upadhya P. C., Dayeh S., Picraux S. T., Taylor A. J., and Prasankumar R. P., 2011, IEEE Journal of Selected Topics in Quantum Electronics, 17, 889 (invited paper)

Dual-band ultrafast optical switching device with negative-index metamaterial, Dani K. M., Ku Z., Upadhya P. C., Prasankumar R. P., Brueck S. R. J., and Taylor A. J., 2011, Optics Express, 19, 3973

The influence of defect states on non-equilibrium carrier dynamics in GaN nanowires, Upadhya P. C., Li Q., Wang G. T., Fischer A. J., Taylor A. J., and Prasankumar R. P., 2010, Semiconductor Science and Technology, 25, 024017 (invited paper in special issue on nanowires)

Sub-picosecond optical switching with a negative index metamaterial, Dani K. M., Ku Z., Upadhya P. C., Prasankumar R. P., Brueck S. R. J., and Taylor A. J., 2009, Nano Letters, 9, 3565

PhD Students:

Sudipta Sengupta, Mandira Pal

Dr Prashanth Upadhya obtained his PhD in Physics from Cavendish Laboratory, University of Cambridge, UK in 2004. Following this he was post doctoral research associate at University of Leeds, UK and research fellow at Center for Integrated Nanotechnologies, Los Alamos National Laboratory, USA. He joined IISER Kolkata in 2011 as a member of faculty in the Department of Physical Sciences.

ACHIEVEMENTS

Although the Department of Physical Sciences at IISER Kolkata is relatively young, it is well on its way towards being a major hub for the study of Physics and allied subjects in India. Our faculty have published in renowned interdisciplinary journals as well as in top journals within their field. They have produced students who are now pursuing higher studies at renowned Universities around the world. Their contributions to science have been recognized both within and outside the country with prestigious awards, honours and fellowships. Departmental faculty also play leaderships roles nationally and internationally and lead major projects of importance to their field. Here is a highlight of these achievements.

Student Performance and Placement

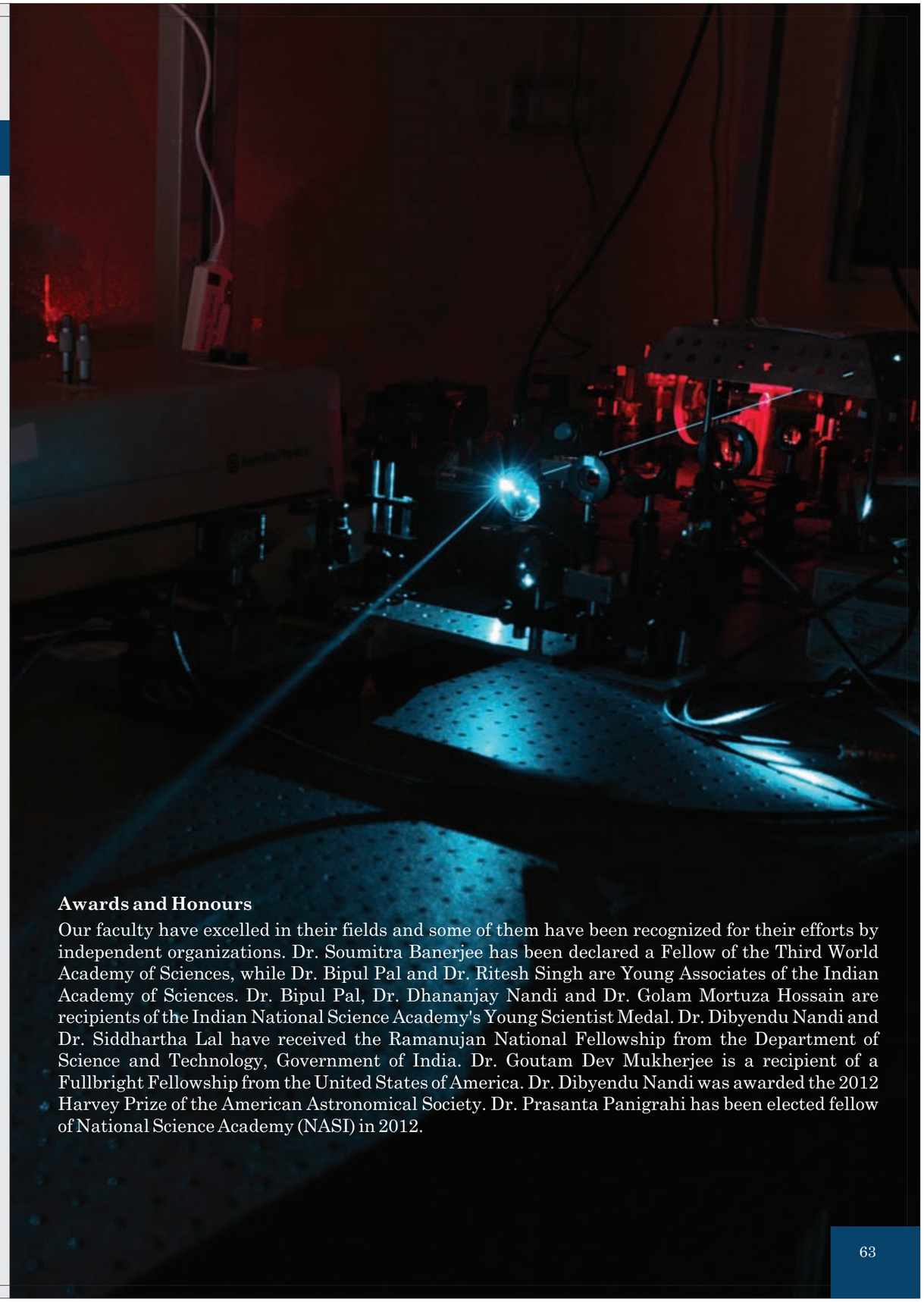
We leave no stones unturned in our effort to impart the best education to our students in a setting that is structured around a formal course-work but which provides ample opportunities of informal interaction to ignite a young, ambitious mind. The fruits of our labour are to be found in the success stories of our past students who have competed with the best of the world to secure positions in top Universities – where they are expected to be the future of Science. This we deem to be our biggest achievement. We produced the only Rhodes Scholar from India in the field of Sciences in 2011 and also a Clarendon Scholar – both now at University of Oxford. Our students are placed in Cornell University, Ecole Normale Superiere, University of Goettingen, Indian Institute of Science, Jawaharlal Nehru Centre for Advanced Scientific Research, and Rutgers University amongst others. We hold our students very dear and are confident that they will make a positive impact wherever they are.

Research Output and Publications

Our primary love is for doing science. While that pursuit should not always be reduced to statistics such as the number of publications and the impact factor of the journals we publish in, that exercise is sometimes useful for general comparisons. Physics Department faculty have in their portfolio the best international journals such as Nature, Nature Physics, Nature Genetics, Science and Physical Review Letters – in addition to the best specialized journals of their field. Their research works have garnered international attention and has been the focus of multiple press releases and feature articles in top media outlets in India and abroad.

Major Projects and Leadership Roles

Faculty at the Physics Department have gone beyond the domain of their individual research to play leadership roles within their community and are involved in projects of major significance. Currently operational cumulative sponsored project grants amount to Rs. 7,80, 58,200 (i.e. INR 7.80582 Crores). Dr. Goutam Dev Mukherjee is the Principal Investigator of a major High Pressure facility funded by the Ministry of Earth Sciences that seeks to explore extreme conditions that are to be found in the Earth's interior. Dr. Dibyendu Nandi is the Principal Investigator and Coordinator of the Ministry of Human Resource Development's Center of Excellence in Space Sciences that is envisaged to study the Sun, explore space weather and help in the hunt for gravitational waves. Dr. Dibyendu Nandi is also a science team Co-Investigator for India's first solar space mission Aditya and is Vice-Chairman of the Panel on Space Weather for the international Committee on Space Research (COSPAR) and Chairman of the International Astronomical Union Working Group on Solar and Stellar Environments. Dr. Rajesh Nayak is playing a significant role in the Laser Interferometer Gravitational Wave Observatory (LIGO)-India project which is envisaged to deploy instruments for detecting gravitational waves.



Awards and Honours

Our faculty have excelled in their fields and some of them have been recognized for their efforts by independent organizations. Dr. Soumitra Banerjee has been declared a Fellow of the Third World Academy of Sciences, while Dr. Bipul Pal and Dr. Ritesh Singh are Young Associates of the Indian Academy of Sciences. Dr. Bipul Pal, Dr. Dhananjay Nandi and Dr. Golam Mortuza Hossain are recipients of the Indian National Science Academy's Young Scientist Medal. Dr. Dibyendu Nandi and Dr. Siddhartha Lal have received the Ramanujan National Fellowship from the Department of Science and Technology, Government of India. Dr. Goutam Dev Mukherjee is a recipient of a Fullbright Fellowship from the United States of America. Dr. Dibyendu Nandi was awarded the 2012 Harvey Prize of the American Astronomical Society. Dr. Prasanta Panigrahi has been elected fellow of National Science Academy (NASI) in 2012.

ALUMNI

ALUMNI INFORMATION OF THE DEPARTMENT OF PHYSICAL SCIENCES OF IISER KOLKATA AS ON 21ST FEBRUARY 2013

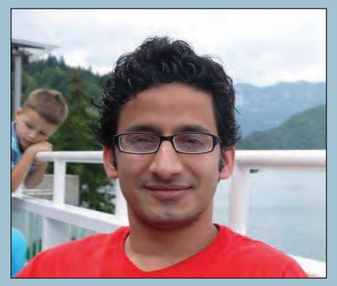
Batch BS-MS 2011(1st Year)

Name of the Students	Position	Placed at	Honorary funding
Challenger Mishra	DPhil, Rudolf Peierls Centre for Theoretical Physics	University of Oxford	Rhodes Scholar 2011
Sambit Bikas Pal	PhD in Quantum Matter Group, Centre for Quantum Technologies	National University of Singapore	CQT Scholarship
Abhishek Dasgupta	DPhil, Department of Computer Science	Oxford University	Clarendon Scholar
Sayan Choudhury	PhD in Theoretical Condensed Matter Physics	Cornell University	
Aabhaas Vineet Mallik	PhD in Center for Condensed Matter Theory, Department of Physics	Indian Institute of Science	CSIR Shyama Prasad Mukherjee Fellow (2011)
Ebad Kamil	PhD in Theoretical Condensed matter physics at Institute for Theoretical Physics	University of Goettingen Germany	DFG FOR 1346 (German Science Foundation) grant
Asit Singh	lecturer in physics	hometown	
Anshul Saini	PhD in Physics	SUNY Buffalo	
Bradraj Pandey	PhD in Theoretical Science Unit JNCASR	Jawaharlal Nehru Centre for Advanced Scientific Research	CSIR-UGC-JRF
Arijit Haldar	PhD physics India	IISc Physics Department	Fellowship: CSIR SPM Fellow
Ipsita Satpathy	PhD	Univ of Goettingen	

Batch BS-MS 2012(2nd Year)

Name of the Students	Position	Placed at	Honorary funding
Ankur Shringi	Project Assistant, Bangalore	Divecha Center for Climate Change,IISc,	
Amit Nag	PhD candidate Dept of Physics, Univ of Maryland, College Park	5029, Berwyn Road, College Park, MD 20740,USA	
Amit Anand	Pursuing MBA from XLRI(HR)	Human Resource Management, XLRI, Jamshedpur	
Irfan Raza			
Piyush Pushkar	Preparing for civil services	Near DAV School, Mourya Vihar Colony, Transport Nagar, Kumhrar, Patna 800026	
Aniket Patra	PhD Physics,	Rutgers University 6898 RPO Way College Avenue, New Brunswick, New Jersey - 08901	
Debashis Sanyal	PhD Student	Argelander Institute for Astronomy, University of Bonn, Germany	
Sibasish Banerjee	PhD Student	University of Montpellier and Ecole Normale Superieure, France	
Anish Bhardwaj	PhD	Florida State Universiy	
Debanjan Basu	PhD, GAUSS	University of Gottingen	
Dibya Chakravorty	Research Assistant, IISER-Kolkata	IISER-Kolkata	
Satish Kumar	PhD (Physics)	University of Texas Arlington, USA	
Harsh Purwar	Doctoral Student	CORIA, University du Rouen, France	

Alumni Space: Messages from our Students



Name: Challenger Mishra, Rhodes Scholar
Year of Graduation (MS Program): 2011
Current Institution: University of Oxford, UK
Degree Enrolled in: D.Phil. in Theoretical Physics

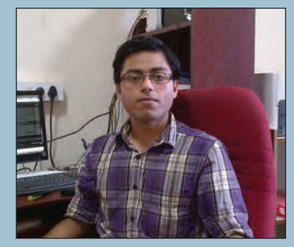
The Physics department at IISER Kolkata boasts of a faculty each member of which is an adept researcher and a brilliant teacher. One of the most exciting features of studying Physics, much like studying any other subject at IISER Kolkata, was the pool of interdisciplinary subjects one could procure knowledge in. This really opened up to us the fact that science is meant to be interdisciplinary. The fact that several faculty members were leaders of their fields truly inspired me. Studying at the IISERs provides an edge to anyone wishing to pursue a career in basic science. The Physics department at IISER Kolkata is no anomaly. During my time, I engaged in research projects not only at my department but also at other institutes around the world. These were crucial in securing admission for further studies at the Institute of my choice. The focal point of the curriculum is involvement in research projects and this inevitably lays the foundations of an exciting career of research in basic science.

Name: Ebad Kamil
Year of Grad (MS Program): 2011
Current Institution: Institute für TheoretischePhysik, Universität Göttingen, Germany
Degree Enrolled in: PhD

5 years at IISER Kolkata indeed turned out to be the most fruitful years of my life. The entire curriculum at IISER Kolkata including well planned course work, intensive research projects, presentations and allowing students to work as teaching assistants for faculty, worked out to be the most suitable recipe for starting a balanced research life. Due to very moderate student-teacher ratio at the Department of Physical Sciences, healthy and friendly research and teaching discussions were abundant. I feel privileged to have been part of the Department of Physical Sciences at IISER Kolkata.

Name: Aabhaas Vineet Mallik
Year of Graduation (MS Program): 2011
Current Institution: Indian Institute of Science, Bangalore
Degree Enrolled in: PhD

It has been a couple of years since I graduated from IISER Kolkata. So, it may not be possible for me to remember all the subtle things about the Department of Physics, which helped me grow as a student and as a person. Nevertheless, looking back at the coarse-grained picture of the five years that I spent at IISER Kolkata, I have no doubt that the training, company and exposure that I got at IISER was completely transforming in nature, both at academic as well as personal level. Though the learning process is still going on, and in all likelihood, will go on for quite some time, I truly feel that the years spent at IISER Kolkata were crucial in making me capable of taking this journey into the field of research in Physics and Science in general.



Name: Dibya Chakravorty
Year of graduation (MS): 2012
Current Institution: TU Munich, Germany
Degree Enrolled in: PhD

Studying at Department of Physical Sciences, IISER Kolkata has been fun and rewarding. With a comprehensive course list (with a vast pool of specialized topics to choose from), modern lab equipment, ridiculously high teacher to student ratio and a culture of promoting core and interdisciplinary research, it's hard to find a better place to get a Physics degree from. I got a generous stipend to support my studies and living, friendly professors and peers to interact with, an informal atmosphere and all the help and guidance that I needed to further my career in research. While the level of course work was challenging, everything else was taken care of. The new BS-MS format with compulsory MS Thesis is internationally acceptable, making sure I never had application jitters after graduating. The large body of faculty representing almost every specialization in Physics meant that I had the freedom to pursue research in any field that caught my fancy. Compulsory seminar courses and a vast array of computational courses that complement coursework made sure that I graduated with a know-how and skill set at par with global standards. Internship opportunities in the best research labs and groups in India and abroad swarmed in plenty during every summer and winter break. Inquivesta, the signature science fest of IISER Kolkata added fuel to our crazy ideas and out of the box thoughts every year. I thoroughly enjoyed my time here and am grateful for the edge it gave me over the traditional university system.

Name: Arijit Haldar
Year of Graduation (MS Program): 2011
Current Institution: Indian Institute of Science, Bangalore
Degree Enrolled in: PhD

I am delighted to hear about the idea of former students expressing their views in the Departmental Brochure. The time spent by me at IISER Kolkata was really great, although we had to change our hostels a few times. Finally we did get our permanent hostels at Mohanpur, which I might say was arranged very quickly considering the fact that Institute was just two years old. After the end of the 4th semester, I chose Physics as major. The curriculum was very thoughtfully organised, and being the first batch wewere able to persuade our professors to teach few courses and topics, that are not usually taught at the undergraduate level, like Quantum Field Theory, General Theory of Relativity. Even the laboratory experiments covered lot of the aspects of classical and quantum physics. The best part I enjoyed about the laboratory curriculum was that we had do a final project at the end of each semester, and we were allowed to be as imaginative as possible, to make any kind of instruments or experiments that would allow us to study some interesting physics. As far as preparing for the exams like NET, GATE, JEST, GRE etc., I did not have to study anything extra. In fact I did not even bother preparing for these exams until the very end. The courses that we credited, the extensive assignments and lab quizzes were enough to prepare us for these exams. In the final year of our Integrated MS program, we had to do a project that contributed to our thesis. For this I was able to work on some recent areas of classical optics. The experience gained in doing my MS project was extremely valuable, and it gave me an idea how real life research is actually done.

Name: Barun Majumder
Year of Graduation (PhD): 2013
Current Institution: IIT Gandhinagar
Current Position: Assistant Research Professor

The tranquil and natural environment of IISER Kolkata is very much suitable and ideal for graduate studies. The diversity of the background in the Physics community contributed greatly in learning many recent research aspects of Physics. IISER Kolkata with its emphasis on cutting edge and empirical research has immensely facilitated in acquiring skills essential to accomplishing my career goals. My learning from IIISER Kolkata is indispensable. More importantly, IISER Kolkata gave me the utmost freedom for independent research and thinking with which I am enjoying my research every moment of my life.

EDUCATION, OUTREACH AND MEDIA

At IISER Kolkata, in addition to reaching out to prospective students in various schools, colleges, and universities, we try to contribute our bit to spread scientific awareness in general to the layman, revealing science as a simple, innovative and fun enterprise. The Department of Physical Sciences too does its bit in reaching out to the external world and spread the joy of physics to all and sundry. In the process, our efforts towards spreading awareness are channelized in three main directions:

Public Lectures in Association with Science City:

IISER Kolkata, in association with Science City, hosts internationally acclaimed scientists in public lectures. Admission to these special events is free for school and college students. The aim is to provide a source of inspiration for students and encouraging young minds of the community to emulate interest so as to consider pure sciences as a career option. The packed auditoriums and halls testify to the strong spirit of enthusiasm as the modern fathers of the sciences instill and enhance a fascination for science and aptitude for excellence.

Some of the distinguished physicists we hosted in the past few years include:

- George Fitzgerald Smoot (Nobel Laureate in Physics, 2006)
- Loren Acton (Astrophysicist and Astronaut, NASA)
- Roger Penrose (Recipient of the Wolf Prize, known for his work on Black holes with Stephen Hawking and his books "Emperor's new mind"and "Road to Reality")
- Sir Anthony Leggett (Nobel Laureate in Physics, 2003)

International Exposure

IISER Kolkata believes in exposing its students to top class facilities. In this regard DPS has successfully collaborated with a number of reputed institutes. Our students have won fellowships and completed projects in places like Rochester Institute of Technology, Caltech, University of Goettingen and University of Hamburg etc. Similarly physics students from top institutes across the globe have found our research environment conducive. Amongst the recent visitors to our institute, we have had students and scientists from Gottingen University, Montana State University, Lund University, University of Toulouse, Changshu Institute of Technology, etc. Also, students are regularly encouraged to visit renowned labs and institutes, both national and international, for summer programmes extending between eight to twelve weeks. DPS students have visited labs in universities and research institutes such as the Max Planck Institute for Quantum Optics, University of Rochester, Rice University, Goethe Universitaet, University of Heidelberg, University of Texas at Arlington, National University Singapore, Indian Institute of Science Bangalore, Tata Institute of Fundamental Research, National Center for Biological Sciences and National Center for Radio Astronomy.

Lectures by Department Faculty

DPS faculty also regularly visits local schools, colleges and Organizations for lectures in general topics in Physics as well as on their own fields of research. Faculty have delivered public lectures in various forums such as the Jawaharlal Nehru Planetarium (Bangalore), Alliance Francaise's Bonjour India Festival and student fests at IIT Kharagpur, NIT Durgapur, St. Xavier's College etc.

Interaction with Schools and College Departments

The Department has organized programs to reach out to local schools and colleges. Apart from lecturing at these institutions, we invite local schools and colleges to visit our Department in our campus. In these visits, there a handful of talks by Departmental faculty about exciting research areas of Physics in which we work, research laboratory visits and hands-on demonstration experiments in teaching laboratories. Very recently, the students of physics in St. Xavier's College, Kolkata visited DPS, IISER Kolkata. We encourage teachers from all schools and colleges to visit and interact with us to exchange new ideas and methodologies of classroom and laboratory instruction. This is in keeping with our philosophy of not just attaining excellence in teaching within our boundaries, but disseminating that knowledge base outside, as well as assimilating excellent and novel teaching methods from other institutes.

INQUIVESTA – The Science Fest

The students' body of IISER Kolkata organizes its annual science fest called INQUIVESTA in spring each year. The fest has been sponsored by various MNCs including Pfeiffer, Buchi, HOLMARC, etc. Inquivesta is the scientific alternative of tech-fests; participants hail from various colleges from all over India ranging well above a thousand every year.

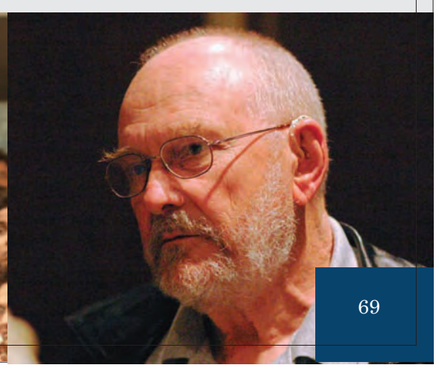
The first ever science fest of its kind in India, Inquivesta aims at celebrating the spirit of science among the students of India. Several students belonging to DPS, both undergrads with physics major, and graduate students participate actively in both organizing as well as participating in INQUIVESTA.

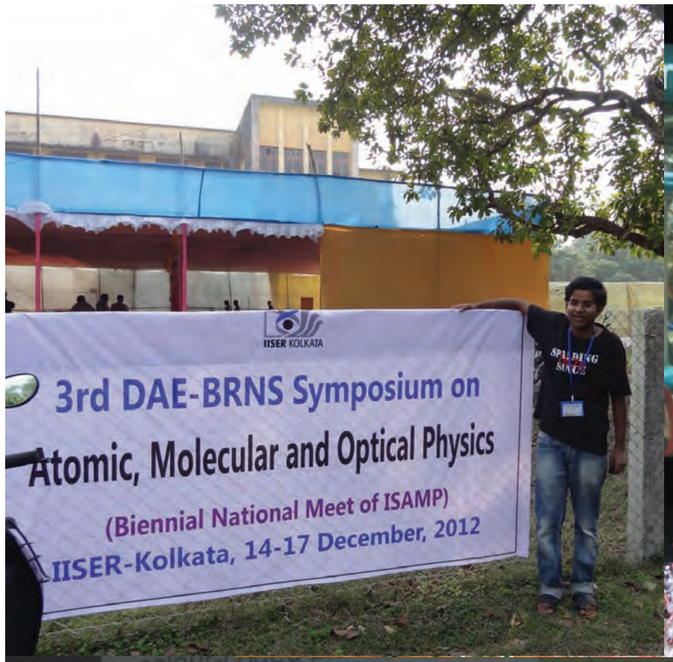
JAGRITI: Social Service Forum

Jagriti is IISER Kolkata's social outreach and help forum, with the workforce including both students and faculty. Since 2009, Jagriti has organized regular classes for the children of security guards, daily wage laborers and other miscellaneous workers who work in the IISER campus. It complements regular school studies with an innovative program of familiarization with science and the languages. Such classes have separate modules, taught by student volunteers, aimed at children studying in classes 5 to 12. Jagriti has recently encompassed a wider range of social activities by organizing regular free medical checkups and blood donation camps with the help of the Institute doctor. Additional donation drives such as distributing warm clothes during winter to people residing in the rural areas around the campus are made. DPS students and faculty members play key roles in Jagriti with a sincere and whole-hearted goal towards reaching out to the underprivileged in our society.

Print, Television Media and the General Public

Research work performed by faculty at the Physics Department have been featured in press and television media both within and outside the country. We appreciate that sharing the excitement of what we do with the general public through media is a necessary and important aspect of publicly funded science programmes. News of our research and interviews of our faculty have appeared in diverse forums such as Reuters, ABC, CBC, Sydney Morning Herald, Dawn, Times of India, Telegraph, Hindu, Deccan Herald, Hindustan Times, Indian Express, The Week, India Today, New York Times Dot Earth Blogs, Scientific American, Sky and Telescope, Discovery Magazine, CNN-IBN, Lok Sabha TV and All India Radio. Our faculty have also written invited articles for reputed magazines such as BBC Knowledge and Physics Today.





CONFERENCES AND VISITORS

1. **International Conference on Cold Atoms,**
   12-16 December, 2008,IISER Kolkata
   Organizers: P., Panigrahi, C. Mitra, P. Sreeram

2. **Workshop on LHC Physics at IISER Kolkata**
   19-24 December, 2008, IISER Kolkata
   Convener: Amitava Datta

3. **The Universe Under a Microscope: Physics at the Large Hadron I Collider**
   30th October, 2009, Science City Kolkata, Kolkata
   Organizers: Harishchandra Research Institute (Allahabad), IISER Kolkata, and Science City (Kolkata)

4. **International Space Climate Symposium 4**
   16-21 January, 2011, Goa, India
   http://www.iiserkol.ac.in/~spaceclimate4/
   LOC Chair and Institution: Dibyendu Nandi, IISER Kolkata

5. **Workshop on Field Theory : Recent trends and applications**
   22-25 August, 2011, IISER Kolkata
   http://www.iiserkol.ac.in/~ftrta2011/
   Organizer: Prasanta Panigrahi

6. **Current Topics in Condensed Matter**
   7-9 October, 2011, IISER Kolkata
   http://www.iiserkol.ac.in/~ctcm2011/CTCM2011.html
   Organizers (IISERK): S. Dattagupta, Siddhartha Lal, Arindam Kundagrami, Rumi De

7. **Indo-Israel Meeting on Condensed Matter**
   15-18 October, 2011, Cochin, Kerala
   http://www.iiserkol.ac.in/~iimcm5-2011/index.html
   Organizers (IISERK): S. Dattagupta

8. **ICTS International Nonequilibrium Winter School**
   27 December, 2011 – 11 January, 2012, IISER Kolkata
   http://www.icts.res.in/program/details/282/
   Organizers: Sushanta Dattagupta, Yuval Gefen, Amit Ghosal, Ganpathy Murthy, Sanjay Puri, Sriram Ramaswamy, Krishnendu Sengupta, Nayana Shah and Subhasish Sinha

9. **1st Inter-IISER Physics Meet**
   17-19 February, 2012, IISER Kolkata
   http://www.iiserkol.ac.in/~iipm/
   Organizers: Uday Kumar, Ritesh Singh and Bhavtosh Bansal

10. **3rd DAE-BRNS Symposium on Atomic, Molecular and Optical Physics 2012**
    14-17 December, 2012, IISER Kolkata
    http://www.iiserkol.ac.in/~amop2012/committee.html
    Organizing Committee: Dhananjay Nandi, Amlan Roy and Ashwani Kumar Tiwari

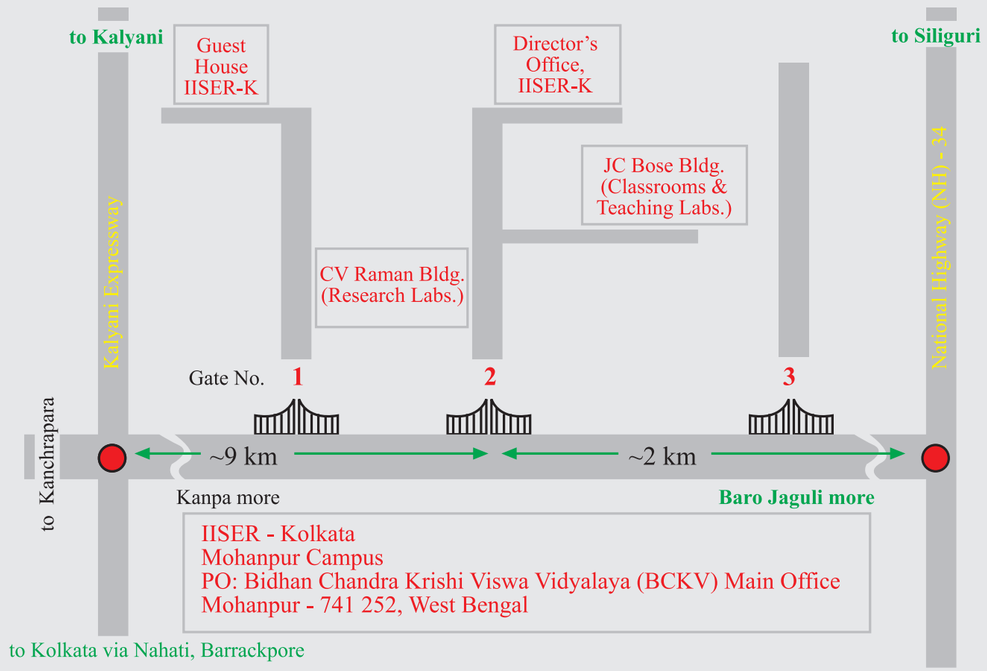
Eminent Visitors for DPS Seminars and Colloquia

J. N. Goswami (PRL), **Sriram Ramaswamy** (IISc), **Jainendra Jain** (Penn State), **Chandan Dasgupta** (IISc), **Bulbul Chakraborty** (Brandeis), **Sunil Mukhi** (IISER, Pune), **T. V. Ramakrishnan** (IISc/BHU), **Guenther Werth** (Gutenberg), **A. K. Sood** (IISc), **Subhasis Dutta Gupta** (Hyderabad), **Markus Münzenberg** (Göttingen), **Piet Martens** (Montana), **Thomas Pruschke** (Göttingen), **Sanjay Puri** (JNU), **Tarun Souradeep** (IUCAA), **D. D. Sarma** (IISc), **G. Döhler** (MPI), **Naresh Dadhich** (IUCAA), **Peter Oppeneer** (Uppsala), **J. V. Narlikar** (IUCAA), **Arnab Rai Choudhuri** (IISc), **Archana Bhattacharyya** (IIGM)

LOCATION

The modest beginning of IISER Kolkata was made from the IIT Kharagpur extension centre and NITTTR campus at Salt Lake, Kolkata in August, 2006. In July 2008, IISER Kolkata was moved to Mohanpur in the Nadia district of West Bengal. The nearest railway station, Kanchrapara, is located on the Sealdah-Kalyani-Krishnanagar main line, about 9 km due west from the campus. The National Highway 34 (NH34) passes through a nearby crossing, Barajaguli, and connects the campus to Kolkata, approximately 50 km away. Alternatively, Kolkata is connected to IISER Kolkata campus through the Kalyani Expressway via Kanchrapara and Barrackpore.

The transit campus, including classrooms, laboratories, and hostels, is a temporary arrangement within the picturesque campuses of Bidhan Chandra Krishi Viswavidyalaya (BCKV) and West Bengal University of Animal & Fishery Sciences (WBUAFS). The permanent campus, in which the construction activities are underway, is being built on a two-hundred acres of land in the nearby Haringhata Mouza that is just 15 minutes bicycle ride away from the transit campus. A lot of teaching and research activities, and facilities currently run from various temporary (pre-fabricated) and permanent buildings in the main campus. The new hostel block for students in the main campus is nearing its completion. The transit and main campuses are well-connected through dedicated bus and vehicle services by IISER Kolkata. The campus is planned to be a green campus, wherein students, faculty and staff can live in harmony with nature. Currently IISER Kolkata is functioning both from transit and permanent campuses.



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Rajesh Kumble Nayak
Mitali Pal