PHYSICS
IIT KANPUR

PhD Placement Brochure 2024-2025

Department of Physics

Indian Institute of Technology Kanpur

Visit https://iitk.ac.in/phy/

Introduction

The Department of Physics at IIT Kanpur, established in 1960, has consistently been a beacon of academic and research excellence. Renowned internationally, it has built a legacy of pioneering research and outstanding teaching. The department spans a broad spectrum of cutting-edge fields, including:

- Biological Physics
- Condensed Matter Physics
- High Energy and Nuclear Physics
- Cosmology and Astrophysics
- String Theory
- Photonics
- Quantum Optics and Quantum Computation
- Information Theory
- Nonlinear Dynamics
- Statistical Physics
- Soft Matter Physics

Our distinguished faculty, supported by DST-Inspire Faculty Fellows and Postdoctoral Fellows, mentor around 120 research scholars engaged in innovative doctoral research. The department offers comprehensive academic programs, including undergraduate courses, a BS+MS program, a two-year M.Sc. program, a Ph.D. program, and a unique M.Sc.-Ph.D. dual degree program for those demonstrating exceptional promise.

IIT Kanpur's Physics Department has produced some of the brightest minds in the field, many of whom continue to contribute significantly to science both in India and around the globe. Its alumni, recognized for their international reputation and contributions, serve as brand ambassadors, reflecting the high-quality scientific training and environment they experienced. With state-of-the-art laboratories and a strong interdisciplinary approach, the Department of Physics at IIT Kanpur remains at the forefront of scientific discovery and education.

HOD's Message

The Physics Department of IIT Kanpur has been renowned since its establishment for its excellence in teaching and research. It is widely regarded as one of India's most prestigious and highly sought-after physics departments. We are actively involved in nearly all branches of modern research across theoretical and experimental physics. The department consistently maintains a harmonious balance between theoretical exploration and experimental investigations. The department fosters a dynamic academic environment that extends beyond traditional classroom teaching. Our goal is to train and nurture young talents to excel in their respective fields in the future.

Currently, our department comprises 49 regular faculty members, 5 visiting faculty along with over 230 Ph.D. students and 15 postdoctoral fellows. We provide a range of programs including B.S., MSc, BS-MS dual degree, and MSc-Ph.D. dual degree courses. Physics Departmet of IIT Kanpur has the legacy of nurturing exceptional alumni. Numerous distinguished physicists, both nationally and internationally, have graduated from our department and now occupy esteemed positions.

- **Prof. Dipankar Chakrabarti**
Head of Department, Physics

Programs Offered

Bachelor of Science (BS)

- A 4-years program which allows admission through the Joint Entrance Examination (JEE). The students get a good solid foundation of core physics concepts. The enrolled students also have an option to pursue a second major or a minor in any departments like Economics, Computer Science, or Mathematics.

Bachelor of Science -Master of Science (BS-MS) Dual degree

- The 4-years BS program in Physics has replaced the 5-year integrated MSc program which was running since 1960's. However, for a more thorough knowledge, the students have an option to do master's also which will result in 5-year BS-MS dual program. This program includes a year of rigorous research work. Apart from their main degree, they also have an option to do a minor in another field or department of their interest

Master of Science (MSc)

- This 2-year course takes admission from Joint Admission Test for MSc (JAM). This program comprises of rigorous coursework followed by a year of research.

Master of Science - Doctor of Philosophy (MSc-PhD) Dual degree

- The students have an option to complete a combined degree of MSc and PhD, involving rigorous coursework and research thesis. Admissions are through JAM.

Doctor of Philosophy (PhD)

- Admission is by a written test and interview for those who have a master's degree in physics and have secured a fellowship (either by clearing the GATE exam with a cut-off score decided each year, or have a JRF for research from agencies such as Inspire/CSIR/UGC/PMRF/JEST). Admission is also possible directly to 4-yr undergraduate degree holders from IITs with a CPI more than 8.0 and to GATE toppers. Its focus, unlike other degrees, is more towards generating new knowledge than learning extant knowledge

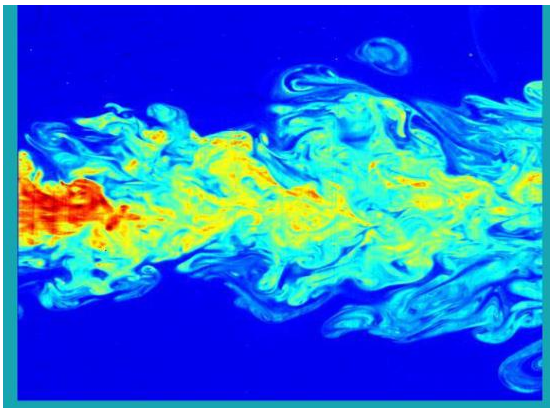
Courses Offered

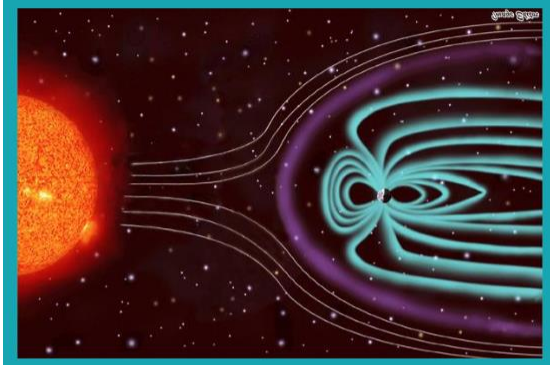
Core courses	• Classical Mechanics • Classical Electrodynamics • Optics • Mathematical Methods I & II • Computational Physics • Modern Physics Lab	• Thermal Physics • Quantum Mechanics I & II • Special Relativity • Statistical Mechanics • Physics laboratory I • Experimental Physics I & II
Quantum Technology and Information	• Quantum Technology • Quantum Coherence and Entanglement	• Quantum Materials • Superconductivity and its applications
Condensed Matter Physics	• Condensed Matter Physics I&II, Quantum Phase of Matter • Advanced Statistical Mechanics • Quantum Many Body	• Soft Matter Physics • Novel Quantum Phases • Nano magnetism and Spintronics • Superconductivity
Quantum Optics and Photonics	• Lasers and its applications • Photonic devices • Optical Imaging	• Atomic, Molecular and Optical Physics
Complex Systems	• Physics of information processing • Order and Chaos • Uncertainty, Information and Classical Dynamics	• Non-linear dynamics • Evolutionary Game Dynamics
High Energy Physics	• Quantum Field Theory • Conformal Field Theory • High Energy Physics I & II • Particle Physics • String Theory	• General Relativity • Cosmology • Machine learning in particle physics

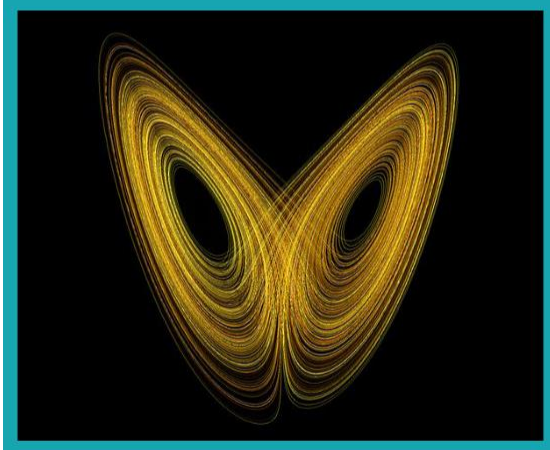
Research Areas

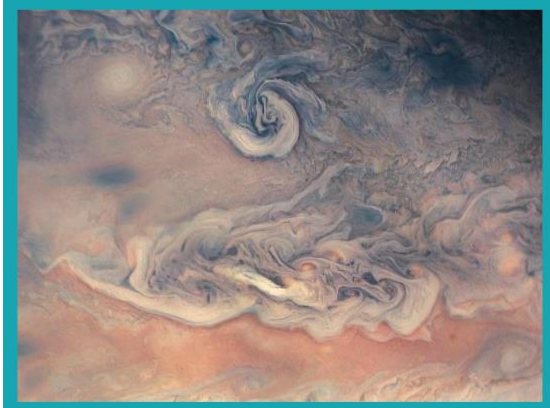
Complex Systems

- **Turbulence Hub: Prof Mahendra Verma**
  - Magnetohydrodynamic turbulence, dynamo, Liquid metal MHD
  - Buoyance driven turbulence, Thermal convection
  - High performance computing
  - Non-equilibrium statistical physics
- **Non-linear Dynamics and Game Theory group: Prof Sagar Chakraborty**
  - Non-linear dynamics
  - Evolutionary Game Theory
- **Space Plasmas, Astrofluids and Complex Environments Group: Prof Supratik Banerjee**
  - Energy transfer in compresssible turbulence
  - Anisotropy in solar wind turbulence
  - Turbulence in ferrofluids
  - Turbulence in active matter fluids
  - Mathematical models of epidemiology
- **Conputational Soft Matter and Bio-physics group: Prof Taraknath Mandal**
  - Multi-scale molecular modeling of polymers
  - Study of rheological properties of micellar solution
  - Protien membrane interactions for understanding cellular processes
- **Soft and Biological matter laboratory: Prof Sivasurender Chandran**
  - Interfacial engineering to control the stability of thin fluid films including polymer films
  - Harnessing nonequilibrium pathways to control the dispersion behavior in polymer nanocomposites
  - Structure formation and dynamics of polymers in evaporating solutions
  - Living systems - Spreading of active solutions
  - Structure formation and dynamics of bacterial biofilms
  - Swarming and other collective modes of bacterial dynamic



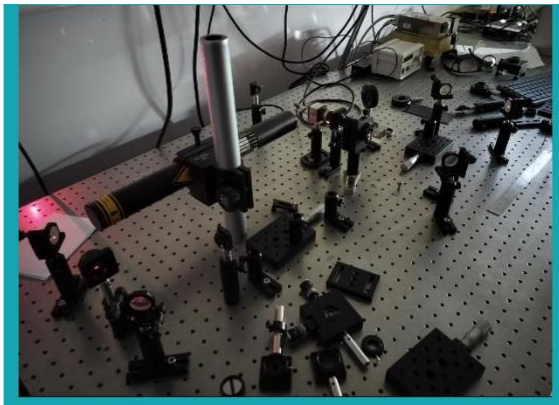


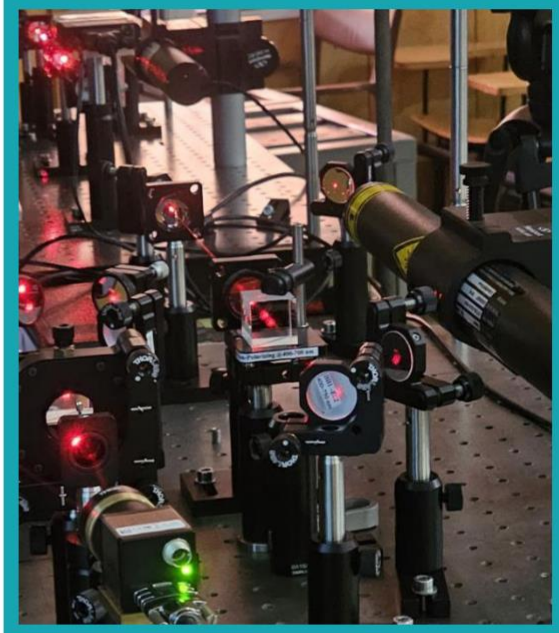


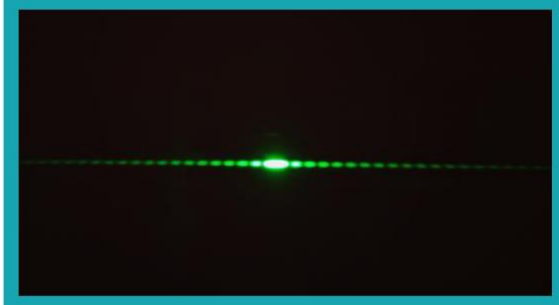


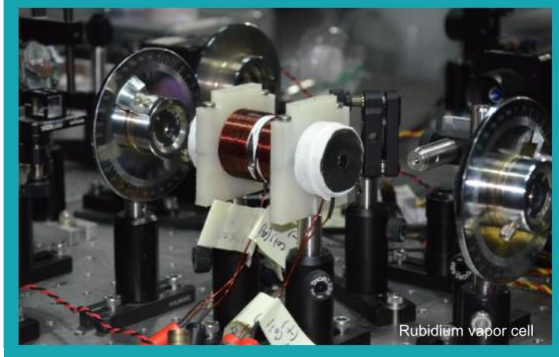
Photonics and Quantum Technologies

- **Quantum Optics and Entanglement Lab : Prof Anand Kumar Jha**
  - Optical Coherence
  - Quantum Entanglement
  - Quantum state reconstruction through coherence function measurement
  - Efficient generation of partially coherent classical and quantum fields
  - Partially coherent light for imaging / communication through scattering and turbulent mediaPartially coherent light for imaging / communication through scattering and turbulent media
  - Orbital angular momentum (OAM) sorter and OAM entanglement
  - Quantifying coherence and entanglement of high-dimensional quantum states
- **Photonics Laboratory: Prof R. Vijaya**
  - Non-linear Optics
  - Fiber Optics
  - Nanophotonics (photonic crystals)
  - RF (Antennas and FSS)
  - Special purpose optics
- **Quantum Measurement Lab : Prof Saikat Ghosh**
  - Coherence in room temperature ensemble of atoms
  - Photon correlations in cold atoms
  - Graphene optomechanics
  - Instrumentation
- **Cold Atoms and Ions Quantum Technologies Lab : Prof Sapam Ranjita Chanu**
  - Quantum computation and simulations with cold ions
  - Cold atoms and quantum metrology with single pure state of cold atoms and ions
  - Quantum States of Light and its properties
- **Quantum Materials and Devices: Prof Sudipta Dubey**
  - Quantum Emitters
  - Valleytronics
  - Moiré physics



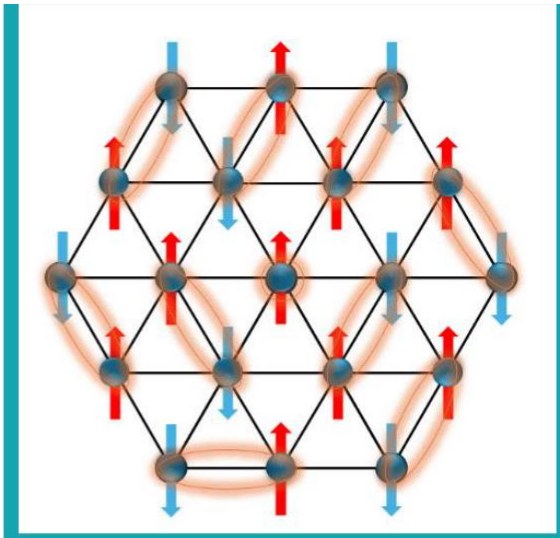


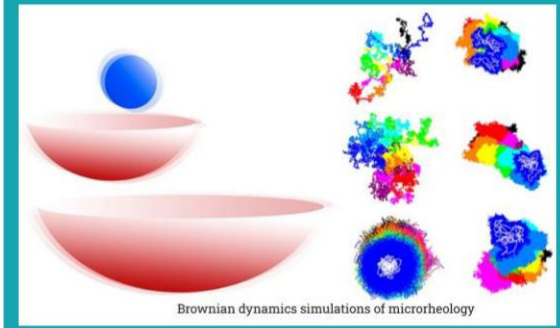




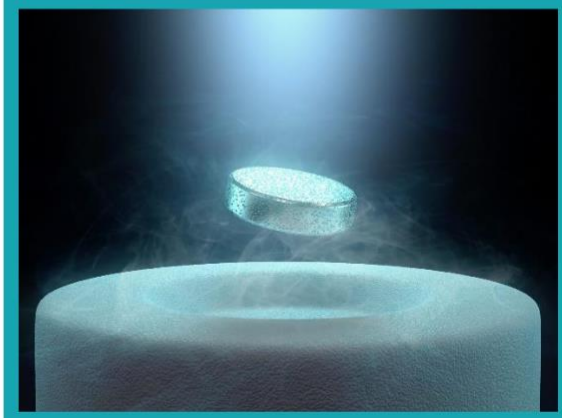
Condensed Matter Physics Experiment

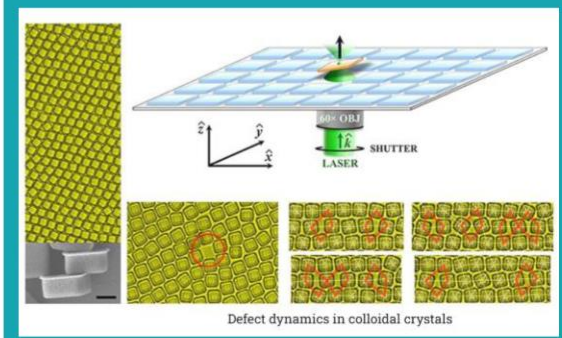
- **Soft Matter Physics Laboratory : Prof Krishnacharya**
  - Open-microfluidics
  - Elastic instability in soft matter
  - Electrowetting on dielectrics
  - Chemically heterogeneous surfaces
- **Soft and active matter research lab: Prof Manas Khan**
  - Active, Nonlinear, and Passive Microrheology
  - Dynamics of Active Brownian Particles in Complex Media
  - Diffusion of Asymmetric Brownian Particles
  - Equilibrium and Nonequilibrium Thermal Fluctuations
  - Defect Dynamics in Colloidal Crystals
  - Heterogeneous Crystallization in Colloidal Systems
  - Membrane Deformability of Human Erythrocytes.
- **Optical Spectroscopy Lab: Prof Rajeev Gupta**
  - Strongly Correlated Electrical Systems
  - Multiferroics and other Oxides
  - Nanomaterials
- **Magneto-electronics Laboratory: Prof Soumik Mukhopadhyay**
  - 3D magnetic van der Waals systems
  - Spin based nanoelectronics
  - Strongly correlated Topological systems
  - Topological Kondo systems
  - Multiferrocity and Magneto-Electricity
  - Spin Liquids
- **Condensed Matter Physics with Optical tools and sensors: Prof Satyajit Banerjee**
  - Superconductivity
  - Magnetism and 2D materials
  - Topological insulators
  - Applications and sensors
- **Ultrafast Light-Matter interaction group: Prof Chandrima Banerjee**
  - Ultrafast Magnetization Dynamics
  - Attosecond Magneto-Optical Spectroscopy
  - Brillouin Light Scattering (BLS) Spectroscopy
  - Micromagnetic simulations





Brownian dynamics simulations of microrheology

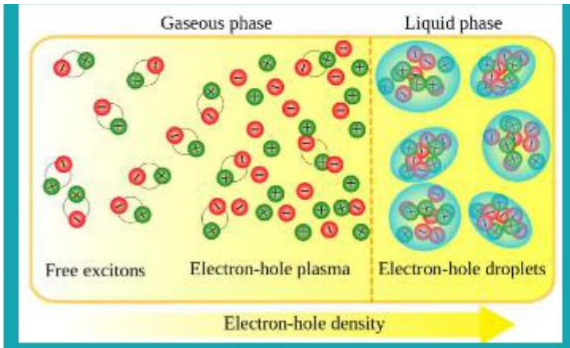


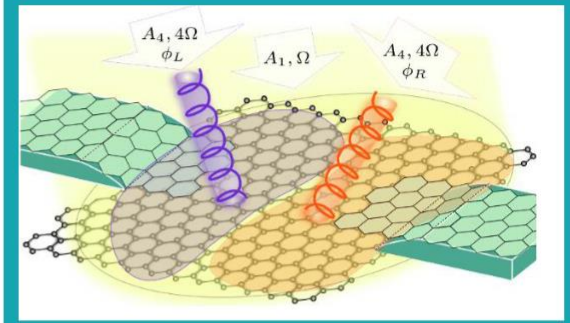


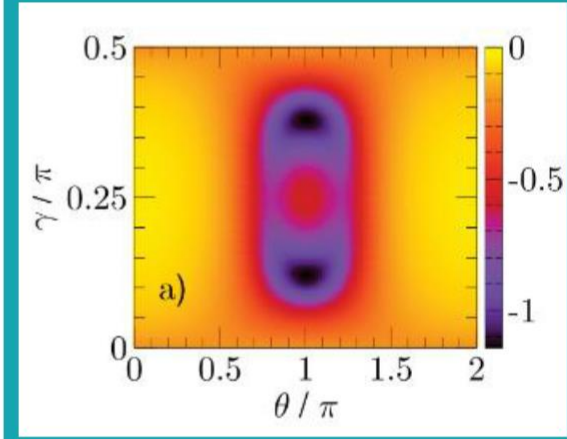
Defect dynamics in colloidal crystals

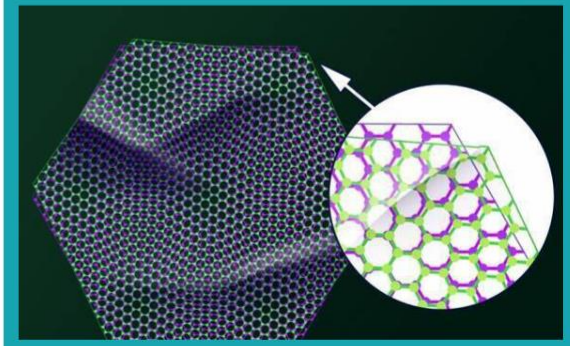
Condensed Matter Physics Theory

- **Quantum Condensed Matter Physics: Prof Adhip Agarwal, Prof Avinash Singh, Prof Manoj Harbola, Prof Tarun Kanti Ghosh**
  - Topological Phases of Matter
  - Magnets and anyons
  - Open systems
- **Quantum Transport and Theory group: Prof Amit Agawal**
  - Transport, electronic and optical properties in Topological materials
  - DFT based exploration of new 2D, magnetic and topological materials
  - Collective density (plasmons) and spin excitations in various systems
  - Nanoscale device modelling
- **Transport and Topology: Prof Arijit Kundu**
  - Topological aspects in Floquet systems
  - Transport in emergent topological systems (Weyl semimetal)
  - Graphene superconductor heterostructure
  - Magnetic transport in topological insulators
- **Materials Physics Group: Prof Koushik Pal**
  - Band and Defect Engineering of Quantum Materials
  - Next-generation Photovoltaics and Thermoelectrics
  - Materials with extreme Thermal Transport Properties
  - Data-driven Design of Advances Functional Materials
- **Metamaterials and Plasmonics Laboratory: Prof S Anantha Ramakrishna**
  - Multi-photon absorption laser microwriter
  - Surface plasmon enhanced spectroscopy
  - Sculptured thin films and their patterning
- **Theoretical Exploration of Quantum Matter: Prof Sudeep Kumar Ghosh**
  - Superconductivity and magnetism
  - Topological order
  - Ultracold atoms`







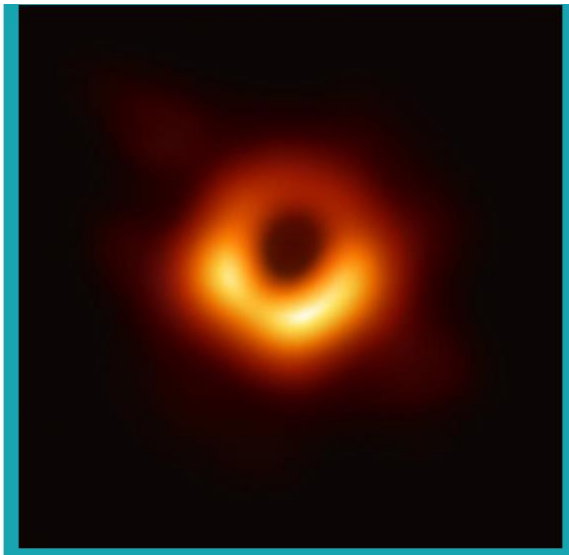


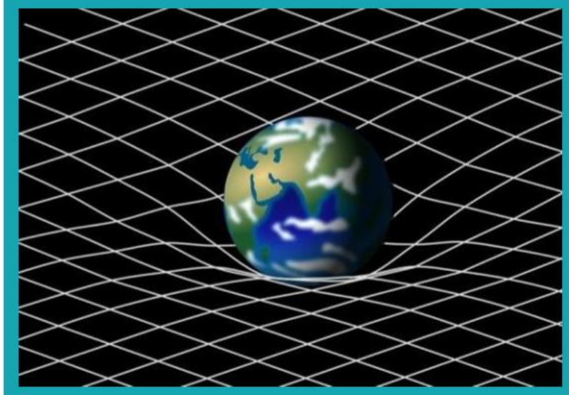
High Energy Physics

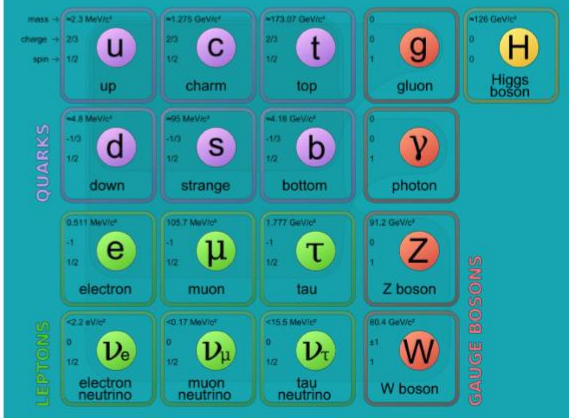
- **String Theory group: Prof Arjun Bagchi, Prof. Apratim Kaviraj, Prof Diptarka Das, Prof Gautam Sengupta, Prof Nilay Kundu, Prof Tapobrata Sarkar**
  - Gauge/gravity duality
  - Quantum Field Theory
  - Classical and Quantum Gravity
  - Critical phenomenon
  - Anti-de Sitter/conformal field theory (AdS/CFT) correspondence
  - Flat spacetime holography
  - Quantum information and gravity
  - String theory and its singular limits
  - Non-equilibrium physics
  - Conformal Bootstrap

Ion Beam, Plasma and Nuclear Solid State

- **Waves and Beams Lab : Prof Sudeep Bhattacharjee**
  - Compact Plasmas confined by dipole magnet
  - Plasmas created at cryogenic temperature - Cryo-plasmas
  - Plasma based creation of focused ion beams
  - Modification of electrical and surface properties of matter by plasma-based low-energy ion beams
  - Atmospheric pressure microplasmas
  - Wave interaction with multicusp plasmas
  - Wave induced plasma initiation







Distinguished Alumni

The Physics Department at IIT Kanpur boasts a remarkable roster of alumni who have made significant contributions to various subfields of physics, earning global recognition for their pioneering work. Among these illustrious graduates is **Ashoke Sen**, a preeminent string theorist at The International Centre for Theoretical Sciences (ICTS, Bangalore), whose groundbreaking contributions have earned him the **Breakthrough Prize in Fundamental Physics,** the **Dirac Medal** and **Padma Bhushan**, among other awards**.** Similarly, **Shiraz Minwalla** at the Tata Institute of Fundamental Research (TIFR) is celebrated for his contributions to string theory. **Jainendra Jain**, a condensed matter theorist at Penn State University, is renowned for his composite fermion theory, which has provided profound insights into the quantum Hall effect. **T. Senthil** at MIT is another luminary in condensed matter physics, recognized for his work on quantum phase transitions and topological phases of matter. **H.R. Krishnamurthy** and **D.D. Sarma** have made notable contributions to condensed matter theory and experimental condensed matter physics, respectively.

Spenta Wadia and **Sandeep Trivedi**, both at TIFR, have made significant strides in theoretical physics, with Wadia known for his work on gauge theories and black hole physics, and Trivedi for his contributions to string theory and holography. **Deepak Dhar**, also at TIFR, is a leading figure in statistical mechanics, known for his work on self-organized criticality and percolation theory. His work has earned him the **Boltzmann Medal** and **Padma Bhushan**. The department also takes pride in **Dinakar Kanjilal**, an accelerator physicist at the Inter-University Accelerator Centre (IUAC), and **Arup Kumar Raychaudhury**, an experimentalist at the S.N. Bose National Centre for Basic Sciences (SNBNCBS), who have advanced experimental techniques in their respective fields. **G. Ravindra Kumar** at TIFR has made significant contributions to the study of laser-matter interactions.

In the realm of high-energy physics, **Jnanadeva Maharana** from the Institute of Physics (IOP) and **Rajeev Bhalerao** at IISER Pune have made notable contributions, enhancing our understanding of fundamental particles and forces. **Samir Mathur**, a string theorist at Ohio State University, is known for his work on the black hole information paradox. **Abhay Pasupathy**, a condensed matter theorist at Columbia University and recipient of the **McMillan Award** in 2011, has made significant strides in understanding strongly correlated electron systems. **Rajesh Gopakumar** at ICTS, Bangalore has contributed extensively to string theory, while **Ashvin Vishwanath** at Harvard University is acclaimed for his work on topological insulators and superconductors.

These distinguished alumni exemplify the high standards of excellence fostered by the Physics Department at IIT Kanpur, and their achievements underscore the department's commitment to advancing scientific knowledge and innovation on a global scale.

Skillsets offered by PhDs

Semiconductor Physics and Flexible Electronics:

- Expertise in mechanical exfoliation & transfer of 2D materials e.g. graphene, MoS_2
- Device fabrication using ink-jet printing, screen printing, spin coating, CVD.
- Characterization techniques including Raman spectroscopy, SEM, TEM, XRD, AFM, photoluminescence, and more.
- Thin film deposition techniques like thermal and e-beam evaporation, sputtering, PLD.
- Cryogenic systems for variable temperature measurements and STM.

Data Analysis and Software Proficiency:

- Programming in Python, C++, Java, Julia, Bash.
- LabVIEW, Mathematica, MATLAB, Origin, LaTeX, Microsoft Excel, Word, PowerPoint.
- Numerical simulation techniques: PIC, FDTD, SOR, and Split-Step Fourier methods, DMRG.
- Data analysis and visualization: ImageJ, EIS Spectrum Analyser, Curve Expert, NODEXL.
- Extensive experience of working with operating systems such as Windows and Linux (Ubuntu).

Vacuum and Plasma Systems:

- Operating and maintaining vacuum systems.
- Plasma diagnostics and high voltage power supplies.
- CAD design and electronic circuit development.

Academics:

- Our PhD students have strong academic background which is required for supervising and mentoring students.
- Debugging and assembling experimental setups.

Miscellaneous:

- Proficiency in COMSOL, AutoCAD, OVITO, LAMMPS, HPC, high voltage systems, cryogenic systems, ultra-high vacuum systems, dielectric barrier discharge systems, and plasma jets.
- Experience in Confocal microscopy, Rheometer operation.

Contact Us

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