DEPARTMENT OF PHYSICS

PH.D. ADMISSIONS JANUARY - MAY 2026

Available Research Topics

S.No	Name of the Faculty	Topics	Title	Abstract	Email Address
1	Dr. Rajesh Singh	THEORY	Fluid physics of life	Using theory and simulations we study the role of fluid flow in non-equilibrium system, such as living matter.	rsingh@physics.iitm.ac.in
2	Dr. Subramanian V	EXPERIMENT	Metamaterial Devices for microwave and millimeterwave applications	With the realization of exotic electromagnetic properties of metamaterial structures, Devices like absorbers, polarization converters, energy harvestors, Sensors, antennas etc. are being developed using this concept. In this project, tunable metamaterial devices would be developed for the communication aspects.	manianvs@smail.iitm.ac.in
3	Dr. Subramanian V	EXPERIMENT	Magnetoelectric Composites for Microwave Applications	Due to the promising nature of laminar composites, new magnetoelectric composites are being developed for different functional applications like energy harvesting, sensors etc. In this project, it is planned to develop new composite materials with improved piezo nature to use as microwave devices also apart from conventional applications.	manianvs@smail.iitm.ac.in
4	Dr. Abhishek Misra	EXPERIMENT	2D materials for opto-electronic devices	CVD growth and development of excitonic devices based on 2D materials.	abhishek.misra@smail.iitm.ac.in
5	Dr. Prabhat R Pujahari	EXPERIMENT	QCD jets and sub-structure in CMS experiment at the LHC	Jet substructure has emerged to play a central role at the Large Hadron Collider (LHC), where it has provided numerous innovative new ways to search for new physics and to probe the Standard Model in extreme regions of phase space. In this measurement the student will work on a comprehensive state of the art machine learning developments in jet substructure. This measurement is meant both as covering the key physical principles underlying the calculation of jet substructure observables, the development of new observables, and cutting edge machine learning techniques for jet substructure. It will prove a useful introduction to the exciting and rapidly developing field of jet substructure at the LHC.	p.pujahari@smail.iitm.ac.in
6	Dr. Ipsita Saha	THEORY	Beyond the Standard Model physics at current and future colliders	Beyond the Standard Model theories are essential for addressing the many unresolved questions that the Standard Model cannot explain, such as the origin of tiny neutrino masses and the nature of dark matter. Current and future particle colliders, including the LHC and its successors, provide a critical platform for testing these BSM theories. While the LHC has yielded significant insights into particle physics, it has yet to produce direct evidence for BSM phenomena. Future colliders will enable more precise measurements and higher-energy collisions, allowing for deeper exploration of previously uncharted territories in particle physics. This research aims to develop and test new theoretical frameworks, uncover potential particles and interactions, and propose experimental strategies to probe them at current and future collider experiments.	ipsita@physics.iitm.ac.in
7	Dr. Basudev Roy	EXPERIMENT	Usage of upconverting particles to perform quantum biology in conjugation with optical tweezers	This is a project in quantum biology where we use the quantum probes like upconverting particles to probe the properties of the cell. We shall perform quantum sensing inside the cell to probe properties like temperature and pH and also perform innovative kinds of experiments. This will use quantum properties like upconverting particle spectra, lifetimes and even absorption correlation spectroscopy to perform sensing inside live cells.	basudev@physics.iitm.ac.in
8	Dr. Pranay Patil	THEORY	Calculating non-linear spectroscopic signatures in magnets using numerical techniques	The response of materials to a sequence of laser pulses allows physicists to develop a deep understanding of the physical processes controlling its dynamics. Although the models for many materials are known, it is not possible to calculate analytically what this response should be. This project would involve developing a Monte Carlo based method to estimate the response without making any approximations. This is expected to be useful for a variety of magnetic systems	pranay.patil15@gmail.com
9	Dr. Sivarama Krishnan	EXPERIMENT, BOTH	Quantum photonics in metastructures (computation and experiment)	(Joint-guidance: Prof. Sivarama Krishnan and Prof. M S R Rao) In this project, we will work on exploiting the unique opportunities provided by quantum optics and photonics to realise quantum technologies in sensing, imaging and communication. The key to this is the realization of efficient entangled-photon sources and single-photon detectors. We will leverage the opportunities provided by photonic metastructures to this end. Quantum-sensors, -spectroscopy, -microscopy, -imaging and -transduction schemes will be target applications. These will be implemented using pulsed or continuous wave lasers. This project will be carried out in collaboration with world-renowned labs in addition to local efforts at IIT-Madras.	srkrishnan@smail.iitm.ac.in
10	Dr. Sivarama Krishnan	EXPERIMENT, BOTH	Femto- and atto-second electron dynamics in nanoscale quantum systems	The 2023 Nobel prize in physics was awarded to the pioneers of attosecond science. In this project, we will take forward our efforts to research quantum dynamics on atto- and femto-second timescales. For this, we will use in-house femtosecond laser systems as well as world-leading synchrotron and xray free-electron laser facilities. We are almost the only group in India to pursue this line of research on this scale with demonstrated success through publications in top-journals like Phys. Rev. Lett., Rep. Prog. Phys., Advanced Science, Advanced Optical Materials, Optics Letters, J. Chem. Phys. Lett. and more which are well cited. The incoming student will get ample international exposure, paving way to post-doctoral opportunities in leading labs as previous members of this group have done. This project will be worked on both experimental and computational aspects.	srkrishnan@smail.iitm.ac.in
11	Dr. Sivarama Krishnan	EXPERIMENT, BOTH	Lab-astrophysics experiments to probe the origins of life (collaboration with NASA-JPL)	In this project which will be carried out in collaboration with NASA-JPL groups, we will investigate through photophysics experiments on complex molecular aggregates to investigate the origins of life as we know it in terrestrial and extra-terrestrial systems. This work will be done both at IIT-Madras and at world-class synchrotron facilities. This projects brings opportunities for the students involved to work closely with experts from leading facilities such as NASA-JPL, DESY (Germany) and RIKEN (Japan).	srkrishnan@smail.iitm.ac.in
12	Dr. Sivarama Krishnan	EXPERIMENT, BOTH	Experimental quantum nano-scopy and bio-imaging	For a funded collaboration with Artic University Tromso, Norway, are looking for a student who can spend a part of her/his time here in Chennai and a good part in Tromso, Norway, to work on implement novel quantum nanoscopy scheme for applications in bio- and medical-technologies. This project involves developing novel on-chip microscopy/nanoscopy module based on conventional and multi-photon imaging of bio-systems. We will exploit some nuances of quantum microscopy in the process. The student in this project will initially spend time at IIT-Madras and subsequently join efforts at University of Tromso in the group of Prof. Balpreet Ahluwalia, who is a pioneer in this field. The student will also interact with high-tech industry in bio- and medical-technologies in the process to do a project which has both immense scientific and technological value. This PhD should leave the student at the threshold of a career both in academia and industry, both at the state-of-the-art.	srkrishnan@smail.iitm.ac.in

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13	Dr. Sivarama Krishnan	EXPERIMENT, BOTH	Development and application of industrial optical coherence tomography and spectroscopy for diamond and quantum materials	In this project, we will develop optical coherence tomography for industrial applications, particularly diamond and other quantum materials. This project will be carried out with a jointly guided student between Prof. Sivarama Krishnan and Prof. M S R Rao, implemented in the India Center for Lab Grown Diamond.	srkrishnan@smail.iitm.ac.in
14	Dr. Sudakar Chandran	EXPERIMENT	2D materials chalcogenides for spintronic devices	Designing 2D materials exhibiting interesting physical properties suitable for spintronic devices is a challenging. This project will explore fabricating, testing, and tailoring the properties of 2D materials and their heterostructures for spintronic devices.	csudakar@physics.iitm.ac.in
15	Dr. Harish Kumar	EXPERIMENT	Magnetoelectronic Materials	Spintronics is an attempt to integrate magnetics with electronics. In a spintronic device spin polarized charge carriers from a magnetic thin film layer are injected into a non-magnetic metallic/semiconducting/Insulating layer and collected by another magnetic layer. The flow of spin polarized charge carriers is regulated by the application of a magnetic field. For efficient spin transport in such magnetic multilayer devices, the magnetic layers from which the spin polarized electrons are injected should have 100% spin polarized electrons at the Fermi level. These materials are known as half metallic ferromagnets or ferrimagnets in which their spin up (or down) band shows overlapping valence and conduction band like a metal, the spin down (or up) band has a gap at the Fermi level similar to a semiconductor. In some materials in addition to the half metallic gap in one spin channel the other spin channel may show either a pseudo gap or partial overlap of valence and conduction band near the Fermi level which are called Spin Gapless Semiconductors and Spin Semimetals respectively. The Ph.D. work involves the synthesis of such novel spintronic material and investigation of their structural, magnetic and transport properties.	harish@physics.iitm.ac.in
16	Dr. Prem B. Bisht	EXPERIMENT	Ultrafast lasers and nonlinear absorption applications	The present project deals with experiments on ultrafast lasers and photodetectors with high sensitivity for applications in single-and multiphoton absorption in organic systems and quantum dots.	pbbisht1965@gmail.com
17	Dr. Sunethra Ramanan	THEORY	Quantum Many-body problems	Many-body system comprise interacting systems exhibiting emergent phenomena, strong correlations etc. These systems require sophisticated numerical techniques. Examples are systems of nuclei, ultracold atoms, light matter interaction etc. The project envisages the study of these classes of systems, as well as those at the interface, using modern quantum many-body approaches.	suna@physics.iitm.ac.in
18	Dr. Chandra Kant Mishra	THEORY	Capturing Eccentric Compact Binaries in LIGO Data	Detecting orbital eccentricity in observed gravitational-wave events is challenging, since binary systems are expected to circularize by the time their signals enter the LIGO frequency band. Nevertheless, nearly 5% of binaries are expected to retain detectable eccentricities. This project will focus on modelling the impact of orbital eccentricity on gravitational waveforms, and on using these models to analyze gravitational-wave data.	ckm@physics.iitm.ac.in
19	Dr. Chandra Kant Mishra	THEORY	Isolating Subdominant Physical Features in LIGO Data	While detecting an event requires accurate modelling of the dominant features of the expected signals, extracting reliable source properties also demands proper treatment of subdominant effects such as orbital eccentricity, spin, and higher multipoles. Although modelling these effects is mathematically and computationally intensive, their presence can also be inferred using data-driven techniques that make minimal assumptions about the signal morphology. This project will focus on isolating such subdominant effects in gravitational-wave data.	ckm@physics.iitm.ac.in
20	Dr. Rahul Sawant	BOTH	Quantum Science and Technologies with cold/warm Neutral atoms	In this PhD projects, we will explore physics of neutral atoms. The activities will involve simulations of atomic interactions. Setting up of a AMO physics labs. Building cold atom or warm vapour experiments.	rahul.sawant@physics.iitm.ac.in
21	Dr. Prahallad Padhan	EXPERIMENT, BOTH	Exploring Materials That Turn Heat into Electricity — and Vice Versa	Every engine, factory, and electronic device around us releases heat that simply escapes into the air. What if we could turn that wasted heat into usable electricity? Thermoelectric materials make this possible. These remarkable materials can directly convert heat into electrical energy — and, in reverse, use electricity to produce heating or cooling without any moving parts. This field combines physics, chemistry, materials science, and engineering to address one of today's most significant energy challenges: enhancing efficiency and sustainability. By designing and studying new thermoelectric materials, researchers aim to power sensors, recover waste heat from industries, enhance renewable energy systems, and even develop solid-state refrigerators. Those working in this field have the opportunity to study cutting-edge materials, explore fascinating nanoscale phenomena, and contribute to the development of clean-energy technologies that can shape our future. The exploration of thermoelectric materials is not just science — it's innovation at the crossroads of energy, environment, and technology. In this project, the student will focus on chalcogenide-based materials to improve the thermoelectric figure of merit (ZT), thereby enhancing energy conversion efficiency and broadening their potential applications in sustainable technologies.	padhan@smail.iitm.ac.in
22	Dr. Prahallad Padhan	EXPERIMENT, BOTH	Beyond Ohm's Law: Exploring Non-Linear and Non-Reciprocal Transport in Quantum Materials	Modern electronic devices rely on how easily electrons can move through materials — their transport properties. But in certain advanced materials, electron flow doesn't always behave in a simple, predictable (linear) way. Under specific conditions, the current may not increase proportionally with voltage, or it may even flow differently depending on the direction — a phenomenon known as non-linear and non-reciprocal transport. Understanding these effects is key to developing next-generation electronic and spintronic devices. In this project, students will explore these fascinating behaviors in oxide and Heusler alloy interfaces — systems known for their rich electronic, magnetic, and topological properties. By combining experimental measurements with theoretical insights, the research aims to uncover how atomic structure, symmetry breaking, and interface engineering influence electron transport. This field sits at the intersection of condensed-matter physics, materials science, and nanotechnology, offering opportunities to learn advanced measurement techniques, thin-film growth methods, and data analysis skills. Students joining this project will contribute to the fundamental understanding of quantum transport phenomena that could drive innovations in low-power electronics, spintronics, and energy-efficient technologies. The exploration of non-linear and non-reciprocal transport is more than just studying unusual currents — it's about discovering how to control electrons in new ways to build the technologies of the future.	padhan@smail.iitm.ac.in
23	Dr. Ramachandra Rao MS	EXPERIMENT	Diamond-based heterostructures for power electronic devices.	Diamond is an ultra-wide band-gap quantum material with a wide range of electronic and quantum applications. Diamond heterostructures (ex., Diamond/AlN; Diamond/Ga_2O_3…) are excellent candidates for high-frequency electronics, Deep UV light emitting diodes and optoelectronic applications. Diamond's high thermal conductivity and AlN's piezoelectricity make it a potential heterostructure for diamond-based electronic devices. Similarly heterostructures of Diamond and Gallium-oxide make them potential candidates for deep UV emission. Our laboratory/centre is well equipped with growth of diamond (CVD), AlN (Sputtering and PLD) and Gallium-oxide (PLD). Good characterization and fab-lab are available for the proposed research topic. M.S. Ramachandra Rao and Praveen Bhallamudi.	msrrao@physics.iitm.ac.in

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24	Dr. Anbarasu M	EXPERIMENT	Diamond based power semiconductor devices and technology	Diamond is the most versatile semiconductor material for power devices. It is an ultra-wide bandgap (5.47 eV) material, with high carrier mobilities (electron mobility 4000 cm2/V·s, hole mobility 3800 cm2/V·s), high critical breakdown electric field (20 MV/cm), and high thermal conductivity (2,200 W/m.K). Diamond is the material for high power electronic applications. Guide: Dr. Anbarasu M., Co-guide: Dr. MS Ramachandra Rao	anbarasu@ee.iitm.ac.in
25	Dr. Anbarasu M	EXPERIMENT	Design and Development of Diamond-based deep UV detectors	A combination (homo-epitaxial layers) of p- and n-doped diamond layers can potentially lead to deep UV emission because of the large bandgap of diamond (~5.42 eV). Deep UV detectors are highly required for many high technology industrial applications. Growth and device fabrication can be carried out using the facilities we have in our group. Guide: Dr. Anbarasu M., Co-guide: Dr. MS Ramachandra Rao	anbarasu@ee.iitm.ac.in
26	Dr. Ravichandran Shivanna	EXPERIMENT	Elucidating the ultrafast photogeneration of charges in perovskite based solar cells	The quest for alternative renewable source of energy has drastically increased due to rapid growth in global energy demand. Perovskite based solar cells are the potential alternative due to their low-cost fabrication techniques. In this project, the research will be focused on fabrication of high efficiency thin film solar cells and understanding the underlying photophysics using femtosecond transient absorption spectroscopy.	ravics@smail.iitm.ac.in
27	Dr. Vaibhav Madhok	THEORY	Studies in Quantum Chaos : Quantum Information and Semiclassical Physics	by employing and connecting three powerful frameworks to understand quantum phenomena - random matrix theory, semi-classical physics and quantum information theory. Quantum-classical correspondence, quantum simulation of quantum chaos and many-body physics and an interplay between entanglement, equilibration, thermalization and non-integrability are the principal directions of focus. Special focus will be studying quantum chaotic dynamics by employing out of time ordered correlators and scrambling of quantum information under quantum chaos.	madhok@physics.iitm.ac.in
28	Dr. Anil Kumar Singh	EXPERIMENT	Experimental condensed matter physics and nanoscience.	Work hands-on with state-of-the-art experimental setups, Learn to fabricate and measure single-atom and single-molecule devices, Study fundamental properties of charge, spin, and heat transport, A strong interest in experimental physics, curiosity about nanoscale science, and motivation to learn advanced laboratory techniques. Work hands-on with state-of-the-art experimental setups.	aksingh@zmail.iitm.ac.in

sd/- ***Selection Committee***