DEPARTMENT OF PHYSICS

PH.D. ADMISSIONS JULY - NOV 2026

Available Research Topics

S.No	Name of the Faculty:	TOPIC	TITLE	ABSTRACT	Email Address
1	Dr. Basudev Roy	EXPERIMENT	estimation of mechanical properties of the cell both membrane and interior and estimation of transport phenomenon inside cells	We have recently done a lot of work on the detection of out of plane rotations in optical tweezers and used it to track cell membrane slope fluctuations and coupled motion of rotation and translation inside the cell. We extend this work during this PhD and explore other facets of the phagosome. Also, we explore other parameters that can be extracted from the cell membrane using a combination of "quadrants" and "octants".	basudev@physics.iitm.ac.in
2	Dr. Basudev Roy	EXPERIMENT	Basic optical tweezers based photonics work and exploration of tribological parameters	We are going to explore out of plane rotation based tribology or the study of friction in this project. It shall be more exploratory on the photonics and soft matter side to study say plant leaves etc.	basudev@physics.iitm.ac.in
3	Dr. Shantanu Mukherjee	THEORY	Study of novel signatures of emergent phases in quantum materials	The theoretical project aims to study a variety of quantum material systems of current research interest such as Ising superconductors, odd parity magnets, altermagnets, and topological excitonic insulators in order to identify their novel quantum phases. The work will focus on spectroscopic signatures that help to reveal the nature of the ordered phases. The student would be expected to learn and implement a variety of theoretical tools used in quantum many body theory. In addition to the work carried with his/her primary advisor at IIT Madras, the student will be expected to work in close collaboration with the research group of Prof. Andreas Kreisel from Uppsala University, Sweden.	shantanu@physics.iitm.ac.in
4	Dr. Anil Kumar Singh	EXPERIMENT	Electronics at the Ultimate Limit: Quantum Transport in Atomic and Molecular Junctions	The project focuses on quantum transport in bimetallic and molecular junctions using the mechanically controllable break junction (MCBJ) technique. The student will fabricate and study atomic-scale junctions to investigate charge transport, thermoelectric effects, and spin-dependent transport through chiral molecules. The work involves low-temperature measurements, nanofabrication, precision electronics, and data analysis. The student will be trained in nanoscale device fabrication and low-noise quantum transport measurements.	aksingh@smail.iitm.ac.in
5	Dr. Anil Kumar Singh	EXPERIMENT	Microscopic Study of Superconductivity in High-Entropy Alloys	The project focuses on the microscopic study of superconductivity in high-entropy alloys using STM/STS. These chemically disordered multi-component materials form single-phase crystals and exhibit superconductivity, providing a unique platform to study how superconductivity survives in strong disorder. The work will involve bulk superconducting characterization and local spectroscopic measurements of the superconducting density of states and spatial variation of the superconducting gap. Guide: Dr. Anil Kumar Singh and Co-guide: Dr. K. Sethupathi	aksingh@smail.iitm.ac.in
6	Dr. Titas Chanda	THEORY	Lattice gauge theories in the age of quantum technologies	Gauge theories are fundamental to modern physics, describing three of the four fundamental forces: electromagnetic, weak, and strong interactions. Their lattice formulation, crucial for addressing non-perturbative aspects of particle physics like quark confinement, faces significant challenges due to the sign problem in traditional Monte Carlo methods. Recent advances in quantum technologies offer new solutions. Key developments include (1) tensor network methods for studying many-body systems without the sign problem, and (2) progress in quantum simulation, providing theoretical frameworks for emulating fundamental interactions. These innovations are driving the development of quantum simulators, enabling exploration of lattice gauge theories beyond classical computational limits. We seek a PhD candidate to work on two objectives: proposing new experimental setups for simulating strongly correlated systems with Abelian and non-Abelian gauge symmetries, and advancing tensor network techniques to study lattice gauge theories in 1+1 and 2+1 dimensions. The research will integrate numerical and analytical methods, aiming to guide experimental implementations. The candidate will gain expertise in quantum many-body theory, tensor methods, cold-atomic physics, and quantum simulations. This position is ideal for candidates with a solid theoretical background in quantum physics, with familiarity in quantum field theory at the master's level being advantageous. An aptitude for coding and computational techniques is also needed.	titas.chanda@physics.iitm.ac.in

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7	Dr. Panchanana Khuntia	EXPERIMENT	Quantum Spin Liquids	The interplay of spin–orbit coupling, magnetic anisotropy, and electron correlations in quantum materials can stabilize exotic quantum states, such as quantum spin liquids (QSLs). A QSL is a highly entangled state in which frustration-induced quantum fluctuations prevent long-range magnetic order down to temperatures approaching absolute zero, despite strong exchange interactions between spins. This project aims to realize and investigate novel two- and three-dimensional quantum spin liquids. The student will be involved in the synthesis and comprehensive characterization of candidate materials with the potential to host exotic magnetic excitations. Experimental investigations will include magnetization, specific heat, nuclear magnetic resonance (NMR), muon spin relaxation (μSR), synchrotron-based techniques, and neutron scattering measurements. A key objective is to elucidate the nature of magnetic excitations in the QSL state, which could provide insights for the design and growth of next-generation quantum materials with potential applications in quantum computing, data storage, and energy technologies. Students will have access to state-of-the-art international facilities, including NMR laboratories at the Max Planck Institute (Germany), Ames Laboratory (USA), and LPS (France), as well as μSR and neutron scattering facilities at PSI (Switzerland) and the European Synchrotron Radiation Facility (France). References: Nature Materials 21, 416 (2022); Nature Physics 16, 469 (2020); Physics Reports 1041, 1(2023); Physical Review Letters 116, 107203 (2016); Communications Materials (Nature) 6, 63 (2025); Communications Physics (Nature) 5, 99 (2022); Nature Materials 14, 479 (2015).	pkhuntia@physics.iitm.ac.in
8	Dr. Panchanana Khuntia	EXPERIMENT	Novel Quantum Phenomena in Frustrated Quantum Magnets	Frustration, spin correlations, and the interplay between competing degrees of freedom can give rise to novel quantum states with exotic, fractionalized excitations in quantum materials. In this project, students will be involved in the synthesis and investigation of frustrated quantum magnets with the potential to host such emergent quantum phenomena. We aim to explore topological order and the associated exotic excitations in frustrated magnets using state-of-the-art experimental techniques, including magnetization, transport, specific heat, nuclear magnetic resonance (NMR), muon spin relaxation (μSR), and neutron scattering. A central goal is to identify and establish universality in topological quantum magnets, providing a deeper understanding of their underlying physics. These efforts may pave the way for the design and growth of novel quantum materials with potential technological applications in areas such as quantum computing, data storage, and energy technologies. Students will have access to advanced international facilities, including NMR laboratories at the Max Planck Institute (Germany), Ames Laboratory (USA), and LPS in Orsay (France), as well as μSR and neutron scattering facilities at PSI (Switzerland) and the Rutherford Appleton Laboratory (UK). References: Nature Materials 21, 416 (2022); Nature Physics 16, 469 (2020); Physics Reports 1041, 1(2023); Physical Review Letters 116, 107203 (2016); Communications Materials (Nature) 6, 63 (2025); Communications Physics (Nature) 5, 99 (2022); Nature Materials 14, 479 (2015).	
9	Dr. Ipsita Saha	THEORY	Beyond the Standard Model physics at current and future colliders	Beyond the Standard Model (BSM) theories play a crucial role in addressing several fundamental questions that remain unresolved within the Standard Model, such as the origin of neutrino masses and the nature of dark matter. Current and future particle collider experiments, including the Large Hadron Collider (LHC) and its proposed successors, provide a powerful framework for testing these theories. While the LHC has delivered significant insights into particle physics, it has yet to produce direct evidence for BSM phenomena. Future colliders, with higher energies and improved precision, will allow for deeper exploration of previously uncharted regimes and increase sensitivity to new physics. This research is driven by the goal of uncovering new particles, interactions, and symmetries, with the potential to significantly advance our understanding of the fundamental laws of nature. It involves a strong emphasis on both theoretical and computational approaches. On the theoretical side, it includes formal studies in quantum field theory, effective field theories, and particle physics model building, strengthening analytical and conceptual skills. On the computational side, it involves numerical simulations, programming, and the use of modern, frontier techniques such as machine learning applied to high-energy physics problems.	ipsita@physics.iitm.ac.in
10	Dr. Vaibhav Madhok	THEORY	Machine learning in quantum information processing and quantum chaos.	The project seeks to address fundamental as well as applied aspects in quantum information processing using machine learning methods. Chaos, classically, is characterised by long term unpredictability of a system and extreme sensitivity to initial conditions. Quantum mechanically, the search for an analogous definition is still an open problem. The project will bridge this gap and address this question from the perspective of machine learning. From the point of view of applications, the project will explore learning a quantum system and targeting its behavior by designing protocols based on machine learning.	madhok@iitm.ac.in

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11	Dr. Vaibhav Madhok	THEORY	Open quantum systems and quantum chaos	Quantum chaos has been an intriguing problem for the last 100 years. How does chaos manifest itself in the quantum domain? How does one characterize and quantify it? Level statistics, out of time ordered correlators and the behavior of Loschmidt's echo have provided partial answers. Still, much less is known about chaos in quantum systems that are not isolated. Do Lyapunov exponents of the classical counterparts influence the rate of decoherence? How does thermalisation happen and how exactly it depends on the magnitude and the nature of the coupling to the environment? Lastly, what does this all mean for recent advances in many body localisation and ergodicity of such systems.	madhok@iitm.ac.in
12	Dr. Rahul Sawant	BOTH	Experimental Quantum Simulation with Ultracold Atoms	This project focuses on the development and control of ultracold atomic systems to simulate complex quantum phenomena. The successful candidate will be integral to constructing and optimizing an experimental platform that utilizes ultra-high vacuum systems, precision laser cooling, and optical trapping (such as optical lattices or tweezer arrays). The primary research objective is to engineer tailored quantum many-body states to study strongly correlated systems, dynamics, and fundamental physics that remain intractable for classical computation. The student will gain extensive hands-on experience in atomic physics, advanced optics, custom control electronics, and data acquisition programming using Python. This role requires a candidate eager to bridge the gap between theoretical quantum mechanics and rigorous experimental engineering.	rahul.sawant@physics.iitm.ac.in
13	Dr. Rahul Sawant	BOTH	Quantum Sensing and Metrology	Quantum sensors leverage the fundamental properties of quantum systems to achieve unprecedented precision in timekeeping, field detection, and inertial measurements. This PhD project involves the design, realization, and optimization of next-generation quantum sensors utilizing highly controlled atomic transitions and Rydberg states. The research will target the development of highly sensitive atomic clocks, electrometers, or inertial sensors, laying the groundwork for technologies essential to GPS-free navigation and advanced metrology. The prospective student will be responsible for setting up stable laser systems, integrating RF/microwave electronics, and conducting high-resolution spectroscopy. The work emphasizes pushing the fundamental limits of measurement sensitivity while exploring the practical translation of these atomic systems into robust, functional technologies.	rahul.sawant@physics.iitm.ac.in
14	Dr. Manu Jaiswal	EXPERIMENT	Angstrom-scale channels in 2D layered materials with tuneable ionic and molecular transport	Layered 2D materials possess angstrom-scale slit like channels which provide ultra-confinement. The confining wall dimensions are quite comparable to the particle size. Water and solvent molecules as well as ions experience significantly altered interactions in this geometry, which strongly influences their mobility. In this work, the student will perform cutting-edge experiments to a control and manipulate the transport of these particles under ultra-confinement with external knobs. These experiments will help engineer applications related to molecular memories similar to those existing in biology, as well as water filtration and ionic sieving applications.	manu_jaiswal@physics.iitm.ac.in
15	Dr. Harish Kumar	EXPERIMENT	Spintronic Materials	Spintronics or magnetoelectronics is an attempt to integrate magnetics with electronics. In a spintronic device spin polarized charge carriers from a magnetic thin film layer is 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 metals. These materials have a peculiar spin polarized electronic band structure. While 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. Hence electrons with either spin up or spin down electrons only participate in electrical conduction and hence the material posses 100% spin polarized charge carriers. 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. In the project work a novel spintronic material will be synthesized and their structural, magnetic and transport properties will be investigated.	harish@physics.iitm.ac.in
16	Dr. Rahool Kumar Barman	THEORY	Exploring new physics in electroweak processes at current and future colliders	The project will focus on the phenomenology of electroweak processes at the current and future colliders, and on their role as sensitive probes of new physics beyond the Standard Model (BSM), through simulation-based studies. We will explore relatively rare processes involving top and Higgs electroweak interactions, as well as other electroweak production channels and non-standard signatures arising in new physics scenarios, with the aim of identifying important kinematic observables, and investigating the sensitivity at the high-luminosity LHC (HL-LHC) and other future hadron and lepton colliders. A parallel focus will be on developing generative machine learning (ML) based unfolding models for improved extraction of such observables from detector-level data along with ML-driven particle identification algorithms and background rejection approaches. Through detailed collider studies, we will assess how these approaches can boost projected constraints within the Standard Model Effective Field Theory framework and other BSM scenarios.	rahoolbarman@physics.iitm.ac.in

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17	Dr. Ayana Ghosh	THEORY	Physics-Aware AI for tailoring coupled functionalities in materials	In complex oxides and layered materials, functional properties such as ferroelectricity, magnetism, and their coupling emerge from competing lattice, charge, spin, and orbital degrees of freedom encoded in the underlying energy landscape. Inferring the governing mechanisms from data remains fundamentally underdetermined, as data-driven models often admit multiple equivalent structure-property relationships without clear physical interpretability. Resolving this requires embedding constraints from symmetry, thermodynamics, and physically meaningful order parameters. This PhD topic focuses on developing and implementing physics-aware AI approaches to identify mechanism-level descriptors and enable targeted tailoring of functional responses. Such capabilities remain inaccessible through the sole use of either first-principles simulations or experiments. By integrating AI/ML architectures with symbolic learning, causal inference, and domain-informed constraints, the approach aims to uncover interpretable pathways linking structure to functionality, and provide material-specific prescriptions for controlling coupled phenomena. The outcome is aimed towards establishing a route toward predictive, mechanism-driven design of multifunctional materials.	research.aghosh@gmail.com
18	Dr. Ayana Ghosh	THEORY	Interpretable Machine Learning for Symmetry-Driven Spin Textures in Low-Dimensional Systems	Spin textures in low-dimensional systems arise from the interplay of symmetry, electronic structure, competing exchange interactions, where reduced dimensionality, interfacial symmetry breaking stabilize nontrivial magnetic states. Capturing these effects requires resolving underlying mechanisms beyond phenomenological or purely predictive models. This PhD project focuses on developing symmetry-driven fingerprints combined with interpretable machine learning to identify mechanism-level descriptors governing magnetic ordering, anisotropy, and noncollinear spin textures. By encoding symmetry operations, local coordination, electronic structure, the methodology distinguishes regimes of itinerant, localized magnetism, while revealing regions of competing interactions associated with frustration, emergent spin configurations. Application to layered materials, oxide interfaces, heterostructures enables systematic analysis of strain, confinement, symmetry breaking in stabilizing complex magnetic phases. First-principles calculations provide validation of predicted crossovers, magnetic phase boundaries, spin textures. This work is aimed at establishing a symmetry-resolved, mechanism-driven framework for understanding, predicting spin textures in low-dimensional systems.	ayana@iitm.ac.in
19	Dr. Ranjit Kumar Nanda B	THEORY	Quantum transports in systems with non-collinear spin-textures	With an eye on the future quantum technologies, one of the emerging research domains is the study of the electron dynamics (and hence charge and spin transports) in systems with non-collinear magnetic structures (e.g. skyrmions). The objective of this project is to develop theoretical and computational tools by employing the understanding from quantum mechanics, mathematical physics, and condensed matter physics. To get a glimpse of the research we are carrying out in this domain, the student is encouraged to go through the following two papers published recently by my group. 1. Quantum dynamics of electron scattering from skyrmions, PRB (2026). https://doi.org/10.1103/2pyv-dcl9 ; 2.Tuning the band topology and topological Hall effect in skyrmion crystals via the spin-orbit coupling, PRB (2025). https://doi.org/10.1103/tlpn-9s4z Prerequisite: The student should be ambitious and should have the basic affinities and interests towards computational methods, and techniques.	nandab@physics.iitm.ac.in
20	Dr. Ranjit Kumar Nanda B	THEORY	Physics of Sustainability: Development of Active Learning tools to design sustainable materials in the field of energy and polymers	Materials that are durable, reusable and reprocessible are essential for advancing sustainability goals. The project has two objectives. In the first one, we aim to develop theoretical workflows involving state-of-the conventional computational tools such as DFT and molecular dynamics and machine learning force fields to design materials with tailored properties (e.g. electrolytes, electrodes, self-healing polymers, etc.). Following the inputs of the first objective, in the second part, we would like to investigate the materials behaviors that are relevant for sustainability by carrying out comprehensive electronic structure calculations and by designing models. This is an emerging domain which suits well with the broader context of AI for science and science for AI Prerequisite: The students should have the basic affinities and interests towards computational methods and techniques. Most importantly, student should be very ambitious. If joined, the student will be jointly guided by me and Prof. Tarak Patra of the department of Chemical Engineering. The student is encouraged to go through the following recent papers published by my group and by Prof. Patra's grou 1. Single Transition Metal Atom Catalyst for a High-Performance Li–S Battery with a Graphdiyne–Graphen Heterostructure Host: A DFT Investigation + ML Predictions, ACS Catalysis (2024) https://doi.org/10.1021/acscatal.4c02066 2. Data-driven methods for accelerating polymer design. ACS Polymers Au 2, 8 (2022) https://doi.org/10.1021/acspolymersau.1c00035	nandab@physics.iitm.ac.in
21	Dr. Sunethra Ramanan	THEORY	Quantum Entanglement and nonclassical effects in quantum many-body systems	Quantum many-body systems, be they, atomic or nuclear exhibit are very interesting, especially when strongly correlated. This project aims to study these correlations from the point of view of quantum entanglement and track nonclassical effects. .	suna@physics.iitm.ac.in

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22	Dr. Santhosh PN	EXPERIMENT	Magnetic and structural investigation of Double perovskites and their potential use in oxygen evolution reaction electrocatalysts and supercapacitors	Double perovskite oxides with A2BB’O6 are promising materials with unique crystal structure that allows for tunable electrical transport and magnetic character. Design of these novel oxides for oxygen evolution reaction (OER) and supercapacitor applications will be explored and the magnetic and structural studies will give crucial insights into the science of these materials. Design and synthesis of few these novel oxides will form the initial part of the research. Rietveld analysis for crystal and magnetic structure investigation will be routinely carried out. Squid Magnetometer, Physical Property Measurement System, X-ray photoelectron spectroscopy, Raman spectroscopy etc. will be routinely used to study the physical properties. Electrochemical studies will be carried out to find the use of these oxides in the fields of OER and supercapacitor applications. Suitable samples will be studied in their thin film form based on their magneto-transport characteristics	santhoshpn@smail.iitm.ac.in
23	Dr. Sudakar Chandran	EXPERIMENT	2D magnetic materials	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
24	Dr. Sudakar Chandran	EXPERIMENT	Halide perovskite based electronics	The project will explore and develop halide perovskite-based electronic devices, leveraging their unique optoelectronic properties—such as tunable bandgap, ambipolar charge transport, reasonable mobility, favorable defect characteristics, and solution processability—for applications in nonvolatile memory and artificial synaptic devices. The project aims to advance the understanding and fabrication of perovskite transistors and memory elements, contributing to next-generation, low-power, and flexible electronic systems.	csudakar@physics.iitm.ac.in
25	Dr. Nimmi Das Anthuparambil	EXPERIMENT	Phase Transitions in Complex Biological Environments: An Entropy–Enthalpy Perspective	Intermolecular phase transitions in biological systems—encompassing aggregation, gelation, fibrillation, and liquid–liquid phase separation—play a central role in the formation of functional biological structures and biomaterials. This project aims to elucidate how environmental conditions, such as pH, ionic strength, temperature etc. tune the intermolecular interaction and thus modulate the activation enthalpy and entropy governing these transitions. By combining kinetic measurements with viscoelastic characterization, the study seeks to establish quantitative links between environmental tuning, intermolecular interactions, and emergent material properties. The outcomes will provide fundamental insights into biomolecular phase behavior and self-assembly, with implications for soft matter physics, biological organization, and biomimetic material design.	nimmi@iitm.ac.in
26	Prabhat R. Pujahar	EXPERIMENT	Experimental investigation of particle correlation and fluctuations in hadronic collisions with the CMS experiment at the LHC, CERN	Correlations and fluctuations is one of the important directions in analysis of heavy ion collisions. At the current stage of LHC exploration, when the details matter, basically any physics question is addressed with help of correlation techniques. In this topic the student will start with a general introduction to the correlation and fluctuation formalism and discuss weak and strong sides of different type of observables. In more detail, the two-particle p_t correlations/\mpt fluctuations. In spite of not observing any dramatic changes in the event-by-event fluctuations with energy, which would indicate a possible phase transition, such correlations measurements remain an interesting and important subject, bringing valuable information. The student will investigate how radial flow can generate characteristic azimuthal, transverse momentum and rapidity correlations, which could qualitatively explain many of recently observed phenomena in nuclear collisions. Apart from the experimental data analysis, the student will take part in CMS experimental shifts and detector hardware when traveling CERN, Geneva.	p.pujahari@iitm.ac.in
27	Dilip Kumar Satapathy	EXPERIMENT	Stimuli Responsive Soft Actuators Based on Protein and Polymer Films	This project focuses on designing and understanding soft actuators that respond to external stimuli such as humidity, temperature, light and electric current. The study will explore protein and biopolymer based thin films that undergo controlled deformation through swelling or phase transitions. A key objective is to connect microscopic processes such as molecular rearrangement and solvent uptake to macroscopic actuation behaviour, including bending, contraction, and force generation. The work will involve fabrication of thin films, optical, structural and mechanical characterization, and quantitative analysis of microscopic phenomena using molecular dynamics based modelling and Python based tools to interpret the experimental data.	dks@iitm.ac.in
28	Dilip Kumar Satapathy	EXPERIMENT	Collective Dynamics and Fluctuations in Active Soft Matter Systems	Active matter systems consist of self-driven units that consume energy to produce motion. These systems show complex and often unpredictable collective behavior, and they operate far from equilibrium. This project explores non-equilibrium behaviour in active matter systems composed active colloids or biomolecular assemblies. The focus will be on understanding emergent collective motion, fluctuations, diffusion and pattern formation using a combination of experiments and minimal theoretical models. The student will investigate how activity modifies transport, correlations, and effective interactions in active matter systems. The work will involve image analysis, statistical characterization of trajectories, and development of simple Python based computational models to connect experiments with theory.	dks@iitm.ac.in
29	V Subramanian	EXPERIMENT	Tunable Metamaterials for Microwave and Millimeterwave applications	Metamaterials are sub-wavelength periodic structures capable of exhibiting extraordinary properties that a homogeneous material cannot possess. In this project, tunable metamaterial structures are designed as absorbers, polarizers, beam shapers etc. These structures are fabricated and tested, depending on the operating frequencies. The structures are designed to work in the frequency span varying between GHz to THz.	manianvs@iitm.ac.in

S.No	Name of the Faculty:	TOPIC	TITLE	ABSTRACT	Email Address
30	L Sriramkumar	THEORY	Observational and theoretical constraints on the initial state of the primordial perturbations	The inflationary scenario is the most promising paradigm to describe the origin of the primordial perturbations. According to the paradigm, the primordial perturbations originate from the quantum vacuum. While the quantum vacuum is a seemingly natural choice, it has become important to examine whether there are theoretical arguments and observational constraints that limit the extent of departures from the vacuum state. Apart from the vacuum state, one of the popular choices for the initial quantum state of the inflationary perturbations is the squeezed state. Interestingly, it is easy to produce specific features in the inflationary power spectra from squeezed initial states. It is also known that squeezed initial states enhance the extent of non-Gaussianities during inflation. Over the last decade, there has been a focus on examining the observational imprints of excess scalar power on small scales. However, there has also arises a concern whether, in such situations, non-linearities can lead to a cascading effect transferring power from small to large scales, affecting the standard predictions. In this project, the student will be calculating the non-linearities (such as non-Gaussianities and loop contributions) generated from non-vacuum initial states and work towards understanding the role they can play in limiting the initial state of the primordial perturbations in inflationary and alternative scenarios.	sriram@physics.iitm.ac.in