



**School of Natural Sciences
Department of Physics
Announcement of Ph.D. Admissions: Monsoon 2022**

The Department of Physics in the School of Natural Sciences at Shiv Nadar University Delhi NCR invites applications for admission to the Ph.D. program commencing in August 2022. Our graduate program is designed to serve a wide range of research interests and offers an excellent learning and research environment to motivated and ambitious students. Many of our research projects are interdisciplinary in nature, involving collaborations within the department and across multiple departments in the School of Natural Sciences, as well as other schools and research centers of the University. Diverse research interests, publications and other relevant information of our faculty members can be found at <https://physics.snu.edu.in/people/faculty>

The department is seeking candidates who may be interested in performing research on the following topics. Prospective candidates are required to mention "*Three (3) Topics of Interest*", to be included in the Statement of Purpose file, during the online application process.

Brief descriptions of the Research fields and related projects are given in [ANNEXURE](#) below)

THEORY and SIMULATION

Field 1: Theoretical and Computational Materials Science

Field 2: Applied and Mathematical Physics

Field 3: Theoretical Condensed Matter Physics

Field 4: Computational Soft Matter Physics

Field 5: Astro Physics

EXPERIMENTAL

Field 6: Soft Matter Physics

Field 7: Semiconductor Materials

Field 8: Advanced Materials Processing for Energy and Sensor Systems

Field 9: Two-dimensional materials

Eligibility: A candidate should have a Master of Science (M.Sc./M.S.) degree in Physics, with a minimum of 60% marks or an equivalent GPA (Grade Point Average). Students whose Master's results (final) are awaited, may still apply if they secured at least 55% marks in their 1st year of their Master's Program. However, all finally selected candidates must produce documentary proof of obtaining a minimum of 60% marks or an equivalent GPA in their Master's program, during the admission process into the Physics Ph.D. program, in the absence of which their selection will be deemed null and void. Only applicants who have received their Master's degree in or after 2020 are eligible to apply.

Selection Process: Shortlisted candidates will be intimated via email for appearing in the written test and interview, which will be conducted at Shiv Nadar University, Delhi NCR campus in Gautam Buddha Nagar District (near Greater Noida), U.P. In case of an online examination, the candidates will be informed in advance about the platform for conducting the exam. Candidates with CSIR-UGC, NET-JRF, INSPIRE etc. and fellowships are eligible for a direct interview.

Duration, Fees and Financial Assistance: The duration of our Ph.D. Program in Physics is 5 years. All full-time Ph.D. students admitted into the program shall receive a doctoral award (Teaching and Research Assistantship) consisting of a tuition-fee waiver (as per department) and a monthly stipend of ₹40,000 for the first two years,

and ₹45,000 for the next three years, subject to qualifying for the “Advancement to Candidacy”. The continuation of the award is subject to satisfactory performance in the program evaluated continuously and compliance with all University regulations. Support will be available for deserving Ph.D. students to disseminate their work through conferences and publications. Please note that students with CSIR, UGC, and INSPIRE fellowships shall receive a 100% tuition fee waiver.

Application Fees: Every candidate is required to pay non-refundable application fees amounting to **Rs. 1,200 (One Thousand Two Hundred Only)** Online, by credit/debit card. Candidates may note that the University reserves the right to accept or reject any application, based on its departmental screening criteria; hence, not all applications may be shortlisted for the written examination and/or interviews. Therefore, no requests for refund of the application fee shall be entertained whether or not the candidates are called for written examination/interviews.

Application Instructions:

All interested applicants shall apply online via the link given below or on the website. Please follow the instructions carefully.

- Fill all the mandatory fields
- **Please upload these documents online:**
 - Passport-size color photograph
 - Current CV
 - All mark sheets/degree certificates (10th standard onwards)
 - Standardized examination certificate- CSIR, UGC, INSPIRE etc. (if applicable)
 - A statement of purpose

Please note that the application will not be considered without all the necessary prescribed documents and the due payment of the application fee.

Important Dates:

- Last date for form submission: **Monday, 20 June 2022.**
- The dates of written test and interviews: To be **notified Later**
- Registration for the Ph.D. program commences from August 2022.

For any other information or query, applicants may contact:

Ms. Heena Slathia
EA to the HOD Physics,
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Physics Research Infrastructure

Physics research laboratories are equipped with basic research facilities, which include clean room, thermal deposition, chemical vapor deposition, pulsed electron deposition, magnetron sputtering, spin coater, ball-milling, vacuum annealing, high temperature oven, high temperature split tube furnaces, hydraulic press, glove box, microwave furnace, fume hoods, bio-safety cabinets, cryostat, XRD, AFM, Photo Luminescence, Raman Spectrometer, PPMS, Ellipsometry, FE-SEM, UV-visible-IR spectrophotometers, I-V measurement system, polarization loop-tracer, polarization microscope, fluorescence microscope, surface profiler, viscometer, thermal conductivity, contact angle, and others equipment within the School of Natural Sciences (SNS).

Computational facilities at the University include a high-performance IBM cluster (“*Magus*”) consisting of 60 compute nodes (plus two nodes with GPU processors) delivering a theoretical peak performance of ~30 TF. Additionally, there are several stand-alone Linux workstations that are used for Teaching and Research purposes. Multiple software for molecular modeling, molecular dynamics, quantum chemistry, bioinformatics and cheminformatics, are also available.

Our library, housed in a modern 5-storey building, provides online access from anywhere in the campus, to e-books, electronic journals and databases from APS, AIP, ACS, RSC, AMS, SIAM, IOP, Springer, Elsevier, Wiley, Nature, and others.

About Shiv Nadar University Delhi NCR

Shiv Nadar University Delhi NCR is a comprehensive, multidisciplinary, research-focused and student-centric institution that is bringing a paradigm shift in higher education in India through its innovative curriculum, interdisciplinary focus, and cross-disciplinary thinking across a wide range of disciplines. The University is building an ecosystem of knowledge to promote recognition of the interconnectedness of ideas, systems, and environments in the world within the campus, and those outside it. The University has 5 schools, 18 departments and 6 research centres engaged in teaching, practice, and research in disciplines as diverse as Engineering, Humanities & Social Sciences, Management, Natural Sciences, Art, Design, Performing Arts, Communication, and Extended Education & Professional Development. The schools offer Bachelor's, Master's, and Doctoral degrees along with a multidisciplinary curriculum to enable students to explore subjects and disciplines that may be widely different from their chosen majors.

[**APPLY NOW**](#)

Summary of Research Topics

Field 1: Theoretical and Computational Materials Science

Project Title i) Computational Search for Promising Materials for Application in Sensors

In this project we aim to explore various low-dimensional materials (2D, 1D) to selectively and sensitively sense hazardous gases and bio-molecules, using density functional theory (DFT) based simulations.

Project Title ii) In-silico search for promising electrode materials for rechargeable batteries

In this project, using various ab-initio simulation techniques like DFT and molecular dynamics (MD), we plan to comprehensively study various promising electrode materials for the application in Li and Na-ion batteries.

Field 2: Applied and Mathematical Physics

Project Title i) Non-hermitian PT-symmetric theories and their applications

Non-Hermitian quantum mechanics is rapidly becoming an emerging field of interest with a wide range of applications. In particular, the sub-class embodying parity-time (PT)-symmetry has proved to be an area of continuous activity. In fact, over the past two decades, a large family of exactly solvable PT-symmetric systems has been discovered, reflecting their intriguing spectral properties. Hamiltonians respecting PT-symmetry may exhibit, under certain conditions related to PT being exact, appearance of real spectra of

eigenvalues, implying balanced loss and gain. Non-Hermitian Hamiltonians undergo non-unitary evolution and generally describe open quantum systems in the presence of gain and loss of particles. Our purpose is to explore further certain inherent ideas of PT and construct specific models in the context of their applications.

Project Title ii) Acoustic black holes

The subject of black hole physics has seen continuing interest since Hawking's pioneering work on interpreting them as thermodynamical systems. Lately, a lot of interest has been generated inquiring into the question of finding the hydrodynamic analogue of a gravitational black hole and to explore how acoustic disturbances propagate in a non-homogeneous flowing fluid. More specifically, the role of dissipative processes at the acoustic horizon were investigated to design analogue gravity experiments. This has given a scope of setting up models for analogue black holes admitting the possibility of Hawking radiation and temperature. We intend to look into all such issues from a general perspective.

Field 3: Theoretical Condensed Matter Physics

Project Title i) Investigations of Quantum Chaos and Many-body Localization in Disordered Fermionic Quantum Systems.

Project Title ii) Investigations of Integrable to Quantum Chaotic Transitions in Correlated Quantum Spin Models in the Presence of Randomness.

In this group, we use a combination of analytical and computational tools to study the Physics of Condensed Matter Systems that involve manifestations of Quantum Mechanics in a fundamental way, like that of Quantum Magnetism, Quantum Localization etc. The main systems of interest are the so-called Strongly Correlated Electron Systems (SCES) where electron-electron interactions are very strong and cannot be dealt with in a mean-field like or perturbative way. We are also currently interested in the effects of disorder or randomness in

such systems, which involves a subtle competition between correlation and disorder effects at a microscopic scale. We use the methods of Exact Diagonalization, Iterative Diagonalization and Random Matrix Theory (RMT) to study these systems via Model Hamiltonians on Lattices. The above listed Projects relate to “Integrable to Quantum Chaotic transitions” in such systems studied via their spectral correlation statistics, which are also often accompanied by a Delocalized to Many-body Localized crossover in terms of the wave functions.

Field 4: Computational Soft Matter Physics

Project Title: Understanding the kinetics and stability of self-assemblies formed by soft material using Molecular Dynamics and Coarse-Grained Molecular Dynamics like Dissipative Particle Dynamics.

Soft matter is ubiquitous in our day-to-day life. A big part of it involves surfactants. A simple surfactant consists of a portion that is easily solvable in an aqueous solvent and a nonpolar portion that avoids an aqueous environment. These portions are called hydrophilic and hydrophobic parts respectively. These surfactants in aqueous solvent form complicated self-assemblies, which are utilized in various ways due to their viscoelastic properties. We want to explore these materials through computer simulations. Since these materials involve length scales that vary from atomic to mesoscales, various computational techniques have to apply from Molecular Dynamics to Coarse-Grained Molecular Dynamics like Dissipative Particle Dynamics, depending on the length and time scale of the problem.

Field 5: Astro Physics

Project Title: Studies of stellar physics in the light of gravitational wave measurements

In this project we propose to look into the physics of neutron stars and binary pulsars, possibly in the light of recent and near future gravitational wave measurements. The project is expected to involve

stellar astrophysics, physics of gravitational waves and aspects of nuclear physics.

Field 6: Soft matter Physics

Project Title i) Understanding the viscoelastic behavior of biopolymers in terms of mesoscopic structures.

Project Title ii) Quantifying the effects of magnetic field on properties of model cellular membrane in presence of magnetic macromolecules.

The Soft Matter Physics research group in the University works in the field of experimental soft material including biophysics. Soft materials used in cosmetic industries are investigated to explore their underlying structures and corresponding viscoelastic properties. These structures are altered by tuning the electrostatic interaction among the self-assembled aggregates in organic macromolecules. In turn, the materials show interesting physical properties, which are important for industrial applications. We also work in the field of membrane biophysics to develop model systems to investigate the interaction of biopolymer (e.g. protein, DNA etc.) with model cellular membranes. Main idea here is to understand the biological phenomena in the view of a physicist. We are also working in the field of nano-technology to understand the wetting and de-wetting behavior of a surface. Different X-ray scattering (X-ray diffraction, X-ray reflectivity, grazing incidence X-ray diffraction etc.), microscopy and rheology techniques are used at in-house and international synchrotron facilities (Photon Factory-Japan and PETRA III-Germany) to study the structures and properties of such soft materials and bio-systems.

Field 7: Semiconductor Materials

Project Title: Physics of semiconductor materials and devices

Our research focuses on novel materials involving organic semiconductors and organic-inorganic hybrid materials for device

applications in field-effect transistors, solar cells, light-emitting diodes, biosensors, and neuromorphic devices. We aim to enrich the understanding of the Physics of Carbon-based molecular semiconductors by studying the charge transport and photo physical mechanisms in semiconductor materials and at various interfaces in devices.

Field 8: Advanced Materials Processing for Energy and Sensor Systems

Project Title i) Dispersion and heat transfer properties of carbon-based nanoparticles in fluids

Project Title ii) Synthesis and characterization of flexible triboelectric Nano generators for energy harvesting application

This research group produces a variety of nanostructured materials (graphene, graphene oxide, metal oxide nanoparticles, metal oxide thin films) using methods such as chemical vapor deposition, chemical exfoliation, laser printing, 3D printing, and physical vapor deposition. We focus our research to analyze the structure, physical and chemical properties of pristine and functionalized nanomaterials and develop new concepts for applying them in sensor, microfluidic and energy applications. Moreover, it is important to regulate the material properties and fabricate devices at the nanoscale level for future technological applications.

Field 9: Two-dimensional materials

Project Title i) Two-dimensional materials for the detection of biomolecules

2D materials (prototypes of graphene) have unique optical and electronic properties that interact differently with different DNA biomolecules. Properly engineered 2D materials with standard DNA probes interact differently with targets of single-stranded DNA and double-stranded DNA and that is reflected from the different fluorescence signals from the probe-target mixture. The goal of the

project will be to fabricate and characterize various 2D materials of different morphologies (nanosheets, nanocrystals, quantum dots, nanotubes) and check their detection abilities of different target DNAs from emitted fluorescence signals. As a byproduct, one may consider the building up of low-cost nanoprobe for molecular diagnostics with emerging 2D materials.

Project Title ii) Two-dimensional materials for energy applications

As an alternative to fossil fuels, hydrogen fuel is considered as the most efficient and cleanest fuel resource for a sustainable energy economy. One of the cleanest way to obtain hydrogen is through electrolysis of water in the presence of suitable electrodes and electrolytes. This process is known as electro catalytic hydrogen evolution reaction (HER) as one requires appropriate catalysts to favor the reaction. Much of the research nowadays is focused on the catalysts which involves non-noble metals and thus to favor low cost and the abundance of them. Two-dimensional materials have shown great promise in HER due to their unique crystalline and electronic structure. In this project, a wide variety of two-dimensional materials and their composites will be investigated as nanocatalysts for achieving optimal HER efficiency. Strategies for developing effective catalysts using 2D materials will be explored by several fabrication routes and performing microstructural, chemical, optical and electrochemical characterizations. Wherever possible, theoretical DFT analysis will also be performed to explain the experimental data.