



Project Proposal for Ph.D.

Project Details (The research problem must clearly indicate the need for an interdisciplinary approach)

Project Title	Design and Development of a Variable Temperature STM for High Resolution Imaging and Spectroscopy
Project Summary (Minimum 500 and maximum 2000 characters)	This project aims to develop a custom-built Variable Temperature Scanning Tunneling Microscope (VT-STM) capable of high-resolution spectroscopy across a wide temperature range (1.8 K – 300 K). Scanning Tunneling Microscopy is a powerful technique for probing the interplay of structural, electronic, and magnetic properties at the atomic scale, with high spatial, energy, and spin resolution. Achieving such precision requires not only ultra-low temperatures but also exceptional mechanical and electronic stability, which are often limited by the cost and complexity of commercial STM systems. Our goal is to design and construct a low-cost, low-maintenance STM setup optimized for stability and flexibility. The system will cool both the sample and tip to ultra-low temperatures to enhance spectroscopic resolution, and will feature an in situ tip exchange mechanism, enabling the use of magnetically coated tips for spin-polarized STM studies. This capability is essential for investigating exotic quantum phenomena such as topological superconductivity and symmetry breaking in materials like Kagome lattices. The success of this project depends on the interdisciplinary collaboration between two scientists with complementary expertise: one specializing in scanning probe head design, ultra-high vacuum systems, and vibration isolation; the other bringing in deep knowledge of cryogenics and high-field magnet design. By integrating these distinct but interconnected domains, the project will create a state-of-the-art STM platform uniquely suited for frontier research in quantum materials for sensing and metrology.

Ph.D. Supervisors*
(Supervisor 1 and Supervisor 2 cannot be from the same department of IITD)

Role	Name of Faculty	Academic Unit in IITD/Institute/University	Email ID (Official)
Supervisor 1*	Dr. Sujit Manna	Physics, IITD	smanna@iitd.ac.in
Supervisor 2	Prof. Satyabrata Patnaik	School of Physical Science, JNU	spatnaik@mail.jnu.ac.in

*Supervisor 1 must be from IIT, Delhi.

+All cells in this table are mandatory fields that need to be filled by faculty for consideration of proposal.

\$The date of superannuation of supervisors should be at least three years from the date of registration of selected candidates.

Project requirements (Student qualifications, experience required, etc)
*The candidate will be shortlisted based on common shortlisting criteria decided by ScRC (SIRe)

- MSc in Physics or MTech in Mechanical engineering, Electronics, or Materials Engineering, Nanotechnology or Electrical & Instrumental Engineering.
- Preferably Qualified either NET/GATE/JEST
- Strong interest in development of Instrumentations
- Good communication skill

Source of fellowship/funding and project number
(CSIR/UGC/DBT/ICMR/ICAR/NEET-PG/DST-INSPIRE/IRD/FITT Project details, if any)

CSIR/UGC/JRF supported by DST project (IRD RP04491)

Role of Faculty Members involved:	
Supervisor-1	Sujit Manna has expertise in Designing the scanning microscope head, integrating with Helium flow cryostat. Performance test, noise reduction & calibration and testing the imaging/spectroscopic capabilities.
Supervisor-2	Satyabrata Patnaik will complement his expertise towards maintenance and test the stability of cold cryostat, liquid Helium production together with synthesis of varieties topological materials both in the forms of single crystal and ultra-thin films.

Note :-

1. Approval from the respective DRC/CRC/ScRC of your Department/Centre/School will be required for using the "Full-time Institute Assistantship (Category-wise) (FIA)" for selecting the students in SRe.
2. Declaration:- Faculty members, please ensure that you have at least 3 years of service left before superannuation along with adequate sitting space & lab facilities for the SRe student.
3. PI/s are also encouraged to submit joint proposals with AIIMS, NII, JNU and institutes with which IITD has an existing MoU. If the Co-PI (Supervisor 2) is from outside IITD, kindly share his/her detailed CV.
4. If a research scholar is to be considered for selection under the project fellowship, then the project should have a minimum of two-year duration remaining.
5. A candidate applying with a valid JRF/INSPIRE/any national level fellowship should have at least two-year validity from the date of joining the Ph.D. program.
6. The third supervisor’s name (if required) can be added only after the formation of Student Research Committee (SRC) subject to a strong recommendation of SRC and subsequent approval from the competent authority.
7. If Institute fellowship is being sought, then DRC approval of the parent department of Supervisor 1 is required at the time of selection.