The University of Queensland - IIT Delhi Academy of Research Joint PhD Project

Project title	**Interface Engineering Topology Driven Quantum Materials Heterostructures**
Project code	**UQIDAR 00190**
Project description	We propose a research program that aims to establish a leading international collaborative group in the emerging field of tunable multifunctional material systems by mastering synthesis of topologically driven quantum materials via interface control, and to potentially realize entirely new physics. A large family of two-dimensional materials that possess interesting properties individually has been discovered in recent years. Stacking different two-dimensional materials to form van der Waals heterostructures has opened up unprecedented opportunities for exploring new physical phenomena and device concepts. We aim to unravel the properties of material systems including layered transition metal dichalcogenides(TMDs), Novel molecules, Heusler alloys, Topological & Vander wall materials(VdW), 2D layered Ferromagnet, ultrathin superconductor and their heterostructures. Our primary motivation will be the synthesis of thin films of these materials and heterostructures with atomic level characterization, which will be crucial for uncovering new physics and future device fabrication. The mission of this proposal is to obtain a thorough understanding on novel quantum phases emerged in two-dimensional (2D) TMD, V-dW and Magnetic heterostructures by manipulating fundamental material properties including structural symmetry, electron correlation, exchange interaction, topological order and dimensionality. This project has three major parts: (i) the growth and engineering of completely new types of heterostructure using insitu molecular beam epitaxy(MBE) and vacuum layer transfer methods(at IITD); (ii) the atomic level characterization of the surface/interface by surface sensitive techniques like AES, LEED, RHEED, STM, and Synchrotron based measurements like XPS, NEXAFS, ARPES (at UQ); (iii) Using nanofabrication(clean room at IITD) method, the low dimensional counterpart of the thin film heterostructures such as nanowires, tunnel junction, optoelectronic devices would be produced. The results of this project will have the potential to impact a range of diverse fields including spintronics and valleytronics, as well as improve understanding of interfacial phenomena and quantum transport in low-dimensional quantum materials.
Project outcomes	* The program will develop synthesis and fundamental understandings of novel quantum phases in 2D materials that are developed due to electron correlations, topological order, exchange field and dimensionality. *Realization of topological phases in van der Waals heterostructures, and new routes towards crystal structural engineering.- Concrete results will unveil new topological order and topological quasiparticle that are much more robust than other reported ones. *We anticipate discovery of new phenomena in both twisted homo-bilayers as well as heterostructures of topological materials and 2D magnetic layers including molecular magnets etc. * Demonstrate topological Kramers Pairs of Majorana Fermions using quantum tunneling and non-local quantum transport. *New approaches will be developed to achieve wafer scale Van der Waals heterostructures. *We anticipate these new materials will have unique electrical, magnetic or optical (and opto-electronic) properties that may trigger commercial interest
Advisory team	**UQ Principal Supervisor**

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Type of student	Applications are open to: i-students who meet eligibility criteria.
Discipline background of student	Ideally, this project requires students with a background in: Physics, Materials or nanoscience.
Ideal candidate	**Essential Capabilities:** Solid background of Solid state and condensed matter physics. Excellent communication in English is necessary. **Desirable Capabilities:** Interest/experience in Vacuum science, cryogenics and surface physics. **Expected qualifications (Courses/Degrees etc.):** The candidate should have a Master degree in Physics and experience in solid state materials. Student must have own scholarship like CSIR, UGC-NET etc.
Application process	Apply online by the due date: https://www.uqidar.org/students/how-to-apply/