

Statement of Research Interest

Sangeeta
PhD applicant

I have been fascinated by science since my senior secondary education. My inclination motivated me to join Miranda House, University of Delhi, to pursue a B.Sc. in Physics (Hons.). Upon graduation, I continued with an M.Sc. in Physics at IIT Gandhinagar with the desire to formulate my career in physical sciences. The postgraduate curriculum was designed to train the students in various fields of Physics and develop strong fundamentals. I developed an interest in two-dimensional materials when I studied courses such as Condensed Matter Physics, Tools of Experimental Physics, and Physics of Two-Dimensional Materials. These courses intrigued me about the vast realm of 2D materials, their properties, and their applications. They expanded my knowledge about exploring the science of these materials and their technological transition for various applications. During class discussions, my interactions with Prof. Gopinadhan Kalon developed an exceptional research aptitude, which helped me secure an internship position under his supervision.

During the internship, I worked on the hydro-stability of 2D materials for Blue energy generation. I received training in various experimental aspects such as membrane fabrication, ion transport, contact angle, and x-ray diffraction measurement. As a result, I developed experimental skills and academic competence that helped me secure the highly competitive Sabarmati Bridge Fellowship. In my current role as a Sabarmati Bridge Fellow, I am working independently on a project that focuses on the surface interactions of water molecules with modified 2D nanochannels and their applications for energy harvesting. Simultaneously, my parallel project investigates the electrochemical intercalation behaviors of cations and the forces involved during the ionic interactions in intercalated 2D membranes with improved antifouling properties. The experience and skills I gained in confined fluidic transport processes and microfluidic devices through my internship and fellowship will provide a strong foundation for this doctoral position.

My research interest lies in studying transport phenomena through confined fluidic channels and developing their applications for various verticals of life. My curiosities align with Prof. Radha Boya's research on molecular, ion, and gas transport processes through 2D materials and Prof. Sunando DasGupta's work on transport processes at the microscale. It always intrigued me how the molecular interactions change drastically in confined fluidic channels on the transition from microfluidic to nanofluidic to angstrofluidic regime with confinement smaller than the range of van der Waals and steric-hydration interactions. This leads to interesting fundamental studies and technical applications of these channels, usually made of 2D materials due to the high surface-to-volume ratio. This unique property of 2D fluidic channels has enticed many researchers to use various novel strategies to solve modern-day problems.

It is inspiring to work on confined fluidic channels and engineer them for energy harvesting applications. The huge dependence on fossil fuels for present-day energy generation is the cause

of many environment-related problems. Environment-friendly, alternative renewable energy resources are needed to meet the respective concerns. According to the International Energy Agency, global renewable capacity is expected to increase by almost 2400 GW. Blue energy could potentially contribute to "Net Zero by 2050" by harnessing the electricity from the salt gradient in water streams using ion-selective channels.

I am confident that I will complete the required coursework and start the preliminary research work with ease at IIT Kharagpur due to my familiarity with the academic environment at the IITs. The diverse and exhaustive advanced material research and the state-of-the-art facilities at the National Graphene Institute offer excellent research opportunities in material science and condensed matter physics at the University of Manchester. The Membrane Separation Laboratory and Microfluidics and Microscale Transport Process Laboratory at IIT Kharagpur offer all the modernized experimental facilities for cutting-edge innovation. A Ph.D. education under the supervision of Prof. DasGupta and Prof. Boya will train me to become an excellent researcher and provide me with a strong foundation to pursue my research career in academia. I believe that I have the necessary drive, intellectual competence, social adaptability, and requisite skills to succeed in this joint graduate program.