Current Research Area in the Research group of
Prof. Amarendra Kumar Sarma

Our current research is primarily focused on the frontier areas of quantum technology. The foundations of quantum technology rely on the insights of quantum physics. Of late, it has become increasingly evident that the use of further quantum mechanical effects has opened up possibilities for a multitude of new technological applications. Out of numerous quantum technology platforms, solid-state based ones are the most useful. Such systems are easy to fabricate, and on-chip integration, due to unprecedented technological advances in lithography techniques, is easy to achieve. It is quite clear that the secure data transmission is of central importance in a digital society. In this context, improving encryption technologies using quantum cryptography could be of immense importance. Now, quantum cryptography is directly related to quantum entanglement. Hence the study of quantum entanglement in solid-state systems is of utmost importance and significance. Again, the precise control of quantum states of artificial atoms is of tremendous importance for quantum sensor technology, as the quantum states could be used in sensors. Here, cavity optomechanics combined with cQED systems offer a new architecture for coherent light-matter interfaces in a solid-state implementation. Mechanical motion can serve as a universal transducer to mediate long-range interactions between stationary quantum systems. Eventually, combining cavity optomechanics with other transduction mechanisms will allow one to exploit the full functionality of micromechanical and nanomechanical devices. Such quantum hybrid systems utilize the mechanical motion to achieve coupling between otherwise incompatible or uncoupled quantum systems. Along with applications, fundamental research is expected to see a huge paradigm shift. The ability to achieve coherent quantum control over the center-of-mass motion of massive mechanical objects provides a fresh approach to fundamental tests of quantum theory in a hitherto unachieved parameter regime.
Our research group is trying to address all the above mentioned issues and topics. We contribute to the theoretical aspects of the area.
Those students interested in our research can visit our research home-page: https://iitg.ac.in/aksarma/research/index.html. We have carried out some important works in the area of quantum optics and quantum technology. As an example, students may look into the following publications to get an idea about the kind of research we carry out:

1. Roson Nongthombam, Sampreet Kalita and **Amarendra K. Sarma**, *Synchronization of a superconducting qubit to an optical field mediated by a mechanical resonator*, Physical Review A **107**, 013528 (2023).
2. Sampreet Kalita, Saumya Shah and **Amarendra K. Sarma**, *Significant optoelectrical entanglement and mechanical squeezing in a multi-modulated optoelectromechanical system*, Physical Review A **106**, 043501 (2022)
3. Roson Nongthombam, Ambaresh Sahoo and **Amarendra K. Sarma**, *Ground-state cooling of a mechanical oscillator via a hybrid electro-optomechanical system*, Physical Review A **104**, 023509 (2021)

Students interested to enter into the area and learn the fundamentals can read the following tutotial and review article by our research group:

1. **Amarendra K. Sarma** and Sampreet Kalita, *Tutorial: Cavity Quantum Optomechanics (INVITED)*, Indian Journal of Pure and Applied Physics **61**, 622. (also see: https://arxiv.org/abs/2211.02596)
2. **Amarendra K. Sarma**, Subhadeep Chakraborty and Sampreet Kalita, *Continuous Variable Quantum Entanglement in Optomechanical Systems: A Short Review*, AVS Quantum Science (AIP) **3**, 015901 (2021)

We are looking for hard-working, sincere and honest students. The student should have good grasp over basic concepts of quantum mechanics. Moreover, familiarity with any programming language will be quite helpful.