INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	SUBHADEEP CHAKRABORTY
Roll Number	:	146121016
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Name of Thesis Supervisor(s)	:	PROF. AMARENDRA KUMAR SARMA
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SHORT ABSTRACT

Understanding the quantum nature of macroscopic systems is a topic of intense research for quite some time now. Numerous efforts have been made to know the classical-to-quantum boundary in various platforms. In fact, it is still not clear exactly when to stop applying the so-called Newton's laws and switch over to the Schrodinger equation. Recently, a new field of research, namely cavity quantum optomechanics has emerged opening many doors to study these open ended fundamental questions, apart from numerous possible applications. A typical cavity optomechanical system consists of two mirrors, one fixed while the other one is movable. These systems may be of micrometer or nanometer in dimensions. The electromagnetic radiation incident on the system may get coupled to the mechanical motion of the movable mirror. This optomechanical coupling is the heart of all phenomena such as quantum entanglement, state-transfer, squeezing and so on. In this thesis, we have explored various aspects of quantum correlations in cavity quantum optomechanical systems. We have proposed various schemes to improve the degree and robustness of quantum correlations. For example, our proposals show how one can achieve robust quantum entanglement even at high temperature. It should be noted that quantum entanglement is the key component of any quantum communication protocols and extremely vital for the realization of quantum computers. We have even come up with a scheme to delay the so-called entanglement sudden death (ESD), an issue considered to be an immediate stumbling block in the realization of various entanglement based quantum information and computing protocols. We have addressed this issue, in an optomechanical platform, by exploiting the phenomenon of exceptional points in binary and ternary mechanical PT symmetric architectures. Apart from quantum entanglement, we have explored other quantum correlations such as, quantum discord and quantum synchronization in our thesis.