



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student : Sanket Das
Roll Number : 176121008
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Name of Thesis Supervisor(s) : Prof. Tarak Nath Dey
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SHORT ABSTRACT

The study of radiation pressure involves a wave's average force on a surface or a particle. This force arises from the transfer of linear momentum when the wave interacts with the surface or particle. The application of radiation pressure ranges from the universe's development to modern laser applications, such as optical tweezers and cavity optomechanics. In cavity optomechanics, when a laser is reflected from a surface, it generates various types of elastic waves that travel through the object but are generally delicate. In simple terms, light can cause a slight movement within the material, and it is observed in whispering-gallery-mode resonators and optomechanical crystals with photonic and phononic modes. The force of radiation pressure leads to various physical phenomena stemming from semi-classical light-matter interactions, one of which is the mechanical analog of electromagnetically induced transparency (EIT). In EIT, an initially opaque three-level atomic medium becomes transparent due to applying strong control and weak probe fields. The destructive interference between two excitation pathways creates a narrow transparency window, resulting in anomalous dispersion and slow light effects. An optomechanical system with a single cavity mode and an acoustic mode closely resembles an atomic three-level system when a strong drive field and a weak probe field are present. This setup allows for the observation of an effect analogous to EIT.

Our research explores the concept of optomechanically induced transparency, demonstrating the controllable generation of output probe fields from both a ring cavity resonator and a magnomechanical cavity system supported by an auxiliary gaining cavity. We also investigate how radiation torque and atom-field coupling influence the reduction of various noise sources

and contribute to optical mode squeezing in a hybrid optorotational system featuring annularly trapped Bose-Einstein condensates. This study offers a versatile approach to leveraging atom-field interactions and radiation torque to produce bipartite and tripartite entanglement among different physical entities within the hybrid system.

