INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

The concept of attaining a controlled optical response of a material lies at the core of many of the advances in the field of optics. In the subwavelength regime, an effective control of the interaction between light and matter has become possible with the advent of metamaterials (MMs) and plasmonics. Over the years, MMs and plasmonics have revolutionized the entire field of optics and photonics by challenging well-established technological restrictions such as the diffraction limit of light. Recently, MMs and plasmonic structures have been used to explore quantum phenomenon such as electromagnetically induced transparency (EIT), in which a medium opaque to a resonant field is rendered transparent by applying another field of similar resonant frequency. In this thesis, we explore the different aspects of the EIT phenomenon such as: tunable transparency window, steep dispersion and enhanced nonlinearity in the context of terahertz MMs and planar plasmonic waveguide structures. The thesis is divided into two parts. In the first part, we discuss the analogue of the quantum EIT phenomenon in terahertz MMs. Here, we propose a terahertz MM geometry comprising an array of two C shaped resonators placed alternately on both sides of a metal strip exhibiting the plasmon induced transparency (PIT) effect. We have further examined a polarization independent PIT response for two orthogonal direction of incident polarization in a symmetric MM structure comprising of an array of a cross structure and four C shaped resonators. Next, the modulation of the PIT effect is explored in a graphene based terahertz MM by varying the vertical and horizontal distances between the resonators. The dynamic tuning capability of the PIT effect is also examined by varying the Fermi energy of the graphene layer. Further, dual-band EIT effect is examined in a concentrically coupled asymmetric terahertz MM structure in which two tunable transparency windows are achieved. In the second part, the excitation and propagation of surface polaritonic solitons and breathers in a planar plasmonic waveguide structure via the quantum EIT effect is discussed. Our study has significant potential in the realization of devices for polarization independent broadband applications, dynamically tunable devices, slow light systems, narrowband absorbers, highly compact ultrafast optical devices, and many more.