INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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The theoretical work in this thesis deals with the coherent interaction of electro-magnetic (EM) fields with atoms. The coherent interaction induces atomic coherence among the coupled atomic energy states which lead to the generation of different coherent phenomena such as electro-magnetically induced transparency (EIT), electro-magnetically induced absorption (EIA), electro-magnetically induced gain (EIG) etc. These coherent effects manipulate the absorptive and dispersive properties of the atomic medium which allow us to generate and control EM fields in both time and space. We present an efficient scheme for the generation, control, storage and retrieval of complicated shaped four wave mixing (FWM) signal. Further, we explore vortex beam assisted FWM process which facilitates the translation of orbital angular momentum (OAM) associated with input optical fields to the generated FWM signal. Next, we study the microwave (MW) coupling between the hyperfine ground states which becomes a powerful implementation to control the EIT features of closed loop atomic system. In last part of the thesis, we discuss how to eliminate diffraction from the narrow width light beam. We demonstrate MW assisted high contrast and narrow core optical waveguide in Rydberg atoms which efficiently guides narrow paraxial light beam of arbitrary modes. These techniques of coherent generation and control of EM fields in atomic system has potential applications in optical communication, quantum information processing, phase-dependent MW magneto-metry, high-resolution imaging.