INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

In recent times, semiconductor-integrated photonics have gained much research interest in making reliable quantum photonic integrated circuits (QPIC) required in quantum technology. Generally, a QPIC is densely packed with tiny optical elements such as quantum light sources, quantum communication channels, detectors, modulators, beam splitters, quantum gates, etc. This thesis addressed three problems in making such optical elements in quantum dots (QDs), satisfying the tiny footprint and low-power requirement criteria. We have addressed the self-induced transparency (SIT) phenomenon in a QD medium at ultra-cold temperatures. In this process, a specific light pulse can propagate through the medium with minimal distortion in pulse shape at resonance frequency for a long propagation length. Further, we have proposed a scheme for arbitrary vector beam generation in a thin disc-shaped QD medium. We have considered a four-level diamond system interacting with one weak probe field and two relatively strong control fields. The four-wave mixing (FWM) process produces a generated signal with orthogonal polarization, and vector superposition with applied field generates a vector beam(VB). We have found the feasibility of generating a nondegenerate two-photon laser for a single QD embedded in a two-mode microcavity. We have analyzed both the incoherent and coherent pumping mechanism and its turnout that coherent pumping provides better conditions for such laser generation. Finally, we have shown that the system exhibits continuous variable two-mode entanglement generation for two-photon resonant pumping.