INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Laser cooling and trapping serve as a crucial gateway, offering insights into fundamental physics and opening the way for diverse quantum technologies. Among the various elements, Rubidium (Rb) is one of the most extensively studied elements in atomic physics. The cold atom community has mainly used Infrared lasers to cool and trap Rb atoms in a Magneto-optical trap (MOT), usually through the $5S_{1/2} \longrightarrow 5P_{3/2}$ transition at 780 nm. In this thesis, we explore the laser cooling and trapping of Rb atoms in MOT using the $5S_{1/2} \longrightarrow 6P_{3/2}$ narrow-line transition at 420 nm (blue MOT). Despite its large branching ratio, we observe efficient cooling with the 420 nm transition, achieving around 10^8 atoms in the blue MOT at a typical temperature of 54 μK. We also present a method for the continuous loading of Rb atoms in the blue MOT and a theoretical framework for cooling atoms with two simultaneous transitions. We also describe the direct spectroscopy of Rb at 420 nm, which is challenging due to its weak transition strength. Furthermore, we numerically analyze the role of spontaneously generated coherence (SGC) in polarization gradient cooling with $F = 1 \longrightarrow 2$ transition and investigate the feasibility of blue-detuned cooling at this transition in the absence of SGC. We experimentally demonstrate blue detuned cooling in type-I and type-II MOT. Additionally, we study various configurations of red-detuned as well as blue-detuned blue MOT, achieving temperatures as low as 24 μK in D_1 MOT and 31 μK in D_2 MOT. Our studies may find applications in quantum technologies based on the narrow-line cooling transitions.