

Title : Characterization of Cold Rb-87 Atoms in the Magneto-Optical Trap

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ABSTRACT

Cold atoms in a magneto-optical trap (MOT) are crucial for quantum technology and high-precision sensors. This research focuses on analyzing the spatial distribution, temperature, and volume of the atomic cloud, while also investigating the effects of laser detuning and magnetic field gradients on MOT efficiency. The experiment was conducted using a standard MOT setup, which consists of counter-propagating laser beams, a quadrupole magnetic field, and an ultra-high vacuum (UHV) chamber. The atomic fluorescence signal was recorded using a Charge Coupled Device (CCD) camera and analyzed using two-dimensional Gaussian fitting method was applied to determine the $1/e^2$ radius and the MOT volume. The results indicate that the atomic cloud exhibits a Gaussian

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spatial distribution, with a $1/e^2$ radius of approximately 1.11 ± 0.3 mm leading to a MOT volume in the range of $6.062 \pm 30\%$ mm³, varying the laser detuning affects the trapping efficiency. This study provides essential insights into the properties of cold rubidium-87 atoms, which can be applied to the development of atomic cooling techniques and future quantum technologies.

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