Summary for the MOT Lab

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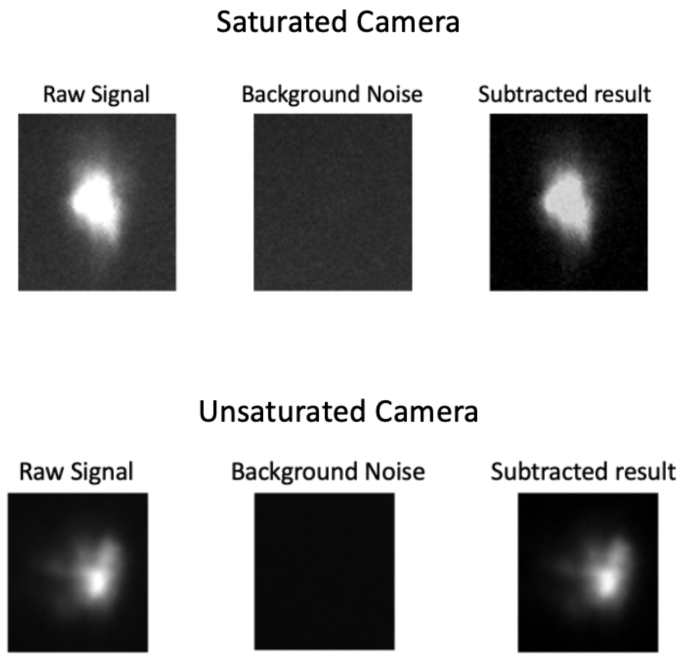

FIG. 1. Effect of camera saturation on MOT fluorescence imaging and background subtraction. The top row shows images acquired with saturated camera settings, where the raw signal (left) is overexposed, resulting in loss of spatial intensity information critical for atom number estimation. The background noise (center) is acquired without trapped Rb atoms, and its subtraction yields a result (right) that retains saturation artifacts, preventing accurate quantification. The bottom row shows images obtained with optimized (unsaturated) camera settings. The raw signal (left) preserves intensity variations corresponding to atomic density distribution in the MOT. After subtracting the background noise (center), the resulting image (right) reveals a spatially resolved fluorescence profile that can be used for atom number calculation, provided appropriate calibration parameters are known.

In this lab project, we implemented and optimized a magneto-optical trap (MOT) for ultracold Rb atoms using a 780-nm external cavity diode laser and a vacuum-sealed glass cell. After revisiting the theoretical foundations of MOT, we engaged in a hands-on alignment of the laser system, balancing optical power across three orthogonal beams and optimizing their spatial overlap at the trap center. We then initiated the atomic source and adjusted camera focus and settings to visualize the MOT. Through iterative optimization of magnetic field gradients, we achieved stable trapping of Rb atoms, observable as bright fluorescence spots. The experiment emphasized practical challenges often abstracted away in theory, including beam alignment, coil geometry, system noise, and detector calibration. This experience deepened my understanding of experimental cold atomic physics and highlighted the importance of non-ideal factors in real-world implementations. It also provided valuable preparation for my future PhD research involving trapped ion platforms.

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