Bragg Scattering of Atoms for Imaging of Optically Trapped Bose-Einstein Condensates

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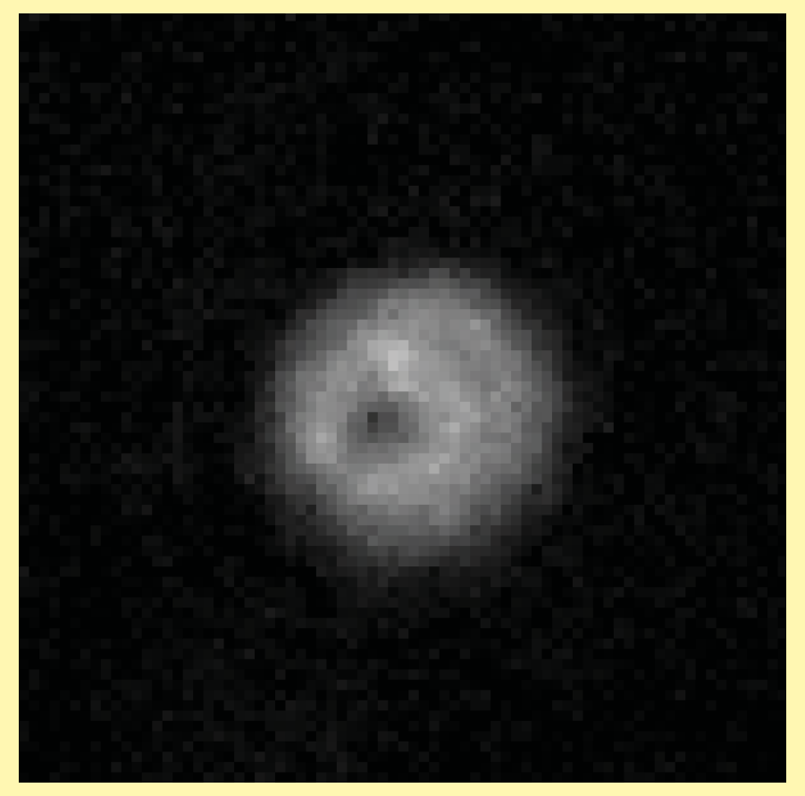
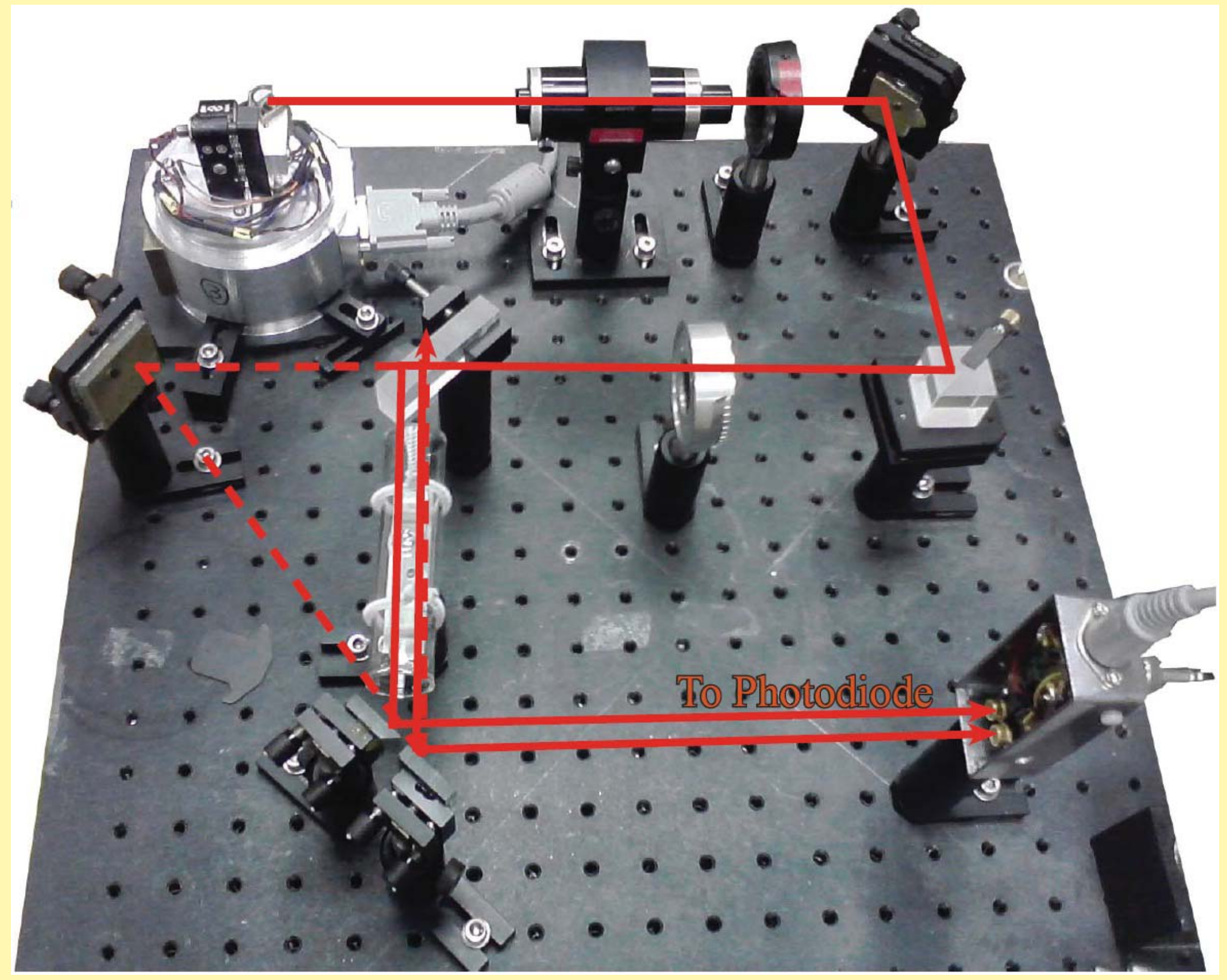


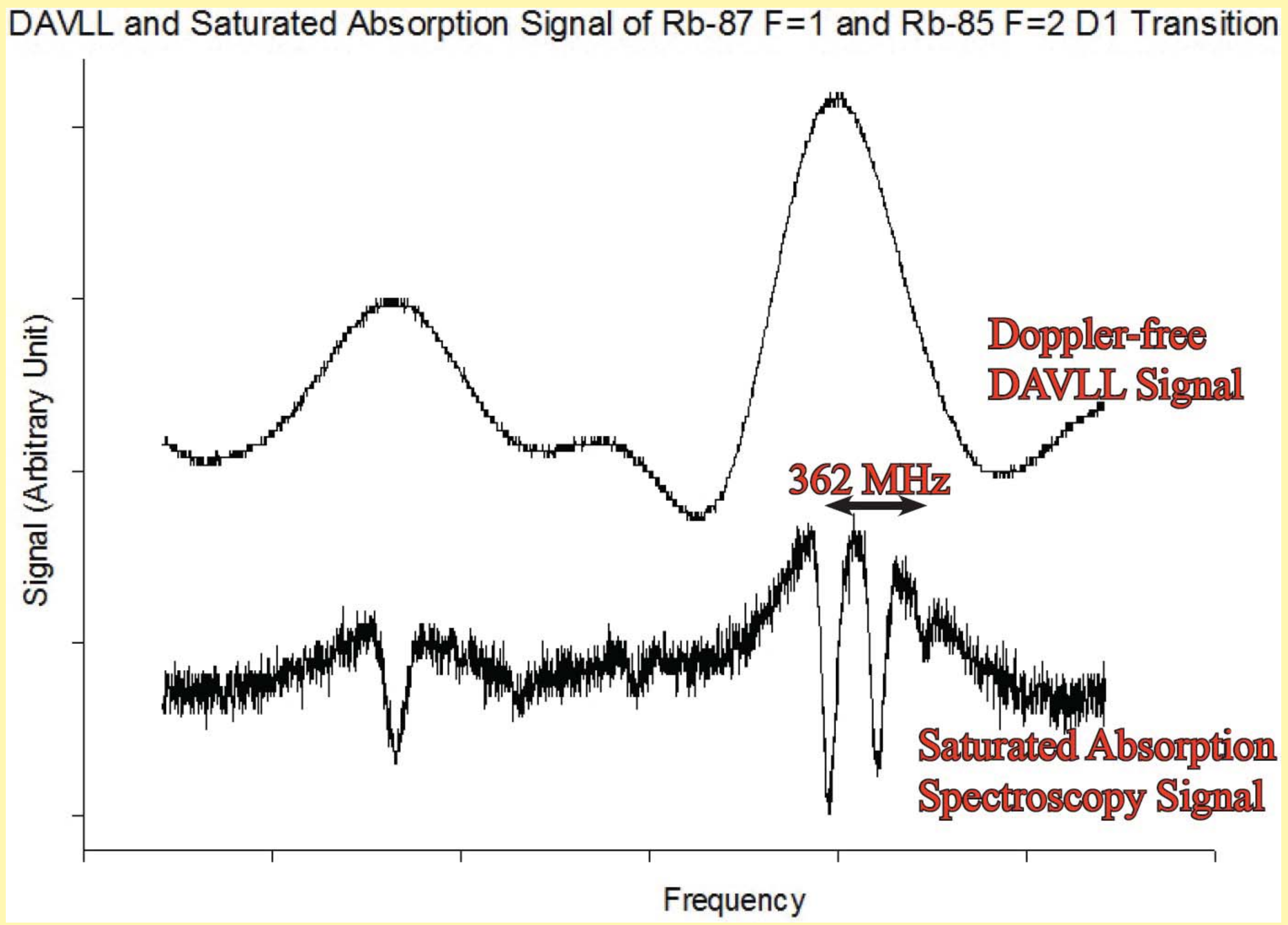
Introduction

We plan to study the real-time dynamics of vortices in optically trapped Bose-Einstein condensates. We need to extract a fraction of atoms from the condensate for imaging without stopping the dynamics. My project this past summer in Professor Hall's lab involved setting up and testing a laser to extract atoms from the condensate in an optical trap.

Saturated Absorption Spectroscopy

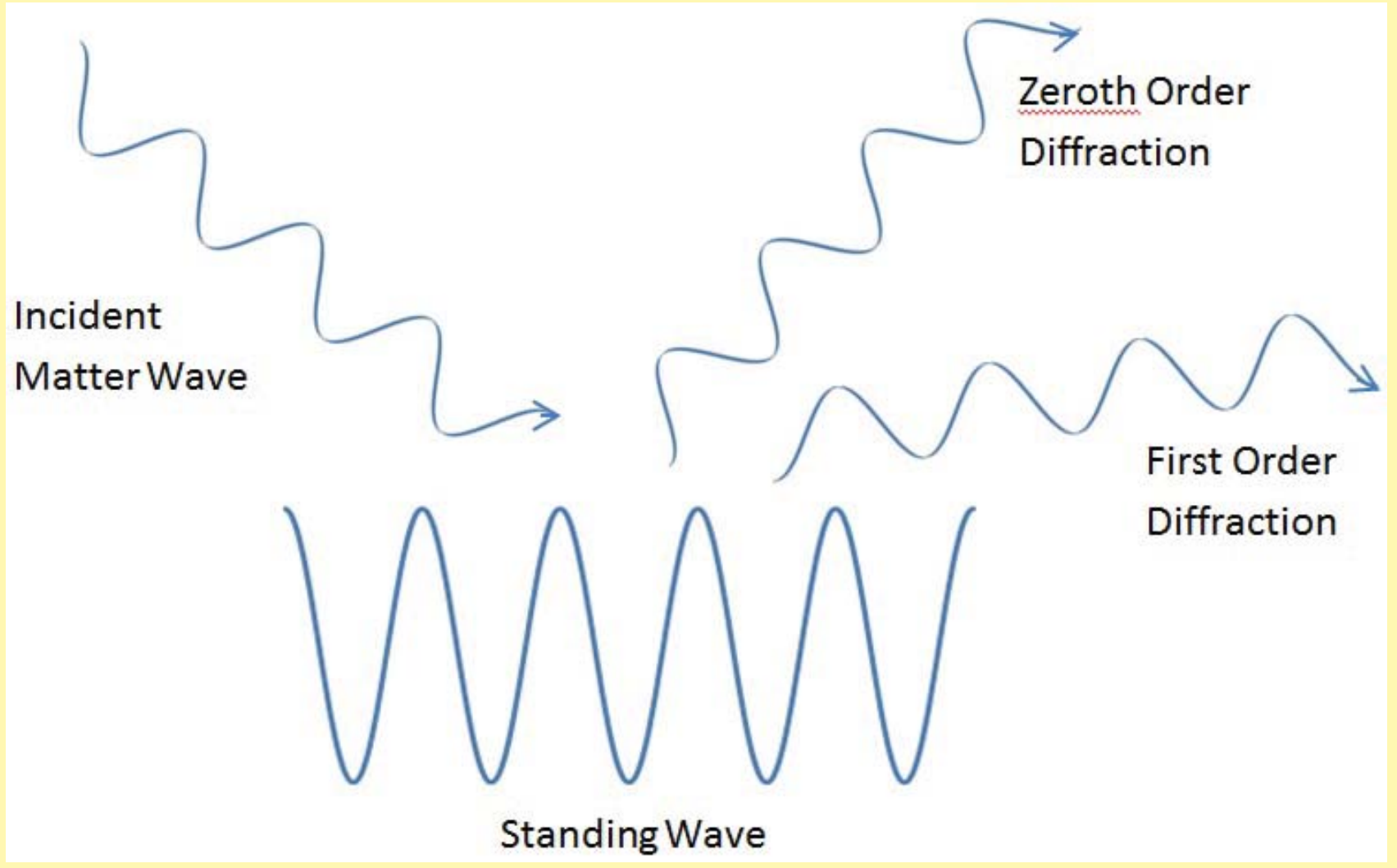
We can lock the laser by using saturated absorption spectroscopy. When the laser is resonant with the D1 atomic transition of ^{87}Rb, the atoms absorb photons from the laser beam. The signal represents the amount of photons absorbed in the atomic transition. We can lock the laser at the atomic transition peak of saturated absorption signal. The Dichroic-Atomic-Vapor-Laser-Locking technique (DAVLL) signal allows us to lock the laser at frequency up to a few GHz away from the transition peaks.

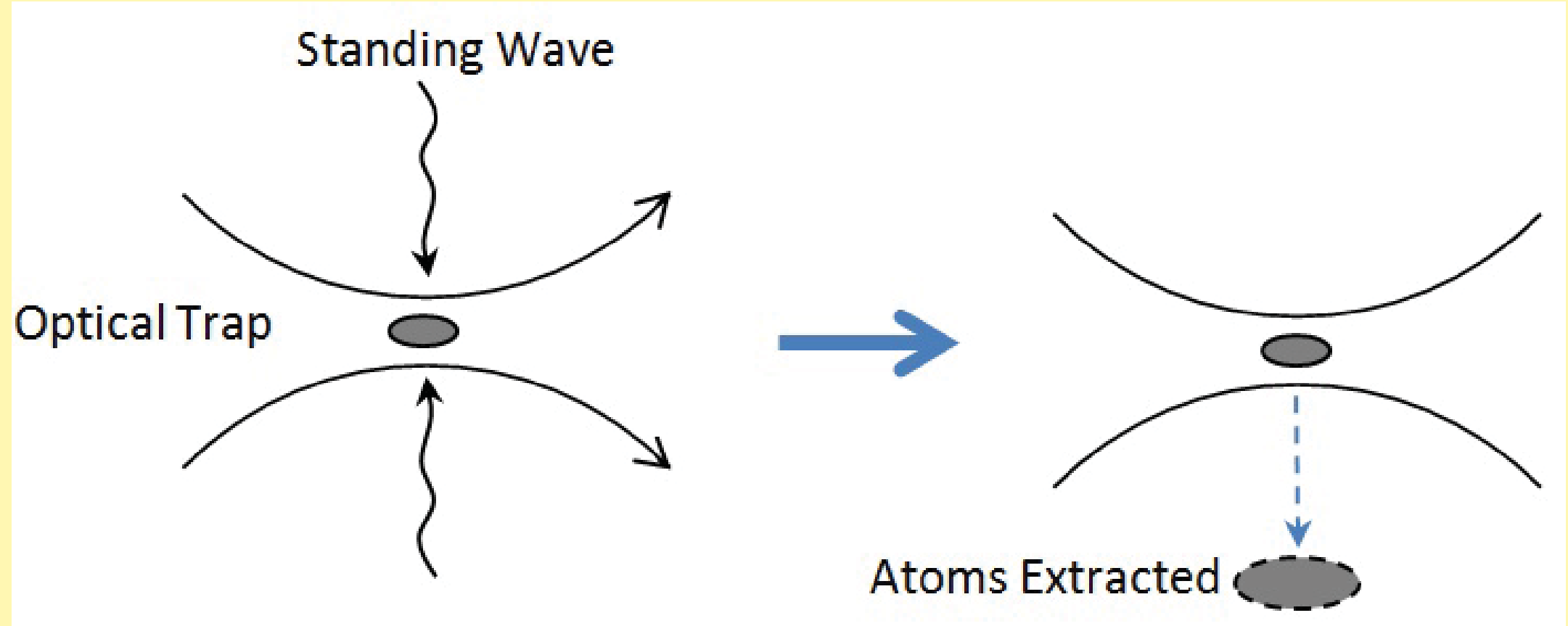




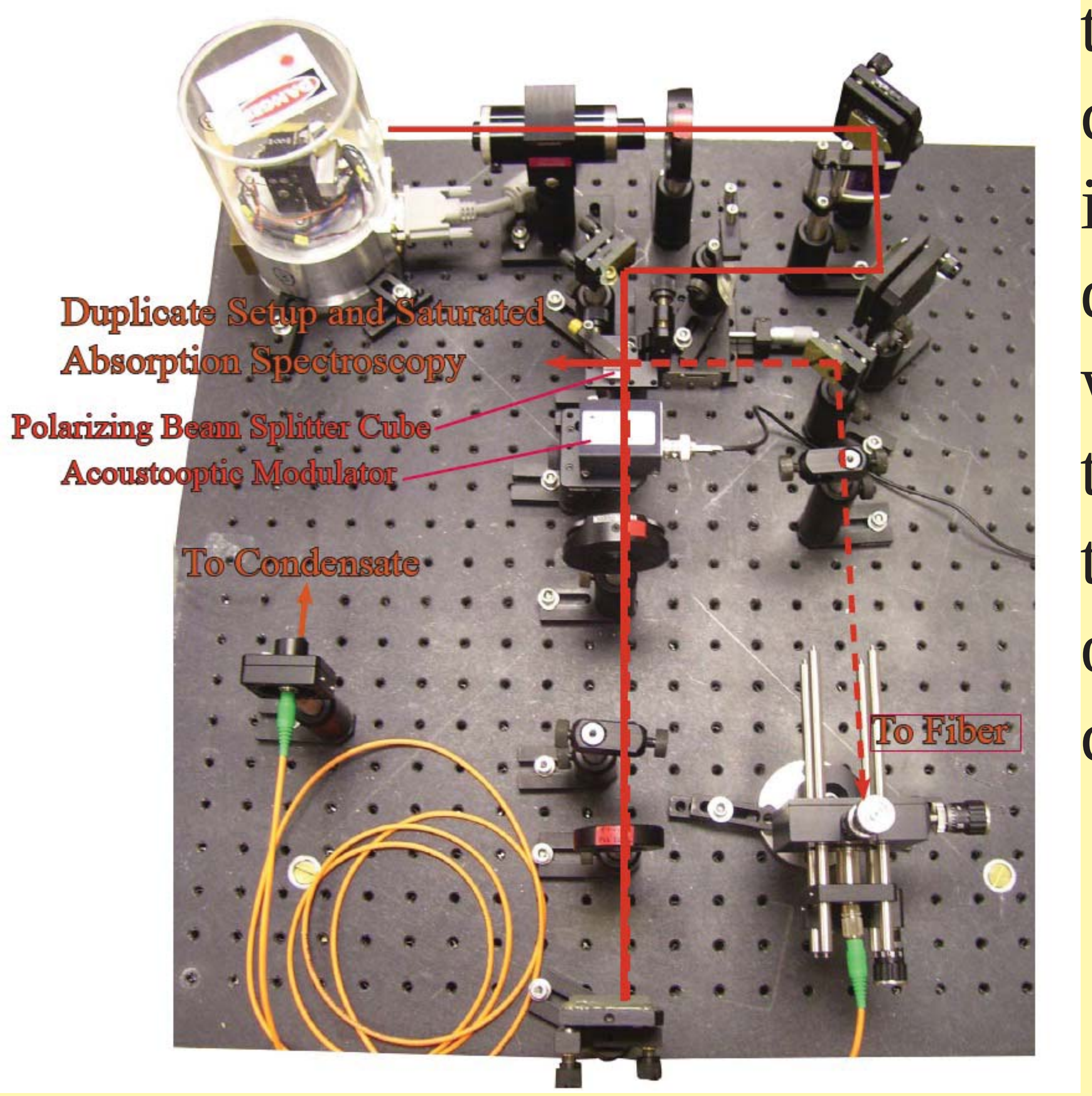
Bragg Scattering

To extract atoms from the optical trap, we diffract atoms by passing a moving standing wave through the condensate. The standing wave acts as a diffraction grating that diffracts atoms, giving them a momentum kick as first or higher order diffractions of the condensate.

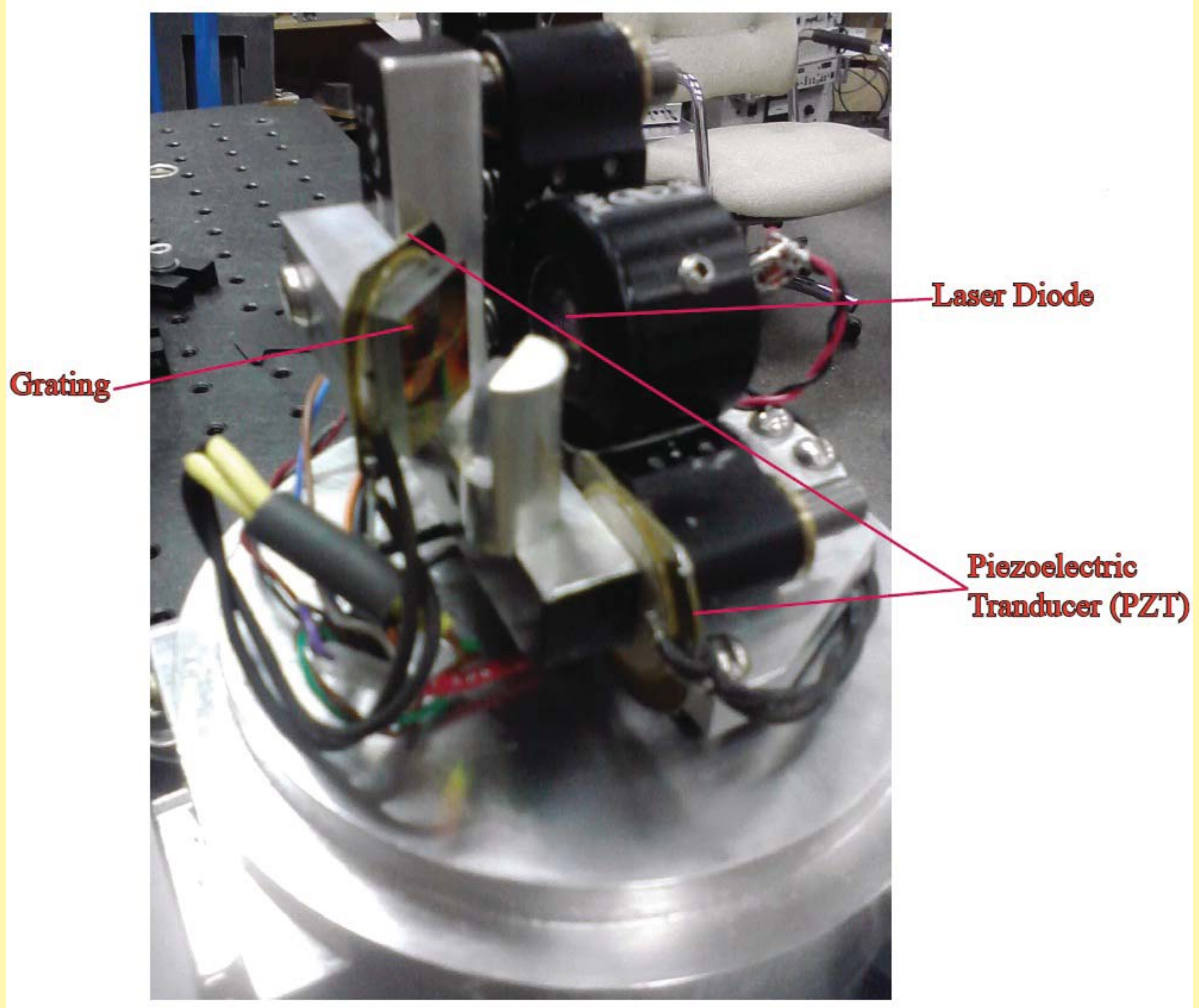




We split the beam into two parts by the polarizing beam splitter cube. Acousto-optic modulator (AOM) diffracts the laser beam and slightly increases the laser frequency. This slight increase in frequency between the two counterpropagating beams produces a standing wave that moves through, and extracts a fraction of atoms from the condensate.



Diode Laser



We want to tune and lock the diode laser at a certain wavelength, at 795nm where the D1 atomic transition of ^{87}Rb occurs. We tune the laser wavelength by either adjusting the current applied to the diode or by changing the distance between the grating and laser diode by using a pair of piezoelectric tranducers (PZTs). Tuning the current allows us to tune the frequency relatively fast, but with a narrow tuning range within a single laser mode. The PZT at the base of the laser mount provides a relatively slow tuning over a large range. We are trying a second PZT behind the grating for a relatively fast, medium-range tuning for increased wavelength accuracy.

Acknowledgement

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