Trapping Krypton and Argon Atoms With Laser Beams
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Research Goal
To detect weak molecular interactions between krypton and argon atoms in a Magnetooptical Trap (MOT).

Magneto-Optical Trap (MOT)
A MOT captures and holds a cloud of atoms in a very small volume (<1 mm³). This type of atom trap uses magnetic fields and laser beams to exert a force which pushes each atom toward the center of the trap. Atoms experience slight “kicks” due to collisions with laser photons; the local magnetic field controls the direction of these “kicks.” Once atoms are trapped, we probe and monitor the trapped cloud in an attempt to detect molecular interactions.

In our particular case, we work with krypton and argon atoms. To create overlapping traps, we need two overlapping lasers to push on the two different types of atoms.

By switching each laser on or off, we can get a trap of either species by itself or a combined trap of both.

Laser Frequency Lock
Why a laser frequency lock?
To interact with the atoms, the energy of laser photons must precisely match the energy between two atomic states. Since laser frequencies drift, a restoring signal must be used to maintain this precise frequency.

A Technical Requirement
We need an electrical “zero-crossing” voltage which varies depending on frequency. It pushes frequency up (+ voltage) when it is too low, and down (- voltage) when it is too high. This idea applies to many systems involving stabilization at a fixed point.

Photo-Association (PA)
The main phenomena studied is photo-association which uses light to tie atoms together into long-range molecules. Where traditional chemical molecules bond by sharing electrons, photo-association molecules bond by sharing the absorbed photons.

Ion Detection
Collisions between metastable atoms result in ion production. Thus, traps of metastables produce ions at a rate which depends sensitively on the number of atoms on the trap. Our ion detector counts the number of ions produced in a certain bin of time. This allows us to see how the number of atoms in the trap changes through time.

Future Experiments
All these things together prepare us for future photo-association experiments. As we scan a photo-association laser to find these frequency of the interactions, we must sync three signals:

- The frequency of the laser
- The fluorescence of the trap as measured by the camera
- The ion production rate of the trap

As we scan the laser frequency, we look for dips in the two trap detection signals which indicate a loss of atoms in the trap, caused by photo-association.

Conclusions
This summer, most of our work was spent on setting up systems and preparing techniques for future photo-association experiments. Our next step is to perform these experiments and use them to learn about the quantum structure of Krypton and Argon atoms.

References