CALIFORNIA STATE SCIENCE FAIR
2007 PROJECT SUMMARY

Name(s)
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Project Number
J1618

Project Title
Laser Cooling and Trapping of Rubidium-87 Atoms using MOL

Abstract

Objectives/Goals
The objective of my project was to laser cool and trap rubidium-87 atoms. I wanted to do this in a short amount of time and with a low cost. Obtaining results would assist in the research of laser cooling and trapping. My question is: Can rubidium atoms be cooled and trapped using a single laser source and no magnetic field? Also, is it possible to build a Laser Cooling and Trapping apparatus only with materials easily available for purchase? My hypothesis is: Rubidium atoms inside a bulb can be cooled and trapped using only one laser source and mirrors to create multiple beams that intersect in one point.

Methods/Materials
Laser Cooling and Trapping occurs when atom#s electrons are hit with photons. From the energy increase, the electrons bounce up one shell. Because of the Pauli Principle, they come back down and release the excess energy in the form of an infrared photon. This photon has more energy than the absorbed photon, and from conservation of energy, this results in lower rubidium atom energy.

In my experiment I measured the volume and concentration of the fluorescent light emitted by the atoms. There is one photon emission per electron bounce, and every bounce means the atom is cooled more. Therefore, volume correlates directly with the amount the rubidium atoms are cooled. To measure this volume I used my apparatus, which consists of an aluminum cube, a laser, laser mirrors, multi-meter, rubidium bulb, CCD camera, and TV. To measure the size of the region being cooled, the camera captures the image and it appears on the TV, where I measure it and use a formula to find the volume.

Results
My results were incredible. My fluorescence experiment varied from 25,000 # 50,000 mm^3*x. My density experiment varied from 5,000 # 30,000 mm^3*x. I added the #*x# because the camera enlarges the image a certain amount. Since I measured my results on the TV screen, my data is on the enlarged image. I tried to find #x# at the beginning of the experiment, but it made my data inaccurate. An interesting thing I noticed was that at 80 and 95 mA, there was a general dip in both experiments. This dip was larger in the density experiment. The highest volume in both experiments was at 90mA.

Conclusions/Discussion
In conclusion, this project was a huge challenge to me. However, it was really fun and a wonderful experience. It was great practice for when I become a physicist or an engineer.

Summary Statement
My project focuses on Laser Cooling and Trapping of Rubidium-87 Atoms by collision with photons through the use of Doppler Shift.

Help Received
Dad helped order rubidium bulb, laser, and mirrors on Ebay. Dad also drove me to The Home Depot and bought aluminum rods, screws, washer, and nuts; also showed me how to use electric saw and drill. Lastly, Dad gave me a variable resistor and showed me how and where to solder it, following the