Cold atoms observed for the first time at the \textit{Universidad de Santiago de Chile}

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Abstract. A cloud of cold \textsuperscript{85}Rb atoms was recently observed for the first time in Chile in a magneto optical trap using a Rb getter. We also observed cooling and trapping of the \textsuperscript{87}Rb isotope. This experience represents a preliminary result for an ongoing effort to promote the experimental research in the field of quantum optics in Chile.

1. Introduction
The construction of our magneto-optical atom trap for rubidium began in 2004 in our laboratory following C. Wieman, \textit{et al} \cite{1}. With the help and collaboration of many people we have succeeded in installing the necessary laser systems, vacuum chamber, and control electronics to create an MOT which became fully operational on November 12, 2006.

We show in this article the main experimental details related to our trap and some representative pictures of the light emitted by the cloud.

2. Experiment
We glued an optical glass cell (Hellma, Model 704.003-OG) with external dimensions 55 x 55 x 52.5 mm to a nominal 4-1/2 to 2-3/4 adapter flange using ultra high vacuum seal (Varian, Model Torr Seal 9530001). The adapter was attached to a 6 way cross (MDC, Model 407002). All the vacuum hardware was based on nominal 2-3/4 CF flanges. Four getters were installed independently to the 6 way cross using an 8 pin electric feedthrough (Lesker, Model EFT0084033). The heater for baking the vacuum line consists in an approximately 10 m long nichrome wire that was inserted into a 10 m hose made of 1 m long, 4 mm diameter fiberglass spaghetti. The end of one spaghetti was inserted at the beginning of the next while the nichrome wire was fed inside the hose. The heater was wrapped around the vacuum line. The glass cell had a smaller independent heater and covered with alu-foil. Both heaters were driven independently by Variac transformers. The advantage of this method is that we can control the length of the heater. The ion pump was heated separately. The temperature at equal spaced points on the line were measured with thermocouples and thermistors. We obtained a vacuum of $4.0 \times 10^{-9}$ Torr. We have baked during three days at 120 °C. To reach this temperature we have increased the temperature at 10 °C every 30 min. We cooled down the vacuum line at the same rate to avoid fracture of the cell. Our cell was fractured once, and we fixed it by adding seal to the offending part. The getter was started by a sequence of 8 A, 2 s long square wave current pulse by means of a
LabView 7.0 procedure. The pulse was repeated every minute until the fluorescence of the atoms was observed. We used a programmable current supply connected by RS232 to a notebook. Further details on the use of a Rb getter to load a trap can be found in [2]. The trapping and the re-pumping laser (Toptica Photonics, Model DL100) were carefully tuned to the transition using the feed forward procedure and finding the correct setup of current, temperature, offset and scan. We have obtained hopping free oscillation for both lasers at the desired transitions and it was possible to turn off the scan next to the transitions. For trapping we tuned one laser 1-3 natural linewidths to the low frequency side of the $5S_{1/2} F = 2 \rightarrow 5P_{3/2} F' = 3$ transition of $^{87}\text{Rb}$ or $5S_{1/2} F = 3 \rightarrow 5P_{3/2} F' = 4$ transition for $^{85}\text{Rb}$ line and for pumping we used the $5S_{1/2} F = 1 \rightarrow 5P_{3/2} F' = 1$ or $2$ for $^{87}\text{Rb}$ and $5S_{1/2} F = 2 \rightarrow 5P_{3/2} F' = 3$ for $^{85}\text{Rb}$. Well resolved saturated absorption spectra of these lines can be seen in [3, 4]. $^{85}\text{Rb}$ lines obtained by us and used here are shown in Fig. 1. Both lines were set manually by locking at a reference of a narrow scan of the saturated absorption and the scan set to zero. The offset was moved carefully near the desired lines, until cold atoms were obtained.

![Figure 1](image)

The magnetic field gradient of 15 G/cm was obtained with two 10 cm diameter anti Helmholtz coils with 200 turns each and separated by 11.5 cm. The current used was typically 3.5 A. The MOT optics (MOT - OPT, Toptica Photonics) was used in a one way path. The beam passes back and forth as depicted in [5]. The ingoing beam power was 64 mW and the return power of the last beam was about half this power due to reflections on the windows. We have installed the mirrors and wave plates as close as possible to the cell in order that small misalignments of the optics would not affect the coincidence of the beams.

We have rotated the trapping beam polarization with a half wave plate to horizontal polarization. The re-pumping laser was vertically polarized. We combined the trapping laser with the re-pumping laser in a polarizing beam splitter cube and made them collinear. Both laser beams were steered around the optical table to maintaining a 10 m path for avoiding back reflections of the MOT cell windows into the lasers. At the end of this path we have expanded the beams using a Galilean telescope made of one 25 mm convex lens and two nearly spaced 300 mm lenses to obtain a 25 mm diameter beam.

3. Results

Fig. 2 shows two frames taken from a surveillance IR camera. The left side hand photo shows the MOT cell without cold atoms when the tuning condition was removed or when the magnetic field was turned off. The right hand side photo shows a bright 5 mm diameter spot that corresponds to the fluorescence of the cold atoms. This fluorescence was fluctuating while the atoms emitted and experimented collisions.
We reproduced the results obtained by C. Wieman et al. following his instructions with some differences: our trap cell has three times the volume of Wieman’s trap cell, our beam diameter was 1.7 times larger and we have nearly 20 times more laser power. We used a one pass laser path instead of dividing the beam in three parts and retro reflecting in mirrors. Although the power becomes unbalanced for the counter propagating directions, we obtained more power on each path. The video taken by the surveillance camera shows that the cloud was only visible when the magnetic field was turned on and the frequency of both lasers were tuned correctly.

4. Discussion and Conclusion
We have demonstrated the operation of a magneto optical trap an obtained cold $^{85}$Rb and $^{87}$Rb atoms for the first time in Chile. Our laser system is very stable, and it was possible to reproduce the experiment many times. The loading of a trap with a getter gives a lot of control to the density of atoms to be cooled and trapped.

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