XXVIII International Conference on Photonic, Electronic and Atomic Collisions (ICPEAC 2013) IOP Publishing
Journal of Physics: Conference Series **488** (2014) 122007 doi:10.1088/1742-6596/488/12/122007

Modification of the temperature of trapped cold ^{87}Rb atoms by an ionizing process

Ya-Ping Ruan*[1] Feng-Dong Jia* Zhen Sun*, Ping Xue†, XU Xiang-Yuan†,‡, Xing-Can Dai†, and Zhi-Ping Zhong*[2]

* School of Physics, University of Chinese Academy of Sciences, PO Box 4588, Beijing 100049
† State Key Laboratory of Low-Dimensional Quantum Physics, Department of Physics, Tsinghua University, Beijing 100084
‡ Department of Physics, Capital Normal University, Beijing 100037

Synopsis The temperature of the remaining trapped ^{87}Rb atoms gradually decreases as the intensity of the ionizing lasers increases. And the relationship between the temperture and atom number of the remaining ^{87}Rb atoms follows an exponential law. This is mainly due to that the photoionized atoms in the state of 5 $^2P_{3/2}$ have higher velocity caused by the detuning of cooling laser, and they escape from the trap after becoming ions. In addition, ion-atom interaction may play a role at a higher ion density.

The characteristics of trapped atoms in a magneto-optical trap (MOT) are sensitive to various types of perturbations [1]. By adding an ionizing laser in the MOT, we elucidate that how the ionizing process modifies the temperature of trapped cold ^{87}Rb atoms.

The experiment is performed by exposing cold ^{87}Rb atoms in a MOT to the ionizing laser of 473nm. The temperature of trapped cold ^{87}Rb atoms are measured by time-of-flight method [2].

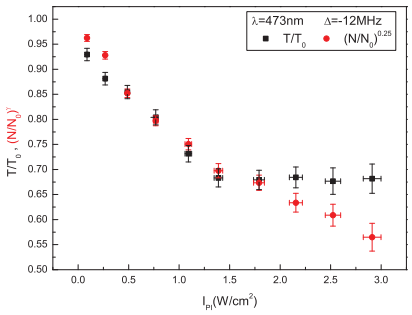

Figure 1. The ratio T/T_0 and $(N/N_0)^\gamma$ measurements as a function of the average intensity of the ionizing laser. T and N are temperature and atom number respectively in the presence of the ionizing lasers, while T_0 and N_0 are temperature and atom number after the ionizing process

As shown in figure 1, T/T_0 firstly decreases as I_{PI} increases until 1.5 W/cm^2 and then remains at a certain value. When $I_{PI} < 1.5$ W/cm^2, T/T_0 and N/N_0 can be fitted by the formula of $T/T_0 = (N/N_0)^\gamma$ which is similar to that in an evaporative cooling process. We propose a suggestion that red-detuned cooling laser excites high velocity atoms to 5 $^2P_{3/2}$, then the atoms in the excited state are photoionized and escape from the MOT, thus the remaining trapped atom has lower temperature and atom number. Based on the suggestion, the factor γ should be dependence of the detuning of cooling/trapping laser. Our experimental results shown in Table 1 support such suggestion.

Table 1. The factor γ in different detunings of cooling/trapping laser at wavelength of 473nm

Δ(MHz)	γ
-6	0.15-0.16
-12	0.25
-16	0.35-0.49

Noted that the relationship between the temperature and atom number deviates from the exponential law as I_{PI} >1.5 W/cm^2, and the temperature decreases more smoothly. It may be heating mechanism resulting from both of electron-ion collision and ion-atom collision which should play an important role as more atoms are photoionized.

This work is supported by the National Natural Science Foundation of China under Grant No 11074299, Open research Fund Program of the state Key Laboratory of Low-Dimensional Quantum Physics and Tsinghua University Initative Scientific Research Program under Grant No 20101081779.

References

[1] J. Weiner *et al* 1999 *Rev.Mod.Phys.* **71** 1.
[2] S. Chu *et al* 1985 *Phys.Rev.Lett.* **55** 48.

[1]E-mail: ruanyaping09@mails.ucas.ac.cn
[2]E-mail: zpzhong@ucas.ac.cn