# A magneto-optical trap for metastable helium at 389 nm

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We have constructed a magneto-optical trap (MOT) for metastable helium (He*) atoms utilizing the $2\,^3S_1 \rightarrow 3\,^3P_2$ line at 389 nm as the trapping and cooling transition. Compared to the traditional He* MOT [1], which employs the $2\,^3S_1 \rightarrow 2\,^3P_2$ 1083 nm transition, the 389 nm MOT offers a three-times larger momentum transfer per photon. This, combined with the fact that the lifetime of the $3\,^3P_2$ state nearly equals that of the $2\,^3P_2$ state, allows for a factor of three reduction of the linear MOT dimensions. In view of the route commonly taken towards BEC [2, 3], this miniature-sized MOT may lead to more efficient magnetostatic trapping of He* atoms, provided the MOT is able to trap a sufficiently large number of atoms.

Our MOT is continuously loaded from a conventional Zeeman slower. Two channeltron electron multipliers are mounted inside the MOT vacuum chamber to separately detect metastable atoms and positive ions, the latter of which are produced by Penning ionizing collisions. Integrating the He* TOF signal that appears after switching off the MOT, we obtain a lower bound of $3 \times 10^6$ for the number of trapped atoms. Compared to the 1083 nm MOTs, which typically contain $\sim 8 \times 10^8$ He* atoms [1, 2, 3], this is a small number. The difference is mainly due to the limited 'capture range' of the 20 mm diameter 389 nm MOT laser beams. The temperature of the atoms is ∼1 mK.

Since 10% of the $3\,^3P_2$ population decays to the $2\,^3S_1$ state via a cascade of two levels, a closed transition at 389 nm does not exist. In combination with the relatively large Doppler shift at 389 nm, this explains the reduced loading of the MOT. Currently, loss processes due to two-body optical collisions and two-photon ionization are investigated. The outcome of this research will give insight into the possibility of using the 389 nm MOT as a tool for obtaining large numbers of He* atoms at high densities.

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