

INTERACTIONS OF ULTRACOLD METASTABLE NEON ATOMS

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Recently we measured elastic and inelastic collisional properties of cold metastable neon (3P_2 state) in a magnetic trap.¹ We obtained elastic scattering lengths of $a = -180(40) a_0$ for ^{20}Ne and $a = +150^{+80}_{-50} a_0$ for ^{22}Ne , with $a_0 = 0.0529\text{nm}$. The rate coefficient for two-body loss was determined to be $\beta = 6.5(18) \times 10^{-12} \text{cm}^3\text{s}^{-1}$ for ^{20}Ne and $\beta = 1.2(3) \times 10^{-11} \text{cm}^3\text{s}^{-1}$ for ^{22}Ne . These losses were proved to be caused by ionizing (i.e. Penning) collisions and to occur less frequently in spin-polarized trapped clouds than with unpolarized atoms. From these collisional properties follows a low efficiency for evaporative cooling. Nevertheless, we achieved a 200-fold increase in phase space density by rf-forced evaporative cooling in the magnetic trap with ^{22}Ne . However, efficiency of evaporative cooling has to be improved in order to reach quantum degeneracy.

Therefore we implemented an optical dipole trap using a laser at 1065 nm with a power of 50 W. Two laser beams with waists of $\sim 40 \mu\text{m}$ are crossed at a small angle of $\sim 50 \text{mrad}$ to form the trap. We can load this trap from a magneto-optical trap as well as from a magnetic trap. It enables us to investigate the magnetic field dependence of collisional properties of metastable neon beyond the limited range of field values accessible in the magnetic trap. More importantly, we can now trap metastable neon in states which cannot be trapped magnetically. Here, the anti-trapping Zeeman state 3P_2 ($m = -2$) is very interesting, because of a possible reduction in two-body loss rate coefficient for this energetically lowest state in a magnetic field, as it occurs in other atomic species, for instance in chromium. Of great interest is also the other metastable state 3P_0 .

Indeed we trapped for the first time neon in the 3P_0 metastable state. After loading the optical dipole trap with atoms in the 3P_0 state, we apply a laser pulse resonant with the $^3P_0 \rightarrow ^3D_1$ transition at 598 nm, while the trap laser is shortly switched off. In this way, we transfer half of the atoms to the 3P_0 state, the other half decays to the ground state via 1P_1 . Currently we work on measurements of the collisional interaction of 3P_0 metastable neon atoms.

¹P. Spoden et al., *Phys. Rev. Lett.* 94, 223201 (2005)