Optical trapping of fermionic ^{40}K atoms

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We report on collisional studies on a sample of cold fermionic ^{40}K atoms in a 1D optical lattice. The lattice is created by about 1 Watt of single-mode radiation from a Ti:Sa laser, red detuned by 20 nm from the D_1 and D_2 transitions, and arranged in a standing-wave configuration. Potassium atoms are precooled in a standard MOT to sub-Doppler temperatures [1], and then loaded in the optical lattice with the help of a compression phase followed by an optical molasses phase.

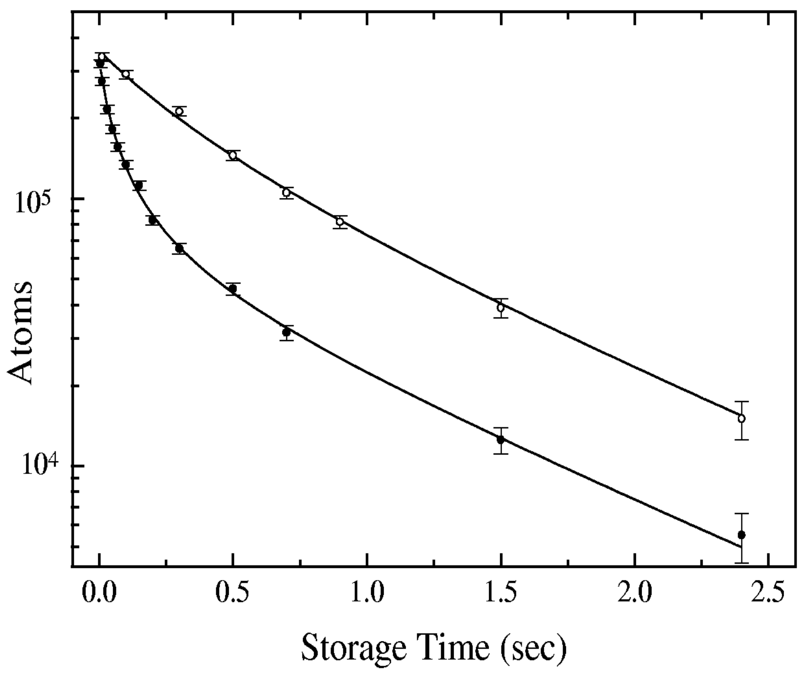

Figure 1: Decay of the number of ^{40}K atoms in the optical lattice when pumped in the F=7/2 upper hyperfine state (solid circles) and in the F=9/2 ground state (open circles). From a fit of the first decay for two-body losses, we estimate the inelastic collision rate between atoms in F=7/2 to be β=4.5(2)$\times10^{-11}$ cm^{-3}.

We can transfer about 10% of the atoms from the MOT to the lattice, resulting in a typical sample of 5×10^6 atoms, at a temperature of 60 μK and with a peak density of 10^{12} cm^{-3}. The trap lifetime is limited by collisions with the background gas to approximately 1.5 sec.

We investigate the collisional properties of the trapped atoms, and we measure the two body inelastic collision rate for unpolarized atoms in the two hyperfine substates of the ground electronic state, through detection of trap losses. We compare the experimental rates for collision partners in (F=7/2, F=7/2) and in (F=7/2, F=9/2) with the predictions of a theoretical model. We are proceeding towards the measurement of elastic collisional rates for atoms in the ground F=9/2 hyperfine state, in presence of an external magnetic field. The interest of the measurement lays in a very broad Feshbach resonance, which has been recently predicted for the collisions between m_F=-7/2 and m_F=-9/2 Zeeman sublevels, at a relatively low magnetic field of 200 Gauss [2]. This resonance could be exploited for a control of the interaction in a degenerate Fermi gas of ^{40}K, in order to move the critical temperature for Cooper pairing to a range experimentally accessible. For this purpose, we are optically pumping the atoms in the selected Zeeman sublevels, and we are measuring the thermalization rate after a fast parametric excitation of the axial mode of the trap, following the scheme used in [3]. We will present the latest results of the experimental investigation.

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