Preliminary determination of the magic wavelength of magnesium-24

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We report on the status of the magnesium frequency standard at the Leibniz University of Hanover. Recently, we performed spectroscopy with first experimental estimations of the magic wavelength.

As loading of the optical lattice directly from a magneto optical trap (MOT) is not efficient enough due to high temperatures of a few milli Kelvin and density limitations we thus continuously accumulate micro Kelvin cold atoms in an optical dipole trap. The experimental sequence is as follows. The atoms are getting precooled in the singlet MOT at 285 nm and subsequently transferred via the $^1S_0$-$^3P_1$ intercombination line to the triplet manifold where a second MOT at 383 nm is operated. By introducing a decay channel from the second MOT to the $^3P_0$ state we accumulate the coldest atoms in the dipole trap at 1064 nm which therefore acts as an energy filter [1].

Due to ionization of atoms from the 3D states during the triplet MOT we cannot apply this scheme to the optical lattice at the magic wavelength, so we first load the dipole trap and then subsequently transfer the atoms to the lattice which is spatially overlapped with the dipole trap. In order to fulfill the power requirements the lattice is enhanced in a linear build-up cavity design. We achieve trapping of up to 10^4 atoms at temperatures as low as 1.3 µK, measured using the thermal distribution of the atoms in the sidebands [2]. An ultra-stable laser system with an instability of 5×10^{-16} in 1 s is available for spectroscopy. The $^1S_0$-$^3P_0$ clock transition is interrogated using magnetic field-induced spectroscopy [3].

The magic wavelength is estimated using measurements of the AC Stark shift at different lattice powers and wavelengths. Remaining drifts of the interrogation laser are tracked using the atomic transition. First estimations of the magic wavelength have values between 467.6 and 469 nm.

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[2] D. J. Wineland et al., *Phys. Rev. A* 36, 2220 (1987)

[3] A. V. Taichenachev et al., *Phys. Rev. Lett.* 96, 083001 (2006)