Hyperfine Structure of Laser-Cooling Transitions in Fermionic Erbium-167

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Lanthanides with submerged 4f-shell electrons, having an exceptionally large electronic angular momentum J, are class of atoms that attract attention in the field of ultracold quantum physics. Their dipolar character can be one hundred times larger than that for alkali-metal atoms. This key property makes lanthanides prime candidates for the study of atomic dipolar physics.
We have analysed the hyperfine structure of the only stable fermionic isotope ofatomic erbium as well as determined its isotope shift relative to the four most-abundant bosonic isotopes. Our work focuses on the J --> J + 1 laser cooling transitions from the [Xe]4f126s2(3H6) ground state to two levels of the excited [Xe]4f126s6p configuration, which are of major interest for experiments[1] on quantum degenerate dipolar Fermi gases. From a fit to the observed spectra we find that the magnetic dipole and electric quadrupole hyperfine constants for the excited state of the strong optical transition at 401 nm are Ae/h = - 100,1(3) MHz and Be/h = - 3079(30) MHz, respectively. For the narrow transition at 583 nm a similar fit leads to hyperfine constants that are in excellent agreement with previous measurements. We have also determined the hyperfine constants using relativistic configuration-interaction ab-initio calculations. The agreement between the ab-initio and fitted data for the ground state is better than 0.1% , while for the two excited states the agreement is 1% and 11% for the Ae and Be constants, respectively.

[1]by F. Ferliano et al at the University of Innsbruck, Austria