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Magic wavelengths for optical cooling and trapping of potassium
M.S. SAFRONOVA, University of Delaware and JQI, ULYANA SAFRONOVA, University of Nevada, Reno, CHARLES W. CLARK, JQI, NIST and the University of Maryland — We carry out a systematic study of the static and dynamic polarizabilities of the potassium atom using a first-principles high-precision relativistic all-order method in which all single, double, and partial triple excitations of the Dirac-Fock wave functions are included to all orders of perturbation theory. Recommended values are provided for a large number of electric-dipole matrix elements. Static polarizabilities of the $4s$, $4p_j$, $5s$, $5p_j$, and $3d_j$ states are compared with other theory and experiment where available. We use the results of the polarizability calculations to identify magic wavelengths for the $4s - np$ transitions for $n = 4, 5$, *i.e.* those wavelengths for which the two levels have the same ac Stark shifts. These facilitate state-insensitive optical cooling and trapping. The magic wavelengths for the $4s-5p$ transitions are of particular interest for attaining a quantum gas of potassium at high phase-space density. We find 20 such wavelengths in the technically interest region of $1050 - 1130$ nm. Uncertainties of all recommended values are estimated.

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