Spectroscopy simulation of Cs atom embedded in Ar matrix

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The spectroscopy of alkali atoms experiences a renewed interest to perform metrology experiment to provide upper limit to the electron dipole moment. The existence of such a dipole moment is a test for particle theory like the standard model and beyond. Such a dipole is extremely weak but it might nevertheless perturb the precession dynamics of the hyperfine states of the atom. To have some chance to measure a weak signal, the target should be as dense as possible. Embedding atoms in cold rare gas matrix is a possible way to enhance significantly the atomic density. A drawback of such method is the perturbation of the embedded Cs atom by the matrix and the possibility of multiple trapping sites. However, each trapping site possesses its own absorption and emission spectrum and we can perform a trapping site analysis by rather conventional method of visible spectroscopy associated to the atomic 6s-6p transitions.

The goal is first to simulate the spectrum of two different trapping sites to allow experimentalists to assign the observed spectrum to a well-defined geometry. The student will compute the electronic structure of the Cs atom trapped in the matrix by solving the Schrödinger equation for the single outer electron of Cs in the field of the Cs ionic core and Ar atomic cores. The simulation codes exist at CIMAP and the student will mainly adapt them to the Cs case. In a second step, the student will analyse the precession dynamics of the hyperfine states of the 6s ($^1S_{1/2}$) configurations under the perturbation of external fields.

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