# Rotational Spectroscopy and Magic 3D Optical Lattices for Ultracold 6Li40K Molecules

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We report our progress in achieving long coherence times for 6Li40K molecules confined in magic 3D optical lattices. Our study begins with rotational spectroscopy of the J=1 hyperfine structure at 215.5 G. Through precise measurement and analysis of transition frequencies to excited rotational states, we extract the hyperfine interaction constants. A specific stretched state transition is further investigated. In a 1070 nm optical dipole trap, the coherence time is limited to approximately 10 microseconds. To extend the coherence time, we perform frequency-dependent polarizability calculations for both the ground state and the first rotationally excited state of 6Li40K. Spin-orbit coupling between A1S and b3Pi reveals a critical transition from ground state molecules to the |b3Pi,v=0,J=1⟩ state at 314.2305 THz. Experimentally, we calibrate the polarizability spectra and identify a broad, far-detuned magic wavelength where the differential light shift across the trap is negligible. Magic points happen at detunings of −8.9 GHz (for 90° laser polarization) and +6.8 GHz (for 0° laser polarization) relative to the nearest transition. At the +6.8 GHz magic point, the differential polarizability changes by only 70 mHz/(W/cm^2) as laser intensity varies from 0 to 7 kW/cm^2. Based on these results, we have constructed a 3D magic optical lattice, with fine-tuning of coherence optimization is currently underway.