Second-Order Hyperfine Structure in Strontium and Impact on New Physics Searches Using Isotope Shift Spectroscopy

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Precision laser-spectroscopy measurements of isotope shifts have been used as a sensitive probe for hypothetical new bosons that would couple electrons and neutrons. Such a boson would cause a deviation from the lowest-order mass and field shifts, which manifests as a nonlinearity in the King plot. Previous studies have almost exclusively focused on spinless nuclei because of the added complexity of the hyperfine interaction. However, in an effort to obtain additional isotopes when stable spinless isotopes are in short supply, one may consider the possibility of using nuclei with non-zero spin and averaging over the hyperfine structure.

Such an attempt has been made previously with measurements performed for strontium. The experiment included three spinless isotopes and one isotope with spin, for which the transition frequency was found by taking the weighted average of the three hyperfine components. The corresponding King plot was not a straight line, as the King theory would predict; instead a non-linearity has been observed.

In my talk I will discuss the second-order hyperfine shift in ^{87}Sr to resolve this non-linearity. We then consider the possibility of including isotopes with spin into existing studies, and analyze the limitations of such an inclusion caused by theory accuracy. Finally, we suggest a method to overcome this difficulty by considering a specific difference of two isotopes with spin. This suggestion puts forward further laser spectroscopy experiment for the search of New Physics.