Creating molecules with unstable isotopes

Svetlana Kotochigova and Jacek Klos

Temple University, Physics Department

Molecules with unstable isotopes often contain heavy and deformed nuclei and thus possess a high sensitivity to various parity-violating effects. In this work, we focus on the ^{223}FrAg molecule. The octupole deformation of the unstable ^{223}Fr nucleus amplifies its nuclear Schiff moment by two orders of magnitude relative to spherical nuclei [1,2]. We have performed relativistic electronic structure calculations of the ground and excited states of ^{223}FrAg, which accounts for the strong relativistic spin-dependent properties of ^{223}Fr. In addition, we study optical transitions between the electronic states to determine the feasibility of STIRAP to form molecular FrAg. In the near future, our goal is to make predictions regarding the locations of magnetic Feshbach resonances in the ultracold scattering between Fr and Ag. These resonances can be used to magneto-associate the atoms into weakly-bound FrAg molecules.

[1] O. P. Sushkov, V. V. Flambaum, and I. B. Khriplovich, *JETP* **60**, 873 (1984).
[2] V. Spevak, N. Auerbach, and V. V. Flambaum, *Phys. Rev. C* **56**, 1357 (1997).

NSM by $> 100\times$ relative to spherical nuclei

In this study we theoretically investigate the electronic structure the ^{223}FrAg molecule. Formation of ultracold ^{223}FrAg molecules from ultracold Fr and Ag is challenging due to lack of knowledge of their rovibrational, and hyperfine modes in both their electronic ground and excited states. Strong relativistic spin-dependent properties must also be accounted for. Kotochigova will perform relativistic electronic structure calculations, determine Franck-Condon factors, and make available other spectroscopic data. She will also make predictions for the locations of magnetic Feshbach resonances in the ultracold scattering between Fr and Ag. These resonances can be used to magneto-associate the atoms into FrAg molecules.