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Magnetically tunable Feshbach resonances in Li+Er

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Ultracold species make it possible to build state-selected quantum systems with controllable interactions, which open the door to exploring fascinating phenomena. Among their many applications, ultracold systems can be used as quantum simulators, to study condensed-matter physics and quantum-controlled chemistry, to develop quantum information devices, and for ultraprecise spectroscopy. Tunable Feshbach resonances are powerful tools to control the interaction and scattering properties of ultracold species, and make many of these applications possible. Having the possibility to address and tune across selected Feshbach resonances is thus key in ultracold experiments.

In this poster, I will discuss our recent work on magnetic s-wave Feshbach resonances in binary mixtures of ground-state Li atoms and bosonic Er isotopes [1]. Our study provides compelling and robust theoretical evidence that low-field resonances exist for Li+Er, with widths well within current experimental resolution. The Li+Er system may be especially appealing for experiments in optical lattices: Dipolar species with tunable interactions are key to studying the effects of long-range anisotropies, quantum magnetism, disorder, and quantum collective behaviour. Very importantly, such Feshbach resonances may be used for magnetoassociation of LiEr molecules, starting from ground-state atoms in order to avoid limiting background losses [2]. In addition, Er is a heavy atom, thus ultracold LiEr may be used to study the time variation of fundamental constants, while the extreme mass imbalance in the system makes it specially well suited for exploring Efimov physics. We predict Li+Er spectra to have strikingly different statistical properties than those of other systems involving highly-magnetic atoms such as Er+Er, Dy+Dy, etc. In particular, the spectra are much less congested and exhibit non-chaotic properties. I will hence discuss a simple model to predict resonance positions for different isotopologues from measurements on a reference system, which would greatly simplify designing experiments with various Er bosonic isotopes.

[1] M. L. González-Martínez and P. S. 379;uchowski, *Phys. Rev. A* **92**, 022708 (2015)
[2] M. L. González-Martínez and J. M. Hutson, *Phys. Rev. A* **88**, 020701(R) (2013)

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