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Controling Interactions of Ultracold Er Atoms with Feshbach Resonances[1] SVETLANA KOTOCHIGOVA, ALEXANDER PETROV, Temple University — Here we pursue ideas for using anisotropic dipole-dipole and dispersion interactions to control collisional properties of ultracold magnetic Erbium (Er) atoms by using Feshbach resonances (FR). This kind of control will allow for converting a weakly interaction gas of atoms to a strongly interacting gas that can exhibit novel collective many-body states. Alternatively, interactions can be turn off all together to create an ideal gas, for which thermodynamic properties are known analytically. Feshbach resonances can also be used to create a BEC and associate atoms into highly magnetic molecules. For fermionic magnetic atoms the BCS-BEC phase transition and universal behavior of infinitely-strong interacting atoms can be studied. Finally, Efimov physics for the complex non-alkali atoms can be explored. The most interesting collision experiment occurs when magnetic Er atoms are prepared in the energetically-lowest Zeeman state $j = 6$ and projection $m = -6$ at nanokelvin temperatures, as Feshbach resonances can be observed. Resonances in magnetic atoms must rely on anisotropic couplings to bound state with non-zero partial wave ℓ. This is in contrast to collisions of alkali-metal atoms. Anisotropic interactions are much weaker there and, in addition, the hyperfine interaction between the electron and nuclear spin gives sufficient complexity so that most FR are due to s-wave bound states.

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