Ultracold coherent control of molecular collisions at a Förster resonance

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The advent of ground-state controlled ultracold dipolar molecules in dense gases has opened many exciting perspectives for the field of ultracold matter. When the molecules are dipolar, their extremely controllable properties have inspired many theoretical proposals for promising quantum applications, such as quantum simulation/information processes, quantum-controlled chemistry and test of fundamental laws.

Ultracold molecules can be used to probe chemical reactions with an unprecedented control at the quantum level. This was done for example with the chemical reaction KRb + KRb → K_2 + Rb_2 at ultracold temperatures. All the fragments of an ultracold chemical reaction, from reactants to products, including intermediate complexes, can now be observed [1]. The state-to-state rotational distribution of the products can be measured [2] and the rotational parities of the molecular products can be controlled with a magnetic field [3,4].

We explore here the ideas of coherent control [5] applied to current experiments of ultracold chemical reactions. By using a microwave to prepare ultracold dipolar molecules in a quantum superposition of three stationary states (qutrit) and by using a static electric field to make collisional states degenerate, we predict [6] that one can observe interferences in the rate coefficients of ultracold molecules (see Figure 1). This work provides a realistic and concrete experimental set-up for current experiments to observe interferences and coherent control in ultracold collisions.

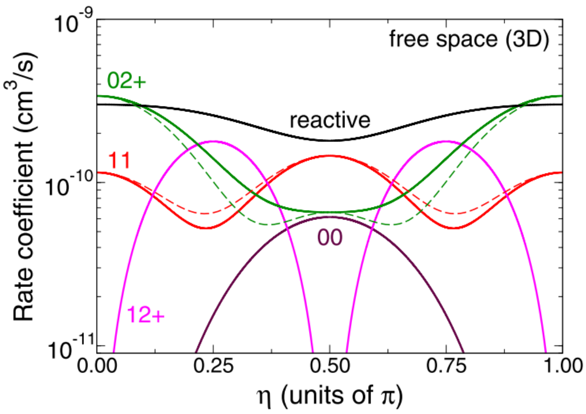

Figure 1: Rate coefficients of two colliding qutrits at a Förster resonance as a function of a microwave control parameter η [6].

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