Crossover from the quantum to the quasiclassical regime in photodissociation of ultracold molecules

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Chemical reactions and collisions at ultralow energies are dominated by quantum mechanical effects. At higher energies the variety of quasiclassical approaches can be used to understand these processes. The reaction investigated experimentally by the group of Tanya Zelevinsky at the University of Columbia in New York was a light-induced photodissociation of the diatomic strontium molecule. The experiment was performed with the full control over the initial quantum states of the molecule, the final states and the kinetic energy of the fragments.

Quantum model of photodissociation, based on the Fermi golden rule, was successfully applied to explain the photodissociation patterns in the ultracold regime [1]. It was extended to describe the photodissociation in external magnetic field, where the Zeeman coupling of the rotational levels causes the standard selection rules to fail [2].

For high photofragment energies, when dissociation becomes much faster than rotation of the molecule, the widely used quasiclassical model [3] was supposed to correctly describe the process. However, we proved that when the photofragments are identical particles, their bosonic or fermionic quantum statistics can cause this model to fail even for high energies. We propose a corrected quasiclassical model which takes into account quantum statistics [4, 5]. It is confirmed by the experimental results of the Zelevinsky group.

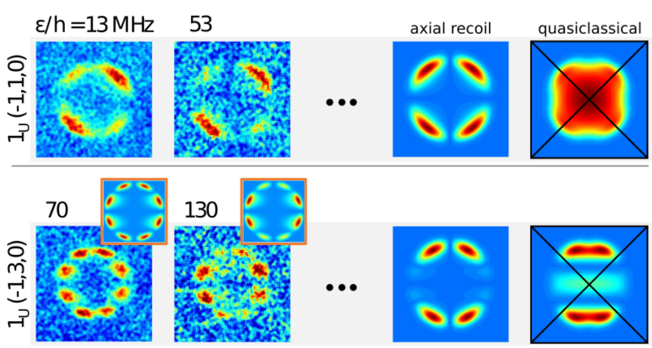

Figure 1: Evolution of photodissociation patterns with energy

References

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