Quantum effects in cold and controlled molecular dynamics

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I will discuss three examples of molecular dynamics where quantum effects are particularly pronounced. (i) The wave nature of matter emerges in cold collisions, giving rise to quantum scattering resonances. Probing these with rotationally state-selected molecules allows for disentangling the isotropic and anisotropic contributions to the inter-particle interaction [1]. (ii) The wave nature of matter also gives rise to phase protection of Fano-Feshbach resonances. I will discuss how this mechanism may protect a bound state from decay despite resonant coupling to a scattering continuum. For rare gas diatomic ions, the corresponding phase dependence results in predissociation lifetimes spanning four orders of magnitude which we find to be in good agreement with experimental measurements [2]. (iii) Yet another signature of quantum mechanics is found in selection rules governing the light-matter interaction. A particularly striking effect is the so-called photoelectron circular dichroism (PECD) found in randomly oriented chiral molecules. I will present a simple, but first principles-based model that allows to explain the PECD that was observed experimentally in the resonantly enhanced multiphoton photoionization of camphor and fenchone molecules [3] and discuss prospects for quantum control [4].

References

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