Precision spectroscopy and quantum information with trapped molecular ions

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The quantum molecules group at Universität Innsbruck utilizes a range of advances in molecular spectroscopy and quantum logic spectroscopy (QLS) to study molecular rovibrational structure and explore quantum information (QI) in trapped molecules. The efforts of our group are divided into four projects. The first utilizes Raman rotational control using a CW laser and frequency comb for precision rotational spectroscopy and to explore applications in QI. Novel QI encoding schemes are possible in rotational states of molecules which are not available in atoms.[1][2] We are developing a dissipative quantum error correction scheme to stabilize a rotational superposition. We aim to demonstrate state preparation, coherent control, and creation of superpositions of rotational states in CaH+ or CaOH+.[3] The second project is pump-probe recoil spectroscopy, where we aim to measure vibrational population dynamics of single molecular ions by mapping them to the electronic state of an atomic ion via QLS.[4] The third project focuses on state-dependent force spectroscopy, where an optical tweezer generates a state-dependent force on a trapped molecular ion. This enables quantum non-demolition measurements of the rovibrational structure.[5] The fourth project involved using the capable platform we have developed to measure one- and two-photon dissociation spectra of CaOH+ molecular ions.

References

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