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Towards state preparation, readout, and control of polyatomic molecular ions using quantum logic spectroscopy

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Molecular ions offer more degrees of freedom than atomic ions. These larger Hilbert spaces are rich and interesting landscapes to explore, possibly enabling quantum information applications such as quantum error correcting (QEC) schemes not available in atomic ions. This requires efficient and precise control of the molecular ion states. Co-trapping a molecular ion with an atomic ion facilitates state preparation and readout via quantum logic spectroscopy. Our group aims to use calcium-based molecules, e.g., CaH+ or CaOH+, co-trapped with a 40Ca+ ion for exploring these applications in QEC and precision spectroscopy. Coherent control within a rotational manifold of a molecular ion can be achieved by driving two-beam Raman transitions, as direct transitions between the sublevels in the same manifold are forbidden by selection rules

Author: ISAZA MONSALVE, Mariano (University of Innsbrcuk)

Co-authors: FUREY, Brandon; MATTIVI, Elyas (University Innsbruck, Quantum Optics and Spectroscopy); SCHINDLER, Philipp (University of Innsbruck); NARDI, René (Universität Innsbruck); WALSER, Stefan; WU, Zhenlin

Presenter: ISAZA MONSALVE, Mariano (University of Innsbrcuk)

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