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Towards quantum logic spectroscopy of molecular ions

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Precision spectroscopy is a driving force for the development of our physical understanding. A prime example is the search for variation of fundamental constants in laboratory experiments through the repeated frequency comparison of highly accurate frequency standards. It is advantageous to compare standards with a large difference in sensitivity of their transitions to a change in these fundamental constants. However, only few atomic and molecular systems of interest have been accessible for precision spectroscopy in the past, since they miss a suitable transition for laser cooling and internal state detection. This restriction can be overcome in trapped ions through quantum logic spectroscopy. I will show how the internal state of a molecular ion can be detected non-destructively on a co-trapped cooling ion by implemented a quantum logic algorithm involving only coherent laser manipulation on the molecular ion [1]. This represents a first step towards extending the exquisite control achieved over selected atomic species to much more complex molecular ions. Steps towards high resolution spectroscopy of molecular ions with the goal of improving the model-independent upper bound on a variation of the proton-to-electron mass ratio will be presented.

[1] F. Wolf, Y. Wan, J. C. Heip, F. Gebert, C. Shi, and P. O. Schmidt, Non-destructive state detection for quantum logic spectroscopy of molecular ions, Nature **530**, 457–460 (2016).

Summary

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