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Higher-order effects of electric quadrupole fields on a single Rydberg ion

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Abstract

Rydberg ions have large dipole and quadrupole polarizabilities which makes them extremely sensitive to external electric fields[1][2]. As a result, an ion in the Rydberg state experiences altered trapping potential which leads to motion-dependent Rydberg excitation energies[3]. Higher the Rydberg state more is the sensitivity to the electric quadrupole trapping fields. The oscillating trapping field induces an energy shift in these states which oscillates at the trap drive frequency and generates sidebands in the spectrum. Unwanted couplings to these field-induced sidebands reduces the fidelity of Rydberg ion quantum gate operations.

Here we study the higher order effects of the quadrupole electric filed on a single trapped Sr^+ Rydberg ion confined in a Paul trap, which arises due to the quadrupole polarizability of the Rydberg states. The effects were investigated on $nS_{\frac{1}{2}}$ and $nP_{\frac{1}{2}}$ states and resonance shifts and spectral sidebands were observed experimentally. The Rydberg excitation energies depend quadratically on the trapping RF field amplitude. For the $nS_{\frac{1}{2}}$ state the first order spectral sidebands were much weaker whereas in the $nP_{\frac{1}{2}}$ state the spectrum showed a forest of sidebands. All results are in good agreement with theory[4].

References

[1] G. Higgins, *A single trapped Rydberg ion.* PhD thesis, Stockholm University and Innsbruck University, 2018.

[2] M. Muller, L. Liang, I. Lesanovsky, and P. Zoller, *Trapped Rydberg ions: from spin chains to fast quantum gates,* New Journal of Physics, vol. 10, p. 093009, Sep 2008.

[3] G. Higgins, F. Pokorny, C. Zhang, and M. Hennrich, *Highly Polarizable Rydberg Ion in a Paul Trap*, Physical Review Letters, vol. 123, 2019.

[4] G. Higgins, C. Zhang, F. Pokorny, H. Parke, E. Jansson, S. Salim, and M. Hennrich, *Observation of second- and higher-order electric quadrupole interactions with an atomic ion*, Physical Review Research, vol. 3, no. 3, pp. 1-6, 2021.

Author: SALIM, Shalina (Stockholm University)

Co-authors: PARKE, Harry (Stockholm University); HIGGINS, Gerard (AUSTRIAN ACADEMY OF SCIENCES, INSTITUTE FOR QUANTUM OPTICS AND QUANTUM INFORMATION VIENNA); ZHANG, Chi (Imperial College London); POKORNY, Fabian (Department of Physics, University of Oxford); HENNRICH, Markus (Stockholm University)

Presenter: SALIM, Shalina (Stockholm University)

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