Contribution ID: **7** Type: **Poster**

Feedback Cooling the Motion of a Trapped Ion

Tuesday, 26 September 2023 19:30 (2 hours)

The inherent quantum nature of single trapped ions makes them promising candidates for the experimental realization of qubits, the fundamental building blocks of quantum computers. In order to harvest the potential that trapped ions posses, it is necessary to not only have precise control over an ion's quantum state but also over its motional state. Doppler cooling is commonly deployed to dampen the thermal motion of an ion inside the trapping potential down to the Doppler limit. Additional cooling methods are, however, necessary to further reduce the ion motion beyond this Doppler limit, so as to achieve more efficient interaction of light and the ion [1, 2]. Feedback cooling can be used to actively dampen the ion's motion by monitoring the momentary displacement of the ion and applying a corresponding feedback signal in real time [3]. This is achieved in our setup by trapping the single ion inside a deep parabolic mirror using a stylus-like trap [4], enabling us to collect most of the emitted fluorescence light due to the large solid angle coverage. An imaging system is used to image the ion onto a knife edge. The signals of single-photon detectors behind this edge are then used to discern the ion's motion in combination with a lock-in amplifier to subsequently extract and provide the feedback signal. The ion motion is observed to be reduced using a spectrum based method [3] and an imaging based method [5].

References

[1] L. Alber, M. Fischer, M. Bader, K. Mantel, M. Sondermann, G. Leuchs, Journal of the European Optical Society-Rapid Publications 2017, 13, 1–10.
[2] M. K. Tey, G. Maslennikov, T. C. Liew, S. A. Aljunid, F. Huber, B. Chng, Z. Chen, V. Scarani, C. Kurtsiefer, New Journal of Physics 2009, 11, 043011.
[3] P. Bushev, D. Rotter, A. Wilson, F. Dubin, C. Becher, J. Eschner, R. Blatt, V. Steixner, P. Rabl, P. Zoller, Physical review letters 2006, 96, 043003.
[4] R. Maiwald, A. Golla, M. Fischer, M. Bader, S. Heugel, B. Chalopin, M. Sondermann, G. Leuchs, Physical Review A 2012, 86, 043431.
[5] B. Srivathsan, M. Fischer, L. Alber, M. Weber, M. Sondermann, G. Leuchs, New Journal of Physics 2019, 21, 113014.

Primary author: Mr DANG, Hans (Max Planck Institute for the Science of Light)

Co-authors: Dr ROY, Atish (Max Planck Institute for the Science of Light); Dr FISCHER, Martin (Max Planck Institute for the Science of Light); Dr SONDERMANN, Markus (Max Planck Institute for the Science of Light, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU)); Prof. LEUCHS, Gerd (Max Planck Institute for the Science of Light, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU))

Presenter: Mr DANG, Hans (Max Planck Institute for the Science of Light)

Session Classification: Tuesday Poster