CO.CO.MAT

SFB/TRR 21 - Colloquium

8. Mai 2015, Ulm

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Reservoir engineering, bang-bang control and transport quantum logic gates with trapped ions

I will describe recent experiments in which we have generated a range of Gaussian states of motion of a single trapped ion using reservoir engineering [1]. We make use of multi-frequency laser fields to couple the motional oscillator to a zero temperature reservoir realized through optical pumping of the ion's spin. The engineered spin-motion couplings lead to cooling in a rotated state basis, producing as the ground state the desired state of interest. We use similar couplings to demonstrate novel measurement techniques for oscillator states, providing a direct measure of state fidelity, and also show a sqrtn scaling in the engineered basis which is analogous to the Jaynes-Cummings result. These oscillator state measurements have been verified independently first by a Fock state decomposition, and using a second technique involving the use of state-dependent forces to entangle the spin and motion. The latter generates squeezed-wavepacket analogues to the well known Schrodinger's cat states. We observe re-coherence after separating the entangled wavepackets by up 20 times the ground state r.m.s. extent which corresponds to more than 60 times the width of the squeezed wavepacket [2]. I will also briefly describe recent results on transport quantum logic gates for trapped ions, as well as a new type of control based on nano-second timescale changes in the trapping potentials. The latter allows us to map out the ion-light interaction at the 10 kilo-quanta level.

[1] D. Kienzler et al. Science 347, 6217 (2014) [2] H-Y. Lo et al., arXiv:1412.7100 (accepted for publication in Nature) (2015)

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