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Title: Tomographical reconstruction of mechanical motion using Rydberg excited atoms

Abstract: Rydberg atoms have proven to be an excellent tool to observe the quantum dynamical features of a microwave cavity mode [1, 2]. Here we investigate their applicability to characterize instead the motional state of a nano-mechanical oscillator. Attaching a ferroelectric domain to the oscillator supplies it with a permanent electric dipole moment. Coupling between mechanical vibrations of such oscillator and a Rydberg transition dipole is thus enabled via an electric dipole-dipole interaction. Atomic Ramsey interference measurements of phase-shifts acquired by Rydberg atom-oscillator states in an off-resonance framework yield a non-destructive detection of discrete mechanical Fock states. Translations in phase space of the motional state of the oscillator, required for its full tomographical reconstruction [3], are implemented with the same arrangement when the atoms are simultaneously driven by optical fields in an off-resonant Raman scenario. Many sequences of Ramsey measurements for different phase space configurations allows us to reproduce the Wigner distribution function of the mechanical oscillator. We work towards demonstrating the experimental feasibility of this idea taking into account all relevant mechanisms of mechanical decoherence.

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References

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