Abstract Submitted
for the DAMOP15 Meeting of
The American Physical Society

Mechanical and electronic energy eigenstates of neutral Rb atoms in deep optical lattices ANDREAS NEUZNER, MATTHIAS KOERBER, OLIVIER MORIN, STEPHAN RITTER, GERHARD REMPE, Max-Planck-Institute for quantum optics — Optical lattices allow for tight three-dimensional confinement of neutral atoms in quasi-harmonic potentials and have become a standard tool in experimental quantum optics. Applications range from fundamental topics like metrology to applications in quantum communication and quantum information processing. Here we present an experimental characterization of the motional and internal energy eigenstates of optically trapped ^{87}Rb atoms. We implement different spectroscopy techniques based on non-destructive hyperfine state detection using an optical cavity. Applying these techniques, we observe and explain a series of effects like the decoupling of the hyperfine spin due to a tensor lightshift and mechanical effects associated with a small non-orthogonality of the lattice axes. Furthermore, we succeed to exploit the latter for optical cooling of a single atom into the two-dimensional mechanical groundstate in an environment with restricted optical access.

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Date submitted: 30 Jan 2015 Electronic form version 1.4