Vibrational ground state cooling of a neutral atom in a tightly focused optical dipole trap

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Centre for Quantum Technologies / Nat. Univ. Singapore — Recent experiments have shown that an efficient interaction between a single trapped atom and light can be established by concentrating light field at the location of the atom by focusing [1-3]. However, to fully exploit the benefits of strong focusing one has to localize the atom at the maximum of the field strength [4]. The position uncertainty due to residual kinetic energy of the atom in the dipole trap (depth ~ 1mK) after molasses cooling is significant (few 100 nm). It limits the interaction between a focused light mode and an atom already for moderate focusing strength [2]. To address this problem we implement a Raman Sideband cooling technique, similar to the one commonly used in ion traps [5], to cool a single $^{87}$Rb atom to the ground state of the trap. We have cooled the atom along the transverse trap axis (trap frequency $\nu_T = 55$ kHz), to a mean vibrational state $\bar{n}_T = 0.55$ and investigate the impact on atom-light interfaces.