PhD THESIS DEFENSE: Single-atom motional dynamics in an optical dipole trap

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This thesis studies, using simulation and experiment, the motional dynamics of a single atom in an optical dipole trap. The optical dipole trap we study is a single-beam, red-detuned, far-off-resonance trap (FORT). This FORT is located at the centre of an arrangement of four high-NA lenses in the "Maltese cross" geometry, which facilitates measurements based on atomic fluorescence. We make a detailed study, combining simulation with experimental measurements, of the temperature of the atom in this system. We note reasons why a single-temperature description could fail to describe the motional statistics of the atom in the trap. We then study the sensitivity of an established method, the release-and-recapture, to a possible anisotropic temperature distribution of the atom. We also measure the optical extinction produced by the atom, from which we extract a lower bound on the strength of

interaction. Finally, we show with simulation results and experiments, how parametric excitation of the atom in the FORT can be used to manipulate its phase-space distribution, which can lead to an effective decrease or increase of the atom's kinetic energy.

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