PhD THESIS DEFENSE: A versatile system for the study of light-matter interactions at the level of individual particles.

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ICFO Auditorium and Online (Teams)

In this thesis, a single-atom trap in a ï¿½Maltese cross'' geometry (MCG) was designed, bui
t up and characterized. A MCG atom trap uses four in-vacuum lenses to achie
e four-directional high-numerical-aperture optical coupling to single trapped atoms and sma
l atomic arrays
 Here, we describe the theoretical background, the design, and the optical methods used
or trapping and cooling atoms in a MCG geometry optimized for high coupling efficiency.?
 We also characterize the resulting properties of the trap and trapped atoms. For this propos
 we measure occupancy, loading rate, lifetime, temperature, fluorescence anti-bunching and

rap frequencies using current best practices. We also report another use of the optical con
rol and coupling offered by the MCG: we use the two on-trap-axis lenses to produce a 1D opt
cal lattice, the sites of which are stochastically filled and emptied by the trap loading proc
ss. The two off-trap-axis lenses are used for imaging and single-mode collection. Correlation
of single-mode and imaging fluorescence signals are then used to map the single-
ode collection efficie
cy. We observe trap characteristics comparable to what has been reported for single-atom t
aps with one- or two-lens optical systems. This shows that four-direction high-NA coupling ca
be achieved with little reduction in trap performance. Finally, we conclude with the near-fu
ure plans of the experim

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