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Light Polarization Dependence of Optical Dipole Traps Created in the Diffraction Pattern of a Pinhole[1]

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We will present the results of our computational exploration of the atom trapping potentials in the diffraction pattern that forms behind, but very close to a small pinhole [1]. Specifically we explored the polarization dependence of these traps [2]. Our simulation indicates it is possible to create two distinct optical dipole traps for atoms in the F = 1 and m_F = +1,-1 sub-states using σ^+ and σ^- polarized light. We explored a range of incident laser angles and found that by adjusting the angles it is possible to manipulate the physical location of atoms that are in the dipole traps. The traps stayed intact beyond angles of 6°, at which point the traps are completely separated. For a 25 μm pinhole and $\sim$100 mW of laser light, tuned 1000 linewidths to the blue of the D2 transition in Rubidium 87 we found trap depths of $\sim$1 mK, radial trap frequencies of $\sim$10 kHz and axial trap frequencies of several kHz. The main goal of this study was to explore a method through which we could create a controllable optical dipole trap that may allow for the implementation of 2-qubit gates using two-dimensional arrays of optical dipole traps.

[1] G. D. Gillen, et al., Phys. Rev. A 73 (2006), 013409
[2] I.Deutsch, et al., Phys. Rev. A, 57 (3), 1972-1986 (1998).

[1]In collaboration with Professors Katharina Gillen-Christandl and Glen D. Gillen, California Polytechnic State University.