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Diffraction effects on optical trapping of small particles RACHAEL HARPER, ALEX LEVINE, University of California, Los Angeles — Geometric ray optics is an elegant and computationally efficient means of numerically calculating the forces on particles of arbitrary shape due to their interaction with a beam of light. This method is limited to the regime in which the particle is much larger than the wavelength of light. Ashkin's pioneering work [1] on force exerted by a laser trap on a spherical dielectric particle relies on this geometric optics limit. In current experiments, however, the size of the trapped particles can be comparable to the wavelength of the trapping radiation field. In this talk, we discuss the corrections to ray-tracing-based calculations of the laser trapping forces due to diffraction effects. Specifically, we compare the momentum transfer from a uniform beam of light to hollow dielectric cylindrical shells obtained from two different calculations using: (i) ray-tracing and (ii) the full physical optics formulation. By changing the radii of the inner and outer edges of the hollow cylinder with respect to the wavelength of light we determine the limits of validity of the ray-tracing solution. In the limit in which the radius of the inner cylinder is comparable to the wavelength radiation we show that the corrected momentum transfer is smaller than that predicted by geometric optics. We attribute this result to the reduction in the scattering force on the cylinder due to diffraction effects not accounted for in the geometric optics formalism. [1] A Ashkin, Biophys. J., 61, 569 (1992).

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