

## Optical Trapping and Manipulation of Nanoparticles

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A strongly focused laser beam can trap and manipulate small particles in a technique that is called "optical tweezers." Applications of optical tweezers involving micron-sized transparent particles, such as glass or plastic spheres, are common; but little work has been done with nanoparticles in optical tweezers. The difficulty is that the trapping force for particles smaller than the wavelength of light is typically proportional to the particle volume. However, sub-nanometer atoms can be trapped by tuning the laser close to a strong resonance transition where the optical response is enhanced. Building upon our previous work in laser cooling and trapping of neutral atoms, we have recently begun work in optical tweezer traps for particles. To trap 1–100 nm particles, we plan to take advantage of the resonant enhancement of the optical response of particles, in analogy with atom traps. There are many potential candidates, such as metallic nanoparticles, metal-dielectric nanoshells, quantum dot nanocrystals, chromophore-doped nanospheres, and carbon nanotubes. Many of these resonances also depend on the size and shape of the particles. Exploiting these dependences would allow us to use the tweezers facility to sort particles by size, shape, or color. Optical tweezers can not only be used to assemble and test nano-scale sensors and devices, but the ability to selectively manipulate nanoparticles based upon their size, shape, or color also would enhance our ability to incorporate functionality into the devices or sensors. Other nanometrology applications include measurement of piconewton forces on particles and nanometer displacements of particles.