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Controlling the Microscopic World with Holograms

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An optical tweezer uses the forces exerted by a strongly focused beam of light to trap and move objects ranging in size from tens of nanometers to hundreds of micrometers. Since their introduction in 1986, optical tweezers have become a mainstay of research in biology, physical chemistry, and condensed matter physics. This presentation highlights recent advances that promise to take optical traps out of the laboratory and into the mainstream of manufacturing, medical diagnostics, and even consumer products. In particular, recently introduced techniques in computer-generated holography can create hundreds of simultaneous optical traps, each of which can be moved independently in three dimensions and can be transformed from force-exerting pincers into new all-optical tools such as torque-exerting optical vortices. By providing unprecedented access and control over the mesoscopic world, the next generation of single-beam optical traps also offers revolutionary new opportunities for fundamental and applied research.