Researchers demonstrate proof of creation of a mirror by optical matter

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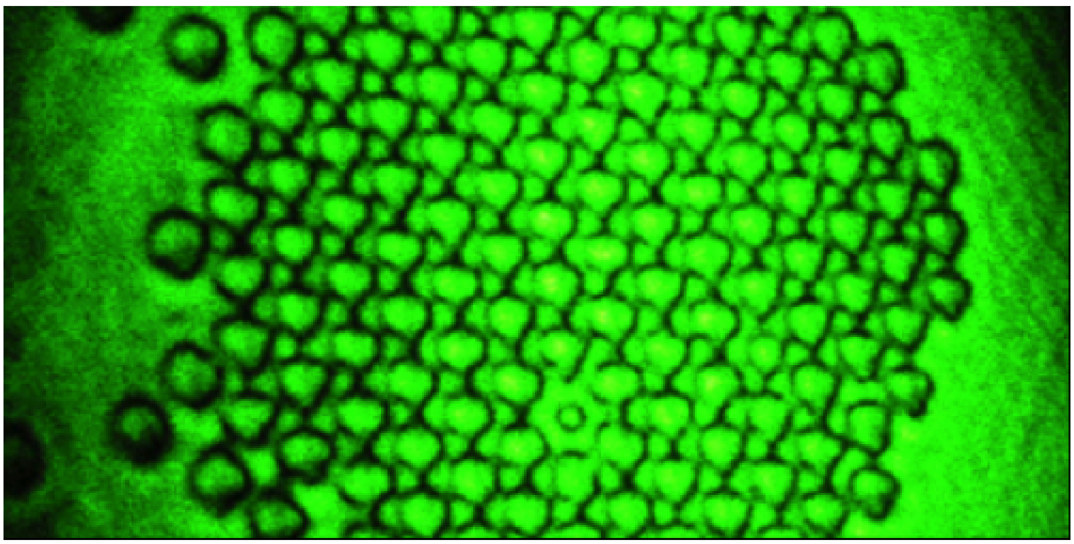

Credit: T. M. Grzegorczyk et al., Phys. Rev. Lett. (2014)

(Phys.org) —A team of researchers working at the Swiss Federal Institute of Technology has physically demonstrated that it is possible to create a mirror from material that is optically manipulated. In their paper published in *Physical Review Letters*, the team describes their demo product and how it might one day lead to giant space based telescopes.

Currently, space based telescopes are limited by their size and weight, particularly regarding the mirror—using rockets for delivery is very restrictive—there are both size and cost issues involved. To possibly get around that problem, the researchers with this new effort are looking into taking advantage of the force produced when a laser is shot at a tiny particle.

Scientists have known for some time that very tiny things can be moved around using nothing but laser light—optical tweezers are one example. Taking the idea a step further, the research team put several micrometer-sized polystyrene beads in water and placed them on a very small pane of glass. Next, they fired a laser at the beads, causing them to move close enough to one another touch—electrostatic force pulled them tightly together. Once in place the beads together formed a reflective surface—reflective enough for the device to be considered a rudimentary mirror. The researchers tested their mirror by shining a light through a plastic ruler—the light that bounced back was displayed on another surface and was clear enough for the team to make out the number "8". This they say, suggests their simple mirror might one day lead to the construction of huge space based telescopes, effectively doing away with the much heavier models used today.

Such predictions may be jumping the gun a bit, however, as there are some very serious impediments to building such a telescope. The main one of course is that such a telescope would require a constantly focused laser beam, which would of course require a lot of power—power that would have to come most likely, from the sun, which would mean sending up massive solar arrays to support the telescope which would bring back the original problem of sending up large or heavy objects.

The researchers are undaunted by such hurdles, suggesting that their mirror demonstrates a path towards the future and that it doesn't seem out of the question to believe that advances in science will make what might now seem impossible, possible

More information: Optical Mirror from Laser-Trapped Mesoscopic Particles, *Phys. Rev. Lett.* 112, 023902 (2014) DOI:

10.1103/PhysRevLett.112.023902

Abstract
Trapping of mesoscopic particles by optical forces usually relies on the gradient force, whereby particles are attracted into optical wells formed by landscaping the intensity of an optical field. This is most often achieved by optical Gaussian beams, interference patterns, general phase contrast methods, or other mechanisms. Hence, although the simultaneous trapping of several hundreds of particles can be achieved, these particles remain mostly independent with negligible interaction. Optical matter, however, relies on close packing and binding forces, with fundamentally different electrodynamic properties. In this Letter, we build ensembles of optically bound particles to realize a reflective surface that can be used to image an object or to focus a light beam. To our knowledge, this is the first experimental proof of the creation of a mirror by optical matter, and represents an important step toward the realization of a laser-trapped mirror (LTM) in space. From a theoretical point of view, optically bound close packing requires an exact solver of Maxwell's equations in order to precisely compute the field scattered by the collection of particles. Such rigorous calculations have been developed and are used here to study the focusing and resolving power of an LTM.