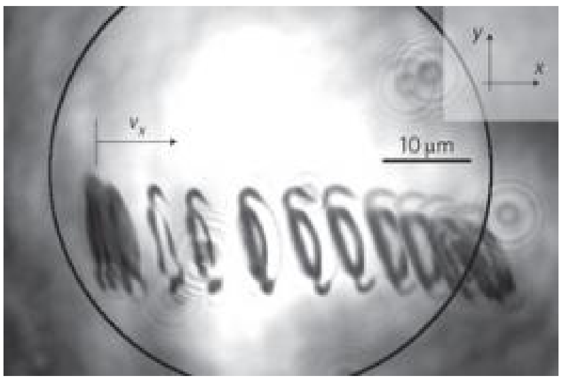
Optical lifting demonstrated for the first time (w/ Video)

December 7 2010, by Lin Edwards



Time-lapsed composite image (1.67 s per shot) of a semi-cylindrical rod lifting sideways from left to right near the bottom of a glass chamber, as a result of a transverse optical lift force. Image credit: *Nature Photonics*, doi:10.1038/nphoton.2010.266

(PhysOrg.com) -- Scientists in New York have predicted, observed and experimentally verified a micrometer-scale object being lifted only by a beam of laser light. Optical lifting may be useful for powering micromachines or improving the design of solar sails for interstellar space travel.

Light has been known for some time to be capable of pushing objects and this is the principle behind the solar sail, which uses light to push vehicles along in space. Now, a new study by physicist Dr. Grover Swatzlander and colleagues of the Rochester Institute of Technology in

Rochester, New York shows light is also capable of creating the more complex force of “lift,” which is the force generated by airfoils that make a plane rise upwards as it travels forward.

In a paper that appeared online in *Nature Photonics* on December 5th, Swartzlander and colleagues describe their demonstration of light providing optical lift to tiny lightfoils. The experiment began as computer models that suggested when light is shone on tiny objects shaped like a wing a stable lift force would be created.

Intrigued, the researchers decided to do physical experiments in the laboratory, and they created tiny, transparent, micrometer-sized rods that were flat on one side and rounded on the other, rather like airplane wings. They immersed the lighfoils in water and bombarded them with 130 mW ultraviolet laser light from underneath the chamber. As predicted, the lightfoils were pushed upwards by the light, but they also moved sideways in a direction perpendicular to the beam of light, in other words they were optically lifted. Symmetrical micro-spheres did not show the optical lift effect.

In aerodynamic lift, which is created by an airfoil, the lift occurs because the wing shape causes air flowing under the wing to move more slowly and at higher pressure than that above the wing. In optical lift, created by a lightfoil, the lift is created within the transparent object as light shines through it and is refracted by its inner surfaces. In the lightfoil rods a greater proportion of light leaves in a direction perpendicular to the beam and this side therefore experiences a larger radiation pressure and hence, lift.

Unlike aerodynamic lift, which has gradual lift angles, the optical lift angles were around 60 degrees, which Swartzlander said was striking, very powerful, and could be compared to a plane taking off at 60 degrees. “Your stomach would be in your feet,” he said.

Swartzlander described the findings as "almost like the first stages of what the Wright brothers did," and said the next step would be to test lightfoils in air and experiment with a variety of materials with different refractive properties, and with other wavelengths of light.

More information: Stable optical lift, *Nature Photonics* (2010) doi:10.1038/nphoton.2010.266