Radiation pressure makes ellipsoidal particles tumble

Authors.

Besira Mihiretie, Patrick Snabre, **Jean-Christophe Loudet**, and Bernard Pouligny.

Affiliations.

CNRS, CRPP, UPR 8641, F-33600 Pessac, France.

University of Bordeaux, CRPP, UPR 8641, F-33600 Pessac, France.

Abstract.

Radiation pressure (RP) forces from a few-milliwatts laser beam are known to produce forces in the picoNewton range, well enough to levitate and manipulate a small (micrometer sized) dielectric particle [1]. Since the invention of laser tweezers [2], based on a single very large aperture beam, considerable savoir-faire and theoretical knowledge have been accumulated in the art of trapping and manipulating particles with light (see e.g. [3]). However, research works have been focused essentially on the simplest kind of particles namely spheres.

In the present study, we report on optical levitation of dielectric particles, of *prolate ellipsoidal* shape, a few tens of micrometers in length, in a low aperture laser beam. Ellipsoids of moderate aspect ratio (k<3) are observed to be trapped on axis of the laser beam, similarly to simple spheres. Conversely, elongated particles (k>3) cannot be kept immobile, and rather undergo sustained oscillating motions, comprising both lateral and angular excursions around the beam-axis; hence the name “tumble". The observed tumbling motion, a straightforward manifestation of the non conservative character of radiation pressure forces, may be explained through a 2-dimensional ray-optics model of the interaction of light with an ellipsoid [4].

References.

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