Engineering light-matter interaction for emerging optical manipulation applications - DTU Orbit (10/12/2018)

Engineering light-matter interaction for emerging optical manipulation applications: Invited review paper

In this review, we explore recent trends in optical micromanipulation by engineering light-matter interaction and controlling the mechanical effects of optical fields. One central theme is exploring the rich phenomena beyond the now established precision measurements based on trapping micro beads with tightly focused beams. Novel synthesized beams, exploiting the linear and angular momentum of light, open new possibilities in optical trapping and micromanipulation. Similarly, novel structures are promising to enable new optical micromanipulation modalities. Moreover, an overview of the amazing features of the optics of tractor beams and backward-directed energy fluxes will be presented. Recently the so-called effect of negative propagation of the beams (existence of the backward energy fluxes) has been confirmed for Xwaves and Airy beams. In the review, we will also discuss the negative pulling force of structured beams and negative energy fluxes in the vicinity of fibers. The effect is achieved due to the interaction of multipoles or, in another interpretation, the momentum conservation. Both backward-directed Poynting vector and backward optical forces are counter-intuitive and give an insight into new physics and technologies. Exploiting the degrees of freedom in synthesizing novel beams and designed microstructures offer attractive prospects for emerging optical manipulation applications.

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