Optical force on a Mie particle by an Airy light-sheet using generalized Lorenz–Mie theory

Ningning Song[a,*], Renxian Li[a,b,], Jiaming Zhang[a], Shu Zhang[a], Han Sun[a], and Bojian Wei[a]**

[a]*School of Physics and Optoelectronic Engineering, Xidian University, Xi'an 710071, China*
[b]*Collaborative Innovation Center of Information Sensing and Understanding, Xidian University, Xi'an 710071, China*

[*]*Presenting author (nnsong@stu.xidian.edu.cn)*
[**]*Corresponding author (rxli@xidian.edu.cn, rxli@mail.xidian.edu.cn)*

Since Ashkin invented optical tweezers in 1986 [1], more and more scientists have been devoted to optical manipulation. The study of optical manipulation of micro- and nano-particles depends on specific light field. Traditional optical tweezers used Gaussian beam as trapping beam. In recent years, some new optical manipulation techniques based on novel laser beams have been developed. Airy light-sheet is a new type of optical field, and its amplitude distribution obeys the airy function. Airy light-sheet have self-healing [2], non-diffraction, self-acceleration [3], self-bending transmission [4] and other excellent characteristics, and provides a possibility for the special and complex manipulation of light on particles. Exact prediction of optical force by laser beam is of practical significance for the development of novel optical tweezer systems.

Generalized Lorenz–Mie theory (GLMT) is an exact solution of the Maxwell equations, and can rigorously predict the optical force on a homogeneous spherical particle induced by laser beams [5]. In this paper, the GLMT is employed to rigorously calculate optical force exerted on a sphere in the Mie regime induced by an Airy light-sheet. The results are of great significance for the development of Airy sheet based optical manipulation technology, and have potential applications in the fields including single-molecule research, living cell research, high-precision measurement, etc. [6].

References

[1] Ashkin, A., 1986: Observation of a single-beam gradient force optical trap for dielectric particles. *Opt. Lett.* **11**, 288–290.
[2] Broky, J., G. A. Siviloglou, A. Dogariu, and D. N. Christodoulides, 2008: Self-healing properties of optical Airy beams. *Opt. Express* **16**, 12880–12891.
[3] Siviloglou, G., J. Broky, A. Dogariu, and D. Christodoulides, 2007: Observation of accelerating Airy beams. *Phys. Rev. Lett*. **99**, 213901.
[4] Dolev, I., T. Ellenbogen, N. Voloch-Bloch, *et al*., 2009: Control of free space propagation of Airy beams generated by quadratic nonlinear photonic crystals. *Appl. Phys. Lett.* **95**, 201112.
[5] Gouesbet, G., and G. Grehan, 1982: A generalized Lorenz–Mie theory. *J. Opt.* **13**, 97–103.
[6] Dienerowitz, M., 2008: Optical manipulation of nanoparticles: a review. *J. Nanophoton*. **2**, 021875.

Preferred mode of presentation: Oral