Optical force on irregular and inhomogeneous particles by an Airy light-sheet using discrete dipole approximation

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Optical tweezers [1] have been become a powerful tool for non-contact manipulation of microscopic objects and have found a huge range of applications in various fields [2]. The discrete dipole approximation (DDA) is an efficient tool to calculate optical forces on particles with various shapes illuminated by any beam [3]. Airy light-sheet is a two-dimensional Airy beam and has been widely utilized in optical particle clearing, particle transport, micromanipulation because of their advantages of non-diffraction, self-acceleration, and self-healing [4].

In this research, the angular spectrum decomposition method is used to derive the electromagnetic field components of an Airy light-sheet. Numerical computations for axial and transverse radiation force are computed for *x*-polarized Airy light-sheet with different transverse scale ω_0, modulation parameter *a*, and beam center. ω_0 involves the size of lobes and the number of side lobes. With the increasing of ω_0, all the lobes will expand and the number of side lobes will reduce. *a* involves the intensity of lobes, and the amplitudes of each lobe will decrease with being greater, while the contrast between the main and side lobes is even more obvious. As the particles shift off the axis in the plane perpendicular to the propagating direction, both stable and unstable equilibrium points are obtained, depending on the size parameters, transverse scale, and modulation parameter.

References

[1] Shaw, L. A., C. M. Spadaccini, and J. B. Hopkins, 2017: Scanning holographic optical tweezers. *Opt. Lett*. **42**, 2862–2865.
[2] Liyang, Y., O. V. Minin, W. Zengbo, *et al*., 2018: Photonic hook: a new curved light beam. *Opt. Lett*. **43**, 771–774.
[3] Donald, J. M., A. Golden, and S. G. Jennings, 2009: A novel high-performance computational framework for the discrete dipole approximation. *Int. J. High Perf. Comput. Appl*. **23**, 42–61.
[4] Vettenburg, T., H. I. C. Dalgarno, J. Nylk, *et al*., 2014: Light-sheet microscopy using an Airy beam. *Nat. Meth*. **11**, 541.

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