Scattering of Bessel beams in the framework of the discrete dipole approximation

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In recent years Bessel beams have been gaining special popularity [1]. They belong to the class of non-diffraction beams which do not spread out during propagation (like an unbounded plane wave). Despite the fact that the ideal Bessel beam cannot be obtained in the experiment due to finite energy, it is often sufficient to have an approximate Bessel beam in a finite domain. While the scattering of these beams by particles of simple shapes, such as spheres, has been discussed in the literature, it is rarely considered for complex particles.

The discrete dipole approximation (DDA) is a popular method to simulate scattering and absorption of electromagnetic waves by particles of arbitrary shape and internal structure. In this method the volume of the scatterer is divided into small cubical subvolumes ("dipoles") whose interactions are approximated based on the volume integral equation for the electric field [2]. In principle, the DDA and the corresponding computer codes are applicable to arbitrary incident fields. However, practical simulations for any beam types are much more accessible to the practitioners if they are built into the code. Thus, the main goal of this work is the implementation of Bessel beams in the open-source ADDA code [2].

On one hand, the simplest description is available for linearly polarized beams associated with linearly polarized Hertz potentials of electric (e−) or magnetic (m−) type [1]. The last two types are linearly independent, even if we consider both x- and y-polarization for each type. On the other hand, there exist axisymmetric beams which are a superposition of linearly polarized beams of e− and m− types. They are interesting because they correspond to quasi-Bessel beams obtained by using a conical lens. Therefore, we decided to implement all these types of Bessel beam in the ADDA code. Each of them is described by the corresponding command line option: "−beam besselCS" and "−beam besselLP", with five parameters: order, convergence angle (tilt angle of a conical lens), and three coordinates of the beam center (relative to the center of the scatterer).

We plan to finish and test the implementation by the time of the conference. As a result, it will be straightforward for anyone to simulate the scattering of Bessel beams by arbitrary inhomogeneous particles.

References

[1] Wang, J. J., and T. Wriedt, 2016: General description of transverse mode Bessel beams and construction of basis Bessel fields. *J. Quant. Spectrosc. Radiat. Transfer* **196**, 8–17.
[2] Yurkin, M. A., and A. G. Hoekstra, 2011: The discrete-dipole-approximation code ADDA: capabilities and known limitations. *J. Quant. Spectrosc. Radiat. Transfer* **112**, 2234–2247.

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