Extension of vectorial complex ray model to 3D light scattering by large non-spherical particles

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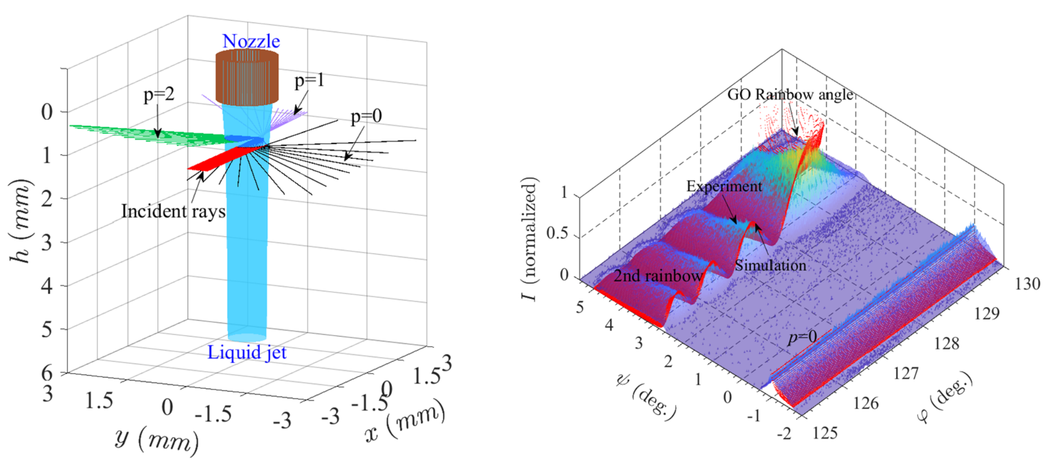
The calculation for the 3D light scattering of large particle with irregular shape is still a challenging problem because of its complexity. The available numerical methods such as *T* matrix, discrete multipole approximation, etc., are severely limited by the size parameter of the scatter [1]. The geometric optics approximation method, be flexible as claimed, has made little headway for 3D light scattering due to its inherent drawbacks. And the variable separation methods such as Lorenz-Mie theory and Debye series expansion are limited to objects with regular shapes such as spheres, ellipsoids and cylinders. Ren *et al*. in [2] proposed the vectorial complex ray model (VCRM), aiming to solve the light scattering by large non-spherical particles. However, the current numerical implementation of the VCRM only addresses rays propagating within a 2D plane [3].

In this paper, we firstly propose the extension of VCRM to the 3D light scattering by large particles of irregular shapes. The proposed method is very flexible and can be applied, theoretically, to solving the 3D light scattering by any large particle, as long as the particle has a smooth surface. Another significant advantage is its efficiency. For a non-spherical particle with size parameter over 5000, the time needed to calculate the 3D scattering field only takes about 20 minutes on a laptop, without parallel computation. An application of the method to the 3D light scattering by a circular liquid jet [4–6] with irregular geometry is given to show its capability, and the simulation result agrees well with that by experiment.



3D Light scattering by a circular liquid jet with size parameter being about 5000 and surface being complex. Left: propagation directions of scattering rays for different times of interaction. Right: comparison of the scattering field near the 2nd rainbow by simulation (in red) with that by experiment (in hot map).

References

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