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Tunneling Efficiency of Arbitrary 3D Objects

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Light waves grazing or passing a particle beyond its geometric cross section contribute to the extinction of light through a tunneling process, similar to the tunneling effect of barrier penetration in quantum mechanics. In addition to the reflection, the refraction, and the Fraunhofer diffraction, an extra contribution to the extinction cross section is usually referred to as the edge effect that is fundamentally due to the aforesaid tunneling mechanism. Rigorous calculation of the edge effect can be conducted for a homogeneous sphere. However, a computational approach for the edge effect of nonspherical particles has remained elusive in the light scattering theory. This talk reports on the accurate calculations of the edge effect for arbitrarily shaped nonspherical particles including objects with sharp corners based on the invariant imbedding concept and Debye's diffraction and reflection. Canonical results are presented to illustrate tunneling efficiencies for spheroids and hexagonal ice crystals. In the case of spheroids, an analytical formula is developed for fast computation of extinction efficiency factors. The solutions based on the present formula closely agree with their counterparts of rigorous solutions computed from the invariant imbedding T-matrix method (II-TM).