Group-theoretical foundation of the random orientation in far-field electromagnetic scattering

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Although the model of randomly oriented nonspherical particles has been used in a great variety of applications of far-field electromagnetic scattering, it has never been defined in strict mathematical terms. We used the formalism of Euler rigid-body rotations to clarify the concept of statistically random particle orientations and derived its immediate corollaries in the form of most general mathematical properties of the orientation-averaged extinction and scattering matrices. In particular, we related the notion of random orientation to the invariance of the orientation-averaged quantities with respect to any fixed rotation of the reference frame. Then the widely used probability density function $\sin\beta/(8\pi^2)$ for averaging over three Euler angles (α, β, γ) follows from the known invariant Haar measure of the 3D rotation group, parametrized with the Euler angles. Our results serve to provide a rigorous mathematical foundation for numerous publications in which the notion of randomly oriented particles and its light-scattering implications have been considered intuitively obvious. More details can be found in [1].

Reference

1. M. I. Mishchenko and M. A. Yurkin. On the concept of random orientation in far-field electromagnetic scattering by nonspherical particles. *Opt. Lett.* **42**, 494–497 (2017).

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