A Study of the Physical Geometric Optics Method In the Case of a Spheroid

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1. Abstract

The physical geometric optics method (PGOM) is used to calculate single-scattering properties (namely, the extinction efficiency, single scattering albedo, and phase matrix) of moderate to large-sized faceted particles. The limitation of implementing PGOM to a spheroid is that a spheroid is not a faceted particle, so it is not currently possible to implement PGOM. The goal of this study is to determine if the physical geometric optics method can be applied to quasi-spheroidal faceted particles by comparing the P_{11} element of the phase matrix to IITM.

4. Results: Sensitivity to Scattering Angle

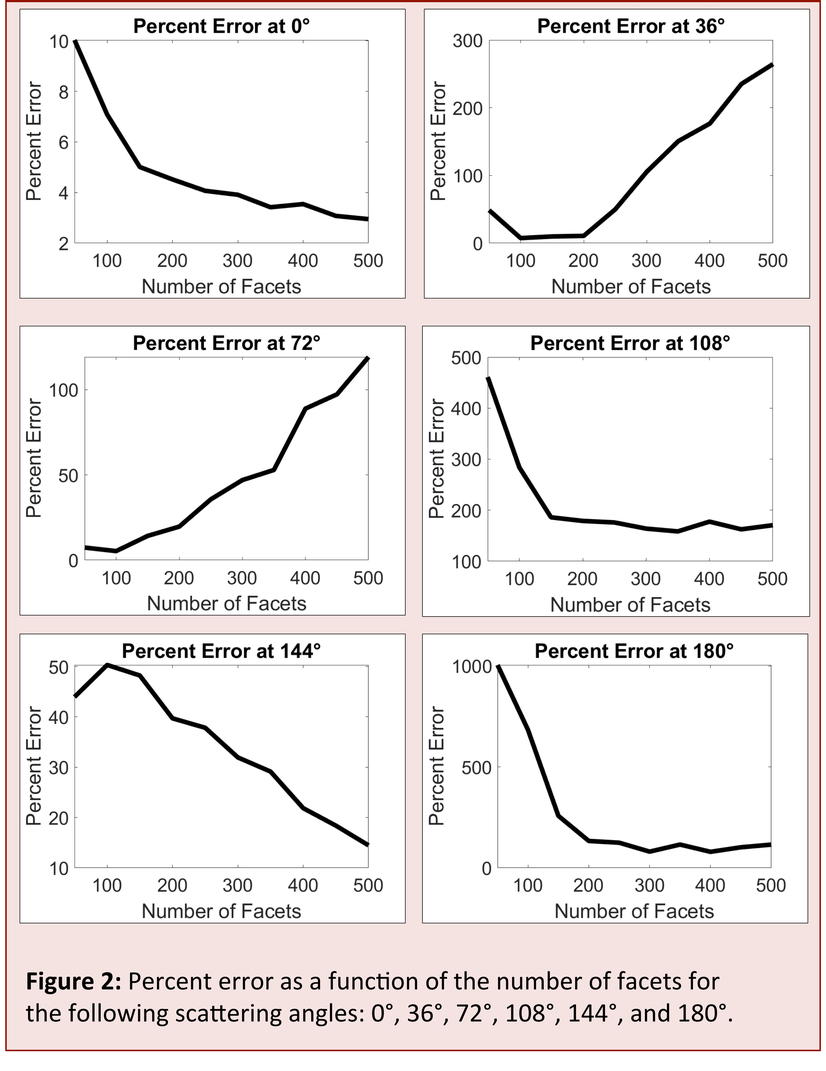


Figure 2: Percent error as a function of the number of facets for the following scattering angles: 0°, 36°, 72°, 108°, 144°, and 180°.

2. Background and Motivation

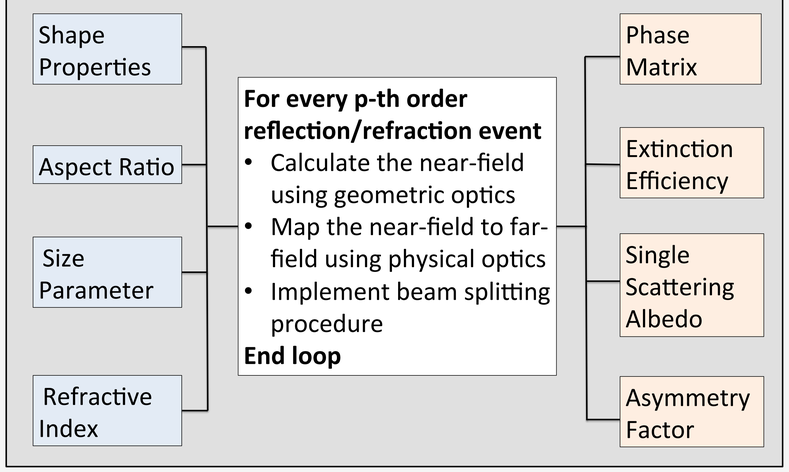
- Aerosol single-scattering properties are essential in remote sensing application, and aerosol radiative effect evaluation;
- The spheroidal shape is a useful approximation to complicated non-spherical aerosol particles;
- PGOM is only applicable for faceted particles.

Scientific Questions

Question 1: Does the convergence properties of PGOM show sensitivity to scattering angle?

Question 2: Does PGOM converge to IITM as the number of facets or sides increase?

Outline of the PGOM Algorithm



5. Results: Accuracy of PGOM

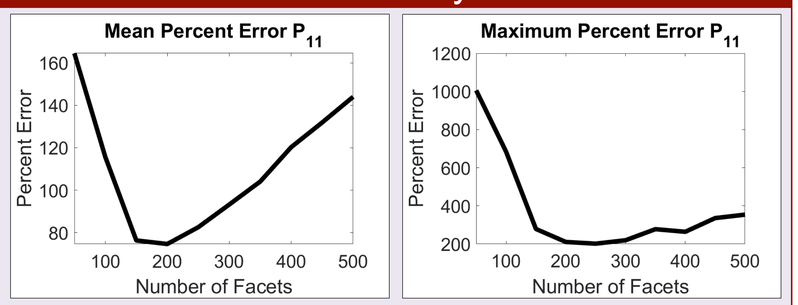


Figure 3: The mean and maximum percent error of P_{11} as a function of the number of facets or sides.

3. Methods

Procedure: Find the relative error at 0°, 36°, 72°, 108°, 144°, and 180°.

Procedure: Find the overall mean and maximum relative error.

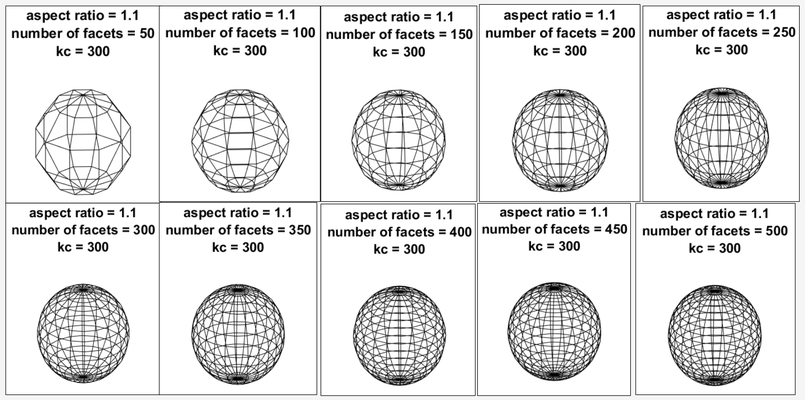


Figure 1: Shape properties of the quasi-spheroidal shapes used in both experiments. The aspect ratio is 1.1, size parameter 300, and refractive index 1.33 + 1e-9 * i

6. Summary and Discussion

We conducted a study to analyze the accuracy and reliability of applying PGOM to a quasi-spheroid by analyzing the P_{11} element of the scattering phase matrix. The main results are as follows:

Other than a few select scattering angles, PGOM diverges as the number of facets increase or converges to a very high relative error.

Based on mean and maximum relative error, PGOM does not converge as the number of facets increase.

References

- Sun et al. "Physical geometric optics method for large size faceted particles", *Opt. Express*, Vol. 25, No. 20, 24044 (2017)

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