Cosmic Dust Exploration using Broadband Microwave Analogues

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Cosmic grains are often expected to be irregularly shaped complex structures of inhomogeneous composition that are hard or nearly impossible to reliably model using common numerical techniques. As a consequence, the interpretation of observational data is similarly difficult. We use microwave analog experiments to study almost any combination of particle composition, size and shape. Notable advantages with the microwave method are: I) the controlled environment where all particle properties are precisely known and can be systematically varied and II) the ability to model exotic volatile materials using their stable microwave analogues.

There are two directions to our approach I) theory development and validity testing [1,2] and II) a systematic exploration of scattering by complex particles using our microwave analogue laboratory. While the diversity of particles of interest to astronomy and astrophysics is more diverse, it is convenient to identify two broad classes: I) relatively primitive particles such as circumstellar, interstellar, and cometary dust, respectively II) fragments of evolved and possibly differentiated bodies such as asteroids, planetary satellites, and ejectae from planetary surfaces. Sample results from both categories of particles will be discussed.

The "primitive" targets include low packing factor aggregates of a few hundred to approximately 6,000 cylindrical or spherical particles ranging from 0.07 wavelengths to 0.4 wavelengths in radius. Their refractive index, ranging from 1.6-0.003i to 1.74-0.005i, is selected to represent silicates and organic refractory materials. These structures have scattering properties reminiscent of zodiacal dust and some cometary dust [3] as well as aerosols in the atmosphere of Saturn's satellite Titan.

Dust from evolved bodies may be irregular compact aggregates or angular fragments produced in collisions. We have obtained results for silicate cubes ranging from 3.25 to 14 wavelengths to the side and from $\sim$ 14 to $\sim$ 20 wavelengths to the side tetrahedrae. We also have results for irregularly shaped particles of homogeneous materials and mixtures.

While the scattering by these structures are very different from that by a Mie-sphere, they have several similarities to the scattering by the "primitive" class of particles. We point out differences between the optical properties of the various models as well as similarities.

References:

[1] Y.-l. Xu and B.Å.S. Gustafson, *Ap. Optics*, **36,** No. 30, pp. 8026-8030, 1997.

[2] Y.-l. Xu and B.Å.S. Gustafson, "Experimental Verification of Multisphere Light-Scattering Calculations: I) Rigorous Solution and II) the DDA", this meeting.

[3] L. Kolokolova, B.Å.S. Gustafson, J. Loesel, and J. Thomas-Osip, "A Comet Dust Evolution Model based on Polarimetric Imaging and Microwave Analogue Experiments", this meeting.

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