Effect of Scattering Dynamics on Model Dust Polarization

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In this work, we analyse the polarization of several oriented dust particles. The orientation of the particles is assumed to be due to scattering interactions. Oriented states are found by explicitly integrating the dynamical state of an initially stationary particle.

METHODS AND RESULTS

We use the electric-current-volume-integral-equation method [1] to calculate the *T*-matrix of an arbitrary inhomogeneous test geometry [2]. The chosen method provides numerically robust solutions for strongly inhomogeneous scatterers.

We model the radiation environment as a discrete blackbody spectrum, with T_{bb} = 5800 K. The cometary dust is modelled as a layered Gaussian random ellipsoid [3]. The permittivity of the outer shell is $\varepsilon_r = 1.95 + i0.786$ and of the cores $\varepsilon_r = 1.69 + i1.04*10^{-4}$, modelling silicate cores covered with a carbon layer.

We determined the dynamical evolution of the test geometry, under the radiation of the Sun. The volume equivalent radius of the particle was a = 200 nm. The radiation spectrum was a 10-point discretization of the blackbody spectrum between 200-2000 nm. The energy flux of the radiation corresponds to solar irradiance of 330 Wm^{-2}.

The scattering rapidly changes the dynamical state of the particle. Aligned orientation is taken from the state, where the particles angular velocity direction oscillates in a stable manner. The aligned average is then taken as the average about the angular velocity vector over a single rotation. Polarization results for unpolarized incident light over the discrete wavelength spectrum are calculated for the randomly oriented case, and for two scattering planes in the aligned case. The first scattering plane contains the major principal axis of the particle, and the second scattering plane is perpendicular to the first.

REFERENCES

[1] J. Markkanen, P. Ylä-Oijala, and A. Sihvola. IEEE Transactions on Antennas and Propagation, 60(11):5195–5202, 2012.

[2] J. Markkanen and A. Yuffa. Journal of Quantitative Spectroscopy & Radiative Transfer, 189:181–188, 2017.

[3] K. Muinonen, T. Pieniluoma. Journal of Quantitative Spectroscopy & Radiative Transfer 112 (11) (2011) 1747–1752.

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