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Combining Linear and Circular Polarization in Remote Sensing of Cosmic Dust and Planetary Aerosols

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Scattering of light by any type of cosmic dust and planetary aerosols always produces some linear polarization. Its degree and polarization plane are sensitive to the characteristics of the scattering particles, specifically their size, shape and composition. Circular polarization arises from more special conditions, namely, when the scatterers or the scattering medium are characterized by a lack of mirror symmetry. Most common sources of circular polarization are multiple scattering in asymmetric media (e.g. nonspherical nebulae), alignment of elongated dust particles, or their optical activity (circular birefringence and dichroism). The last case is of special interest as optical activity is typical for life-related molecules due to their homochirality, and, thus, circular polarization can indicate presence of biological or pre-biological organics. There are numerous observations of circular polarization, e.g. in molecular clouds and comets, and in the future we may expect to see it when studying the atmospheres of extrasolar planets. In all cases it is important to determine the cause of the circular polarization, specifically to prove or disprove its biological origin. We explore how this can be done by combining linear and circular polarization. Correlations between linear and circular polarization are discussed for cosmic dust and planetary aerosols. The discussion is based on spectral and angular dependence of linear and circular polarizations obtained using computer modeling of light scattering by complex, including optically active, particles and with laboratory measurements of light scattering by biological objects.