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A chirality-based search for extraterrestrial biological and prebiological material

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Important evidence relevant to extraterrestrial life is the existence in space of organic molecules of prebiological or biological significance. Such molecules are often characterized by a special type of asymmetry called "homochirality" (domination of molecules of a specific handedness). This results in optical activity of the material that contains those molecules. Due to optical activity, the light scattered by such materials is characterized by non-zero circular polarization. We review laboratory measurements of light scattered by biological (e.g. bacteria, leaves) and non-biological (minerals) samples. These have revealed distinctive features in the circular polarization spectra in absorption bands for the biological samples. We present theoretical simulations of light scattering by homochiral materials made with the superposition T-matrix code for clusters of optically-active spheres. This allowed us to simulate light scattering by biological objects, e.g. colonies of bacteria, and by materials of prebiological value, e.g. cometary dust. We explore how circular polarization depends on the porosity and size of aggregates. Based on this, we provide some recommendations for observing signs of life in space, specifically, on exoplanets.

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