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# Interference phenomena at light backscattering by large atmospheric ice crystals

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Optical and microphysical properties of ice crystals constituting cirrus clouds (i.e. the scattering or Mueller matrix as well as sizes, shapes and spatial orientation of the crystals) are of great interest for the atmospheric optics and climate research. These properties are experimentally studied by means of either radiometers measuring the Mueller matrix as functions of scattering directions or by lidars that are measuring only the backscattering Mueller matrix. At present, the theoretical data concerning the Mueller matrixes for ice crystals of cirrus are obtained rather approximately. The reason is that ice crystal sizes are usually much larger than the wavelengths and the conventional numerical calculations become computationally expensive for them. For example, the Mueller matrix at all scattering directions for the hexagonal ice crystals has been recently calculated by the combination of the Invariant Imbedded T-matrix method and the Improved Geometric-Optics Method for the case of random crystal orientation [1] but these data are not useful for the backscatter.

The backscatter for the atmospheric ice crystals was studied in a number of papers by the authors [2 -4]. Thus, we showed in [2] that the backscatter by the large hexagonal ice crystals revealed a fine interference angular structure around the exact backscattering direction. This interference pattern quickly oscillates with a change of crystal orientations that impacts essentially on the backscatter averaged over orientations. In particular, the backscatter was recently averaged for both randomly oriented [3] and arbitrarily oriented [4] crystals. However, the depolarization ratio and the color ratio obtained proved to be not well matched with the experimental data.

In this contribution, we state that this discrepancy would be overcome by the assumption that ice crystal shapes occurring in the nature are not perfect. This imperfectness essentially changes the fine interference pattern at the backward scattering direction mentioned above. Therefore we have calculated the backscatter for the hexagonal ice crystals with distorted angles among the crystal facets within the framework of the physical-optics approximation. We demonstrate that all parameters of the backscatter match better to the experimental lidar data if the crystals are of the distorted shapes.

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