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THE INFLUENCE OF SCATTERING PARTICLES MORPHOLOGY ON THE CHARACTERISTICS OF LIDAR SIGNALS

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The characteristics of light scattering by a separate spherical particle are used as a priori information when interpreting the data on laser sounding of atmospheric aerosol. Analogously, it is necessary to have a priori information on the characteristics of light scattering by single crystals in order to restitute the microstructure of crystal formation in the atmosphere. In contrast to the aerosol particles the crystals are of different shapes. On the one hand, this complicates the solution of electrodynamic problems on light scattering by such crystals. On the other hand, if obtaining such a solution is possible, one can determine the morphology of scattering particles according to the sounding data and this enables one to obtain additional indirect information on such meteorological parameters as temperature, pressure, humidity.

Linear dimensions of crystals in the atmosphere are tens and hundreds times greater than the wavelength sounded. Therefore the determination of a scattered field in the near area is possible only by means of geometric optics. In this case, it is reasonable to use the geometric optics in the limits of beam approach, i.e., to construct the beam path taking into account the beam distribution on crystal surfaces. When determining the scattered field in the far area it is reasonable to use the wave concept which enables us to consider analytically the beam transformation to a spherical wave. Using this geometric-wave approach the problem of scattering of plane electromagnetic wave on convex polyhedron of arbitrary form was solved. As a result, the expressions have been obtained for electric field components of perpendicular and parallel polarizations scattered in any given direction.

A hexagonal crystal was chosen as a numerical model of crystal particle. Figure 1 gives the scheme of beam distribution as a result of four interactions of the plane wave front with the prism surface. The beams 1 - 6 form the field of backscattering. In the backscattering all the features of the form of hexagonal prism are shown, i.e., the prism investigated is right, the opposite lateral faces are parallel, the lateral faces are located at angles of 60°. The beams 3 - 6 are typical only for hexagonal prisms and are stipulated by all three characteristics, and their paths represent the broken helical lines. The beams of 1,2 types are formed in any right regular prism with parallel opposite surfaces due to reflections from these surfaces and prism bottom. Thus, the field of backscattering is an interference field. The presence and absence of separate components in the field depend on the shape of crystal. Each interference field is strongly dependent on

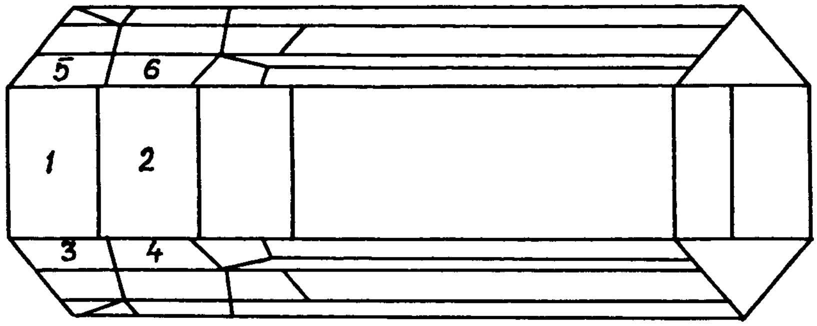

Figure 1. Scheme of the plane wave front distribution taking into account its four interactions with the surface of hexagonal crystal. The plane of wave incidence is perpendicular to a lateral surface, the angle of incidence is 30°. The ratio of the lengths of lateral edge to the side of the bottom L/a =5. The complex refractive index n = 1.31 + i 10^{-3}.

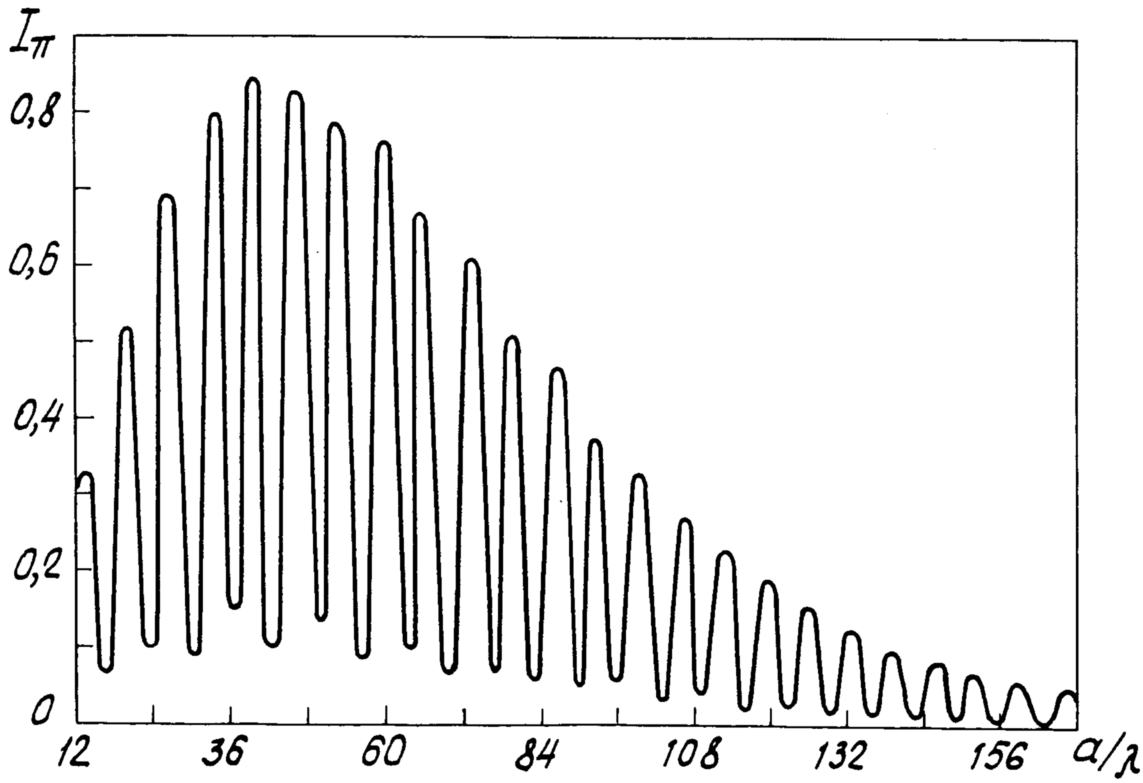

Figure 2. The dependence of field intensity of back-scattering I_π on the diffraction parameter a/λ for the system of similar hexagonal crystal (L/a = 5). The complex refractive index n = 1.31 + i 10^{-3}.

variation of phase relations among its separate components. As a result, if the diffraction parameter a/λ varies, the backscattering field I_{π} strongly oscillates (Fig.2). One can judge the crystal shape according to the presence or absence of oscillations and their depth and periodicity. Thus, the obtained solution of the light scattering problem by a separate crystal will allow the construction of algorithms of interpretation of data of laser sounding of crystal clouds with their identification according to the crystal shape.