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On Scattering Cross-Section Calculation Accuracy of Nonspherical Particles of Rain Precipitation using the Dipole Scattering Approximation

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Abstract—Comparative relationships of the numerical simulation results of the scattering cross-section (SCS) of raindrops have been presented using the approximate method of dipole scattering and the rigorous method of moments. The scope of applicability of the dipole scattering were also determined with due regard for the calculation accuracy of nonspherical drop SCS.

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INTRODUCTION

The methods of remote probing have been actively developed and used in recent decades for solving a great variety of problems including those for investigating the characteristics of precipitations [1]. In this case meteorological radars are widely used for ensuring the measurement of microstructural parameters of the raindrop size distribution [2], while the development of methods for reflected signal processing is one of the main tasks of remote probing of rain precipitation.

In particular, the majority of known approaches [3, 4] utilize the spherical drop approximation making it possible to use the well-known Mie scattering theory [5]. However the shape of real drops can be essentially different from spherical, especially for large drops [6]; that is why the investigation of scattering properties of nonspherical drops is of particular interest.

In this connection the papers [7, 8] dealing with models for generating drop shapes under the impact of gravitation, aerodynamic resistance, etc., (resulting in more complex shapes) are of great importance.

In the general case the problem solution of the field diffraction on nonspherical drops was obtained only by approximate methods [9, 10], and these results have an overcomplicated form for its use in calculations of the field scattering on ensemble of particles.

In this context paper [9] features considerable advantages since it presents transparent results for ellipsoidal drops. However, these results were obtained using the dipole scattering approximation; this brings up the question of the scope of applicability of the used method and also its possible use for drops having a more complex shape (Pruppacher-Pitter drop).

That is why the purpose of the present paper is to elucidate the accuracy of calculations of scattering cross-section (SCS) of nonspherical drops using the dipole scattering approximation [9].

1. CALCULATION RELATIONSHIPS

The calculation of scattering characteristics of electromagnetic waves by nonspherical raindrops include the selection of model for describing the shape of drops and a method of scattering field calculation. In both cases the parameter of task is the root-mean-cube radius of drop $r_3 = \sqrt[3]{ab^2}$ equal to the spherical drop radius of equivalent volume, where a, b are the minor and major ellipsoid axes.

As was repeatedly shown by experiments [11], if the root-mean-cube radius of drop does not exceed the value $r_3 \le 140$ μm, its shape does not practically differ from a sphere. However, with further rise of the drop size, its shape gets much more complex. In this case the creation of drop model that could have described the