Scattering of Electromagnetic Waves on Aspheric Dielectric Particles

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Abstract – **The study of electromagnetic scattering by nonspherical dielectric particles is performed for estimation of rain radar measurements. The shape of the particle is based on Pruppacher model and dipole moments and Mie theory are used to find radar cross section of the elliptic drops**

Keywords – **Scattering of electromagnetic waves, non-spherical particles.**

I. INTRODUCTION

The methods developed for remote sensing of rainfall, dust storms and industrial emissions are now widely used. At that the use of radar techniques is the most promising because it gives the opportunity to get information over large areas.

Existing methods of the theory of scattering of electromagnetic waves by dielectric particles are mainly based on the assumption of a spherical particle shape, which allows the use of rigorous methods of scattering theory (Mie theory [1]). However, in general particles shape differs essential from a sphere due to interaction of forces of gravity and air resistance for falling rain drops. In addition, the solid particles contained in industrial emissions also are not spherical. Therefore, the scattering characteristics of such particles may differ significantly from the characteristics predicted by using the approximation of spherical shape of the particles.

Therefore, the purpose of this paper is to estimate the impact of non-sphericity of raindrops on measuring of the scattering electromagnetic energy.

II. EXPERIMENTAL STUDY

To calculate the deformation of falling drops, we used an experimental data [2] that the particle shape is deformed when exposed to the forces of gravity and aerodynamic resistance.

The result was formulated by the following empirical expression for the ratio of the semiaxes of the ellipse $\frac{a}{b} = 1.03 - 0.124 \cdot r$, where r - radius of a sphere of equivalent volume. Relations of the ellipse semiaxes may be expressed through equality of volumes of the ellipse and the equivalent volume sphere $V_{el} = V_{sf}$, i.e. $\frac{4}{3}pab^2 = \frac{4}{3}pr^3$. The results of calculation of the actual droplet size along the major and minor axis of the ellipse is shown on Fig. 1. This figure shows the difference of the elliptic axes of the drop v.s. equivalent radius of the sphere. It can be concluded – the larger droplet size – the bigger difference of the axes.

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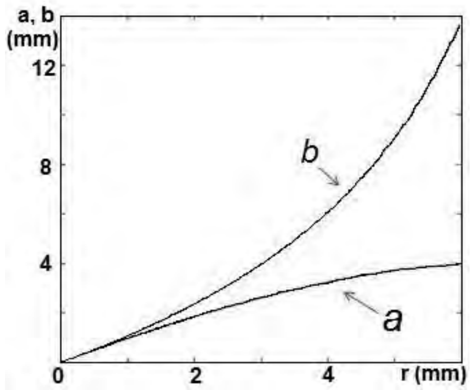

Fig. 1 Dependence of the deformation of the axes of the radius of the equivalent volume sphere

Non - sphericity of drops also effects on the energy dissipation of the electromagnetic field in two orthogonal planes. Therefore the backscatter section $s_p = \frac{2pr^2}{r^2}\sum_{n=1}^{\infty}\left(|a_n|^2 + |b_n|^2\right)$, where a_n, b_n - coefficients of Mie, $r = \frac{2pr}{l}$ - the diffraction parameter [1] was considered fig. 2.

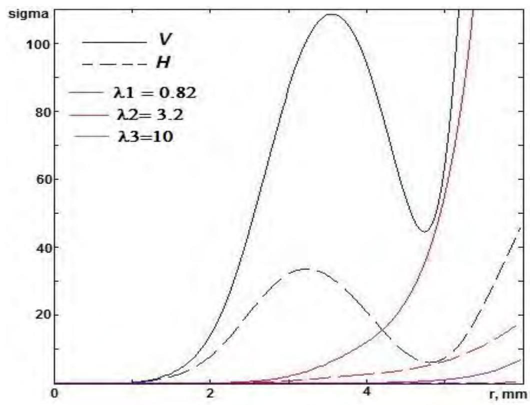

Fig. 2 The dependence of the deformation of the axes of the radius of the equivalent volume sphere

So in the paper the peculiarities of the electromagnetic scattering by non-spherical drops are discussed

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