LIGHT SCATTERING BY MERGING SPHERES HAVING DIFFERENT SIZES. D. V. Petrov, Yu. G. Shkuratov. Astronomical Institute of Kharkov V. N. Karazin National University. 35 Sumskaya St. Kharkov. 61022. Ukraine. petrov@astron.kharkov.ua

Introduction: The *T*-matrix method may be used for calculations of scattering properties of aggregated non-spherical particles that can be considered as an approximation of planetary regolith particles. Recently we develop a modification of the *T*-matrix method (*Sh*-matrix technique) allowing analytical solutions for non-spherical particles [1,2]. This technique can be applied for modeling some optical phenomena observed for planetary surfaces. An example of such phenomena is the negative polarization branch observed at small phase angles. Using the *Sh*-matrix technique, we have derived analytical *T*-matrix solutions for merging spheres with different sizes, making it possible to carry out rapid calculations. We note that merging particles are very often observed for lunar agglutinates.

Particle model: The shape of the merging spheres is described by the following equation:

$$R(\theta) = \begin{cases} \dfrac{\sqrt{1+\mu\cos 2\theta}}{\sqrt{1-\mu}}, & 0 \le \theta < \dfrac{\pi}{2} \\ \dfrac{\sqrt{1+\mu_1\cos 2\theta}}{\sqrt{1-\mu_1}}, & \dfrac{\pi}{2} \le \theta < \pi \end{cases},$$

where θ is the polar angle in a spherical system of coordinates with the center on the equal distance between the sphere centers (θ is counted off the axis *z* that goes through the centers), $|\mu_1|, |\mu| < 1$ are the parameters of merging. Scattering properties of particles of different sizes are characterized by the size parameter $X = \dfrac{2\pi r}{\lambda}$ where *r* is the sphere size and λ is the wavelength of incident light. The size parameter of the first sphere is X, whereas for the second one (basic spheres) it is X_1. The ratio of size parameters could be calculated as follows:

$$\frac{X_1}{X} = \frac{\sqrt{1+\mu_1}\sqrt{1-\mu}}{\sqrt{1+\mu}\sqrt{1-\mu_1}}.$$

Several examples of merging spheres are presented in Fig. 1. All calculations were made for orientationally averaged merging spheres.

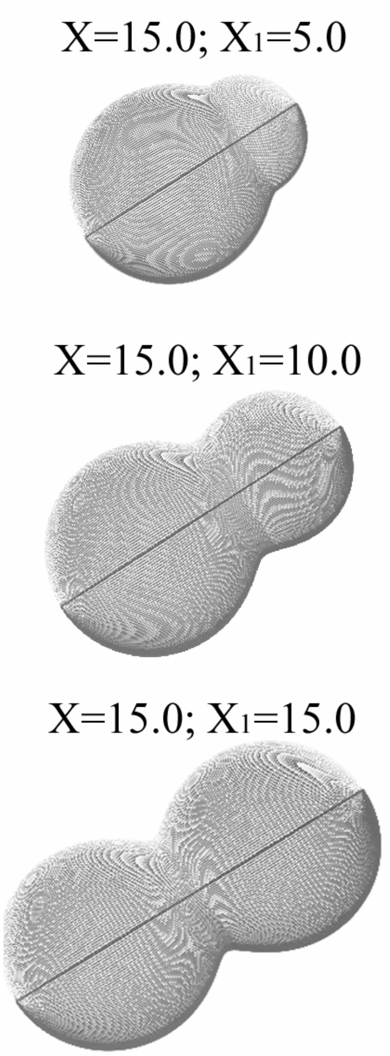

Fig. 1. Examples of different merging spheres.

Results and discussion: We calculated the dependences of intensity and linear polarization degree of merging spheres having different sizes on the scattering angle. Figure 2 shows the results at the size parameter of the basic sphere $X_1 = 15.0$ and refractive index $m_0 = 1.5 + i0.1$; the size parameter of the other sphere changes from $X = 5.0$ to $X = 15.0$. The parameter of merging μ was chosen to be μ = 0.8, whereas μ_1 changes accordingly to the ratio of spheres size parameters.

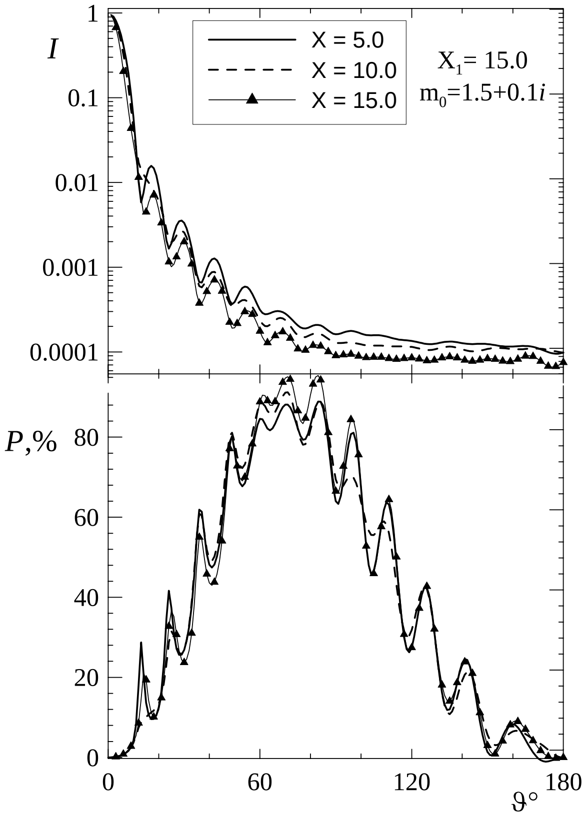

Fig. 2. Dependences of intensity and polarization degree for merging spheres at their different sizes on scattering angle.

Both intensity and polarization curves have many oscillations that is characteristic for a sphere. As can be seen, the locations of the main features of the curves remain approximately the same. Their amplitudes noticeably change. We can conclude that contribution of large sphere dominates.

As can be seen in Fig. 2, no opposition effect in intensity that can be attributed to the coherent backscatter effect is found.

There is a negative polarization branch at large scattering angles (small phase angles) (Fig. 4). The negative polarization branch depends on the sizes of spheres. This dependence is complex. The contribution of smaller sphere can strongly change the shape, depth and location of the negative polarization branch. Moreover, this can make this branch deeper more than twice (X = 5.0) and completely eliminate negative polarization branch.

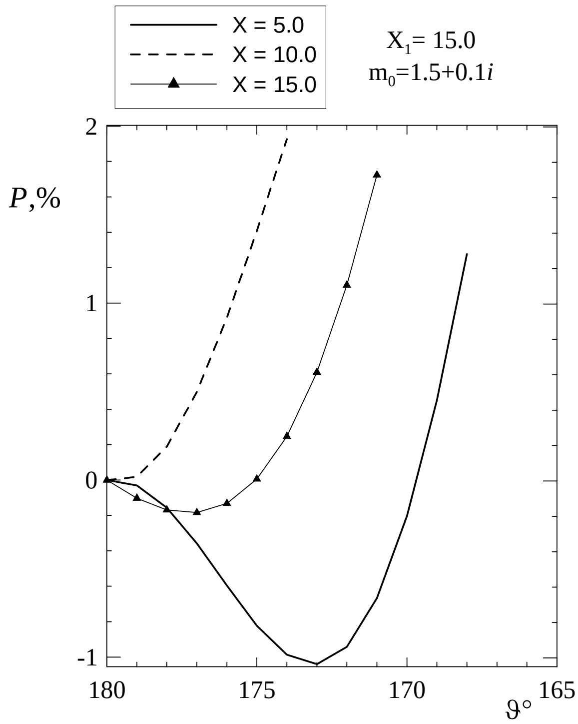

Fig.4. Negative polarization branch for merging spheres at their different sizes at large scattering angles (small phase angles).

Conclusion: Using the T-matrix method we have found an analytical solution for merging spheres having different sizes. Figures 2 and 4 show that difference between the sizes potentially is important parameter influencing light scattering by agglomerated particles.

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References: [1] D. Petrov at el. (2006) *J. Quant. Spectrosc. Rad. Transfer* ***102***, 85-110. [2] D. Petrov et al. (2008) *Optics Communications 281*, 2411–2423.