Venusian Glories: Existence Conditions and the Effect of Size and Shape Variations

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Abstract. We have studied in detail the question of the existence of glory with different parameters of scattering particles. We have found that prominent glory can exist at more wide range of size variations, than is believed to be before. Spherical sulphuric acid droplet having size R = 1.05 μm could produce glory even at size variation $\nu = 0.34$ μm at wavelength 0.513 μm. Moreover, we found that nonspherical particles can produce glory too, and determine the range of appropriate nonsphericity of Venusian atmosphere particles.

Keywords: planets and satellites: Venus; planets and satellites: atmospheres

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1 Introduction

The atmosphere of Venus consists of a large part of spherical microparticles of highly concentrated sulfuric acid, which produce an optical phenomenon known as a glory (van de Hulst, 1981). The measurements of the phase functions of light, scattered by Venusian clouds, were carried out during the Venus Express mission. The observations were carried out at three wavelengths, equal to 0.365, 0.513, and 0.965 μm (Petrova et al. 2015).

2 Glories Produced by Spheres

We have studied the existence of glory with different parameters of scattering particles. For calculations we used the fundamental theory of electromagnetic scattering by a spherical particle, invented by Gustav Mie (Mie 1908). Fig.1 shows the area of distinct glories existence at sphere radius R =1.05 μm. Three black points corresponds to parameters of observation (Petrova et al. 2015). Calculations show that glory on Venus most likely does not exist at λ >1.4 μm and at refractive indices greater than 1.6. Also we estimate an influence of size distribution, suggesting it has to be Gaussian. Calculations show that $\nu = 0.34$ μm is the maximum possible variation of the particle size.

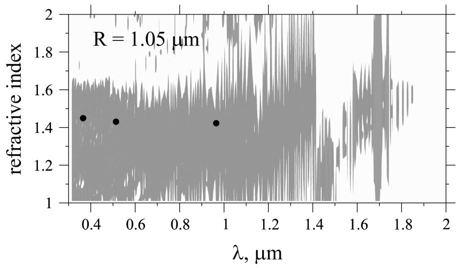

Fig. 1. Area of distinct glory existence for monodisperse spheres (zero size variation), having size R = 1.05 μm at different wavelength and refractive indices.

3 Effect of Shape Variation

We investigated the glories produced by spheroids. We calculated the changes in glory at different ratios of the axes of the spheroid a/b with the help of Sh-matrix method (Petrov et al. 2010). Calculations show, that variations of shape have strong influence on glory value, but there is some range of spheroid axes ratio, at which glory is still exist. Ratio of two axes of scattering particles should be in the bounds of a/b = 0.94...1.07.

4 Conclusions

We investigated the effect of size and shape variations on the main parameters of glory on Venus. It has been established that with a sphere size 1.05 μm, glories can be produced mainly at wavelengths less than 1.4 μm and with refractive indices less than 1.6. Maximum possible variation of particle size is 0.34 μm, and the maximum possible ratio of two axes of particles (non-sphericity parameter) varies from 0.94 to 1.07.

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Bibliography

van de Hulst, H.C., 1981, Light Scattering by Small Particles (Dover Publ., NewYork)
Mie, G. 1908, Annalen der Physik, 330, 377
Petrov, D., Shkuratov, Y., & Videen, G. 2010, Journal of Optics, 12, 095701
Petrova, E. V., Shalygina, O. S., & Markiewicz, W. J. 2015, Planet. Space Sci., 113, 120