USE OF AN ORBITAL PHASE CURVE OF EXTRASOLAR PLANET FOR SPECIFICATION OF ITS MASS. A. P. Vid'machenko, V. N. Krushevskaya, *Main Astronomical Observatory of a NAS of Ukraine, (vida@mao.kiev.ua).*

At remote observations of a planet circulated on an elliptic orbit around central star, its brightness will change in rather significant limits. The dependence of such change on a phase angle in stellar magnitudes Mp is determined from expression:

$$2.512^{m^*-m_P(\alpha)} = (\frac{R \cdot a}{r^* \cdot \Delta})^2 \cdot A_\Gamma \Phi(\alpha), \qquad (1)$$

where m^* - stellar magnitude of the central star, a - phase of visibility of a planet for the terrestrial observer, r^* and R - distance from a star to a planet and to the observer, correspondingly, a - planet radius, D - distance from a point of observing to a planet. $G(\alpha)$ characterizes reflective properties of a visible layer of a planet and a geometry of radiation falling from a star and reflected by clouds

$$G(\alpha) = \frac{\pi}{2} A_\Gamma \Phi(\alpha), \qquad (2)$$

where A_Γ - geometrical albedo and $\Phi(\alpha)$ - phase function of a planet. Knowing, or setting, proceeding from some assumptions, the value of planet geometrical albedo it is possible to calculate phase functions $\Phi(\alpha)$ for different wavelengths. Spatial indicatrise of reflection of a visible giant-planet cloud layer in the continuum is defined, basically, by optical properties and function of distribution on the sizes of particles at levels of formation of outgoing radiation. For spectral region at $\lambda > 500$ nm we shall assume, that 1) the aerosol component of an atmosphere plays a dominant role at formation of a scattered radiation field; 2) the aerosol layer represents a homogeneous flat-parallel layer of infinite optical thickness consisting of not absorbing homogeneous particles of the spherical form; 3) the observable true absorption is caused by a gas multiplier of atmosphere; 4) the particles are distributed on the sizes according to the well known normal - logarithmic law; 5) factor of refraction n of particles does not depend on wavelength. Farther calculations were made with help of the program described in [2]. We have estimated some parameters of aerosol particles, calculated the spectral distributions of disk brightness on a planet for a values of a phase angle in an interval from 0° up to 180° and on these data we have determined a values of spherical A_C, geometrical A_Γ albedo and planet phase functions $\Phi(\alpha)$. It was supposed, that the basic observable parameters of a planet atmosphere is similar to an atmosphere of Saturn.

On the basis of the made accounts the conclusion is follows, that the change of of phase function with a phase angle is caused by the appropriate behaviour of indicatrise of dispersion [3]. At this, with decreasing of value of albedo of single dispersion ω_0, i.e. at increasing of absorption, the similarity between behaviour of phase function and indicatrise of dispersion is very strongly increase. It is a consequence of that at the large true absorption the role of multiple dispersed light is sharply decreases. And, hence, for planet atmospheres with traces of methane, ammonia, water, and other powerful absorption bands, and also at presence of an extended cloudy cover it is necessary to expect non-standard behaviour phase curve in strong absorption bands. Peculiarity is reveal in that after rather sharp decreasing of a brightness at the growth of a phase angle from $\alpha = 0^\circ$ up to 60° - after $\alpha = 60^\circ$ its increasing begins again.

Using such technique we have made calculations of relative change of integral brightness of a planet rotating around the central star. In figure the relative change of its visible (in $\lambda = 550$ nm) brightness is given depending on an orbital phase angle in the assumption that the inclination of a planetary orbit plane to a perpendicular to a picture plane varies in limits from $i = 20^\circ$ up to $i = 80^\circ$. For comparison similar dependence in $\lambda = 890$ nm is put there. As shown in our work [1], the spectral and astrometric methods allow with the characteristics of the central star and with a value of extrasolar giant-planet rotating period (EGP) to determine only lower limit of planet mass to within a sine of an inclination angle of an EGP orbit plane to a picture plane

$$M_P = M_{P0} \sin i, \qquad (3)$$

In [1] we adduce a substantiation of an opportunity of realization of a method of extrasolar planet research with application of a technique of photometric observations with the photons account on moderate and even on small telescopes with one- or two-channel photometer. For 14 stars with planets it has appeared perspectively to detect the orbital change of exoplanet brightness, that is to receive phase curves of planet atmosphere brightnesses as it is supposed that the exoplanet spectrum similarly to a Jupiter spectrum should also to have a number of absorptive features. With the help of broadband filters, centered on the elected wavelengths, it will be possible to receive a general characteristic of planets albedo changes on a spectrum. Therefore, for exoplanet research it is possible to use a photometric technique widely used earlier to study the planets of Solar system. Working with two-channel photometer, one of which channels investigates light from system "star + plane" in a continuous region of a spectrum and another is centered on a very powerful absorption band of planet atmosphere, we in the second case shall receive practically "pure" radiation from a star. In the first case the photometric phase curve from EGP can be fixed. As the result of accounts show (see figure), for some star systems (Gliese 86, HD 46375, 51 Peg, HD 75289, HD 83443, HD 209458, HD 187123, HD 217107, HD 121504, τBoo) there is a real opportunity to make reconstruction of an orbital phase curve. The features of its inclination can allow to make comparison of the observable data at $\alpha_{(orb)} = 0^\circ$ and $\approx 50 - 70^\circ$ and to estimate a value of an inclination angle i of an EGP orbit. The specification of value i (as it seen from (3)) at the not central transit of a planet on a star disk can in some cases $(\sin 10^\circ \approx 0.17)$ increase real exoplanet mass almost in 6 times.

Literature.

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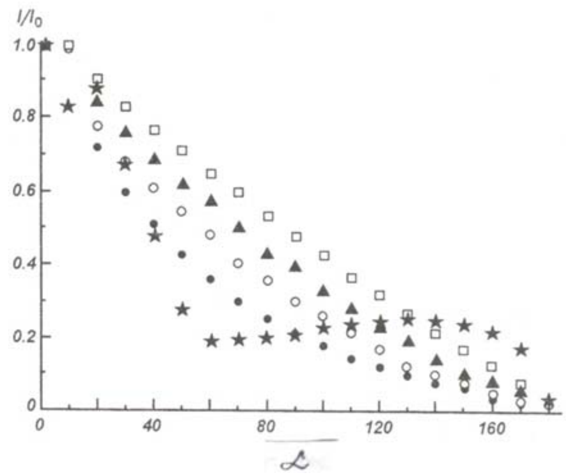

Fig.1. The relative change of visible planet brightness (in $\lambda = 550$ nm) depending on an orbital phase angle at the different orbital inclination angles i: 20° (squares), 40° (triangles), 60° (circles), 80° (spots); asterisks indicate for data in strong methane absorption band in $\lambda = 890$ nm for i = 80°.