DIFFRACTION MODEL OF THE NEGATIVE POLARIZATION OF LIGHT SCATTERING BY ATMOSPHERELESS COSMIC BODIES

Yu.G.Shkuratov[1], L.Ya.Melkumova[2]
[1]Astronomical Observatory of Kharkov State Univ.,310022,Kharkov,USSR
[2]Institute of Radiophysics and Electronics,310088,Kharkov,USSR

Existing models of the negative polarization (NP) based on the geometrical optics approach [1,2] do not explain increasing of NP with decreasing of particle size up to wavelength of incident light for glass samples [3]. This fact and a lot of other ones are explaned in a frame of a new NP model [3,4]. The model takes into account polarization of single and double scattering beams. Moreover, interference of double scattered rays interracting with the same scatters is taken into account, e.g. (see Fig.1): the first path is (source -> particle # 1 -> particle # 2 -> observer), the second path is (source -> particle # 2 -> particle # 1 -> observer). For a phase angle (α) dependence of polarization (P) a following approximate formula is obtained:

$$P = \frac{G}{18}\,(1+2\sqrt{1-w}\,)^2\left[\sin^2\alpha + 2\,\frac{\mu w(1-\sqrt{1+\beta^2\sin^2\alpha}\,)^2}{\beta^2\sin^2\alpha\,\sqrt{1+\beta^2\sin^2\alpha}\,\ln(1-\mu)}\right]$$

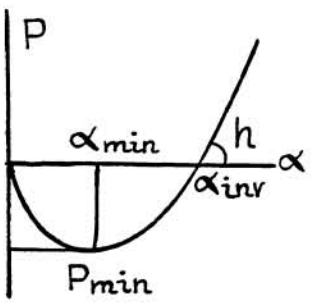
$$\beta = 8\pi r/3\ln(1-\mu);$$

$$w = 24A\,(32A+15+4\sqrt{24A+9}\,)\,/\,(9+32A)^2.$$

Used parameters:

A - a visible surface albedo (w - a single scattering albedo)
r - an average particle radius divided by wavelength;
μ - a porousity (a number of particles in the particle volume);
G - a polarimetric ability of scatteres ($0 < G \leq 1$);

Two theoretical $P(\alpha)$ dependencies are plotted in Fig.2, where they are fitted to observed lunar data [5] (crosses) and to laboratory measurements of MgO sample [6] (dots). Curves 1 and 2 (for the Moon and for MgO) are characterised by following numerical values of the model parameters: $A = 12\%$, $\mu = 0.45$, $r = 0.5$, $G = 0.2$ and $A = 97\%$, $\mu = 0.07$, $r = 0.4$, $G = 0.2$ respectively. Relation of the polarimetric parameters P_{min}, α_{inv}, $\alpha_{inv}/2\alpha_{min}$, h to the model parameters G, μ, A, r are shown in Fig.3. The main numerical means of the model parameters are: $G = 0.2$, $\mu = 0.4$, $A = 0.12$, $r = 0.3$.



Comments. Decreasing α_{inv} with increasing r attracts attention. It is quantatively close to laboratory data [6]. A dependence between P_{min} and A has two branches, that corresponds to experimental data [7]. The same situation is for h - A dependence in the low albedo case.

References.

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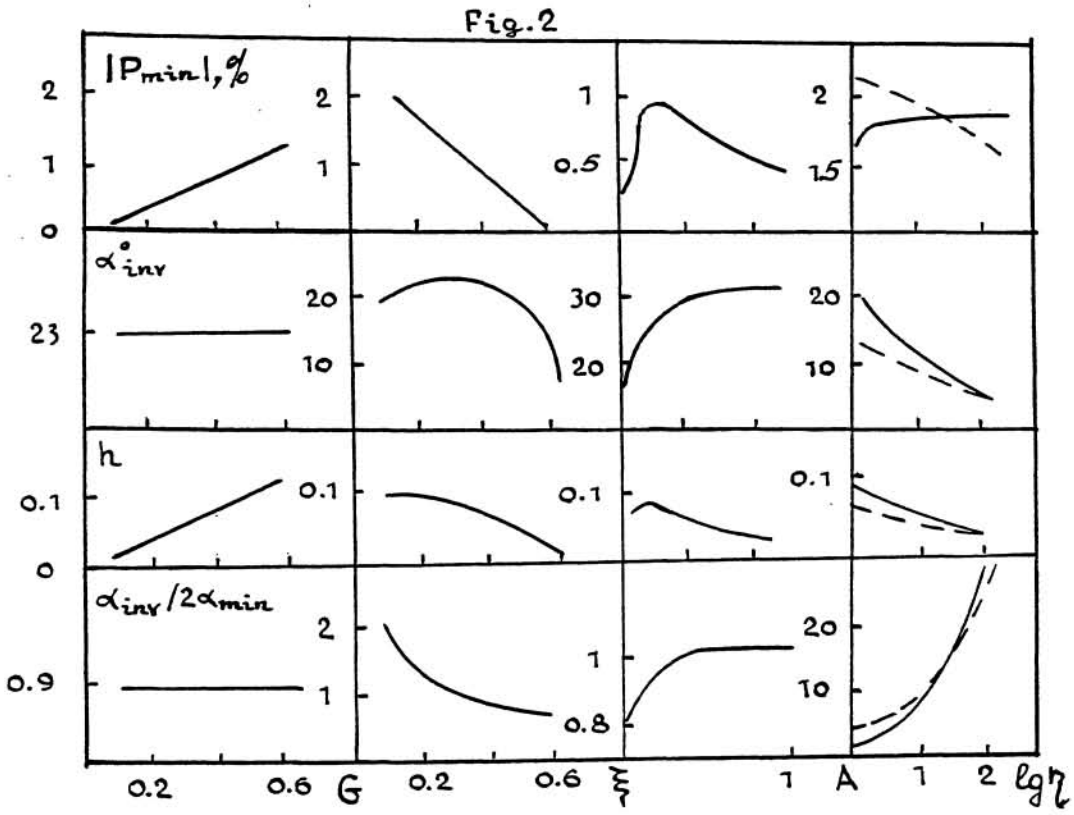
Fig.2



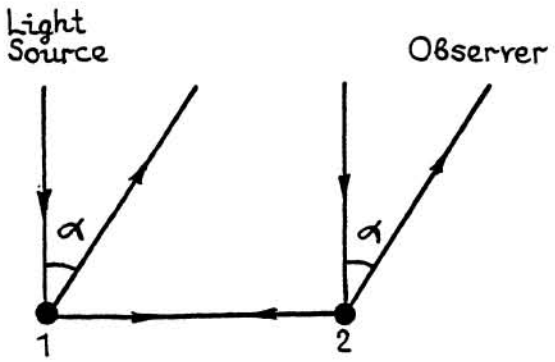


Fig. 1