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

\[
P = \frac{G}{18} \left(1 + \frac{1}{\sin^2 \alpha} \right)^2 \left[ \sin^2 \alpha \ln(1 - \mu) \right]^{1/3} \left(1 + \beta \sin^2 \alpha \ln(1 - \mu) \right)^{-1/3},
\]

\[
\beta = \frac{8\pi r}{3\ln(1 - \mu)};
\]

\[
w = \frac{24A (32A + 15 + 4 \sqrt{24A + 9})}{(9 + 32A)^2}.
\]

Used parameters:
A - a visible surface albedo (w - a single scattering albedo)
r - an average particle radius divided by wavelength;
μ - a porosity (a number of particles in the particle volume);
G - a polarimetric ability of scatters (0 < G ≤ 1);

Two theoretical P(α) 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
classified by following numerical values of the model parameters:
A = 12%, μ = 0.45, r = 0.5, G = 0.2 and
A = 97%, μ = 0.07, r = 0.4, G = 0.2 respectively.

Relation of the polarimetric parameters Pmin, αinv, Ginv/2αinv, 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,
μ = 0.4, A = 0.12, r = 0.3.

Comments. Decreasing αinv with increasing r
attracts attention. It is quantatively close to
laboratory data [6]. A dependence between Pmin
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