Comparison of space-debris and asteroid photometric properties

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Optical detection and identification of space debris originating from different sources is a vital objective nowadays. The most commonly used, effective, and accessible are photometric observations of natural and artificial space objects for determining their color and albedo. The color index and albedo data eventually provide information allowing to identify the observed surface. The author's investigations have shown that the surface optical properties of man-made objects are quite diverse [4-6]. Part of the artificial debris surfaces have both diffuse and specular components. Their color characteristics are quite different from those of the natural surfaces. Diffuse scattering of light from artificial surfaces is quite orthotropic and can, at a first approximation, be defined by the Lambert law. Quite a significant role here can be played by glory effects in glass fibers, which additionally decrease the phase curve slopes. The phase coefficient of these surfaces varies from 0.010 to 0.013 magnitude/degree. The colors of natural atmosphereless celestial bodies are practically all reddish and brown- grey. Therefore, the position of natural atmosphereless body surface materials in the «albedo-color index» diagram is close to the position of reddish artificial coverings with the low albedo. This does not make it possible to discriminate between them by using color indices. The surfaces of natural debris have rather low albedos and color indices corresponding to grey-brown and reddish bodies. Light scattering by natural atmosphereless astronomical body surfaces is far from being ideal. It is influenced by mutual shadowing of surface particles, the tubular structure of regolith covering the surfaces, etc. Their scattering is diffuse and differs from that of the Lambert law and is described by the Hapke and Lommel-Seeliger functions regarding the porosity of such surfaces [1, 2]. Thus, the phase coefficients of atmosphereless astronomical body phase curves and natural debris surfaces are notably greater than those of the artificial debris and basically exceed the value of 0.024 magnitude/degree [3, 7]. It is obviously seen here that natural-surface phase coefficients notably exceed the phase coefficients of artificial body surfaces. Consequently, for similar color indices B-V of both artificial and artifical objects, the above effect can really make the difference between artificial and natural surfaces: the phase coefficients of natural object surfaces are at least twice as large as those of the artificial object surfaces. The obtained results show that the set of such parameters allows to quite confidently identify the space debris components by using photometric observations.

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