GENERALIZED CALIBRATION OF THE POLARIMETRIC ALBEDO SCALE OF ASTEROIDS.

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Introduction: The polarimetric method for determining geometric albedo of asteroids p_v is based on the correlation between albedo and parameters of the phase dependence of polarization:

$$\log p_v = C_1 \log h + C_2 \quad (1)$$

$$\log p_v = C_3 \log P_{min} + C_4, \quad (2)$$

where h and P_{min} are the polarimetric slope and the depth of the negative branch of asteroid polarization phase curve, respectively. The accuracy of the method is determined by the accuracy in the estimates of the constants C_1–C_4. To date about ten different calibrations of the polarimetric albedo scale of asteroids have been published [1-6]. Each of them has its own systematic errors and gives its own values of the asteroid albedos. As a result this makes it difficult to analyze and compare them, and besides it becomes difficult to determine which of the proposed calibrations should be used to obtain the most reliable albedo values. In addition, in recent years new databases on asteroid albedos, obtained from radiometric surveys by means of the satellites (IRAS, AKARI, WISE, NEOWISE) have appeared, and the database on asteroid diameters and albedos, obtained from observations of asteroid occultation of stars, was also significantly enlarged. All this makes it relevant and expedient to develop a generalized scale of polarimetric albedo of asteroids that would take into account the advantages and disadvantages of existing calibrations, and would also be based on more complete data on the albedo of asteroids and their parameters of polarization.

Currently Available Calibrations: Each of the proposed calibrations has its own peculiarities. For example, calibration [1] was carried out using laboratory measurements of meteorite samples and some carbonaceous silicates. In [2] the authors used IRAS, ground-based radiometric and available albedos from occultations but only of 7 asteroids. In calibrations [4, 5] the authors used occultation albedos from [7] but for very limited numbers of asteroids, and ignored the correlation (2). Calibration [6] uses WISE-albedo but only for 41 asteroids and its coefficients differ significantly from the calibrations [1-5], most likely because of an error in the calculations. Summarizing a review on the currently available calibrations, it should be stressed that no unified system of polarimetric albedos of asteroids exists at the present time. Each calibration gives its own albedos, which differ for the same asteroid by a factor of 1.5–2.

Individual Scales: We used five sets of asteroid albedo-data (IRAS, AKARI, WISE, NEOWISE and albedos from occultations) and the most complete data on the polarization parameters of asteroids h and P_{min}, measured with relative error of not worse than 20%, to obtained five individual calibrations. The number of asteroids used in the five specified individual calibrations was determined by the presence of the corresponding values of h and P_{min} and was within 50–60 in the determination of C_1, C_2 and 100–116 in the determination C_3, C_4. Analysis of the obtained values of the coefficients C_1–C_4 allows us to conclude that all five individual calibrations performed agree rather well with each other. The differences between the values of the corresponding coefficients C_1–C_4 are comparable to the values of their root-mean-square errors in order of magnitude. Thus, the values of coefficients C_1–C_4 of these five calibrations can be used to obtain an averaged, i.e. final for the moment, calibration of polarimetric albedo scale.

Generalized Scale: The generalized scale of the polarimetric albedo can be obtained by averaging the coefficients of the individual calibrations with their weights, taking into account the accuracy in the used albedo values, the number of asteroids taken for calibration, the systematic trend of the albedos of each individual calibration and the other criteria. Two versions of weights were chosen for the control over the convergence of results and an understanding of the sensitivity to the choice of weights. Version 1 actually reflects only the mean accuracy in the albedo used in a certain calibration, while version 2 additionally takes into account the systematic trend in the albedo values obtained in a certain calibration. The following values of the coefficients of generalized calibration are obtained:

$$\log p_v = -(1.016 \pm 0.010) \log h - (1.719 \pm 0.012)$$

$$\log p_v = -(1.331 \pm 0.015) \log P_{min} - (0.882 \pm 0.016).$$

They give well convergence of the albedos calculated using the parameter P_{min} and parameter h and small systematic albedo trend.

Conclusion: Proposed calibration is based on the use of all major data sets on asteroid albedos and the most complete data on the polarization parameters of asteroids. It yields the values of asteroid polarimetric albedos in the system unified with the radiometric albedos and the albedos from occultations, allowing their comparison, joint analysis, etc. Further advances in determining the polarimetric albedos of asteroids can be expected from the use of powerful ground-based telescopes especially dedicated to these purposes and from the polarimetric surveys of the sky by means of orbital space technologies.

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