A SPOT OF HYDRATED SILICATES ON THE M ASTEROID 201 PENETOLPE?

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Observations of the main belt asteroid 201 Penelope were done in August 1993 with phase angle Φ=1° in order to establish the causes of changes of its brightness with rotation. The spectral measurements were carried out with the 1.25 m telescope in Crimea and the scanning spectrophotometer operating in the photon-counting mode in the region 338-762 nm with resolution 5 nm. As a standard, the F5 star HD334 was used which was calibrated by observations of α Lyr with the same spectrophotometer and employment data [1] (Biryukov V., unpubl. data). To calculate reflectivity spectra of the asteroid the spectral energy distribution in the solar spectrum by Makarova E.A. et al. [2] was used. The reflectivity spectra of Penelope (shown in absolute units in Fig.1) were obtained in the consecutive moments with ab. 18 minutes interval on August 24/25: curve 1 - 23.875, 2 - 0.192, and 3 - 0.475 hours of UT. Standard deviation through the spectral region is shown only on curve 1; corresponding points on other spectra have similar errors (Fig.1). The photometric observations of the asteroid were fulfilled on night August 25/26 with the 60cm telescope in Crimea. Lightcurve measurements were made in the standard band V with photometer operating in the photon-counting mode (the method described in [3]). As a standard, the star HD210803 [4] was used. Lightcurve of Penelope is presented in Fig.2. It has a symmetrical form with different levels of extremes. Rotation period is 3.747 hours, and zero phase corresponds 2449223.5 Julian day. Ordinate axis in Fig. 2 is absolute brightness V(Φ, α). Approximation of the lightcurve by Fourier series to the power four is drawn by solid line. Extrapolation of the lightcurve on the night August 24/25 showed that Penelope's reflectivity spectra 1-3 correspond to values of rotation phase indicated by vertical arrows in Fig.2.

Co-ordinates of the pole λp = 258° and βp = -22° calculated in [5] indicate that aspect of the asteroid in this opposition was close to the equatorial one. Taking into account amplitude of brightness variation 0.42 magnitude from our observations of the asteroid with small phase angle (0.7°) and neglecting an albedo change with asteroid rotation, we estimated an axes ratio of ellipsoid which approximates figure of the body. This yields a/b = 1.49 which is in accordance with the value a/b = 1.50 from [5].

Asteroid 201 Penelope was classified with certainty by Tholen D. as M and by Barucci M. as MO [6]. But we can see from our data (Fig.1 and 2), that a transformation of the reflectivity spectra with asteroid's rotation occurred: from a typical M asteroid curve to one similar to B-G asteroid curve with a fall in overall albedo to ab. 30%. Moreover, there are a sharp absorption band at 430 nm (increasing twice to spectrum 3 at minimum of the asteroid brightness, see Fig.1-2), and signs of broad and weak absorption band at 550-760 nm on spectra 2 and 3 (a strong absorption in spectral interval 720-760 nm was probably caused by wa-
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Water vapor in earth's atmosphere. These absorption features are very similar to those found by Vilas F. et al. [8,9] on some C-G primitive asteroids and attributed to a ferric iron spin-forbidden (at 430 nm) and Fe(2+)-Fe(3+) charge transfer transition (at 700 nm) absorptions present in minerals created as a result of aqueous alteration. This possibly gives evidence about the presence of hydrated silicates on igneous M asteroid 201 Penelope. It seems rather puzzling, but it is corroborated by Rivkin A. et al.'s [10] observations of the diagnostic absorption feature at 3 μm on the asteroid. If, nevertheless, we keep a widespread opinion on the nature of M asteroids, hydrated silicates on 201 Penelope were probably created as a result of past low-velocity collision of the asteroid with some sort of primitive hydrated body.

References:

Fig. 1.

![Fig. 1](image1.png)

Rotational phase

Fig. 2.

![Fig. 2](image2.png)

Reduced V magnitude