THE REFLECTION SPECTRUM OF THE LIDIA 110 ASTEROID AND ITS COMPARISON WITH THE SPECTRAL CHARACTERISTICS OF THE MOON

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Of late new results have been appearing which show that the surface material of many asteroids of the M-type (they include also 110 Lidia) contains, along with metals, a considerable silicate component /1/.

Fig. 1 gives (1, 2) reflection spectra of 110 Lidia in the spectral range of 0.34 to 0.76 mcm, as well as the reflection spectrum of the platform 13 km in size in the centre of the lunar mare crater Plato (denoted by 3). Spectral data 1 and 3 are obtained by us on a 60-cm reflector installed in the Crimea by means of a spectrophotometer of a scanning type operating in the mode of the counting of photons with spectral resolution of about 48 Å (spectrum 1 is obtained on September 14/15, 1989 at 110 Lidia's phase angle +4°.5 with the fixing to the star 10 Tau; spectrum 3 is obtained on August 17/18, 1989 at the Moon's phase angle +11°.4 with the fixing to α Lyr). For the sake of comparison Fig. 1 shows 110 Lidia's reflection spectrum normalized on the wavelength 0.56 mcm. The spectrum was obtained earlier by American authors (2) and it is combined with our spectrum on 0.56 mcm /2/.

With the general sufficiently good agreement of the relative variation of spectral curves 1 and 2 and comparable photometric accuracy (at least around the middle of the visible range) due to a higher (by 4-5 times) spectral resolution we apparently have revealed some additional spectral features of the surface material of 110 Lidia.

It seems that the version of the simplest explanation of the presence of almost all faint absorption bands in the reflection spectrum of 110 Lidia is based on the assumption about the predominance of such chromophore ions as Fe^{2+} and Fe^{3+} in its surface layer. In particular, a very weak absorption band for 0.43 mcm apparently originates in case of the intervalent charge transfer of $Fe^{2+} \rightarrow Fe^{3+}$ /3/. Absorption bands for 0.47 mcm (this feature takes place only on curve 1, Fig. 1) and for 0.51 mcm can be caused by electron transitions forbidden as regards the spin in the crystal field in Fe^{3+} and Fe^{2+} ions, respectively /4, 6/. These transitions become more intensive in case of the considerable violation of the crystal lattice of silicates which is quite probable in these conditions. Absorption bands for 0.58 and 0.63 mcm can also be explained by the action of the intervalent charge transfer of $Fe^{2+} \rightarrow Fe^{3+}$. The signs of the presence of the absorption band on 0.80 mcm explained by the action of the same mechanism of the charge transfer /4/ (see Fig. 1, curves 1 and 2) possibly confirm the latter. The effect of electron transitions which are forbidden as regards the spin in the ion Fe^{3+} manifests itself apparently near 0.65-0.67 mcm (curve 1). And finally the noticeable absorption band (about 10 %) close to 0.36 to 0.40 mcm can be a sign of the partly shaped absorption edge during the charge transfer oxygen → metal typical of material of silicate composition.

The nearly exact coincidence of the mean inclinations of reflection spectra in absolute units at close phase angles of this asteroid and the Plato crater on the Moon (Fig. 1, curve 3) is probably an indirect confirmation of the considerable portion of the silicate component on the surface of 110 Lidia. As known from experience of the theoretical and experimental studies of lunar samples /5/, the overall inclination of lunar reflection spectra in the visible region is shaped by the wing of the ultraviolet absorption band which originates during the charge transfer oxygen → metal. The intensity of the band depends mainly on the total amount of ions of transitional metals in silicate material and on the extent of the violation of its crystal lattice. The reflection spectrum of the Plato crater is practically devoid of absorption features (except for the very weak depression whose position in Fig. 1 is designated by the arrow) mainly due to low albedo and, hence, the insignificant contribution to the reflected light flow of the component which passed through the material and which carries chemical and mineralogical information. As shown by our studies, weak absorption bands /7/ can originate in reflection spectra of even dark lunar formations of the mare type in case of the enhanced titanium content on those wavelengths which are evidently typical of the spectral signs of ions of Fe^{2+} and Fe^{3+} for 110 Lidia. In conditions of the extreme low content of molecular oxygen on the Moon's surface the presence of iron in the form of Fe^{3+} is practically excluded there and the display of the spectral properties mainly of Fe^{2+}, Ti^{3+} and Ti^{4+} ions is possible /6/.

Thus, the spectral properties of 110 Lidia the detection of which is contributed to by its high reflectivity seem to testify to the presence of the considerable portion of silicate minerals (olivine, pyroxene, etc.) and their oxidized forms in surface layers.

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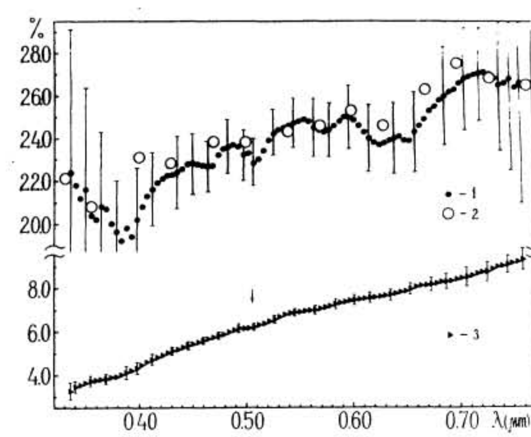

Fig. 1