DIAMETER AND DENSITY OF NEPTUNE (DIAMETR I PLOTNOST' NEPTUNA).

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THE DIAMETER AND DENSITY OF NEPTUNE

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The occultation (eclipse) of any star by the Moon or a planet makes it possible to perform a whole series of astronomical observations with a high degree of accuracy.

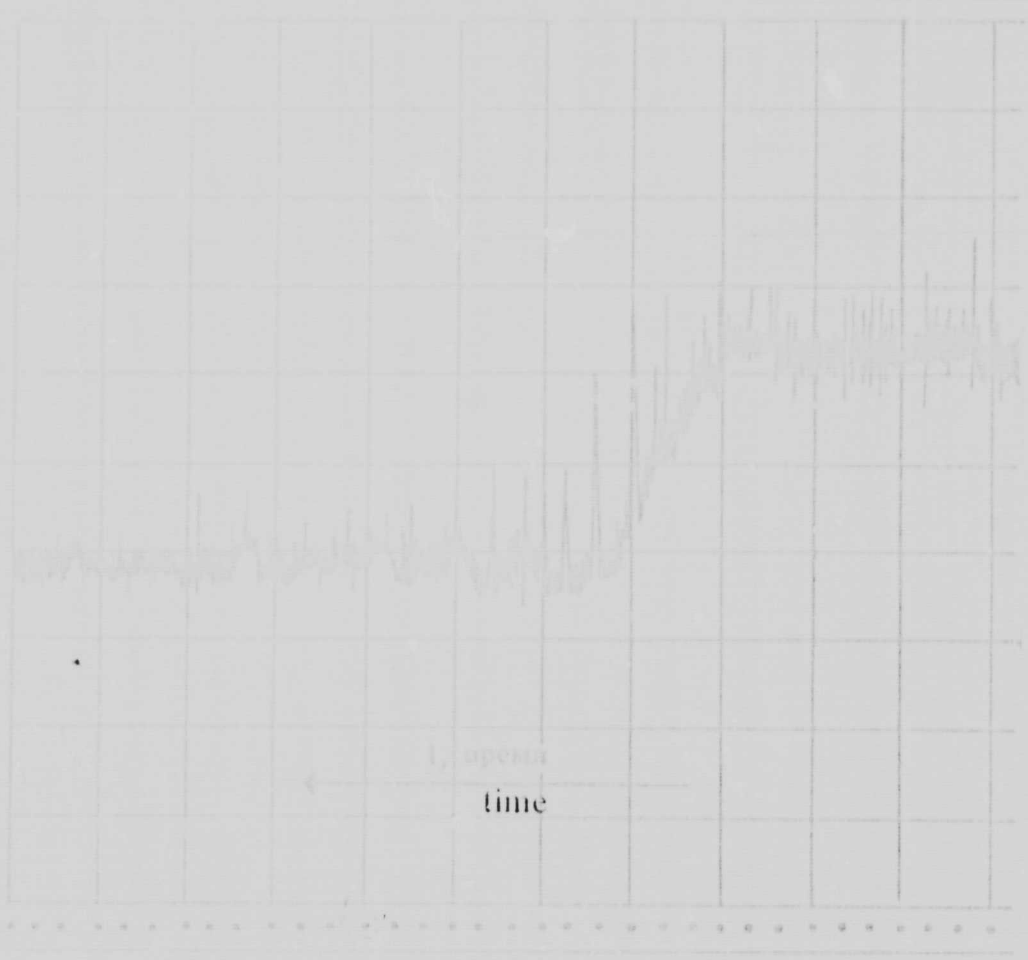
On 7 April 1968 there was an occultation by Neptune of a star of 7.8 magnitude of the constellation Libra. The duration of the occultation was 40-45 minutes at different observation points. Photoelectric observations of the occultation were made in Japan, New Zealand, and Australia. Since Neptune has an extensive atmosphere, the disappearance and reappearance of the star took several tens of seconds (Figure 1).

An analysis of the observations gave three values for the diameter of Neptune: the maximum—determined by the time from the beginning to the end of the just noticeable attenuation of the light of the star; the minimum—determined by the duration of the complete invisibility of the star; the intermediate—determined by twice the attenuation time of the light of the star. As the analysis of the observations that was made by Taylor (England) showed, these diameters are respectively 50 500 ± 100 km, 49 000 km, and 50 100 ± 200 km. Neptune is so massive that there is a perceptible deflection of light rays from the rectilinear in its field of gravity. Allowing for this requires an increase in the three values of the diameter by approximately 100 km. In addition, the minimum and intermediate dimensions must be increased because of refraction of light in the atmosphere of the planet. For a layer that attenuated the light of the star by one-half, this correction is also equal to 100 km. Taking both corrections into consideration, the true diameter corresponding to half-attenuation of the star is 50 300 km. As for the minimum value of the diameter, the correction associated with the refraction is greater, but it is difficult to estimate its precise value.

Taylor considers the diameter of the visible surface of Neptune, i.e., the surface of the cloud layer, to be 50 000 km based on occultation observations.

The new value of the diameter of Neptune is almost 10 per cent greater than that obtained in 1953-1955 by Camichel, Dollfuss, and Kuiper [Kamishel', Dol'fyus, and Keyper] (they measured it by means of a discometer and double-image micrometer), and only a little less than that obtained by Barnard in 1899-1900 who performed the measurements with a filament micrometer.

If one starts from the measurements of 1953-1955, then, as has been considered in the last few years, the mean density of the planet is equal to



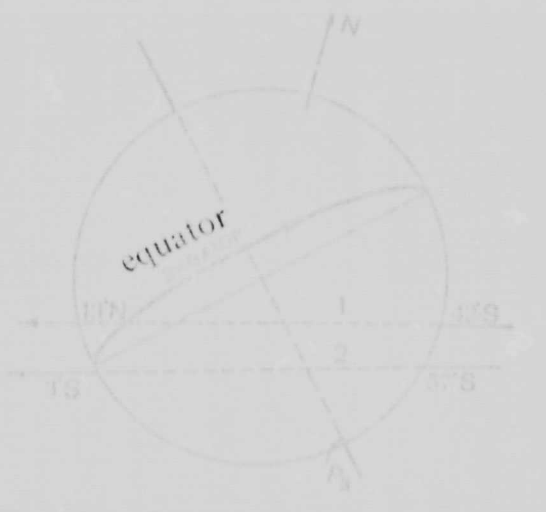


Figure 2. The conditions of Neptune's occultation of the star for observations in Japan (1) and in Australia (2). The arrow at the top points to the north pole of the celestial sphere.

Figure 1. Photoelectric record of the total light of Neptune and the star at the astronomical station Dodaire (Japan) during Neptune's motion on to the star (beginning of occultation).

2.5 ± 0.1 g/cm^3, i.e., noticeably above the mean density of Uranus. The new value of the diameter of Neptune yields a density of 1.6 g/cm^3, practically coinciding with the density of Uranus. Thus, both planets should have an almost identical composition.

The course of the attenuation and the intensification of the light of the star during its disappearance behind Neptune and reappearance yields important information concerning the atmosphere of this planet. Even in 1929 C. Fabry [Sh. Fabri] developed a theory of attenuation of the light of a star during its occultation by a planet having an atmosphere. Applying Fabry's theory to the set of observations of Neptune's occultation made at all the [observation] points, it was found that in the layer responsible for the half-attenuation of the light of the star, the so called height of homogeneous atmosphere, which characterizes the slope of decrease in its density with altitude, is 45 km. Hence, it is possible to determine the minimum value of the temperature in this layer, assuming that it consists only of molecular hydrogen. This minimum temperature turns out to be surprisingly high, i.e., 118°K. One may suspect that this value of the height of the homogeneous atmosphere is exaggerated. The density of this layer turns out to be approximately $2\text{-}5 \cdot 10^{-6}$ g/cm^3, i.e., the same as the density of the Earth's atmosphere at an altitude of 30-40 km. The just noticeable attenuation of the light of the star was caused by layers apparently located 100-150 km above the layer of half-attenuation. How much below it are the layers that caused the total disappearance of the light of the star remains unclear, since it is difficult to calculate the refraction created by them.

The characteristics of the atmosphere of Neptune obtained through observations of the beginning and end of occultation, and also at different observatories, are easily distinguished from one another. This may be associated with either the local properties of the atmosphere or the effects of latitude (Figure 2).

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