PHOTOMETRY OF THE LUNAR SURFACE DURING LUNAR ECLIPSES

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Abstract. The photometric observations of the lunar surface during lunar eclipses were carried out on four nights between 1972 to 1978, using the 91 cm reflector of the Dodaira Station of the Tokyo Astronomical Observatory. The photometry was performed in B-, V-, and R-colours, and arranged in accordance with the angular distance from the centre of the Earth's shadow. The results do not show any large systematic differences between the four nights, showing no support for Danjon's proposition.

1. Introduction

The Danjon (1920a)'s proposition, according to which the Moon's brightness during total lunar eclipses changes synchronously with the cycle of the solar activity describing the saw-tooth curve, has been repeatedly confirmed so far (Danjon, 1920b; De Vaucouleurs, 1944a, b; Bell and Wolbach, 1965). But in all these re-examinations, the adopted brightness scale is always the same one as that which Danjon (1920a) proposed: namely, the brightness degrees from $L = 0$ to 4 depend only on the impressions of the observers with naked eye. Therefore, the doubt remains as to whether Danjon's proposition is still valid when we adopt the modern method of photoelectric photometry for the evaluation of the Moon's brightness.

For the purpose of examining this problem, the author tried to make the photoelectric photometry of the Moon's surface on the occasions of the total lunar eclipses since 1972, using the 91 cm reflector of the Dodaira Station of the Tokyo Astronomical Observatory, and succeeded in observing the four lunar eclipses shown in the Table I.

2. Observations

The apparatus for the present observations has been the same as the one which has been used for the ordinary Moon's photometry and polarimetry by the author, a short description of which has already been published (Sekiguchi, 1972) – except for the following point. In the present observations, the diameter of the diaphragm was changed to 2.35 mm, which corresponds to about 54 km at the Moon's distance, with due regard to the faintness of the lunar brightness during eclipses.

As in the author's usual photometry, the photometric standards are the stars in the Arizona–Tonantzintla Catalogue (Iriarte et al., 1965); and most of them have a visual magnitude of about 4 or 5. Observations were made in V-, B- and R-colours. The corrections due to the background brightness of the sky have not been applied to the observed
observed results, because in almost all cases the Moon's surface is much brighter than the sky background except for the B-colour. This point will be discussed further at a later date.

The observations were carried out for the four eclipses tabulated in Table I. The observation (a) was on the Moon-rise eclipse and that of (d) was the Moon-set eclipse. On the nights of (a) and (b), the Moon was frequently covered by clouds, but the transparency of the sky was fine. On the nights of (c) and (d), the sky was completely clear. The eclipse of (c) has the time of maximum obscuration near midnight in Japan, and the observation was carried out completely.

The measurements were performed exclusively on the central part of the mare regions during the eclipses, owing to the ease of guidance. In eclipse (a), the observations were made for many mare regions; namely, on Mare Imbrium, Lacus Somniorum, Mare Serenitatis, Mare Tranquillitatis, Mare Crisium and Oceanus Procellarum. But by the experience of these observations, the number of the observed regions were reduce in successive observations. In eclipse (b), Mare Imbrium, Mare Serenitatis and Mare Nubium were observed. In eclipse (c), Mare Imbrium and Mare Serenitatis were observed. Finally in eclipse (d), Mare Serenitatis alone was observed. For the sake of comparisons, the region near the Aristarchus was observed in (b) before the beginning of the penumbra eclipse, and in the same way the regions Plato and Proclus were observed in (c).

In (a), the observations were carried out only on V- and B-colours, and the R-colour observation was not included.

The present observations were able to record the polarization degrees. But in the lunar eclipses, the polarizations were very weak, and we cannot discuss it with sufficient reliability. Therefore, in the present study, the results of the polarimetry were ruled out of the discussion.

3. Observational Results

The observed brightness were all reduced to the magnitude per square second of arc and arranged in accordance to the angular distance from the centre of the Earth's shadow expressed in minutes of arc. The results are shown in Figures 1, 2 and 3 for the V-, B- and R-colours, respectively; and the colour indices B–V and V–R are shown in Figures 4 and 5, respectively. In each diagram, the radii of umbra and penumbra are shown on respective nights.

The results of observation before the beginning of the penumbral eclipse are, for the