V1010 OPHIUCHI: DOES THE DEPTH OF PRIMARY MINIMUM VARY?

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Abstract

Published photoelectric light curves of the eclipsing binary V1010 Oph suggest that the depth of primary minimum varies. However, unpublished photoelectric data from ten seasons between 1965 and 1988 do not show variation in the minimum depth greater than 0.02 magnitude.

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V1010 Oph (HR 6240, HD 151676) is an eclipsing binary whose steadily decreasing orbital period suggests continuous mass flux from the A7 IV-V primary to the cooler, less massive G-type secondary (Lipari and Sistero 1987 and references therein).

All photoelectric observers have used the comparison star HR 6235 = HD 151527, spectral type A0. Some observations have been reported as instrumental Δv and some as Δ**V**, but for present purposes they are comparable. V1010 Oph and HR 6235 are almost identical in color, Δ **B-V** $\tilde{=}$ 0.1; in the normal range of **V**-band transformation coefficients, Δv and Δ **V** should agree within 0.01 magnitude. Note: with regard to color transformation, observers should know that the **B-V** index listed for V1010 Oph = BS 6240 in the **Bright Star Catalogue** (Hoffleit and Jaschek 1982) is erroneous. (Confirmed by Hoffleit, private communication. The data on this line probably refer to another star.)

In 1966, the first photoelectric investigation of V1010 Oph (Leung 1974) found a primary minimum depth of +0.92 Δv. But in 1983, Mauder (1984) found that "the depth of primary minimum [has] decreased by almost 0.1 magnitude," with Δ**V** = +0.85 (estimated from the published light curve). Then Hamdy et al. (1985) published light curves from observations in 1985 that again show the depth of primary minimum as +0.92 Δv (estimated from the published light curve).

In a previous paper (Williams et al. 1986) I noted an apparent time-keeping or calculating error of about +0.025 day in the times of minima reported by Hamdy et al. (see also the O-C diagram in Lipari and Sistero 1987). It must also be noted that their observed depth of primary minimum does not agree with other photometry during the 1985 season, including, in one instance, simultaneous observations of the same eclipse.

A cooperative observing project to obtain times of minima for V1010 Oph was conducted in 1985 (Williams et al. 1986). Figure 1 shows the primary minimum observed on July 27, 1985 UT, by L. Pazzi (Nigel Observatory, South Africa), indicating Δ v = +0.84. This eclipse happens to be one of those observed by Hamdy et al. Observations during the same season by H. Louth, F. J. Melillo, R. Milton, and R. Wasson confirm Pazzi's depth of minimum. My own photometry during the following three seasons, 1986-88, shows the depth of primary minimum as +0.83 Δ**V** (Figure 2).

The gap in published observations between 1966 and 1983 can be partially closed. In 1968, Guinan (1970) found the depth of primary minimum from narrow-band **V** photometry to be +0.83 (estimated from photocopy of light curve). In discussing our observations of this

star, he noted that no substantial change was found in subsequent unpublished photometry in 1970, 1971, and 1977.

The unusual depth of minimum observed in 1966 is therefore unique. In such circumstances it would be helpful to have additional photometry near that time, and such is available. On July 1, 3, and 5, 1965 UT, AAVSO member Leonard Kalish made photoelectric measures of V1010 Oph with a 20-cm Cassegrain reflector and yellow filter at Big Bear Lake, California. These observations (Figure 3) were reported to the AAVSO Eclipsing Binary Committee but were not analyzed at that time because of incomplete phase coverage. The observations show considerable scatter. However, except for the three asymmetric points near +0.9 Δv on July 3, the depth of minimum is close to +0.84.

Since only two visual timings of minima are available for 1965, I have determined the times of mid-eclipse from the Kalish data by using a complete, high-quality photoelectric light curve as an overlay:

HJD 2438943.725	945.711	947.694
$\pm$0.002	$\pm$0.002	$\pm$0.002

The indicated error represents the range of good fit. The external error may be greater.

The observations reported here, and the photometry of Guinan and Mauder, indicate that the depth of primary minimum was consistent at +0.84 $\pm$0.01 Δv in 1965, 1968, 1970-71, 1977, 1983, and 1985-88. The depth observed by Hamdy *et al.* in 1985 is discordant with the results of several other observers. If the depth of primary minimum observed in 1966 represents a secular change in V1010 Oph's light curve, it was of brief duration, the eclipse deepening by about 0.08 magnitude between the 1965 and 1966 observing seasons and returning to the previous value by the 1968 season. Since then, the depth of primary minimum does not appear to have varied by more than 0.02 magnitude.

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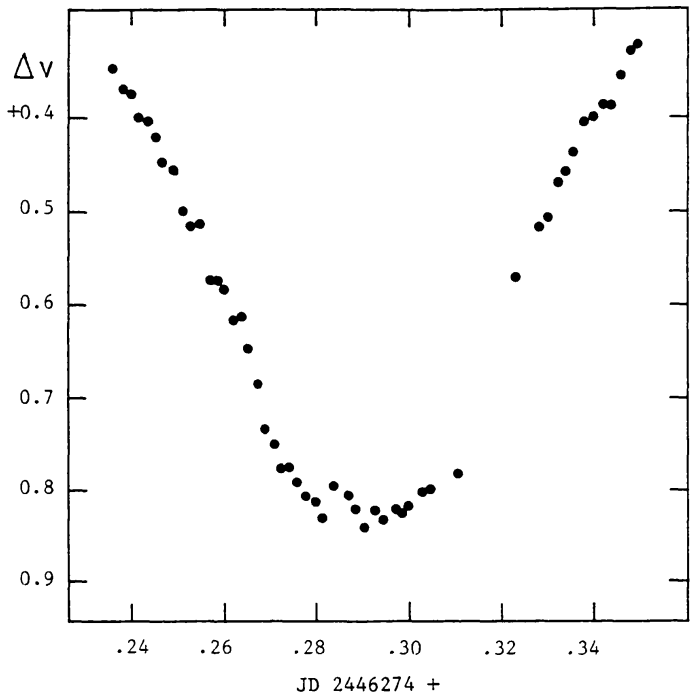

Figure 1. V1010 Oph, primary minimum observed by L. Pazzi, Nigel Observatory, South Africa, on July 27, 1985 UT. This eclipse is identical with one observed by Hamdy et al. (1985).

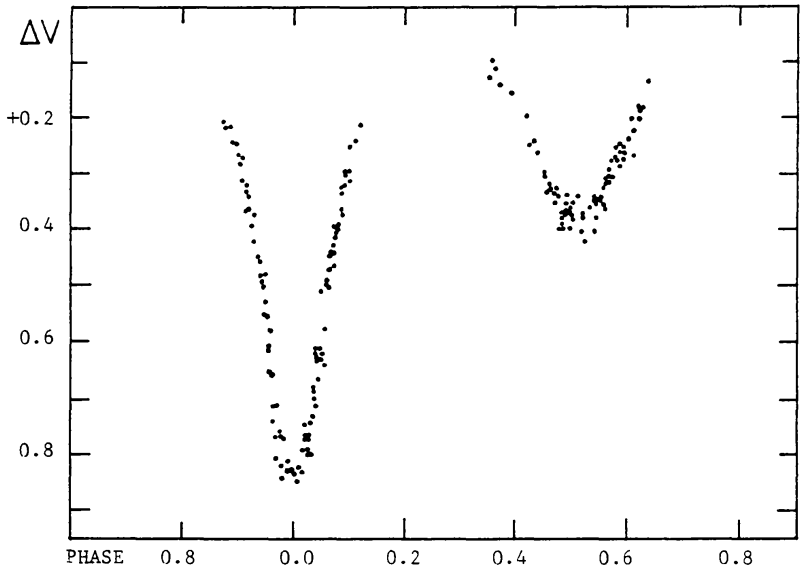

Figure 2. V1010 Oph, combined light curve of photoelectric measures by the author in 1986, 1987, and 1988.

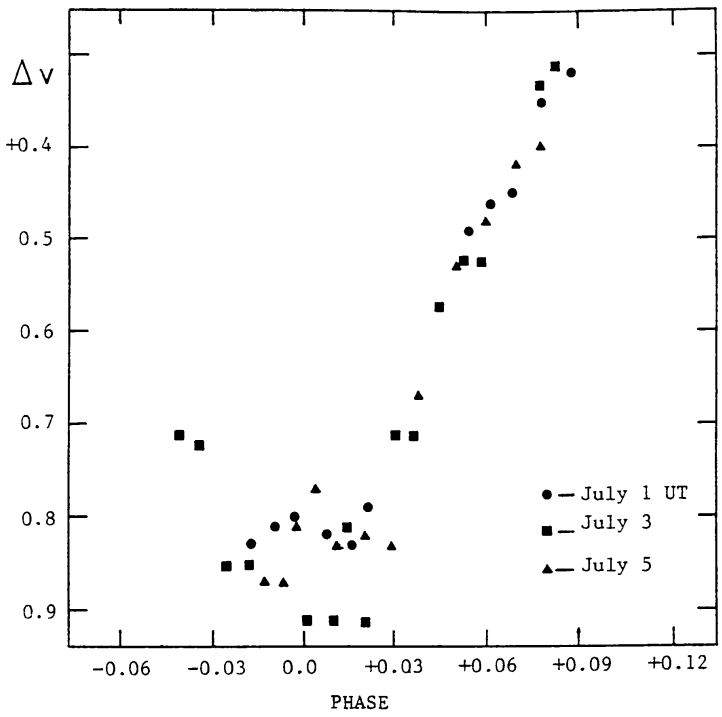

Figure 3. V1010 Oph, combined light curve of photoelectric measures by L. Kalish, July 1, 3, 5, 1965 UT.