THE 1981 LIGHT CURVE OF THE UNIQUE CEPHEID HR 7308

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Abstract

The photoelectric light curve of HR 7308 in mid-1981 is given and discussed. The total amplitude is 0.385 magnitude, the largest value yet observed, and the light curve is non-sinusoidal. The observations support a modulation period of 1210 days, but they do not support a model based on the beating of two close periods.

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1. Introduction

HR 7308 (HD 180583, F6 I-IIb, m_v=5.93) is one of the many interesting objects to be found in the Yale Catalogue of Bright Stars (Hoffleit 1964). It was discovered to be variable in brightness by Breger (1969), but he did not investigate the nature of the variability at that time. The variability was rediscovered by Percy et al. (1979), who proposed that HR 7308 was a small-amplitude Cepheid with a period of 3.04 days. Subsequent observations by Percy and Evans (1980) and independently by Burki and Mayor (1980) revealed two unique characteristics of this star: (1) the period was actually 1.49 days, the shortest period of any known classical Cepheid; and (2) the amplitude of the star decreased slowly by a factor of five, in both light and velocity, between 1978 and 1979. Such behavior is unprecedented in a classical Cepheid.

Both Percy and Evans (1980) and Burki and Mayor (1980) noted that HR 7308 lies close to the red edge of the Cepheid instability strip. This conclusion was strengthened by VBLUW observations by Van Genderen (1981), which showed that its temperature places it 300° redward of the red edge of the instability strip.

Breger (1981), in an important paper, presented his 1966-1969 observations and combined them with all other published observations. He refined the pulsation period to 1.49077 days. He also suggested that the amplitude variations might be periodic, with a period of 1210 (or possibly 955) days. He discussed possible explanations for the amplitude variations. In particular, he showed that if the amplitude variations were due to the beating of two close periods, then there should be O-C variations with the same long period as the amplitude variations. The amplitude of these O-C variations depends on the ratio $\Delta m_2/\Delta m_1$ of the amplitudes of the two close periods; the O-C variations would have an amplitude of 0.25 of a period if $\Delta m_2/\Delta m_1 = 1$, and would be zero, of course, if $\Delta m_2/\Delta m_1 = 0$. The observed O-C variations are $\leq$0.05 of a period, which requires that $\Delta m_2/\Delta m_1 < 0.3$.

2. New Observations

During the summer of 1981, we continued to monitor HR 7308, using a photoelectric photometer on the 0.4m Boller and Chivens reflector on the main campus of the University of Toronto. This telescope is used for teaching during the academic year, but is available for research in the summer months. Despite its location in the center of a city of 2,000,000 people, it is quite capable of good photometric results.

Photometric observations were made and reduced as described by Percy and Evans (1980).

3. Results

The mid-1981 light curve is shown in Figure 1. The total amplitude ΔV is 0.385 $\pm$ 0.01 magnitude, the largest value yet observed. The light curve is noticeably non-sinusoidal, in contrast to the situation when the amplitude is small (Breger 1981). Maximum light occurs very close to phase 0.0, using the ephemeris given by Breger (1981). Thus the period of 1.49077 days is supported.

The amplitude of 0.385 magnitude is consistent with a long period of 1210 days, but not with a long period of 955 days. If the amplitude variation is due to the beating of two close periods, then their total amplitudes must be 0.22 magnitude and 0.17 magnitude. Breger (1981), however, has shown that two close periods with nearly equal amplitudes would produce large O-C variations. These are not seen in Breger's data or in ours. Thus the hypothesis of the beating of two close periods is not supported.

The explanation for the behaviour of HR 7308 thus remains unknown. The star is not a detectable binary system (N. R. Evans, unpublished), which seems to rule out tidal effects as an explanation. Perhaps the explanation is related to the position of the star on the H-R diagram, well to the red of the red edge of the instability strip.

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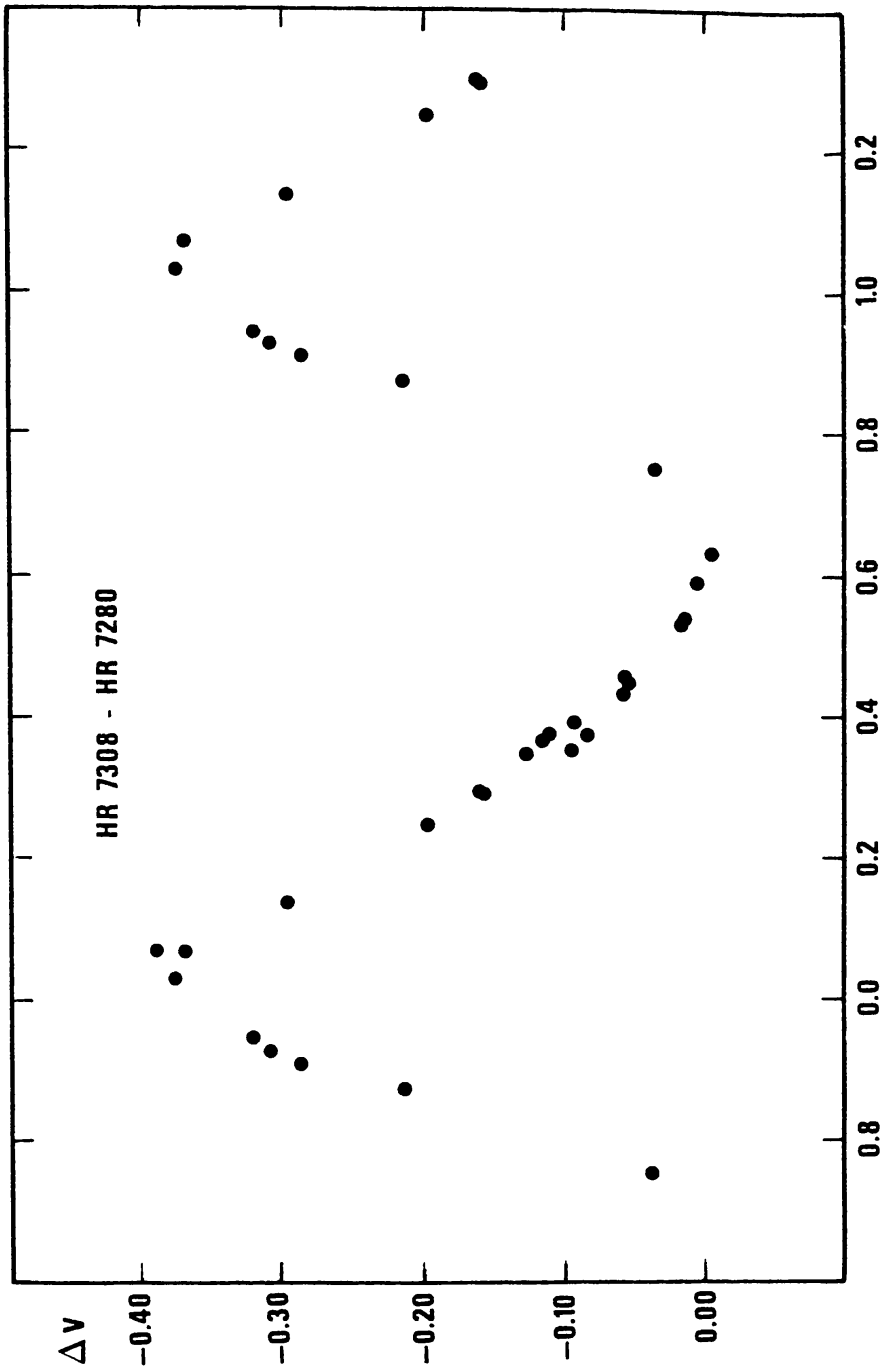

Figure 1. The light curve of HR 7308 in mid-1981, in a V filter, relative to HR 7280. The ephemeris is that given by Breger (1981).