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Photoelectric Observations of HR 4047

HR 4047 (HD 89343, Sp. T. A7n, $V = 5.80$) was chosen as a comparison star for VY UMa in the American Association of Variable Star Observers (AAVSO) photoelectric photometry program. However, it was found in 1986 to be variable by a few hundredths of a magnitude by Don Pray (Cranston, Rhode Island), and this result was confirmed in 1987 by Howard J. Landis (Locust Grove, Georgia). The spectral type and amplitude of the star suggest that it is most likely a δ -Scuti star.

An observation program of HR 4047 was therefore undertaken in the summer of 1987 and May of 1988. HR 4215 (Sp. T. A1V, $V = 6.39$) was used as the comparison star. The use of HR 4021 as a check star was discontinued when the task of isolating it from a nearby star in the field proved difficult at best. Also included in the program were the stars HR 4026 and HR 4108 which, on the basis of their spectral types, might also be δ -Scuti stars but so far have been found to have little or no short-term variability.

The observations were taken differentially in the V filter only, with the University of Toronto's 0.4m reflector, located on the 16th floor of the McLennan Physical Laboratories in downtown Toronto. The DC photometer used an *EMI 6094* photomultiplier tube which was operated at 1300 volts supplied by a *Keithley Instrument 242 Regulated High Voltage Supply*. The signal from the photometer was amplified by a *Keithley Instruments DC Amplifier* and the output was fed into a *Vidar 240 Voltage to Frequency Converter*. The 10 second integrations were performed by a *NOVA* computer which also displayed the results on screen and printed them on paper.

In all, 22 observations on 5 nights were obtained in 1987 and 64 points on 5 nights in 1988. These will be deposited in the IAU Commission 27 Archive for Unpublished Photoelectric Photometry (Breger 1988). The precision of the observations is estimated at $\gtrsim 0.007$ magnitude. This value is the standard deviation of the HR 4026 and HR 4108 measurements taken on the night of HJD 2447307 and excludes 3 points which lie more than 4σ from the mean. Of course, in using the HR 4026 and HR 4108 data, we make the possibly false assumption that these two stars are non-variable. However, based upon the

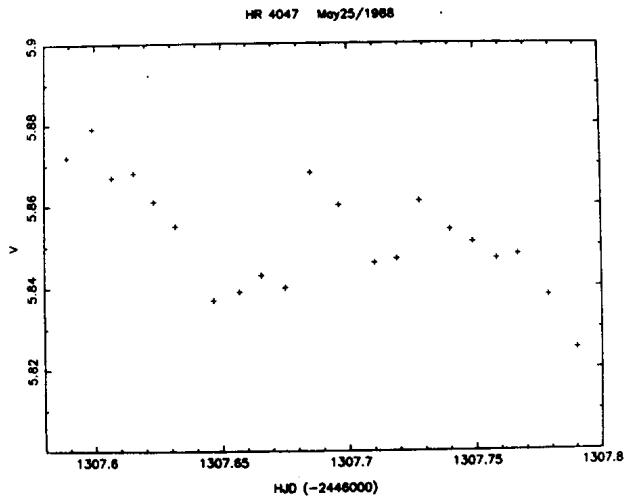


Figure 1. Light curve of HR 4047 for one night of data only.

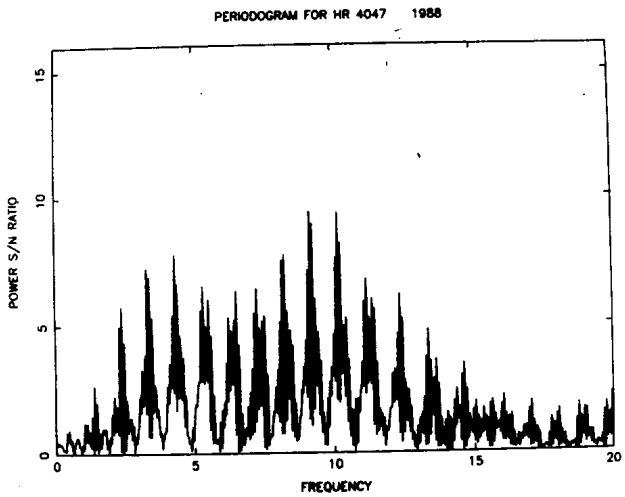


Figure 2. Power spectrum of HR 4047 utilizing all 64 points from 1988.

data so far received, this assumption appears reasonable. A value of ~ 0.007 magnitude is consistent with the precision obtained in other photometric programs using the same telescope.

Preliminary analysis of the light curve (*e.g.* figure 1) and the power spectrum (*e.g.* figure 2) of HR 4047 has yielded an amplitude of approximately 0.05 magnitude and a dominant period somewhere around 0.11 to 0.14 days. However, as can be seen in figure 2, the power spectrum is fairly complicated and seems to indicate the presence of at least two periods. The power spectrum was obtained using Scargle's method (Scargle 1982).

Power spectra of the comparison star have shown a maximum realistic signal to noise ratio of about 0.4 at a frequency of 12.24, negligible when compared to HR 4047's maximum peak of 9.416 at a frequency of 9.16 (see figure 2). A sine wave of frequency 12.24 was fit to the HR 4215 data by the method of least squares and has given an amplitude of 0.00459. This translates into a maximum variation of about 0.009 magnitude. Therefore, it appears that HR 4215 is not variable and any small peaks seen in its power spectrum can be attributed to noisy data.

Clearly there is a danger of over-interpreting the results obtained from so few points. It will probably take many closely-spaced nights of observations (preferably from observatories at widely-spaced longitudes) to disentangle the periods in this star.

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