PHOTOMETRY OF EU DELPHINI IN V AND I

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Abstract

Photometry of EU Del was carried out in the V and I bands from August to November 1994. Light curves obtained in both bands were compared and a color curve was generated. Maximum light occurred 13 days earlier in the I band. Period analysis indicated 64.23 days for the V data and 64.45 days for the I.

1. Introduction

EU Del, an SRb variable (Sp. M6 III), has been observed systematically by observers of AAVSO Photoelectric Photometry Program stars since 1983, and a preliminary report was published by Landis (1984). All those observations were single band-pass, in V. As far as is known, the star has not been previously measured in the near-infrared by AAVSO observers.

2. Observations

EU Del was observed on 29 nights during the 1994 season but was observed in both V and I on 12 nights. For this paper the data are limited to those 12 nights where comparison between the two bandpasses is direct.

The AAVSO Photoelectric Photometry chart issued for EU Del was used, so the comparison star is SAO 106396 = HD 179249 = HR 7923 (Sp. K0) and the check star was SAO 106253 = HD 195993 (Sp. K5). The procedure was to take the V measurement first, then the I. For this reason the check star was not used in the infrared observations. The observing sequence was CVCVCVCKC in V and CVCVCVC in I, where C is the comparison star, V is the variable, and K is the check star. The comparison star HR 7923 has been suspected of variability (Goss *et al.* 1993) but not confirmed.

The photometer was an SSP-3 attached both to a 25-cm Schmidt-Cassegrain telescope and a 286 computer running the data acquisition program ACQ (cf. Jones 1991). The photometer's V filter peaks at 540 nm and the I filter at 900 nm. The computer handles the timing and integration and produces a data file which can be fed to a reduction program. Each computer output is the average of three 10-second integrations. The effective aperture of the photometer diaphragm is 2 arc minutes in this f/6.3 telescope.

The data were reduced by programs written by the author, which made it possible to use the same algorithms for the V and the I reductions. These are the ones given by Hall and Genet (1988). Provision is made for reducing all results to a UBVRI standard and deriving the standard error for each observation. Approximate (V-I) values were obtained, for the variable by first measuring the raw instrumental delta V and I, then calculating (V-I), and for the comparison star by taking the average (V-I) of all the K0 stars in the *Arizona-Tonantzintla Multicolor Catalogue* (Iriarte *et al.* 1965). ε (I) was determined by using ζ Sge and δ Sge from the five-color list of standard stars included with the Jones (1991) software.

3. Results

Table 1 summarizes the raw data, where the Julian dates are geocentric, "Δ" is in the sense variable minus comparison, and the standard error comes from the dispersion of the three 10-second integrations. Figure 1 shows the light curve in V, Figure 2 the curve in I, and Figure 3 the color curve.

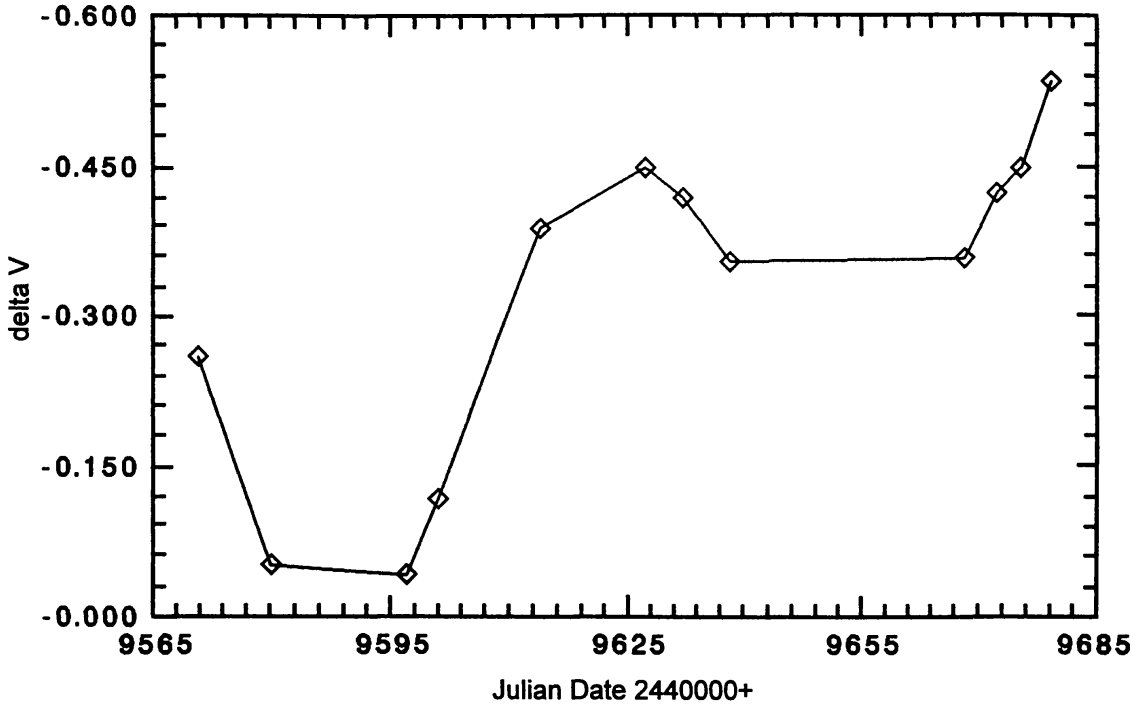

Figure 1. Light curve of EU Del in V, showing a minimum at JD 2449597, a maximum at JD 2449627, and an amplitude of 0.485 magnitude.

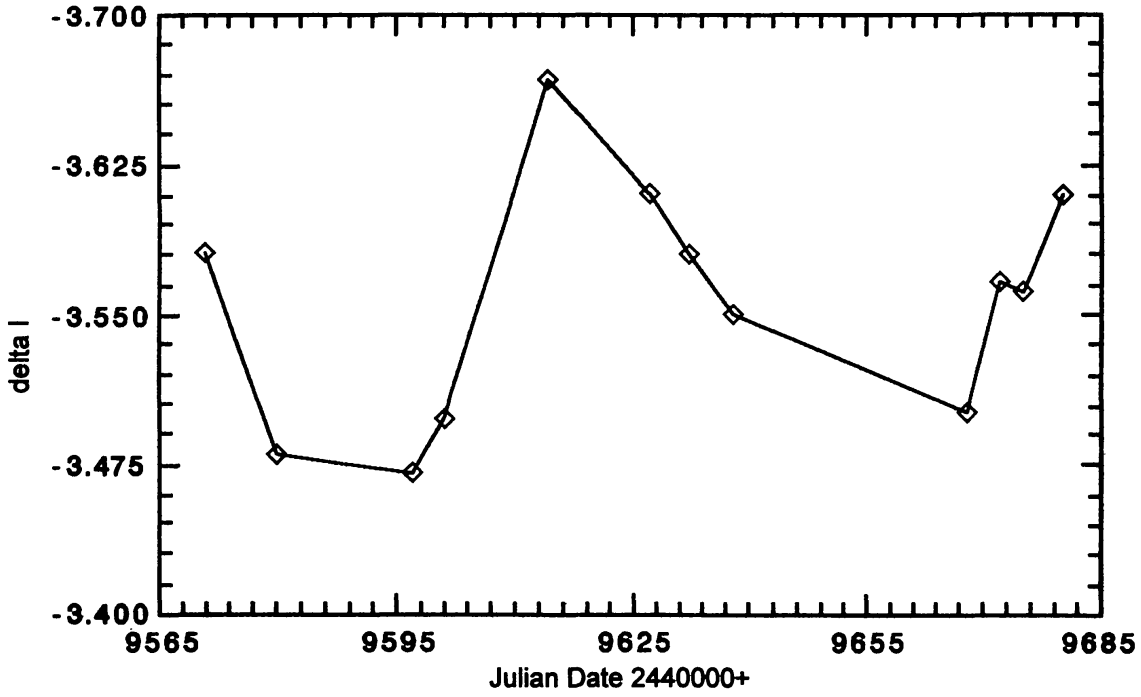

Figure 2. Light curve of EU Del in I, showing a minimum at JD 2449597, a maximum at JD 2449614 (13 days before V maximum), and an amplitude of 0.197, much smaller than in V.

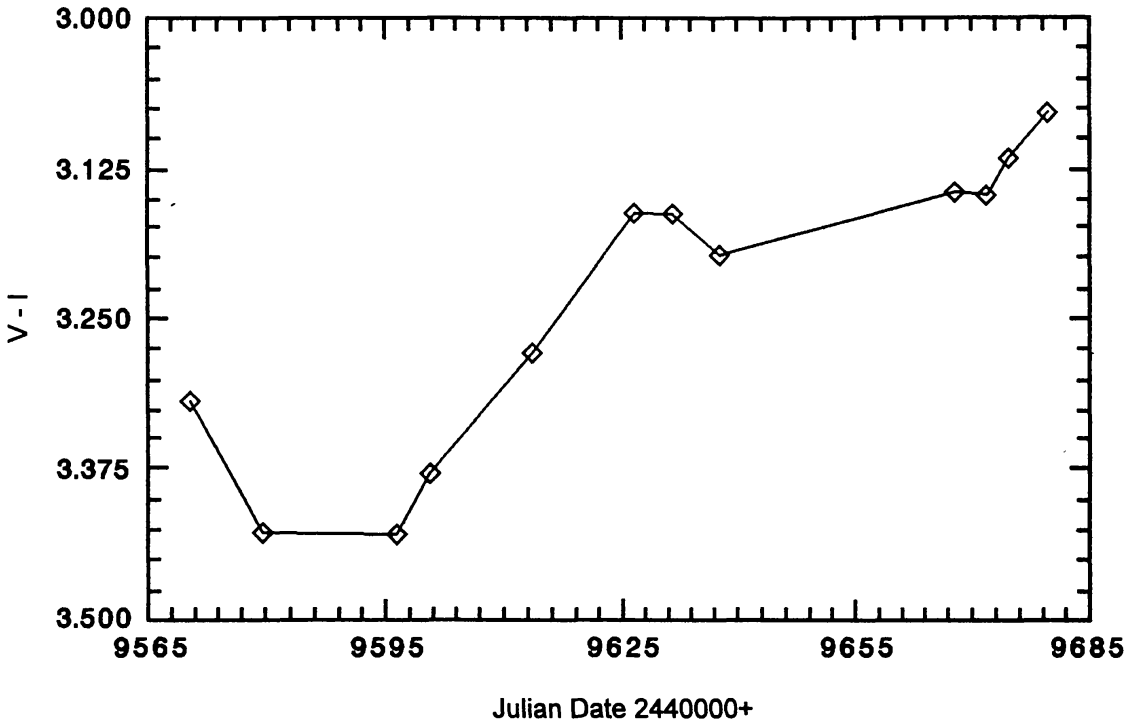

Figure 3. The color curve (V-I) of EU Del. Mid-range value is 3.25.

Comparing the V and I curves, the most obvious difference is in amplitude: in V, 0.485, and in I, 0.197. This can be explained by a combination of Planck's Law and Wien's Displacement Law (Pasachoff 1987). When a star changes temperature, as pulsating stars do, the changes are always greater in the shorter wavelengths and smaller in the longer. The next point of interest is the extreme brightness of the star in the infrared—it is greater in I by three magnitudes. In using the I filter, it was necessary to reduce the gain on the photometer by a factor of 10 or the counter went into overflow.

In general, the two curves are roughly parallel, but the V high point at JD 2449627 comes 13 days after the I high point at JD 2449614. Between these two dates, the I curve

Table 1. Raw data for EU Del in V and I.

JD 2440000+ (geo.)	*Δ V*	*Std Error*	*JD 2440000+ (geo.)*	*Δ I*	*Std Error*	*Δ V - Δ I*
9571.7319	-.260	.0027	9571.7229	-3.580	.0018	3.320
9580.6743	-.051	.0061	9580.6896	-3.480	.0008	3.429
9597.6306	-.041	.0075	9597.6535	-3.471	.0011	3.430
9601.6264	-.118	.0096	9601.6521	-3.498	.0009	3.380
9614.5958	-.390	.0059	9614.6208	-3.668	.0033	3.278
9627.5625	-.451	.0042	9627.5847	-3.611	.0030	3.160
9632.5389	-.419	.0068	9632.5625	-3.581	.0028	3.162
9638.5083	-.354	.0178	9638.5410	-3.551	.0073	3.197
9668.4764	-.358	.0149	9668.5021	-3.501	.0041	3.143
9672.4750	-.423	.0158	9672.5021	-3.568	.0097	3.145
9675.4535	-.449	.0206	9675.4389	-3.563	.0038	3.114
9679.4667	-.536	.0052	9680.4854	-3.611	.0037	3.075

is climbing while the V curve is falling. Both graphs show a minimum at JD 2449597, but the data are perhaps not complete enough to be absolutely sure that they actually coincided. In the complete V data set there is a minimum at JD 2449648. Unfortunately, I did not measure I during this minimum. It would have been interesting to see if the same pattern repeated here.

Also of interest is the hint of a hump on the final rising leg of the curve, more pronounced in I, which is not what one would expect. Another effect shows up in Table 1. As the star moved to the west, far from the meridian and into the twilight, the error values in V showed a marked increase, whereas those in I did not. This underlines the fact that, as long as the airmass is reasonably free from water vapor, observing in the near-infrared is much more tolerant of low altitudes and twilight skies. In addition, the average standard error in V is 0.0098, but only 0.0035 in I. No doubt this is due partly to the greater signal fed to the photometer. In this connection it is important to remember that the silicon diode PN detector used in the SSP-3 has its peak response at 940 nm, well into the near-infrared.

Since the observations cover more than a complete cycle, it was thought worthwhile to feed the data into the Date Compensated Discrete Fourier Transform program from the Maria Mitchell Observatory (Ferraz-Mello 1981). The period of the best-fit sinusoids are 64.2295 days for the V data and 64.4474 days for the I. The listed period of EU Del is 59.5 days (Hirschfield and Sinnott 1985).

The color curve shows a (V-I) color index ranging from 3.075 to 3.430 with a mean of 3.2361, a median of 3.1795, and a mid-range of 3.2525.

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