EI CEPHEI: RECENT UNUSUAL PHOTOMETRIC BEHAVIOR

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Abstract

Recent visual observations of the eclipsing variable EI Cephei indicate that one of the components may be an irregular physical variable with a range exceeding a magnitude. Both slow and rapid changes have been noted, and the star was well below normal maximum on all 49 nights of observation between January and April 1986.

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EI Cephei ($21^h\ 28^m\ 43^s$, $+76^\circ\ 11'.0$, 1950) is located in the fourth edition of the **General Catalogue of Variable Stars** (GCVS) (Kholopov et al. 1985) as an Algol-type detached main sequence eclipsing binary with a **V**-magnitude range of 7.54 to 8.06 (secondary minimum 7.98) and a period of 8.439334 days with initial epoch JD 2436820.4665. Its light variations were discovered by Strohmeier (1958) and the elements determined from extensive photoelectric measures by Abrami (1966) and Padalia and Srivastava (1975). Both primary and secondary minima were found to last about 13 hours, with secondary minimum occurring at phase 0.50P. Of particular relevance to the observations reported below is the fact that no light variations in excess of $0^m.1$ were noted outside of minima during the periods of photoelectric observation (38 nights, 1959-65; 32 nights, 1968-70). Both stars are of spectral type F, perhaps somewhat evolved from the main sequence.

As part of an extensive observing program on bright eclipsing variables, visual observations of this star have been made with 16x70 binoculars on 281 nights since the fall of 1984. The visual sequence was prepared by use of available **V** and visual magnitudes of neighboring stars (e.g., from the **Sky Catalogue 2000.0**, (Hirshfeld and Sinnott 1982), suitably adjusted. The comparison stars are SAO 10043 (30' SW, $7^m.5$), SAO 10108 (78' SSE, $8^m.1$, perhaps slightly variable), and SAO 10067 (9' SE, $8^m.3$). Using this system, the observed visual range of EI Cephei is magnitude 7.5 to 8.3 (secondary minimum at 0.50P, $8^m.2$).

The uncertainty of the individual observations is estimated to be rarely more than $0^m.1$. Significant systematic errors due to the rotation of the field are unlikely, since precautions have been taken by rotating the binoculars during observation and independently checking the estimate against each of the three comparison stars. No such effect has been noted in observations of the nearby eclipsing variables EK and U Cephei.

For purposes of description, the visual observations are divided into the following six time intervals, with all JD as 2446... and the associated phases according to the GCVS elements given in parentheses:

(1) JD 079-134: 11 observations of 8 nights; at maximum, except near $8^m.0$ on JD 087.5 (0.075P) and 101.5 (0.74P).

(2) JD 206-410: 143 observations on 80 nights; mostly at maximum; faint (below $8^m.0$) on JD 272.6 (0.01P), 310.6 (0.51P), 314.6 (0.99P), 418.6 (0.775P); rapid declines near JD 371.6 (0.74P), 378.7 (0.58P), and 393.6 (0.35P); rapid increase near JD 365.5 (0.02P).

(3) JD 421-433: 24 observations on 9 nights; some observations near maximum; rapid declines near JD 425.5 (0.13P) and 432.6 (0.97P); a

rapid increase near JD 429.5 (0.60P); at $8^m.0$ on JD 421.5 (0.66P).

(4) JD 434-554: 131 observations on 49 nights; all estimates are between $7^m.8$ and $8^m.3$, averaging $8^m.0$; changes of up to $0^m.3$ noted over several hours on some nights.

(5) JD 560-784: 335 observations on 95 nights; mostly at or near maximum; at or below $7^m.9$ on JD 618.6 (0.01P), 627.6 (0.075P), 628.6 (0.195P), 656.6 (0.51P), 673.6 (0.52P), 698.6 (0.49P), 711.5 (0.015P), 715.6 (0.50P), 736.5 (0.98P), 749.5 (0.52P), 756.7 (0.37P), 757.7 (0.49P), 770.5 (0.01P), 777.6 (0.85P), 778.7 (0.98P), and 779.6 (0.08P).

(6) JD 786-854: 174 observations on 40 nights; most estimates between $7^m.8$ and $8^m.1$; below $8^m.1$ on JD 829.6 (0.013P), 833.7 (0.49P), 834.6 (0.60P), 840.6 (0.31P) - rapid decline of $0^m.3$, 850.7 (0.50P), and 854.8 (0.00P).

All observations near the expected times of primary and secondary minima, with one exception, are consistent with an eclipse taking place although there is considerable scatter at secondary minimum ($8^m.0$-$8^m.3$). However, it is evident that many of the results summarized above are inconsistent with the elements, especially during the fourth and sixth intervals. A plot of all the observations according to phase resembles a scatter diagram except within $\pm$ 0.01P of primary and secondary minima. Both slow (days) and rapid (hours) variations have been noted that cannot be associated with eclipses. The mid-eclipse observations suggest that the eclipses are occurring approximately as predicted by the GCVS elements ($\pm$ 0.02 days); the not-entirely-observational scatter on the shoulders of the combined light curve does not permit greater accuracy in the determination of O-C. Data and plots of observations near minima are available upon request from the author.

The simplest explanation of these data is that one component of this system is an irregular physical variable with an amplitude that might exceed $1^m.0$ (since the system out of eclipse has sometimes been seen as faint as during minima). However, the actual situation may well be more complex. Detailed photometric and spectrometric investigations of this system would be desirable. Of special interest would be the observation of eclipses when the combined light of the system is well below maximum. Long-term efforts may be required, as the observational evidence suggests that periods of activity may be rare and are at least intermittent.

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