C-IV 155-nm LINE IN β CEPHEI

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The class of early B variable stars known as β Cephei stars are characterized by short-period radial velocity and light variations. The coolest stars of this group have an effective temperature of about 20,000 K and the hottest, about 28,000 K; the surface gravities are of the order of 10^4 cm s^{-2}. These stars are not related to the classical Cepheids whose temperatures are of the order of 6000 K.

The amplitude of the radial velocity variation β Cephei stars is in the tens of kilometers per second and the light variation is less than 0.2 mag, that is, less than 10 percent. The fastest pulsation is 3 hr and the shortest is 6 hr. The prototype β Cephei has a period of 4 hr 34 min. Ultraviolet observations were taken using OAO 2 to investigate the relationship between the visual and the ultraviolet variations.

The lower curve in Figure 1 shows data taken on April 5, 1971, with the resonance lines of hydrogen at 121.5 nm, 3 times ionized silicon at 139.9 nm, and 3 times ionized carbon at 154.8 nm. The ordinate in this figure is the decadic logarithm of the instrumental counts and the abscissa is wavelength in nanometers.

Data taken 14 days later on April 19 are shown in the upper curve, which has been arbitrarily shifted upward for visibility. One can clearly see that the C-IV line is in emission. The slight bump that exists at a slightly shorter wavelength is persistent through all the observations that we have; it is not part of C-IV line.

Additional data were taken because of this mysterious disappearance to investigate the cause. We obtained considerable data in June for a total of 64 scans covering 76 days, including the April data.

If we connect the left-hand side of the line at 153 nm to the right-hand side at 157 nm and measure the area lost to the line and follow this measurement with time, we have then a measure of the strength of this line with time.

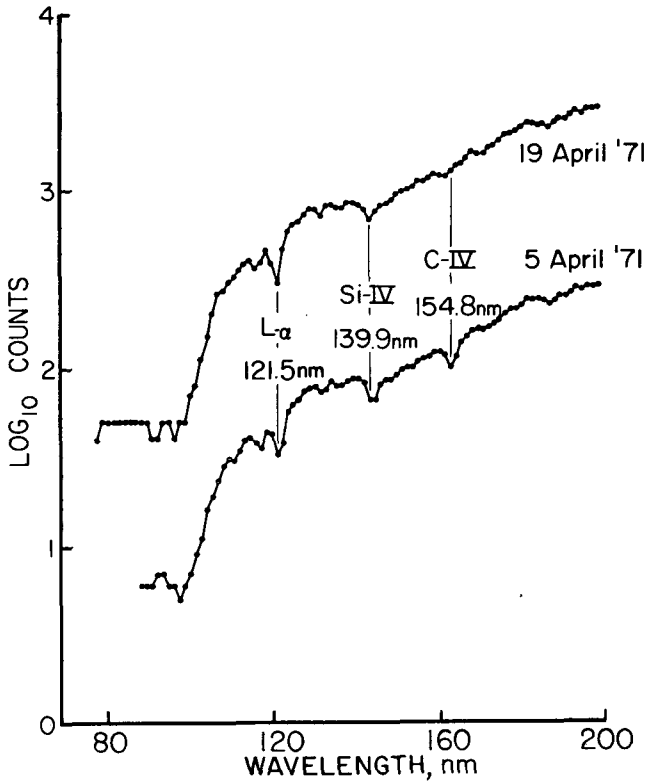

Figure 1–Results of ultraviolet observations of β Cephei.

Figure 2 shows this measurement of the equivalent width in counts in the C-IV line as a function of phase over a 6-day period. These are data taken and folded back on themselves every 6 days, showing a reasonable light curve.

No other feature shows any variation with a period of 6 days and we are unable to detect any other periodic variation except the 4 hr 34 min fundamental period characteristic of β Cephei. If this 6-day variation is due to the beating of another pulsation against the 4 hr 34 min one, then that pulsation would have to have a period of either 4 hr 43 min or 4 hr 26 min. Neither have been observed, either in the visual or in the ultraviolet spectra.

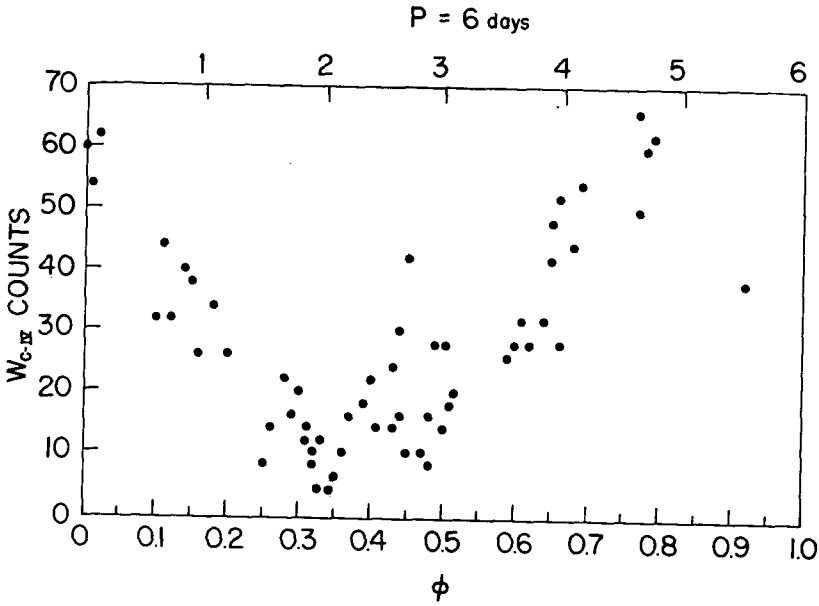

Figure 2–Measurement of the equivalent width in the C-IV line.

Alternatively there is evidence from the visual spectrum that β Cephei is a single-line spectroscopic binary. The estimated period from those data is 11 days, but it has a very highly eccentric orbit. There is also some difficulty in interpreting the data. In any event, if β Cephei is a binary, then the tidal distortions caused by the unseen companion would give rise to the variation in the C-IV line because C-IV is very sensitive to pressure.

Figure 3 illustrates two possible models of β Cephei. One model has a nearly circular orbit with a period of 12 days such that the front and back tidal bulges are seen alternately by the observer, one every 6 days. The other model has a very elliptical orbit whose period is of the order of 6 days; the tidal bulge comes and goes so that one sees the bulge every 6 days.

At this point in time we are rather partial to the first model, but we need more proof of that. In any event, we believe that the variation in the C-IV line at 155 nm in β Cephei is a very dramatic effect of tidal distortion.

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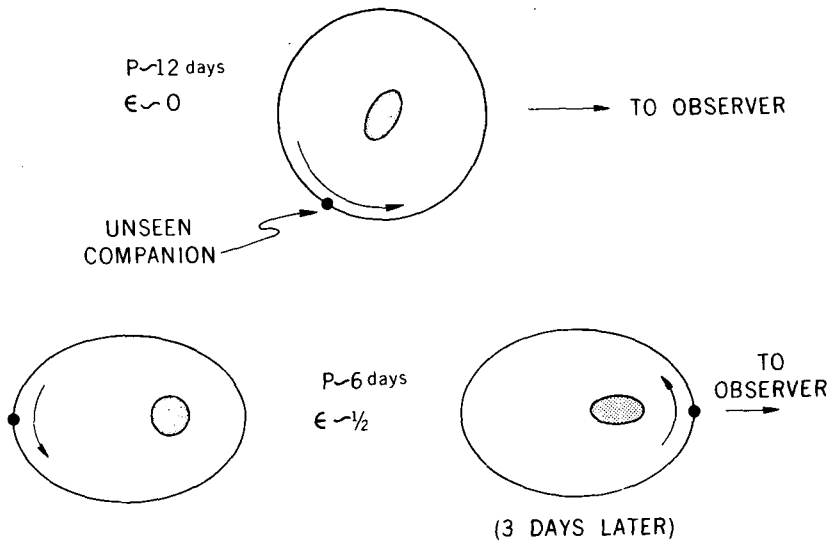

Figure 3–Two possible models of β Cephei.