β Cep: a Magnetic Be Star?

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Abstract

Besides the well-known pulsation period of 4^h34^m, the B1 IV star β Cep has a very significant period of 6 or possibly 12 days in the equivalent width of the ultraviolet resonance lines. This was discovered by Fishel and Sparks (1972) with the OAO-2 satellite, and later confirmed with IUE data. Until now, no explanation has been put forward for this period.

We propose that the UV periodicity arises from a 12 day rotational period of the star and that the stellar wind is modulated by an oblique dipolar magnetic field at the surface.

Support for this hypothesis is given by the striking similarity between the UV-line behavior of β Cep and of known rotating magnetic B stars, for example the B2 V helium-strong star HD 184927 (Barker et al. 1982), and by the measured magnetic field strength of $B \pm \sigma = (810 \pm 170)$ G for β Cep itself by Rudy and Kemp (1978). A rotational period of 12 days corresponds well with an adopted radius between 6 and 10 $R_\odot$, given the reported values of 20 – 43 km/s for $v\sin i$.

To verify our hypothesis we carried out new magnetic field measurements simultaneously with UV spectroscopy. We confirm the 12 day UV period in the equivalent width of the stellar wind lines of C IV, Si III, Si IV and N V (see Figs. 1 and 2), but find a lower and likely variable field strength (Fig. 3), which is consistent with a 12 day period, but not conclusive.

It remains puzzling why our new magnetic field measurements show a lower field than in 1978. It is interesting to recall the recent discovery (Mathias et al. 1991) that β Cep has entered a new Be phase (July 1990), when Hα turned into emission (see Fig. 4). This opens the suggestion that the lower magnetic field is related to the emission phase. Because the UV period is still the same, the field must still be strong enough to modulate the wind. A possibly higher equivalent width of the 1991 UV data with respect to the 1979 data might also be related to this transition, but this needs to be confirmed.

The star β Cep appears to be the only star in its class which shows this wind variability and in this respect β Cep is an exceptional β Cep star.

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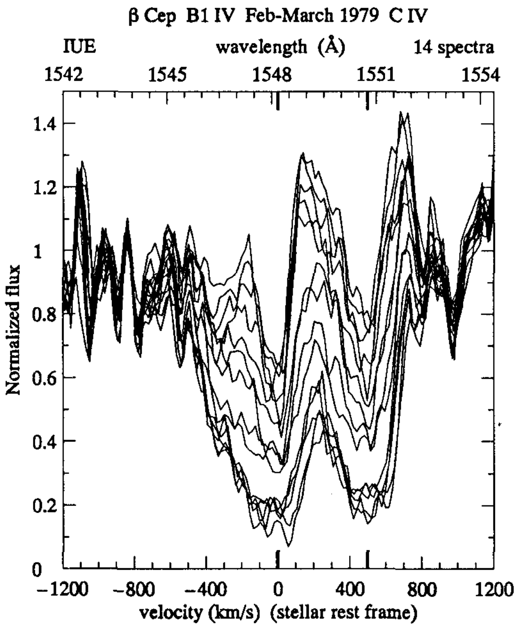

Figure 1 Significant variations in sample spectra of the ultraviolet C IV stellar wind line in β Cep in 1979 (IUE archival data). New data taken in 1991 are very similar.

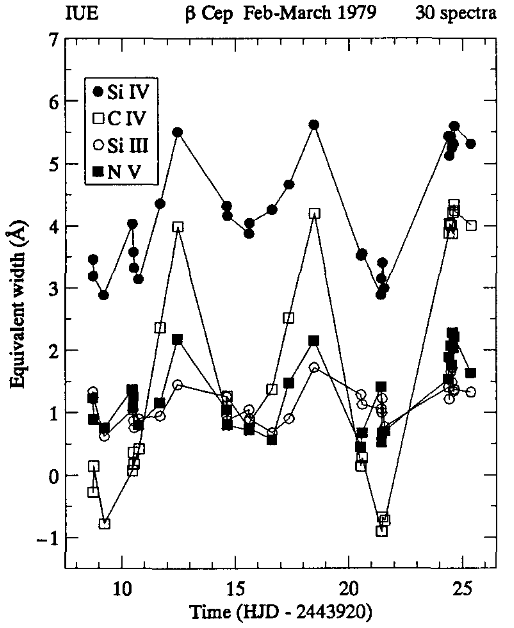

Figure 2 Equivalent widths of C IV, Si III, Si IV and N V of the 1979 data, showing a 12, rather than 6 day period. The new 1991 data might have a larger equivalent width.

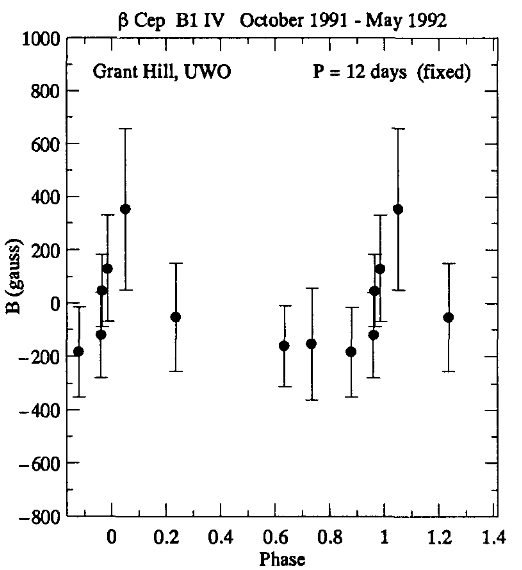

Figure 3 Longitudinal magnetic field measurements over 7 months. Each datapoint is an average of 8–16 measurements. The data are folded with a 12 day period.

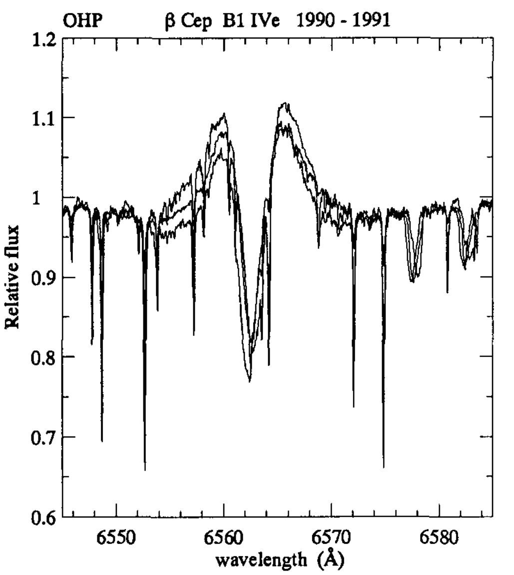

Figure 4 (From Kaper *et al.* 1992) Hα spectra of β Cep on 1990 July 18, 1991 Feb. 5 and Oct. 28 (left peak decreasing, respectively). Hα is usually observed in absorption.

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