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Magnetic field evidence for the supergiant *ν* Cep (HD 207260)

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Summary. On the basis of 55 Zeeman spectrograms the effective magnetic fields and the radial velocities of the supergiant *ν* Cep (HD 207260) were determined. For the effective magnetic field a slow variation occurring on a time-scale of years was found. The spectrograms taken at the first epoch show only moderate effective magnetic field strengths of a few hundred Gauss but in 1978 values of +2000 G were detected.

The measured radial velocities show a long-term variability similar to that of the magnetic field as well as more rapid changes of ≈ 39.9 day. Not only the Balmer absorption lines H*β*, Hγ and H*δ* but also the various elements and ions have different radial velocities.

The existence of strong longitudinal magnetic fields in Ap stars has been proved beyond dispute since Babcock's (1947) observation of the longitudinal Zeeman effect in the spectra of such stars. However, few results have been accumulated until now concerning the existence of strong magnetic fields in stars of other luminosity classes and spectral types. During the years 1975-1979, 55 Zeeman spectrograms of the supergiant *ν* Cep were obtained with a Zeeman analyser at the Coudé focus of the 2-m telescope at Tautenburg. All spectrograms but one have a reciprocal linear dispersion of 7.9 Å mm^{-1}, the width of the slit was equivalent to 0.12 Å. The spectral region used for the measurements was approximately λλ 4000B4600 Å. Thirty-six spectrograms were used for determining the effective magnetic field strength, and all of them for determining the radial velocities. The measurements were carried out by using the oscilloscope display machine described by Gerth *et al.* (1977). The values were determined by taking the mean of all measurable lines of a spectrogram, i.e. in most cases 40B50 lines. The accuracy (rms) of one value of the radial velocity is about ±0.4 km s^{-1} and that of the effective magnetic field strength about ± 250 G.

In Fig. l the effective magnetic field strength B_{eff} is represented as a function of time. A periodic behaviour with a period of about 4 yr and a maximum value of the magnetic field of +2000 G at the beginning of 1978 can be seen. The reality of the existence of such a strong longitudinal magnetic field has been confirmed by the construction of a ΔλBz diagram for the plates with large positive magnetic field. Moreover, the existence of a magnetic field in *ν* Cep is also supported by the proof of a small circular polarization observed by Stokes *et al.* (1974) and Avery *et al.* (1975).

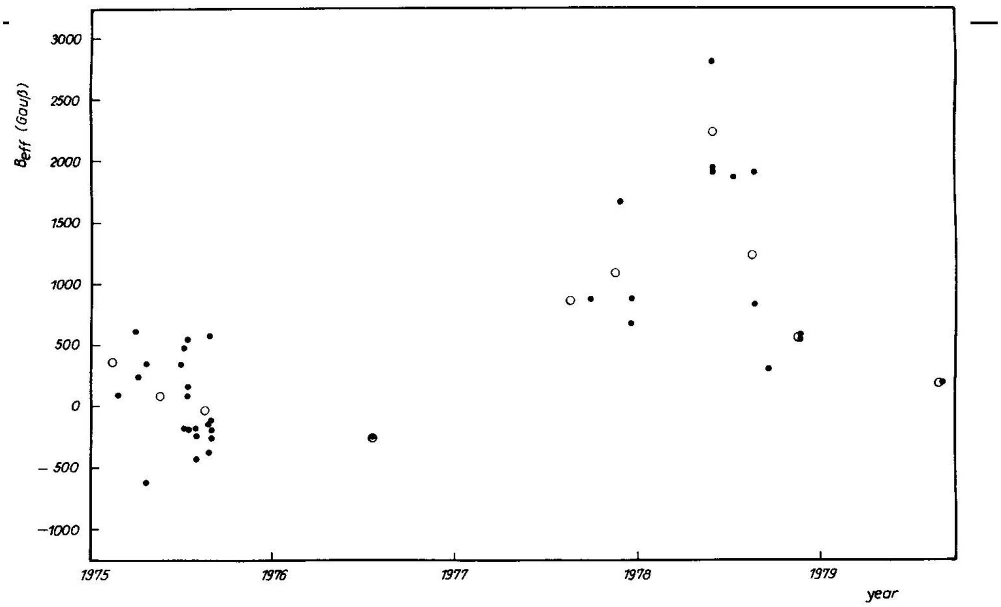

Figure 1. Effective magnetic field versus time (filled circles). Open circles denote mean values of three months.

The question arises whether or not the magnetic variation of *v* Cep can be explained in the same way as for the magnetic Ap stars. The periodical changes of the effective magnetic field $B_{\rm eff}$ observed for many Ap stars are most frequently interpreted by the rotation of the star. For *v* Cep the equatorial rotational velocity can be estimated from the parameters $T_{\rm eff}$ and $M_{\rm bol}$ published by Burki (1978). On the basis of these values the radius of *v* Cep would be 35 RM, so that the magnetic period of about 4yr would yield an equatorial rotational velocity of ~ 1.2km s^{-1}. According to Rosendhal (1970) the measured *v*sin*i* value is 38 km s^{-1}. Even accepting a large uncertainty in both values, it seems more plausible to assume that the slow variation of the detected magnetic field is produced by a physical process within *v* Cep rather than solely by the rotation of the star.

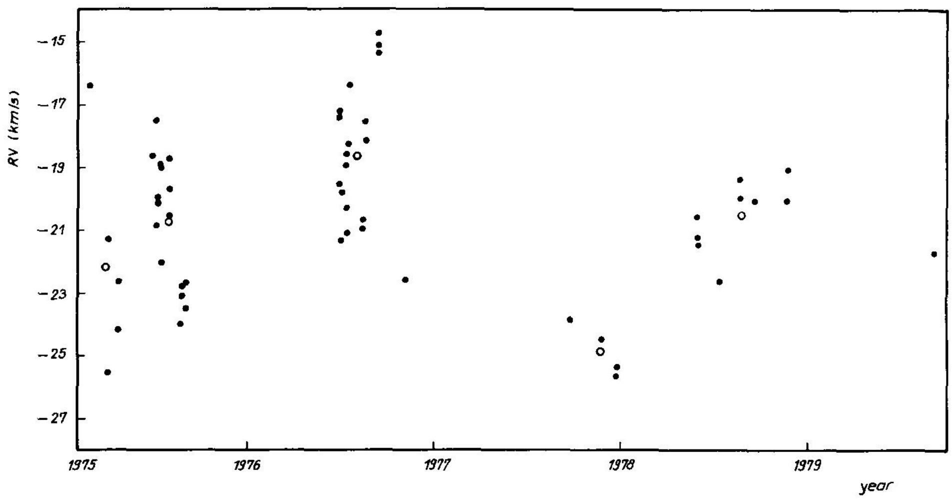

Figure 2. Radial velocities versus time (filled circles). Open circles denote mean values of a group.

Table 1.

Element	RV (km s^{-1})	Differences (element)	RV (km s^{-1})
$H\beta$	-25.42	Fe II	-20.36
$H\gamma$	-22.81	Fe II–Cr II	$-\ 1.15 \pm 0.24$
$H\delta$	-16.77	Fe II–Ti II	$-\ 0.54 \pm 0.20$

Fig. 2 represents the radial velocities on the same time-scale as the magnetic field strength. The shape is similar to that of the magnetic field, but a large scatter is conspicuous at each observational epoch. A search for a period in the radial velocities during 1975 and 1976 using the method of Lafler and Kinman yielded a faint hint at a period near 39.9 or 44 day. The occurrence of two equally well determined periods is caused by the fact that a separate treatment of the data for 1975 and 1976 gives a period of 41.8 day in each case, but with a phase shift between the two years. Unfortunately, the number of observations per year is so small that this result could be quite accidental.

The radial velocities of ions of the elements Fe n, Cr n and Ti n show significant differences similar to those discovered in other supergiants; the absorption cores of the Balmer lines Hß, Hγ, and Hδ also show clear velocity differences. The results are compiled in Table l.

A dependence on time cannot be found. These velocity differences indicate B as does the PCygni profile of Hα observed by Frandsen (1975) and Rosendhal (1973) B the presence of an expanding envelope in *v* Cep.

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