Cosmic Magnetic Fields:
From Planets, to Stars and Galaxies
Proceedings IAU Symposium No. 259, 2008
K.G. Strassmeier, A.G. Kosovichev & J.E. Beckman, eds.

doi:10.1017/S1743921309030816

Magnetic observations of pulsating B and Be stars with ESPaDOnS and Narval

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Abstract. Discoveries of magnetic fields in pulsating B and Be stars have been claimed from low-resolution spectropolarimetric observations with FORS1 at VLT. We used the new generation of high-resolution spectropolarimeters, ESPaDOnS at CFHT and NARVAL at TBL, to check for the existence of these fields. We find that most of the claimed magnetic stars do not host a magnetic field. This work shows the importance of a critical analysis of FORS1 data when searching for weak magnetic fields in early-type stars and the advantage of using ESPaDOnS and NARVAL to study such type of stars.

Keywords. Stars: magnetic fields – techniques: polarimetric – stars: early-type – stars: emission-line, Be

1. Introduction

Slowly Pulsating B (SPB), β Cephei and Be stars are pulsating variables classically considered to be non-magnetic stars. Up to now only two β Cephei stars, β Cep itself (Henrichs *et al.* 2000) and V2052 Oph (Neiner *et al.* 2003a), and one SPB star, ζ Cas (Neiner *et al.* 2003b), are known to host a magnetic field, discovered using the MuSiCoS spectropolarimeter at TBL. Amongst the Be stars only ω Ori (Neiner et al 2003c) showed evidence suggestive of the presence of a magnetic field. The longitudinal fields in the detected stars are relatively weak, of the order of a hundred gauss.

However, recent observations by Hubrig *et al.* (2006) have suggested that the occurrence of observable fields in SPB stars is significant (∼50%) and they should be considered a class of magnetic pulsators. In addition Hubrig *et al.* (2007) report that 3 out of a sample of 15 Be stars (χ Oph, υ Sgr and EW CMa) are magnetic with weak fields detected at the 3σ level. To verify this potentially important result, an observing program was undertaken using the ESPaDOnS and NARVAL spectropolarimeters installed at CFHT (Hawaii) and TBL (Pic du Midi, France) respectively.

2. Results

The spectra have been reduced using the libre-ESPRIT data reduction package (Donati et al 1997). The peak signal-to-noise ranges from 300 to 1100 and in all cases the spectra were normalised using an automated code with a polynomial fit of 5 or 6 degrees. To obtain a longitudinal field measurement, Least-Squares Deconvolution (LSD; Donati *et al.* 1997) was implemented. In each case a suitable atmosphere line mask based on solar abundances was used. Input atomic line data for the spectrum synthesis were extracted

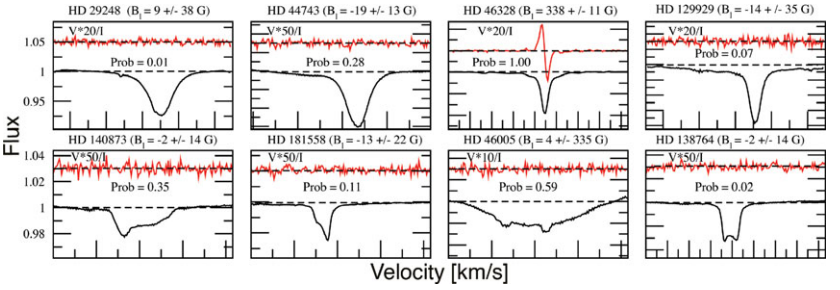

Figure 1. LSD profiles for a sample of stars included in this study. Each square represents a different star, with the bottom line showing the LSD mean intensity (Stokes I) profile and the top line showing the Stokes V profile.

from the VALD database (Kupka *et al.* 1999). For the Be star line masks, only lines not showing emission were used in order to minimize the impact of the circumstellar environment.

The LSD results are shown in Fig. 1. With the exception of the marginal detection in 16 Peg, we detect no field in any of the other SPB targets, with the highest detection probability (excluding 16 Peg) being 0.59 (HD 46005). In agreement with Hubrig *et al.* (2006), of the β Cephei stars we only detect a field in ξ^1 CMa, greater than the 3σ level. Of the Be stars we detect no field in either objects υ Sgr and χ Oph over 4 and 3 observations respectively.

3. Conclusions

The incidence of detected magnetic field in SPBs, β Cephei and Be stars appears to reflect what is seen in other stellar groups (a few percents), such as magnetic Ap/Bp stars compared to normal A and B stars (Power *et al.* 2008), or non-magnetic to magnetic Herbig AeBe stars (Alecian *et al.* 2008). It may also be that the objects detected as magnetic may represent the extreme magnetic cases of these stellar groups. Regardless of the reasoning, our observations certainly indicate that, to date, magnetic SPB, β Cep and Be stars remain rather rare. Our study also emphasises the necessity of using high-resolution data for a robust magnetic field diagnosis of these types of stars.

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https://doi.org/10.1017/S1743921309030816 Published online by Cambridge University Press