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Magnetic fields of massive stars

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Abstract. We recently carried out a spectropolarimetric study of a sample of massive O-type stars and pulsating β Cephei stars using the SOFIN echelle spectrograph at the 2.56 m Nordic Optical Telescope and the low-resolution FORS 2 spectrograph at the VLT in spectropolarimetric mode. The sample consists of massive stars already detected as magnetic in the course of our previous low-resolution polarimetric observations with FORS 1 and a few O-type stars with magnetic field detections reported in the literature.

Keywords. stars: magnetic fields, techniques: polarimetric, stars: early-type, stars: rotation, stars: oscillations, stars: kinematics, stars: individual (HD 108, HD 191612, V1449 Aql, ξ^1 CMa)

1. Observations and analysis

To date, only a small number of O, early B-type, and Wolf-Rayet stars have been investigated for magnetic fields, and as a result, only about two dozen magnetic massive early type stars are known. On the other hand, a lot of effort has been put into the research of massive stars in recent years in order to properly model the effects of rotation, stellar winds, surface chemical composition, and evolution. Polarimetric spectra of the massive O-type stars HD 108, HD 36879, 15 Mon, 9 Sgr, and HD 191612 were obtained with the SOFIN spectrograph, which is equipped with three optical cameras and mounted at the Cassegrain focus of the NOT. The new magnetic field measurements confirm the presence of longitudinal magnetic fields in these stars (e.g. Hubrig *et al.* 2008, 2009a). The presence of a longitudinal magnetic field in the Of?p star HD 108, $\langle B_z \rangle = -150 \pm 10$ G, was recently reported by Martins *et al.* (2010), using NARVAL and ESPaDOnS observations. For this star, Nazé *et al.* (2006) suggested a period between 50 and 60 years. Applying the moment technique, we obtain a mean longitudinal magnetic field $\langle B_z \rangle = -168 \pm 35$ G. A mean longitudinal magnetic field $\langle B_z \rangle = -220 \pm 38$ G in the Of?p star HD 191612 was measured by Donati *et al.* (2006), combining spectropolarimetric observations from four nights. The rotation period of 537.6 d was determined by Howarth *et al.* (2007). Using ephemeris from this work, the magnetic field measurements of Donati *et al.* (2006) have been carried out at a rotation phase of ∼0.24. Our measurements using eight spectral lines result in $\langle B_z \rangle = 450 \pm 153$ G at rotation phase 0.43. The difference in phase between the measurement of Donati *et al.* (2006) and our measurement is about 0.19. Thus, we observe a change of polarity over ∼100 days.

Over several years, we undertook a magnetic field survey for main-sequence pulsating B-type stars, namely the slowly pulsating B (SPB) stars and β Cephei stars, with FORS 1/2 in spectropolarimetric mode at the VLT, allowing us to detect in four β Cephei stars and 16 SPB stars, for the first time, longitudinal magnetic fields of the order of a few hundred Gauss. The SOFIN measurements of ξ^1 CMa, separated by one year,

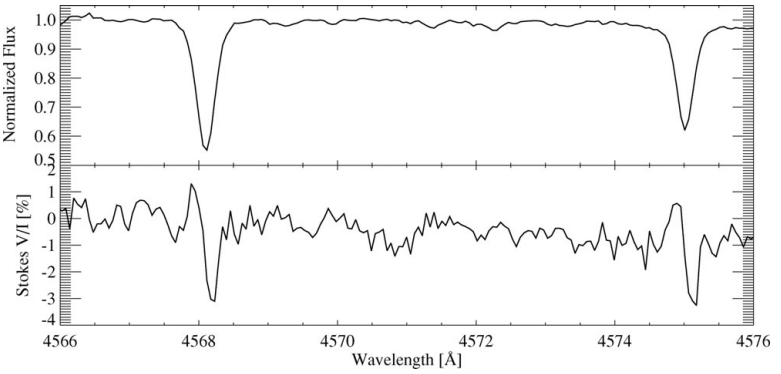

Figure 1. SOFIN I and V spectra of ξ^1 CMa in the spectral region around the Si III (Mult. 2) lines.

$\langle B_z \rangle = 386 \pm 139$ G and $\langle B_z \rangle = 297 \pm 126$ G, confirmed our previous detection of a slightly variable magnetic field in this star (Hubrig *et al.* 2006). In Fig. 1 we present SOFIN I and V spectra of this star in the spectral region around the Si III (Mult. 2) lines. Another β Cephei star, V1449 Aql, previously reported by Hubrig *et al.* (2009b) as magnetic, was found to show the strongest mean longitudinal magnetic field among the magnetic β Cephei stars, of the order of -800 G. The detection of such a strong magnetic field in this massive star is of special interest due to the recently discovered solar-like pulsations using CoRoT observations (Belkacem *et al.* 2009).

2. Summary

Although it was possible to recognize a few hot magnetic stars as being peculiar on the basis of their spectral morphology prior to their field detection (Walborn 2006), the presence of a magnetic field can also be expected in stars of other classification categories. Our measurements of several massive stars indicate that magnetic fields are possibly present in stars with very different observed properties in visual, X-ray, and radio domains. Future magnetic field measurements of massive stars in field and cluster stars will constrain the conditions controlling the presence of magnetic fields, and the implications of these fields on their mass-loss rate and evolution.

References

Belkacem, K., Samadi, R., Goupil, M.-J., Lefèvre, L. *et al.* 2009, *Science* 324, 1540
Donati, J.-F., Howarth, I. D., Bouret, J.-C., Petit, P. *et al.* 2006, *MNRAS* 365, L6
Howarth, I. D., Walborn, N. R., Lennon, D. J., Puls, J. *et al.* 2007, *MNRAS* 381, 433
Hubrig, S., Briquet, M., Schöller, M., De Cat, P. *et al.* 2006, *MNRAS* 369, L61
Hubrig, S., Schöller, M., Schnerr, R. S., González, J. F. *et al.* 2008, *A&A* 490, 793
Hubrig, S., Stelzer, B., Schöller, M., Grady, C. *et al.* 2009a, *A&A* 502, 283
Hubrig, S., Briquet, M., De Cat, P., Schöller, M. *et al.* 2009b, *AN* 330, 317
Martins, F., Donati, J.-F., Marcolino, W. L. F., Bouret, J.-C. *et al.* 2010, *MNRAS* 407, 1423
Nazé, Y., Barbieri, C., Segafredo, A., Rauw, G. *et al.* 2006, *IBVS* 5693
Walborn, N. R. 2006, in: *The Ultraviolet Universe: Stars from Birth to Death*, Proc. IAU Joint Discussion 4, #19, Prague, Czech Republic

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