A Massive Star Odyssey, from Main Sequence to Supernova
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Search for magnetic fields in A-type supergiants

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Abstract. We have searched for magnetic signatures in A-type supergiants. The obtained magnetic values for seven of these stars are presented here.

Radiation driven-wind theory can reproduce the overall characteristics of the stellar winds observed in A-type supergiants (Kudritzki *et al.* 1999). However, this theory cannot explain the variability, nor some of the observed line profiles (Verdugo *et al.* 1999a). A simple model, which combines the magnetohydrodynamic equations and the theory of radiation-driven winds, reveals that a magnetic field with a polar value of only 2.5 G can already dramatically change the profile of the wind lines (Verdugo *et al.* 2001). This analysis has motivated us to undertake a search for magnetic fields in the atmospheres of A-type supergiants. The main characteristics of the observed stars are listed in Table 1.

The observations were obtained with the MuSiCoS echelle spectropolarimeter (Donati *et al.* 1999) at the 2m Bernard Lyot telescope of the Observatoire de Pic-du-Midi, during June-July 1999 and June 2002. A least-squares deconvolution allows the detection of the longitudinal component of a stellar magnetic field through the Zeeman signatures in the Stokes V line profiles (Donati *et al.* 1997). The magnetic measurements (B_l) together with their 1-σ uncertainties are listed in the Table 2. The Julian date is given at the center of the exposure time ($t_{\rm exp}$).

Table 1. Characteristics of the observed A-type supergiants.

star name	HD	spec. type	M_v	$M/M_\odot$	$R/R_\odot$	$v \sin i$ (km s^{-1})
γ Umi	HD 137422	A3 Iab	–2.84			160
α Cyg	HD 197345	A2 Ia	–8.55	23.6	205	43
V2140 Cyg	HD 199478	B8 Ia	–7.86	14.8	83	45
ν Cep	HD 207260	A2 Ia	–6.82	14.7	92	44
4 Lac	HD 212593	B9 Iab	–5.86	11.9	52	35
6 Cas	HD 223385	A3 Ia	–8.30	22.0	193	50
V819 Cas	HD 223960	A0 Ia	–6.90	19.2	89	54

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Table 2. Magnetic measurements B_l of target stars.

star	no.	JD (-24000)	t_{exp} (min)	S/N (pxl^{-1})	v_{rad} (km s^{-1})	B_l (G)	$\sigma(B_l)$ (G)
γ Umi	1	52432.437	40	760	−8.6	−24.7	79.3
α Cyg	1	51359.428	8	650	−5.7	−19.6	11.1
	2	51359.451	16	970	−5.7	−13.7	6.5
	3	51359.470	20	1130	−6.0	−6.8	5.3
	4	51360.447	12	990	−5.8	2.0	6.2
	5	51360.466	12	980	−5.7	−6.6	6.4
	6	51361.453	12	790	−6.7	−18.9	8.1
	7	51363.524	20	1140	−5.1	−12.5	4.7
	8	51366.499	20	1260	−1.5	−4.1	3.3
	9	51367.376	27	1160	−1.2	0.2	3.6
	10	52432.469	13	800	−5.0	1.8	6.0
V2140 Cyg	1	52432.517	80	270	−23.3	−14.3	44.1
	2	52432.576	80	300	−22.2	−3.1	40.4
ν Cep	1	51359.612	87	610	−24.7	−4.5	11.7
	2	51363.587	120	710	−24.5	−6.3	10.4
	3	51366.619	60	840	−23.0	11.9	7.7
	4	51367.483	60	640	−23.3	−10.9	10.9
4 Lac	1	52432.625	48	420	−26.5	16.9	25.9
6 Cas	1	51367.547	80	210	−52.8	43.6	35.8
V819 Cas	1	51360.600	120	170	−58.4	281.3	159.8
	2	51362.586	120	240	−57.4	−47.3	108.3

The S/N per 4 km s^{-1} interval in the raw Stokes V spectra is measured around 550 nm. The heliocentric radial velocities (accuracy: 2.5 km s^{-1}) are also listed. Some of the magnetic field values presented here could be considered as 'real' detections. However, no Zeeman signatures were detected in any of the observed stars. In spite of this, the values presented in this work cannot be considered as upper limits, because the estimated rotation periods (Verdugo *et al.* 1999b) of our sample stars (about 100 d) makes for a dipolar field, that only during a small fraction of the rotation cycle a magnetic pole could be favorably pointing towards the observer. In addition, the used technique only measures the averaged value of the longitudinal component of the field. Therefore, much larger field strengths than presented here may remain hidden.

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