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Magnetic activity in the young star SAO 51891

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Abstract. We present preliminary results on a study based on contemporaneous photometric and spectroscopic observations of the young K0-1V star SAO 51891. We find that SAO 51891, a possible member of the Local Association, shows emission cores in the Ca II H&K and fillings in the Hα and Ca II Infra-Red Triplet (IRT) lines. Moreover, we detect absorption lines of He I-D3 and Li I and measure a $v \sin i$ of 19 km s^{-1}. A clear rotational modulation of both the light and the photospheric temperature, due to photospheric spots, has been detected. The net Hα chromospheric emission does not show any detectable variation, while the Ca II IRT emission displays a fair modulation.

Key words. Stars: fundamental parameters – Stars: activity – Stars: individual: SAO 51891

1. Introduction

Stars just arrived on the Zero Age Main Sequence (ZAMS) or on their way to reach it are in an important evolutionary phase because they start to spin up getting free from their circumstellar disks which can begin to condensate giving rise to proto-planetary systems. At the same time, they start to loose angular momentum via magnetic braking. SAO 51891 is in this evolutionary stage; it is indeed a young star counterpart of an EUV source with an IR excess attributed to dust around the star (Najita & Williams 2005).

The spectra were acquired in August 2006 with FOCES@CAHA at a spectral resolution $R \approx 40000$ in the wavelength range 3720-8850 Å with a signal-to-noise ratio higher than 200. The contemporaneous photometry was performed at OACt in the BV Johnson bands.

2. Stellar parameters

Applying the ROTFIT code (Frasca et al. 2003) to the yellow-red portion of the FOCES spectra, we derive a spectral type of K0-1V and a $v \sin i$ of 19 km s^{-1}. From its position on the HR diagram, with the effective temperature $T_{\rm eff}$=5260 K derived through the line-depth ratio (LDR) method, we obtain a mass of 0.8±0.2 $M_{\odot}$ by comparison with the evolutionary tracks of D'Antona & Mazzitelli (1997) and Palla & Stahler (1999).

The lithium abundance of $\log N({\rm Li}) \approx 3.2$ dex deduced from the equivalent width (EW) of the Li line at 6708 Å is somewhat lower than the Pleiades upper envelope, indicating an age of $\sim$ 100 Myr corresponding to a Post T Tauri (PTT) or ZAMS star. Thus, the magnetic activity detected at photospheric (Henry et al. 1995), chromospheric (Mulliss & Bopp 1994) and coronal (Voges et al. 1999) levels should be essentially the effect of its young age.

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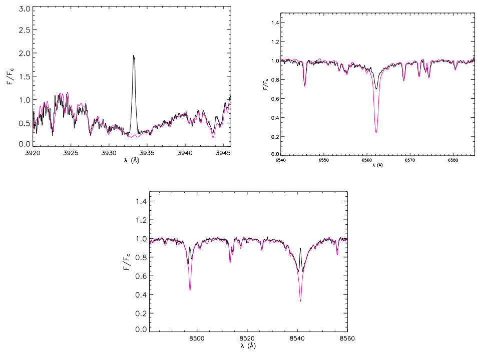

Fig. 1. Observed (thick lines) spectrum in three spectral regions, together with the non-active template spectrum (thin lines).

3. Magnetic activity

The spectroscopic method based on LDRs (Gray & Johanson 1991; Catalano et al. 2002; Biazzo et al. 2007a) allows us to detect a $T_{\rm eff}$ variation with an amplitude of 90 K, which is intermediate between the value of ~40 K found in stars with moderate activity (e.g., κ1 Cet, Biazzo et al. 2007b) and 130 K found in stars with a very high activity level (e.g., II Peg, Frasca et al. 2008). Moreover, the $T_{\rm eff}$ curve is in phase with the *BV* photometry, confirming the hypothesis of cool spots as the primary cause of the observed variations.

As diagnostics of chromospheric emission we used Ca II H&K, He I-D3, Hα, and Ca II IRT lines, formed at different atmospheric levels. Using the spectral subtraction technique (Frasca & Catalano 1994) we obtain the chromospheric radiative losses in these lines. In Fig. 1 we show portions of spectrum in the Ca II H&K, Hα, and Ca II IRT spectral regions, with the non-active template superimposed. The Hα and the Ca II IRT profiles are filled-in by emission, with the latter displaying a central reversal nearly reaching the continuum and suggesting a strong contribution to the total chromospheric losses (Busà et al. 2007). The Ca II H&K lines show a strong core emission typical of cool magnetically active stars. Measuring the EW of residual emission profiles in the difference spectrum, we find that the net Hα chromospheric emission does not show any detectable variation with phase, while the Ca II IRT displays a fair modulation with a possible phase shift with respect to the light curve.

4. Conclusions

From the study of photospheric and chromospheric inhomogeneities based on spectroscopic and photometric monitoring of SAO 51891, we find a clear light and $T_{\rm eff}$ rotational modulation due to spots and a modulation of the total IRT Ca II emission due to plages. This chromospheric diagnostic seems to indicate a possible shift between spots and plages. Thus, as a follow–up of our previous works (Biazzo et al. 2007b; Frasca et al. 2005, 2008), we aim to develop a spot/plage model for reproducing the observed behaviours at photospheric and chromospheric levels and for deriving spot/plage parameters. SAO 51891, and other weak-line T Tauri and PTT, and ZAMS stars already observed by us with FOCES@CAHA and SARG@TNG, are important to explore the correlations between global stellar parameters (e.g., $\log g$, $T_{\rm eff}$) and spot characteristics (e.g., filling factor and temperature) in stars with different evolutionary stage and activity level.

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