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The sensitivity of three lines to AR

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Abstract. We study the sensitivity to AR of three photospheric lines, comparing experimental results, from THEMIS observations, with spectral synthesis, demonstrating the inappropriateness of using these lines as indicators of quiet sun modifications, because their variations in the active regions. We try to reconstruct the cyclic lines behavior.

1. Introduction

Faculae, network and sunspots explain almost all of Total Solar Irradiance (TSI) cyclic variations (Krivova et al. 2003), but it is plausible the whole structure varies. Gray and Livingston (1997, G&L henceforth) measured the depth (D) variation of three line (Fe I 537.958, C I 538.032 and Ti II 538.103 nm) to infer the background contribution to the δ(TSI), but the observed lines behavior cannot be reproduced by a $\delta(T_{eff})$ alone (Caccin et al. 2002). Here we show as the AR presence affects these lines, by comparing spectral synthesis with experimental results. Additionally, we implement a simplified model to reconstruct the cyclic lines trend.

2. Effects of bright active regions

The dataset was acquired at THEMIS (July 6 and 7, 2003) with IPM (Cavallini 1998). Facular and quiet zones (FZ_n and QZ) were defined via a threshold criterion on the Mg I (518.740 nm) image, choosing three threshold values, obtaining three FZs. We obtained D values via parametric fit of the averaged spectral positions, while the spectra synthesis was computed via SPECTRUM (Gray 1994), using FAL models (Fontenla et al. 1999). In Tab.1 we report the results (Penza et al. 2004 for details).

3. Lines during the Cycle (1978-1992): a simplified model

We reproduce the D trend by weighting model results with corresponding coverage factors. Because we have no data about facular and network coverage for years 1978-1992, we exploit the knowledge deriving from Cycle 23 (1996-2002), monitored by PSPT in Rome (Penza et al. 2003). We used an unique activity index (MgII index, from www-iup.physik.uni-bremen.de) and establish a (linear) relation between that one and facular, network and spot coverage (A_f, A_n, A_s). By extending these relations, we estimate the unknown coverages. By comparing A_s so obtained with the Rome archive data (ftp.ngdc.noaa.gov) and the $\delta(TSI)$ produced by these A_i with the PMOD/WRC data (Frölich & Lean 1998), we check the approach validity, obtaining a sufficient confidence for the model reliability. Then, we reconstructed $\delta(D)$ through the formula: $D = \sum_i D_i I_i^c A_i / \sum_i A_i I_i^c$, where I^c is the continuum and i indicates the different models. We took: modC and modE for quiet sun and network, a Kurucz model (T_{eff}=5200K) [Kurucz 1994] for spot and alternatively modF and modH for facula (Fig.2).

4. Conclusions

The Fe I and Ti II lines are shallower in AR than in quiet zone; in other hand, these lines are sensitivity to AR presence, then at least a part of $\delta(D)$ observed by G&L was

[*] We regret to note that Bruno Caccin passed away on June 19, 2004.

Line	THEORETICAL (%)				THEMIS (%)		
	modE	ModF	modH	modP	FZ_1	FZ_2	FZ_3
Fe (July 6)	-2.8	-6.8	-17.8	-28.7	-2.2 ± 0.3	-4.7±0.6	-6.6 ± 0.8
Fe (July 7)					-6.9 ± 0.8	- 8 ± 1	-4.2 ± 0.5
C (July 6)	+0.6	+2.4	+0	-6.6	-1.9 ± 0.1	-2.8 ± 0.1	-4.2 ± 0.2
C (July 7)					+4.9 ± 0.3	+4.7 ± 0.2	+11.1 ± 0.6
Ti (July 6)	-0.9	-2.4	-8.2	-14.8	-0.50 ⊥ 0.08	-5.6 ⊥ 0.9	-4.2 ⊥ 0.7
Ti (July 7)					-0.20 ± 0.04	-0.3 ± 0.05	-7 ± 1

Figure 1. Experimental line-depth differences QZ/FZ, compared with the models.

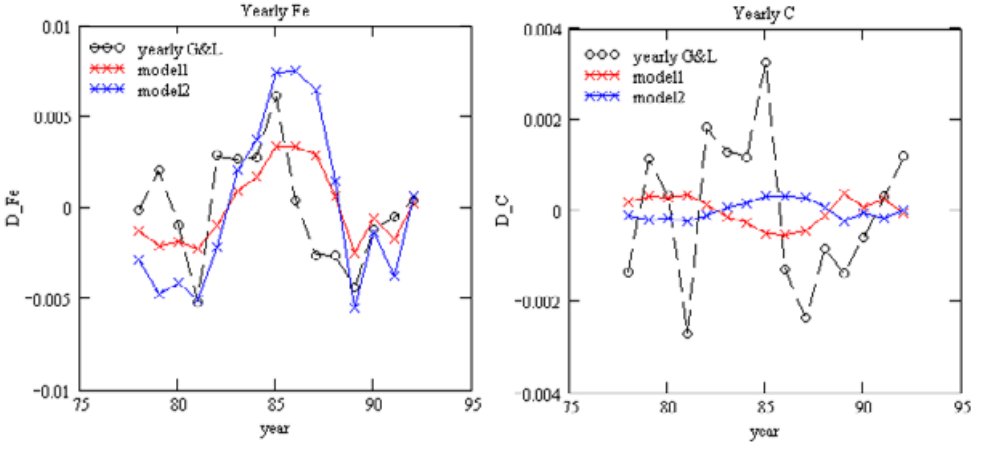

Figure 2. Line-depth from 1978 to 1992 compared with G&L data.

due to AR cyclic modulation. The C line, instead, does not present a monotonic trend. A qualitative D reconstruction (only AR coverages varying) along the cycle, shows that ARs could account for the Fe variation, but the C one seem to conceal another phenomenon.

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