SURFACE MAGNETIC FIELD MEASUREMENTS IN HOT CHEMICALLY PECULIAR STARS

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ABSTRACT. The first results of magnetic field measurements are presented here for HD 187474, a slowly rotating Ap star. From resolved Zeeman pattern the strength of the field and its mean inclination were obtained. From differential magnetic broadening a second value of the field strength has been deduced, which is compatible with the previous one. The "Robinson" method has been tested and a good agreement is found between observed and calculated Zeeman broadening of FeII lines. This method can therefore certainly be used to measure the surface field in slow rotating chemically peculiar stars.

1. INTRODUCTION

The magnetic field present in some Chemically Peculiar (CP) stars,seems to play an important role in the phenomena observed in these stars (variations, diffusion,...). The knowledge of the surface field (Hs) is therefore of great interest.

Hs is deduced from line splitting or broadening measured in unpolarized light on classical spectra. Measurements are difficult and the Zeeman pattern is often not resolved in stellar spectra. To go futher and measure Hs in more stars the differential magnetic broadening must be studied. The application of different methods to slow rotating magnetic star first, will show if they are consistent and reliable.

I present here the results concerning the CP star HD 187474. It has a rotational period of 6.7 years and so is a very good candidate to perform the first tests.

2. OBSERVATIONS

High resolution spectra (R=100000) at high S/N (≃300) were obtained with the CES and a Reticon at the ESO Coudé Auxiliary Telescope. The spectra cover a wavelength range of about 50Å. Five spectra of HD 187474 were obtained in October 1986, centered on the following wavelengths: λλ 4505Å, 5020Å, 5295Å,6240Å and 7400Å.

G. Cayrel de Strobel and M. Spite (eds.), The Impact of Very High S/N Spectroscopy on Stellar Physics, 313–316.

3. Hs MEASUREMENTS FROM RESOLVED ZEEMAN PATTERN

I have selected 16 "nice" Resolved Zeeman Pattern (RZP) to obtain a well suited Hs value from their splitting. 11 have been identified and the corresponding mean is Hs=5.1±0.6 KGauss (Didelon, 1987).

The good quality of the data allows not only to measure the displacement of the components, but also to measure their individual intensities. These intensities are a function of the angle θ between the magnetic field axis and the line of sight (Gray, 1984). The measurements of the equivalent width give: $I\pi/I\sigma=0.98\pm0.2$, which corresponds to $\theta=55°\pm5°$. This one of the rare cases where the direct determination of the magnetic field orientation was possible.

4. DIFFERENTIAL MAGNETIC BROADENING.

I selected in the spectra at λc=4505Å the strongest identified lines, which have the same intensities. Then the line widths must be realted to magnetic field broadening. I plotted the Full Width at Half Maximum (FWHM) of the lines versus their Landé factor z (Fig.1).

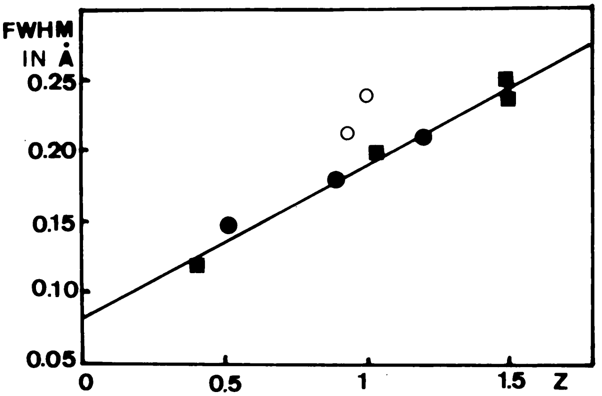

Figure 1. Magnetic broadening of lines

The FWHM seems to increase linearly with z. This is expected if Zeeman splitting is simply added to a mean profile observed at z=0. Empty circles represent lines which are certainly blended and so they have been excluded from the regression analysis. Fill squares give the position of the FeII(37) lines used in Robinson method. Note that they all lie near the mean relation. The straight line of fig.1 has been obtained by least square fit. Its slope gives a Hs value of 5.5 KGauss; which is compatible with that deduced from RZP.

5. TEST OF THE ROBINSON METHOD

Differential Magnetic Broadening (DMB) can be studied more precisely with the so-called "Robinson method", which has been applied only to cool stars (Sun et al, 1987; Gray, 1984). This method uses the division of the Fourier Transform (FT) of two lines with different magnetic sensitivity, which gives the Zeeman Broadening Function (ZBF). I haye studied the DMB effects on FeII(37) lines. I used the line at λ4491A (z=0.4) as unsensitive magnetic line of reference. The wavelengths and z values of the three other lines are respectively; λ4489Å,z=1.5; λ4515Å, z=1.0; λ4520Å,z=1.5. The division of the FT of one of these lines by the FT of the "unsensitive" reference line gives the observationnal ZBF. The values of the field strength and its inclination given by RZP are used to calculate the expected ZBF.

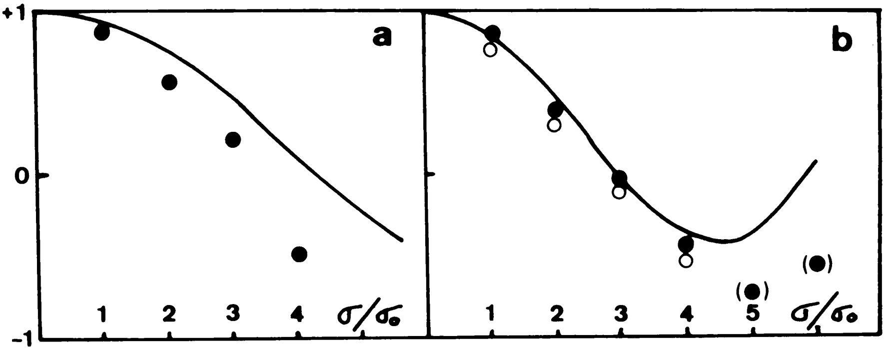

Fig.2: Zeeman broadening functions associated with different FeII Lines.

The figures 2a and 2b show the comparison of the observed and calculated ZBF. The full lines correspond to the calculated ZBF, the points give the observed ZBF. The ZBF obtained with the sensitive line λ4515Å is plotted in figure 2a. The calculated ZBF didnot fit the observed one, which is much stepper. This effect is due to additional broadening certainly due to a small undetected blend. This blend did not affect the FWHM of the line (see fig.1). In figure 2b i plotted together the ZBF obtained with the 2 other sensitives lines, which have the same z values (1.5). The observed ZBF of λ4520, respectively λ4489, is represented by full dots, respectivelly empty dots. The agreement between the calculated and the observed ZBF of these lines is satisfactory. Moreover the two observed ZBF have approximately the same values, which confirms the reliability of the data. The discrepancy at high frequency is due to noise contamination.

Finally, for the lines with z=1.5, a good agreement exists between observed and calculated ZBF. The Robinson method can therefore certainly be used to determine Hs, at least in slowly rotating CP stars. However several ZBF are necessary to get a field value with a good confidence level, to avoid undetected additionnal sources of broadening.

REFERENCES

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DISCUSSION

MATHYS Have you performed, or do you intend to perform tests of the Robinson method at different phases of variation ? I do indeed think that the geometric aspect of the field may critically influence the success of the Robinson technique for the determination of the surface field of Ap stars.

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- Yes I plan to pursue tests of the Robinson method, and follow some stars through their variation period.
- The geometrical aspect of the field is only a problem when mixed with the geometrical aspect of abundances patches. This effect is not so crucial in slow rotators which I observed for the moment but it will certainly limit the method in rapid rotators.

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