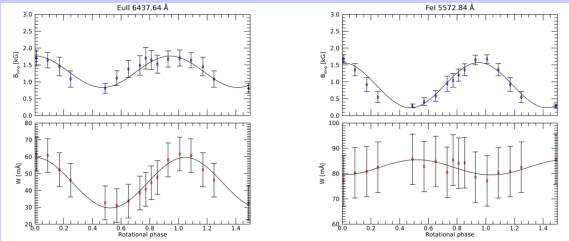
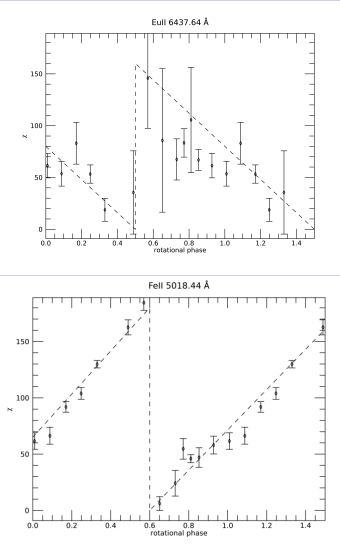


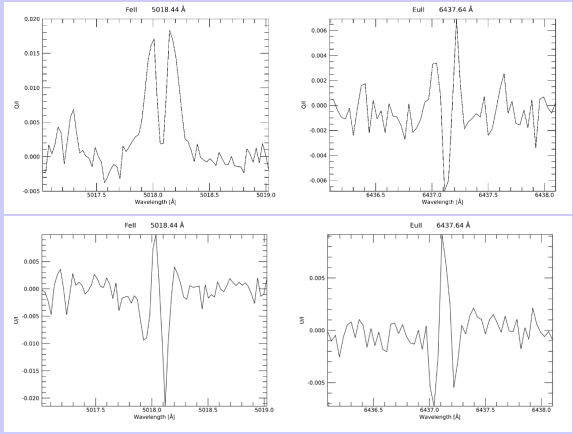
phase iron peak elements are located at equatorial latitudes.

A result confirmed by the out-of-phase changes of χ for these elements.



Conclusions

Looking at the Stokes profiles of Rare Earths and Iron-peak spectral lines of one single spectrum, the sign inversion in Stokes profiles immediately show these elements are mainly located in two regions whose magnetic field orientation is oppositely oriented.



In conclusion, a single spectrum in full Stokes polarisation supplies the same information on the distribution of elements on the surface of magnetised stars than the highly demanding Doppler Imaging.

UNIVERSITÀ degli STUDI di CATANIA

Dipartimento di Fisica e Astronomia "Ettore Majorana"

MSC PROGRAMME IN PHYSICS

LORENZO GIUSTOLISI

ZEEMAN NON-DOPPLER IMAGING OF HD 24712

FINAL PROJECT

SUPERVISOR:
CHIAR.MO PROF. F. LEONE

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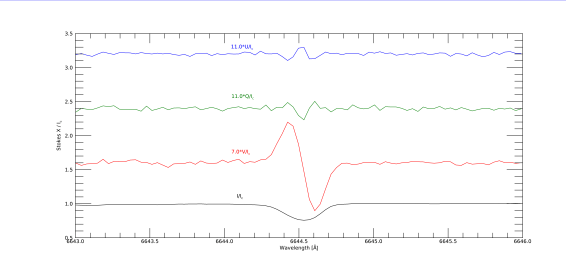
Introduction

Ap magnetic stars are among the most unpredictable objects for their chemical and physical properties. They are characterised by very intense magnetic fields whose values generally lie in the range $1-10\,\mathrm{kG}$ and very high abundance of heavy elements and in particular Rare Earths. For this reason they also constitute the group of CP1 (Chemically Peculiar) stars. Past studies report also photometric, spectroscopic and magnetic variability all with the characteristic period of rotation. The modulation is nowadays quite well known to be due to a magnetic axis inclined with respect to the rotation axis. Further, as modulations of magnetic field and equivalent width depend on the elements considered,the distribution of elements is thought to be non-uniform on the surface.

Objectives

Distribution of elements of the stellar surface is routinely obtained via the Doppler Imaging. This is a highly demanding technique requiring a large amount of telescope time to collect high resolution spectroscopy along the stellar rotational period and computing resources to invert spectral profiles. Our goal is to extract the same amount of information decoding the magnetic field effects of the spectral lines of any single spectrum in polarised light.



Techniques & methods

As representative of Ap stars, HD24712 has been chosen as the subject of this work. Time resolved spectropolarimetric data covering the rotational period of this star were collected in January 2010 at La silla Observatory with HARPSpol. A linear regression has been adopted to infer the longitudinal and transverse components of the magnetic field as well its orientation χ via the Stokes parameters.

$$\frac{V_\lambda}{I_\lambda} = -4.67 * 10^{-13} g_{eff} \lambda^2 B_{long} \frac{1}{I_\lambda} \frac{dI_\lambda}{d\lambda},$$

$$\frac{Q_\lambda}{I_\lambda} = -5.45 * 10^{-26} \overline{G} \lambda^4 B^2_{transv} \cos 2\chi \frac{1}{I_\lambda} \frac{d^2 I_\lambda}{d\lambda^2},$$

$$\frac{U_\lambda}{I_\lambda} = -5.45 * 10^{-26} \overline{G} \lambda^4 B^2_{transv} \sin 2\chi \frac{1}{I_\lambda} \frac{d^2 I_\lambda}{d\lambda^2}.$$

Synthetic spectra computed with COSSAM (COdice per la Sintesi Spettrale nelle Atmosfere Magnetiche) are used to test the reliability and possible biases of the here proposed method with special attention to line saturation.

Results

Looking at the superimposing of the variability of equivalent width of lines, and the derived longitudinal field as functions of rotational phase, it is possible to conclude that the in-phase Rare Earths and other elements like Co for instance are locate in the magnetic polar regions; while the out-of-