Synoptic program - Variations of the turbulent magnetic field

by

L. Kleint [1,2], S. Berdyugina [1,3], M. Bianda [2]

(1) Institute of Astronomy, ETH Zurich, Switzerland (2) Istituto Ricerche Solari Locarno (IRSOL), Switzerland (3) Kiepenheuer-Institut für Sonnenphysik, Germany

Abstract

We have initiated a synoptic program at the Istituto Ricerche Solari Locarno (IRSOL) to observe variations of the turbulent magnetic field with the solar cycle. Our main target are C_2 molecular lines at 5141 Å which are excellent for employing the differential Hanle effect to determine the strength of the turbulent magnetic field (see Berdyugina & Fluri 2004). These lines are monitored about twice per month at five position angles around the solar limb (N, NW, W, SW, S) at μ=0.1. Several other lines, for example the Cr I triplet at 5206 Å, have also been chosen for our observations.

This is the first systematic study of temporal variations of the second solar spectrum, and we have already noticed significant differences between single measurements taken at the solar maximum and minimum. We present a description of the synoptic program and first observations.

Introduction

Turbulent magnetic fields are unresolved fields below the resolution limit. While their mixed polarities cannot be seen via the Zeeman effect, their impact on the linear polarization signatures that are caused by scattering processes can be observed as Hanle depolarization. During the past years, the existence of these turbulent fields has been confirmed by various measurements (Berdyugina & Fluri 2004, Derouich et al. 2006, Asensio Ramos & Trujillo Bueno 2007) but their temporal and spatial variations are still unknown.

The aim of our synoptic program is to find long-term variations of these fields. We use the 45 cm Gregory-Coudé IRSOL telescope with its high-resolution spectrograph and our ZIMPOL polarimetry system to perform periodic observations of a few selected wavelength regions.

Differential Hanle effect

Interpretations of the linear polarization of different lines usually require complex radiative transfer models. However, if many lines of the same molecule with different magnetic sensitivities are observed simultaneously, a technique called 'differential Hanle effect' can be used for a much simpler interpretation (Stenflo et al. 1998, Trujillo Bueno 2003).

The main advantage of the C_2 molecular lines at 5141 Å is that the P (ΔJ=-1) - and R (ΔJ=+1) -triplets can be observed in one spectral window and that the R-triplet is unblended. Through a comparison of several *Q/I* amplitude ratios many uncertain factors can be eliminated and the magnetic field strength can be determined.

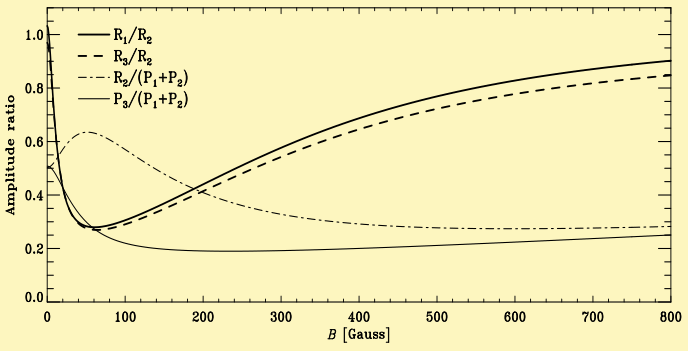

Fig. 1. *Amplitude ratios and resulting magnetic field strength calculated using line parameters from Berdyugina & Fluri 2004. The magnetic field strength may be overestimated by a factor of two due to the Einstein coefficients that are claimed to be lower by a factor of two by other authors. We will recalculate this to determine the correct coefficients.*

Observations

The observations are performed during one day while changing the position angle on the Sun. For each position, dark and flatfield images are taken and a polarimetric calibration is performed. To determine the limb distance we use simultaneously taken slit-jaw images.

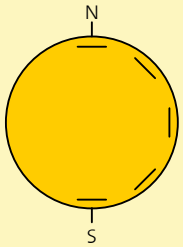

Fig. 2. *Graphical representation of the observations that are performed with the slit parallel to the solar limb, at μ=0.1, and 5 position angles (heliographic N, NW, W, SW, S).*

Through the special working principle of our polarimeter we get images of *Q/I* and *V/I* at the same time, and thus we can be sure that there are no strong oriented magnetic fields as our target is the quiet Sun.

Data analysis

After a standard data reduction, the data can be used as input for the model which finds the best fit.

Fig. 3 shows an observation from January 8, 2008 (solid black) and as comparison the data from Gandorfer's atlas (dotted), both taken at the solar north pole. The colored lines are model fits for different magnetic field strengths. The best fit is about 15 G.

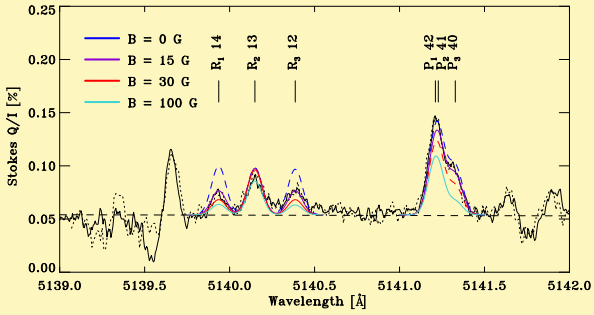

Fig. 3. *Observations (solid, black), atlas data (dotted) and model fits (colored) showing the linear polarization due to the Hanle effect in the C_2 molecular lines at 5141 Å.*

References

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ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

For more information: kleint@astro.phys.ethz.ch