MEASUREMENTS OF THE MAGNETIC FIELD IN SOLAR PROMINENCES WITH A SPECTRALLY SCANNING MAGNETOGRAPH

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Abstract. We describe observations with a new magnetograph capable of recording the whole profile of emission lines in prominences. Two recordings are used simultaneously to study the Zeeman effect in circularly polarized light. The spectral scan is produced by the action of piezo ceramics of a Perot–Fabry interferometer combined with a narrow band interference filter.

The instrument is calibrated using 100% circularly polarized light and an emission line produced in Laboratory conditions in a simulated longitudinal magnetic field. The magnetograph was attached to the large coronagraph (~ 53 cm) of Kislovodsk to give a series of measurements of the Hβ line of several quiescent and active prominences. The observed values of the longitudinal component of the magnetic field are between: −25 G + 13 G with a noise level at ± 2 G for a corresponding resolution of 8 arc sec.

Effects produced by the instrumental polarization are discussed.

1. Introduction

Since the first measurements of the longitudinal magnetic field in Solar Prominences by Zirin and Severny (1961) a large amount of progress has been achieved using specially designed magnetograph and polarimeters, as well as conventional magnetographs.

A few authors have reported very high values (Smolkov et al., 1971, for example) of up to 1000 G in active prominences, although these results should be considered with caution because instrumental polarization effects were not properly accounted for (see Bashkirtsev, 1975). However, more accurate and statistically significant results were obtained using the Climax HAO-magnetograph (Harvey and Tandberg-Hanssen, 1968). We therefore extracted from the excellent review by Rust (1972) a relative frequency of occurrence of Prominence magnetic field intensities for the observations at Climax using the assumption that the field in the prominences has no preferred direction. This frequency shows a first flat maximum between 5 and 15 G for non active region prominences and, also, a second large maximum near 80 G for active region prominences. The question of the role of spatial resolution for this kind of measurements seems to be still open. Recently, much progress in this field was made by Leroy (1978) using polarimetric measurements of the Hanle effect (Sahal-Brechot et al., 1977). The longitudinal field in quiescent prominences was successfully measured in D3 line, giving a relatively low value of the most commonly occurring magnetic field (near 6 G for the longitudinal component).

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The method is less suitable for measurements of high values of the magnetic field, so no statistics are available for active region prominences. For this reason, the use of the Zeeman effect seems to us more promising. In order to measure it we developed a new kind of instrument, the prototype of which will be described below. This instrument was adapted to the Coudé focus of the large 53 cm aperture coronagraph of the Kislovodsk High Altitude Observatory, and it provided a first series of measurement of the Hβ line. We believe that the method we developed is better than previous ones for measuring the Zeeman effect in emission lines, because we measure the polarization along the whole profile of the line with an axially symmetric Fabry–Perot interferometer. However, we recognize in the description of the new HAO Stokes polarimeter working at Sacramento Peak Observatory (Baur et al., 1980) which appeared very recently, some similar advantages. However a comparison of both methods should await the publication of results concerning the measurements of prominence magnetic fields, the HAO instrument being certainly superior for certain studies such as that of sunspot magnetic fields.

2. Description of the Magnetograph

2.1. General set up

A plan of the magnetograph package is given in Figure 1. A part of the image situated above the solar limb is formed at the level of the entrance diaphragm D₁ situated at the Coudé focus of the coronagraph (scale: 16 arc sec per mm, aperture ratio F/28). O₁ and O₂ are adapted achromats (f₁ = 180 mm; f₂ = 300 mm) forming a 1.7 times magnified...