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A new spectropolarimeter for the San Pedro Martir National Observatory

E. Iñiguez-Garín, D. Hiriart, J. Ramirez-Velez, J. M. Núñez-Alfonso, J. Herrera and J. Castro-Chacón

Instituto de Astronomía, Universidad Nacional Autónoma de México,
Ensenada, B. C., México
email: einiguez@astro.unam.mx

Abstract. We present the design of a stellar spectropolarimeter to measure the magnetic field of point sources. The polarization module interfaces the Boller and Chivens (B&Ch) intermediate-low resolution (R $\sim$ 500 – 4000) spectrograph to the 2.1-m telescope of the San Pedro Martir National Astronomical Observatory in Mexico. The module uses a Savart plate to split the beam into two orthogonal states of polarization and a quarter (half) waveplate to measure circular (linear) polarization. The module is mounted to the telescope and it feeds the spectrograph through a set of four fibers, two for the polarized star images and two for the spectrograph calibration lamp. The instrument will be capable of measuring polarization in spectral lines to determine the longitudinal and transversal fields in magnetic stars.

Keywords. Astronomical instrumentation: polarimetry – magnetic fields – stars: magnetic stars

1. Introduction

We present a polarization module operating at optical wavelengths that interfaces the B&Ch spectrograph and the 2.1m telescope of the San Pedro Martir National Astronomical Observatory(SPM-NAO). The polarization module feeds the spectrograph through a set of four optical fibers that allows the instrument to be mechanically decoupled from the telescope in arrange used in similar instruments (Kim *et al.* (2007)). This new polarization module at SPM-NAO will replace the actual one that it is directly coupled to the spectrograph (Hiriart *et al.* (2011)). An advantage of using fiber optics in this new version is that the images of the star remain fixed at the spectrograph slit, reducing problems due to the error in telescope guiding and seeing effects.

2. Design

Figure 1 presents an schematic of the new proposed spectropolarimeter. The polarization module consists of either a rotatable quarter-wave plate (QWP) or a rotatable half wave plate (HWP) followed by a Savart plate (SVP). The beam emerging from the waveplate is split by the SVP in two beams of orthogonal polarized states. Each of the beams is injected into a fiber optic that brings the light to the slit entrance of the spectrograph.

The optical system is capable of feeding the comparison lamp thru the same optical train by reflecting it at the back of the slit entrance of the module. The retarder plate plus the SVP system generates two orthogonal polarized states of the star simultaneously with the orthogonal polarized states of the calibration lamp. The polarization elements could be removed from the optical axis of the telescope when it is required the regular use of the spectrograph.

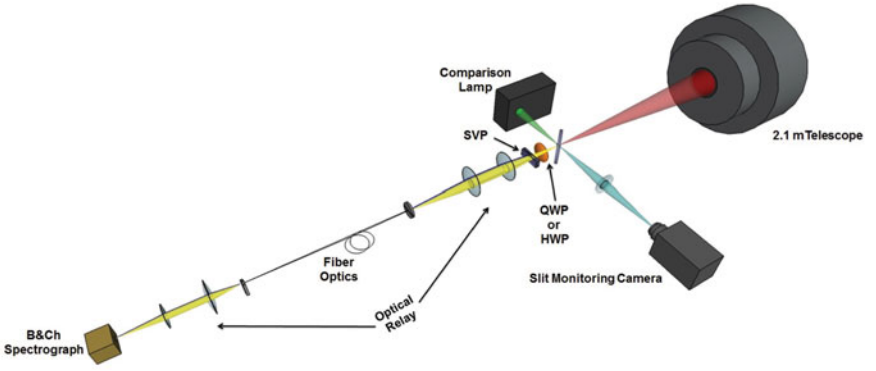

Figure 1. Optical layout of the polarimeter module for the B&Ch spectrograph at the 2.1-m telescope of the San Pedro Martir Observatory.

The retarder plates are made of birefringent polymers by Astropribor Company. These QWP and HWP are true zero–order retarders with a super–achromatic response that retards the wave at a rate of $0.25 \pm 0.001\lambda$in 400–860 nm and $0.50 \pm 0.001\lambda$ in 380–810 nm, respectively. The SVP was manufactured by United Crystals Company. The emergent beams from the SVP are parallel with a displacement of 600 μm at 633 nm. The SVP has a broadband anti–reflective coating from 300 to 900 nm on both surfaces. The optical fibers are manufactured by Polymicro Technologies. Each fiber has a core diameter of 200 μm, a cladding thickness of 20 μm, and an external polymer coating of 20 μm. The fibers have a total length of 13 m. These fibers, manufactured specially for astronomical applications, have a very small focal ratio degradation. The coupling lens system to the fibers will be made with a 1:1 optical relay to preserve the focal ratio of the telescope. Optical relays are composed by two achromatic doublets separated by 100 mm.

3. Conclusions

We presented the design of a new spectropolarimeter module for the 2.1-m telescope at San Pedro Martir National Astronomical Observatory. The instrument is intended to measure the magnetic fields of point sources thru their spectra. This instrument will be capable of measure polarization in spectral lines to determine the longitudinal (circular polarization) and transversal (linear polarization) magnetic fields in magnetic stars.

Acknowledgements

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