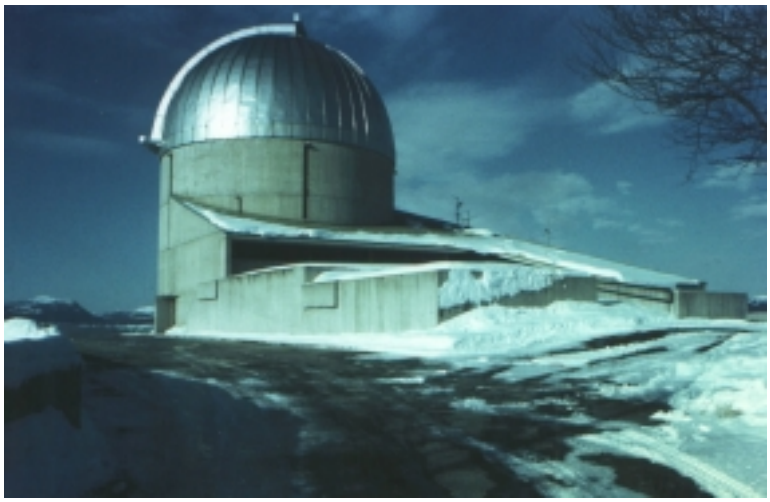
ISSN 1594-1906

Padova and Asiago Observatories



AFOSC POLARIMETER

Giro E., Pernechele C.

Technical Report n. 18

November 2001

Document available at: **http://www.pd.astro.it/**

Vicolo dell'Osservatorio, 5 35122 Padova – Tel. +390498293411 – Fax +390418759840

This page is left intentionally blank

1 Introduction

The Asiago Faint Object Spectrographic Camera (AFOSC) is now equipped with a dedicated polarimeter. This document presents the description of the instrument with its basic characteristics, how to use it and the first measurements obtained.

2 Instrument description

The design of the polarimeter takes advantage of the high flexibility in mounting optical components near the pupil inside AFOSC. Following Ref. 1, it consists of a simple combination of two Wollaston prisms and two wedges. This configuration permits simultaneous measurements of the polarized flux at angles 0, 45, 90 and 135 degrees without any need of l /2 rotating plates or other moving elements. In this way its setup is very simple consisting only in mounting a polarimeter mask in the slit wheel and in an alignment of the optical device on the grism wheel. In Fig. 1 the optical layout of instrument is shown. Light incoming from the telescope intercepts a polarimetric mask on the telescope focal plane. After a collimator, light is split into four beams by the two Wollaston prisms and a camera refocuses the four images on the CCD. The two wedges avoid overlap between ordinary and extraordinary rays incoming from the two Wollaston prisms. The double quartz polarimetric prism has been built by Bernhard-Halle[1].
The typical field permitted by the mask consists of four strips of the order of 40 arcsec. Often for stellar object a large slit (20 arcesec) is used instead of the mask.

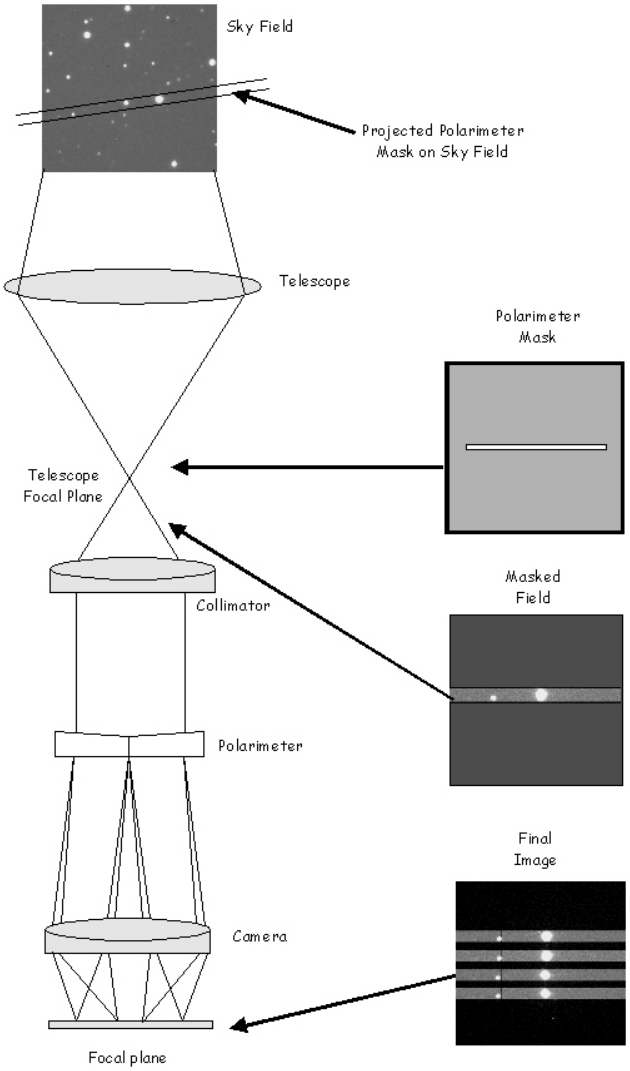


Fig. 1: Polarimeter optical layout

[1] http://www.b-halle.de/

3 Instrument operation

Typical telescope operations to acquire polarimetric images are very similar to spectroscopy. Here there is a list of the operations to execute:

- Obtain a white light image of the target;
- Perform an offset of the telescope to put the object inside the slit or the polarimetric mask (see AFOSC manual for details);
- Acquire the polarimetric images selecting the large slit (20 arcsec) or the mask, the filter and the polarimeter (named POL) on the AFOSC exposure sequencer. To use automatic data reduction software images must be full frame;
- At least two flat images (for 0 and 90 degree of the adapter) and a bias must be taken.

4 Some preliminary results

During commissioning phase some polarimetric standard objects have been observed. In Tab. 1 we report our results. Only few observations have been made. Preliminary measurements indicate an instrumental polarization about 0.7 % mainly due to the total reflection inside AFOSC. Estimation errors may considered a superior limit. Measurements on the polarized object (HD 154445, HD 183143) show a good agreement with literature data (Ref. 2).

Object	**Band**	**P(%)**	**Theta**	**U**	**Q**
Gl 9533	B	0.73±0.20		-0.0035±0.0015	-0.0064±0.0015
Gl 9533	R	0.76±0.16		-0.0030±0.0012	-0.0071±0.0012
G 561	R	0.701±0.094		0.00188±0.00078	-0.0067±0.00076
HD 154445	B	3.42±0.39	95.4±2.9	-0.0063±0.0035	-0.0336±0.0035
HD 154445	R	3.44±0.25	94.1±2.0	-0.0048±0.0020	-0.0341±0.0021
HD 183143	B	5.89±0.23	178.8±0.6	-0.0024±0.0022	0.0588±0.0022
HD 183143	R	6.08±0.39	177.7±1.0	-0.0048±0.0044	0.0606±0.0036

Tab. 1: Polarimeter results

5 Data reduction software

To simplify data reduction for stellar objects a dedicated software has been written in IDL 5.2 language. This is a first release. It can be downloaded at the AFOSC home page. Its consists of an user interface (Fig. 2), to load the four images requested for data reduction. The user simply displays the scientific image and select the object, following the instruction displayed on the bottom of the user interface. Two graphical windows permit to estimate the data reduction, displaying polarization and flux. The polarization is calculated at three sigma from the center of the star. With a slide bar it is possible to change the range in which is selected sky flux.

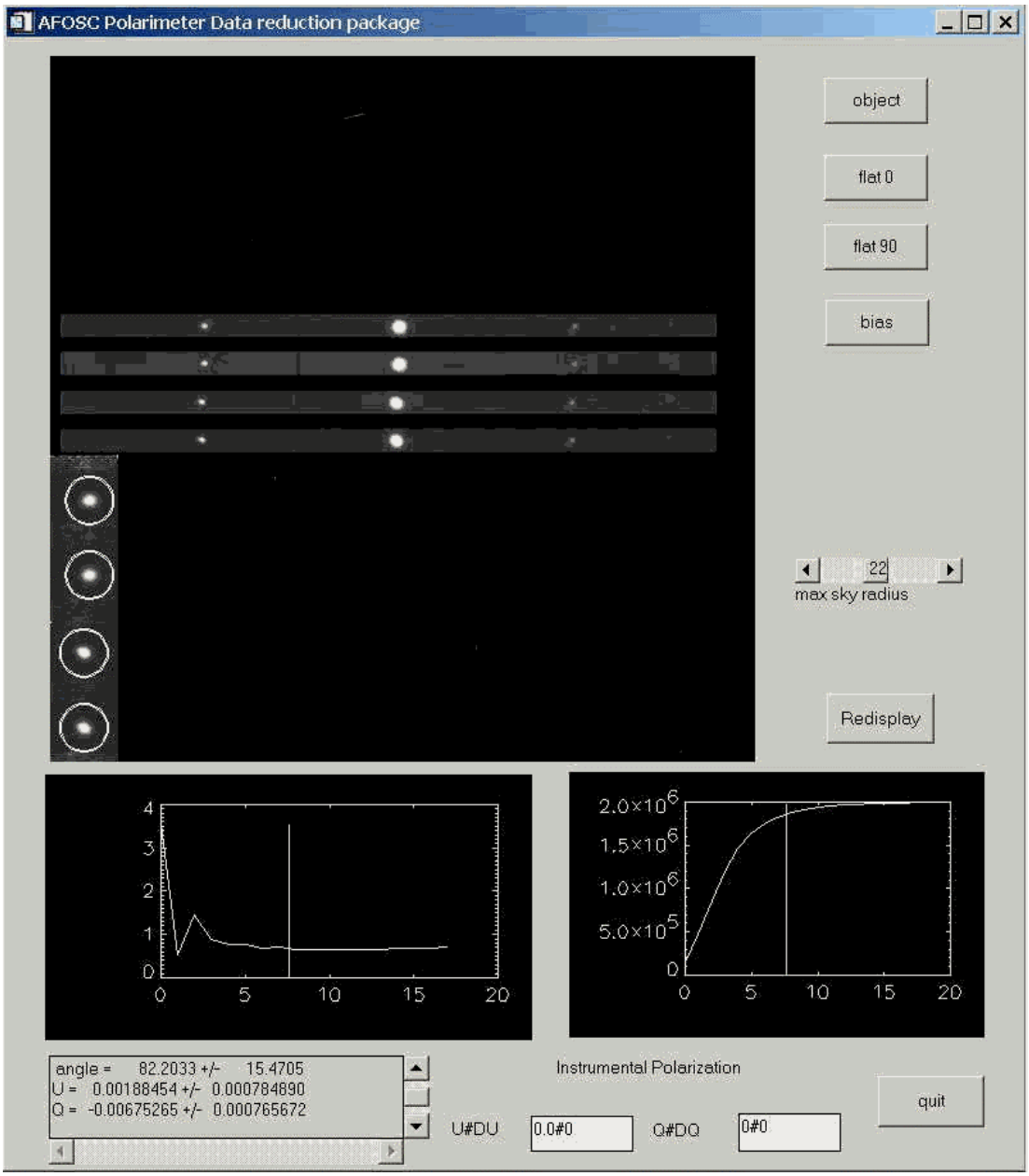


Fig. 2: User interface

6 First light in spectropolarimetric mode

During the period October 2000- January 2001 some tests of the spectropolarimetry mode have been made. In this configuration the polarimeter is mounted on the filter wheel and it splits the light in the four channels before the grism and perpendicularly to the direction of dispersion of the grism. Moreover a short (40 arcsec) slit has been mounted instead of the standard long slit, to avoid the overlapping of the spectra. The results appear very promising also if instrumental operations and data reduction are a bit more complicated than in polarimetric mode. In fact to avoid spurious effects along spectral lines and to minimize instrumental effects the observer must obtain an image at 0 degrees of rotation of the adapter and an image at 90 degrees. Particularly important is the alignment of the polarimeter along the rows of the CCD to avoid to fit the four spectra in wavelength during data reduction. Observations of two famous objects AG Draconis and R Monocerontis are reported.

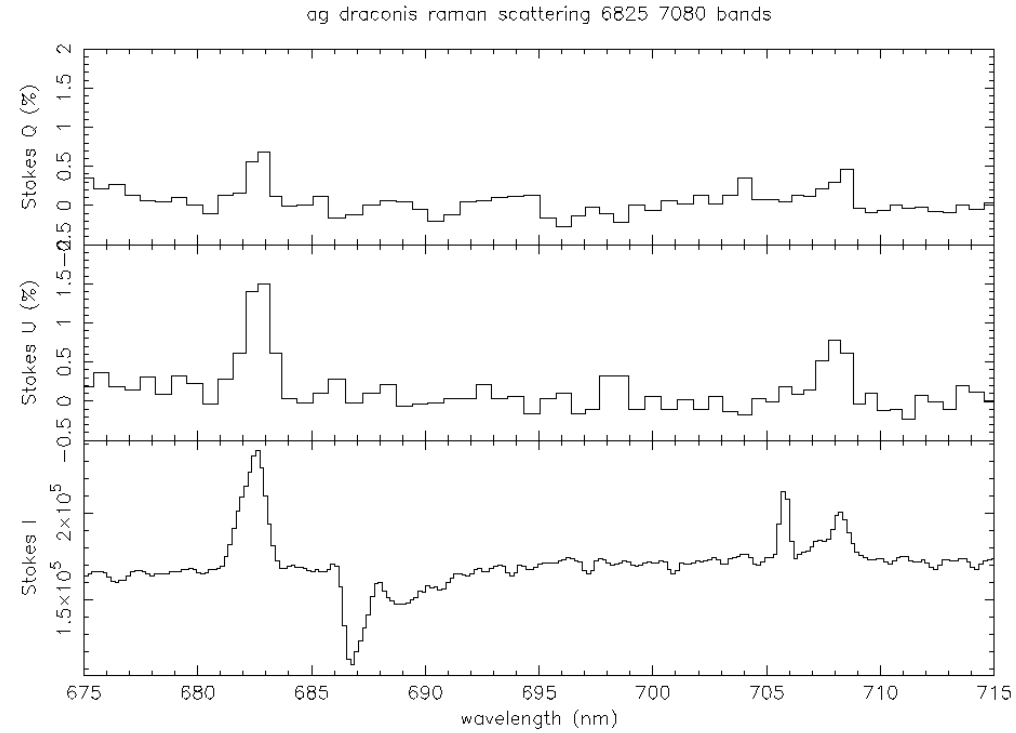


Fig. 3: Spectrum of AG draconis

The spectrum of AG draconis (Fig. 3) has been obtained using a slit width of 1.26 arcsec, the polarimeter and grims 8. Two expositions 900 seconds long have been taken. The spectropolarimetry of Fig. 3 shows the region about the two Raman bands (682.5 and 708 nm). U and Q zero values have been calculated respect to the continuum and fluxes have been binned to obtain 1 s error of 0.3%. The polarization of the bands is well evident.

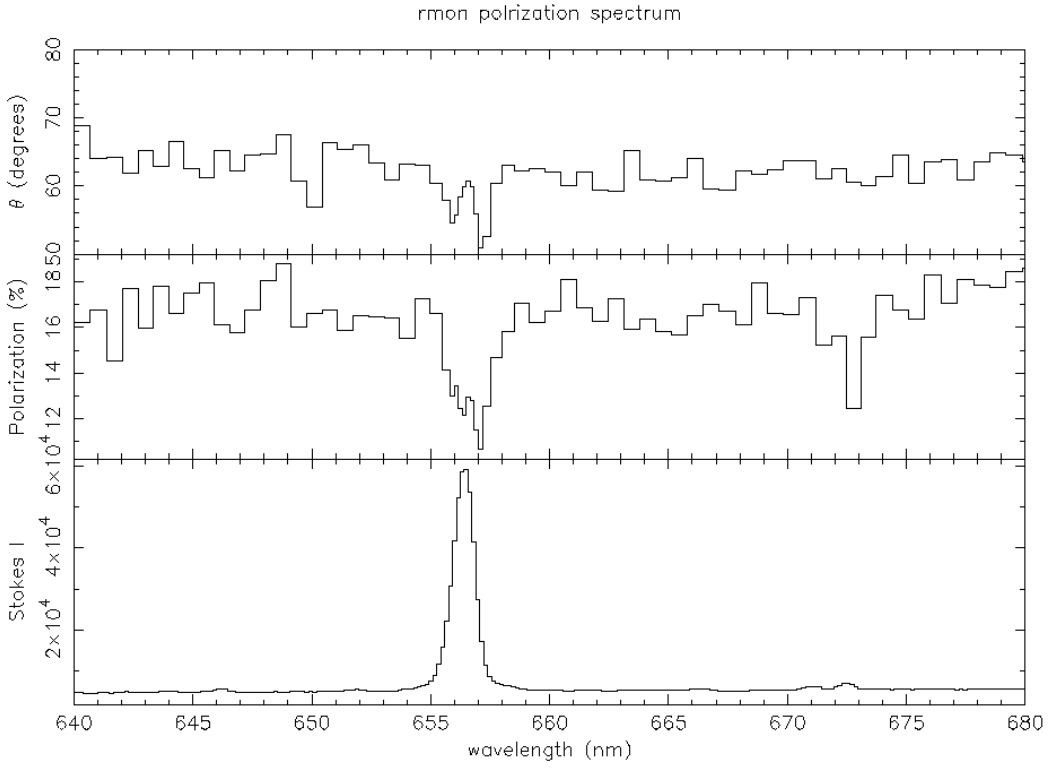


Fig. 4: Spectrum of R Monocerontis

The spectrum of R Monocerontis (Fig. 4) has been obtained using a slit width of 3 arcsec, the polarimeter and grism 8. An exposition 2400 seconds long has been taken. The spectropolarimetry of Fig. 4 shows the region around Ha . The spectrum has been binned to obtain 1 s error of 1% in polarization. A well evident depolarization and a rotation in the position angle are present across the line.

Conclusions

The new polarimeter for AFOSC has been tested both in polarimetric mode than in spectropolarimetric mode. An instrumental polarization about 0.7% has been measured. Extensive measurements have to be conducted to investigate if this polarization is constant. In spectropolarimetric mode well know objects have been observed. The spectra, which fit very well literature data, appear very promising.

References

Ref. 1: Oliva A&AS 1997, 123, 589

Ref. 2: Hsu & Breger, ApJ 262, 732, 1982