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Recent results from IBIS

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Abstract. IBIS (Interferometric BIdimensional Spectrometer) is a new instrument for solar bidimensional spectroscopy. It essentially consists of two Fabry-Perot interferometers, piezo-scanned and capacity servo-controlled, used in classic mount and in axial-mode, in series with a set of narrow-band interference filters.
This instrument will operate on a large field of view (80") and on a large wavelength range (580 - 860 nm), with high spectral, spatial and temporal resolution. IBIS, developed to become one of the focal plane instruments of THEMIS, has been completed in its essential form and some tests have been already performed. It is now possible therefore to compare expected with measured values of the more relevant instrumental parameters.

Key words. Solar physics – Solar instruments – Spectroscopic instrumentation

1. The instrumental function

A frequency and intensity stabilized He-Ne laser and a collimator, producing a highly collimated beam (30 mm in diameter), have been used to measure the reflective instrumental function of each interferometer. The cavity errors have been then measured on the area of the entrance pupil (39 mm in diameter) by using as a source a small diffuser (8.2 mm in diameter) illuminated by the same laser light. The real instrumental function of each interferometer has then been obtained as the convolution between the reflective profile and the distribution function of the cavity errors. The product between the so obtained two transparency functions finally represents the overall instrumental profile.
This result allows us to compare the expected and the measured values of resolving power and peak transparency at the laser wavelength. The resolving power of the measured instrumental profile ($\mathcal{R}$ = 260,400) is identical to the expected one, while a peak transparency of 17.3 ± 0.5 % is found vs. a 16.4 % expected value. Such a good agreement makes us confident also about these quantities as calculated at other wavelengths (Fig. 1 and Tab. 1).

2. The parasitic light

The parasitic light, defined as the ratio between the signal outside and inside the in-

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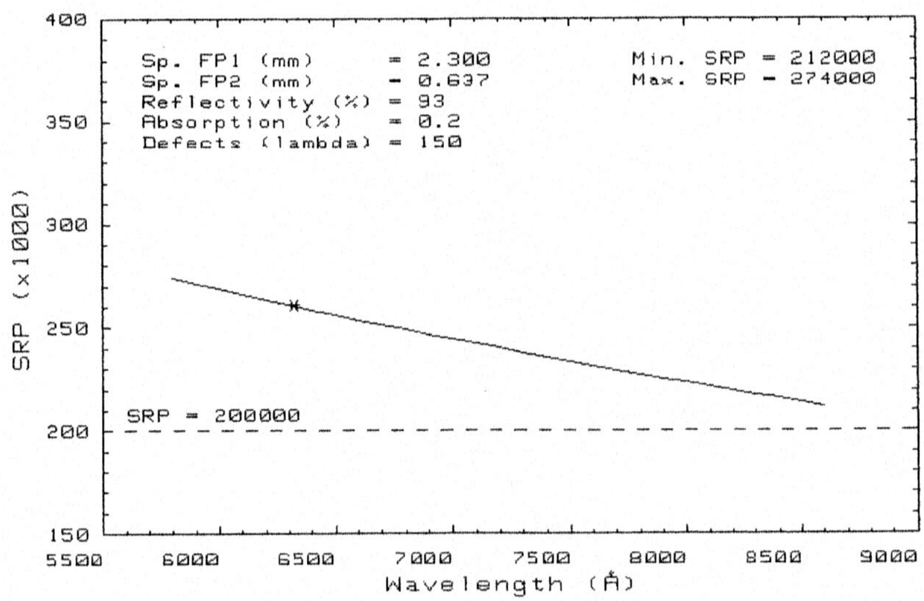

Fig. 1. IBIS Spectral Resolving Power ($\lambda/\Delta\lambda$) vs. wavelength. The asterisk represents the measured value

strumental profile, has been also measured. For this purpose, a lens, put in front of the instrument to simulate the relative aperture of THEMIS, has been used to form a small image of the full solar disk. A spectral scanning has been performed on a range of 2 Å around the 5896 Å Na D1 line and the monochromatic images have been integrated to obtain a spectrum which has been then normalized to the Kitt Peak Atlas (Neckel 1999). A parasitic light of 2.8 $\pm$ 0.5 % has then been found by comparing the measured central intensity of the line with that of the solar atlas. The so obtained value is very similar to the expected one (3.2 %), making us confident about the same quantity calculated at other wavelengths (Tab. 1).

3. The exposure time

The exposure time has been measured by using the same instrumental setup used for the measurement of the parasitic light.
From a mean of the observations performed in five different days, an exposure time of 15 $\pm$ 2 ms has been found vs. an expected value of 16 ms. This value is calculated for observations obtained in the solar continuum near the 5896 Å Na D1 line, for a total count of 10,000 photoelectrons (S/N = 100), a Sun height of 45° and a telescope transparency of 65 %. In practice, the calculation of this value is difficult, requiring an accurate evaluation of many instrumental characteristics. However, the good agreement found between the measured and the expected values for this quantity makes us confident also about the exposure times calculated at other wavelengths (Tab. 1). We want to remark that such short ex-

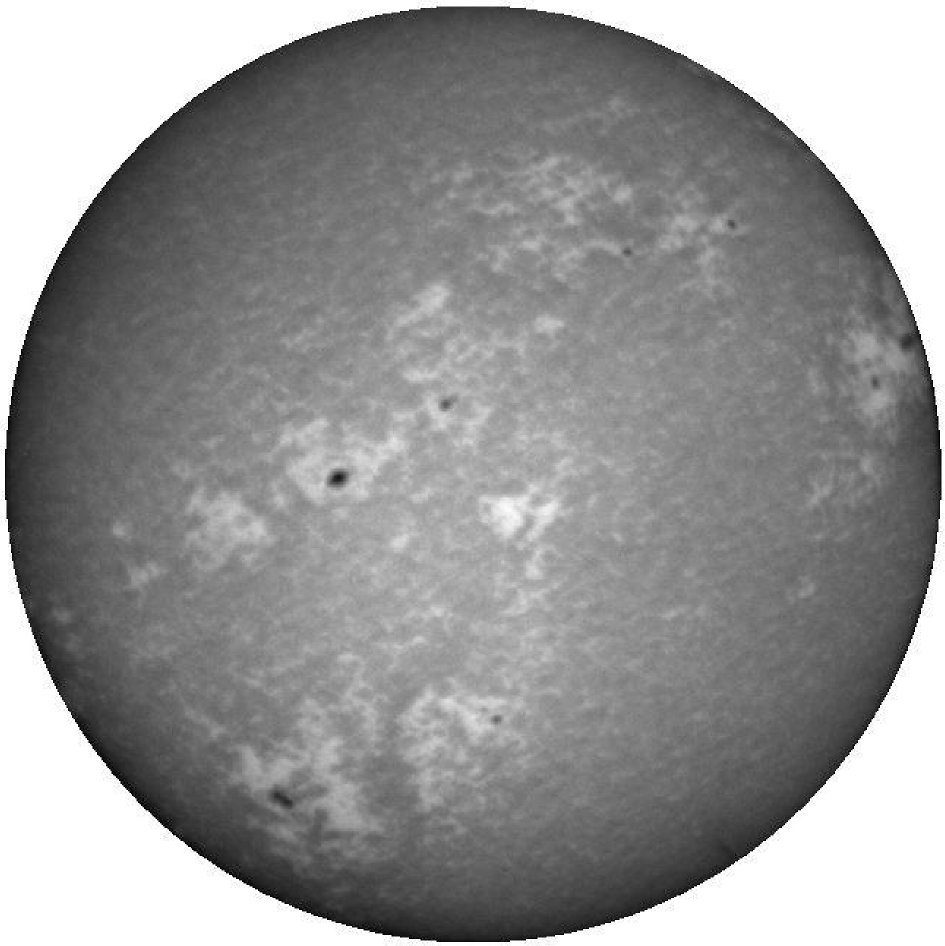

Fig. 2. Image of the full solar disk obtained with IBIS on the core of the 5896 Å Na D1 line in November 16, 2001

posure times allow the use of *post facto* techniques, as the *phase diversity*, to correct the seeing effects and to reach a spatial resolution near the maximum achievable by the telescope.

4. The images

Fig. 2 shows the full solar disk as observed with IBIS in November 16, 2001. This rough image (only the bias has been subtracted) has been obtained in the core of the 5896 Å Na D1 line by using the same instrumental setup used to measure the parasitic light and the exposure time. It may be seen that the image is "clean", in the sense that it is free from ghosts (due to interreflections), from spurious images (due to dust or defects of the optics) as well from fringing.

Table 1. IBIS instrumental characteristics

Wavelength range	**5800 Å – 8600 Å**
Available ranges	**5896 Å (Na D1), 6302 Å (Fe I), 7090 Å (Fe I), 7224 Å (Fe II), 8542 Å (Ca II)**
Spectral resolving power (λ/FWHM)	**212,000 – 274,000**
Parasitic light	**1.0 % – 3.5 %**
Wavelength drift of the instrumental profile	**$\leq$ 10 m s^{-1} on 10 h**
Field of view (circular)	**80 arcsec**
Peak transparency	**15 % – 20 %**
Exposure time (S/N $\geq$ 100; 2 pix/resolved element; $T_{Tel.}$ = 65 %)	**7 – 18 ms**
Acquisition rate (1024×1024 pix; 2 pix/resolved element; dynamic range: 12 bits)	**3 frames s^{-1}**

5. Conclusions

The more relevant instrumental characteristics of IBIS are reported in Tab. 1. Some of these have been measured and a good agreement has been found between the expected and the measured values.
In summer 2003 the instrument will be provisionally installed at the Dunn Solar Telescope of the Sacramento Peak Observatory for tests and scientific observations.

References

Neckel, H. 1999, Solar Phys. 184, 421