GENERAL PRESENTATION OF A SINGLE IRIS SITE RAW DATA ANALYSIS PROBLEM

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Abstract. A complete software package has been built for the calibration in m s$^{-1}$ of the velocity residuals due to solar oscillations in the raw IRIS (International Research on the Interior of the Sun) data. It takes into account all known astronomical components contributing to the line-of-sight velocity between the instrument and the solar surface, and also the apparent velocity due to the non-uniform integration of the solar rotation as seen through an inhomogeneous Earth atmosphere. The IRIS data itself is used for the estimation of the nonlinear instrumental response to the velocity, and the residual can be directly obtained in velocity units, without low frequency filtering. On a day of typical photometric sky quality, the power spectrum obtained appears to be solar noise limited.

1. Introduction

The IRIS instrument has now proved capable of providing high-quality full-disk Doppler measurements of the low-degree solar oscillations (Grec et al., 1991; Baijumanov et al., 1991). However, it is important to keep in mind that between good quality raw data and its scientific analysis, there is a long process of selection, characterization and calibration, and that the scientific results will depend strongly on the care taken in each individual step of this process.

As we know, the Doppler shift is measured by means of differential monochromatic intensity photometry made on the blue and red wings of the sodium D1 line (Figure 1). Given the very small amplitudes of the solar oscillation modes (a fraction of 1 m s$^{-1}$) compared to the D1 linewidth (about 15 km s$^{-1}$), it seems that the signal can be regarded as a linear function of velocity, and can be approximated by

$$ S = zV, $$

(1)

with

$$ S = (I_1 - I_2)/(I_1 + I_2), $$

(2)

where $z$ is defined by the slope of the line wings and the instrument sensitivity. However, though the oscillation amplitudes are indeed very small, the instrument, in fact, measures the total line-of-sight velocity between the solar surface and its entrance window. Because of the constant gravitational red shift, of the elliptical orbital motion of the Earth and of its spin motion, this total velocity can be as large as 1.5 km s$^{-1}$ and can

drift between morning and evening by an amount of about 0.7 km s\(^{-1}\) (depending on the site latitude), which cannot be regarded as completely negligible in units of linewidth. The measurement can thus not be regarded as linear, and Equation (1) must be replaced by

\[ S = f(V), \]

where \( V \) must be calculated by taking into account all components of line-of-sight velocity in the Sun's direction, and \( f(V) \) must be defined by the line profile shown in Figure 1, with an accuracy much better than any achievable with standard spectroscopy.

In addition the two measured intensities \( I_1 \) and \( I_2 \) include a fraction of non-resonant scattered light, acting as an optical offset following to first order the sky transparency, and also include some electronic offset, constant with time at first order. These values must be accounted for in the calibration procedure at the same high level of precision. They are slightly different for each instrument, so that the calibration procedure must include some adjustable parameters.

Finally, the sky quality or a temporary technical problem can damage the quality of the data during short or more or less extended periods. It is necessary to define criteria of quality and to make a selection of the data that will be subject to calibration and later to scientific analysis. Here again, the quality of the scientific results may depend