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IMPROVING ALGORITHM FOR AUTOMATIC SPECTRA PROCESSING

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Abstract. Testing and improving of the computer program for automatic processing (flat-fielding) of a great number of solar spectra obtained with the horizontal heliospectrograph HSFA2 has been done. This program was developed in the Astronomical Institute of Academy of Sciences of the Czech Republic in Ondřejov. An irregularity in its work has been discovered, i.e. the program didn't work for some of the spectra. To discover a cause of this error an algorithm has been developed, and a program for examination of the parallelism of reference hairs crossing the spectral slit on records of solar spectra has been made. The standard methods for data processing have been applied-calculating and analyzing higher-order moments of distribution of radiation intensity. The spectra with the disturbed parallelism of the reference hairs have been eliminated from further processing. In order to improve this algorithm of smoothing of spectra, isolation and removal of the harmonic made by a sunspot with multiple elementary transformations of ordinates (Labrouste's transformations) are planned. This project was accomplished at the first summer astronomy practice of students of the Faculty of Mathematics, University of Belgrade, Serbia in 2007 in Ondřejov.

1. INTRODUCTION

The Faculty of Mathematics of the University of Belgrade, and Astronomical Institute in Ondřejov organized the first practice for the students of astronomy which took place in Ondřejov in summer 2007. As its participants we worked at the Department of Solar Physics with Dr. Pavel Kotrč on improving the computer program for automatic spectra processing. Spectra were obtained with the horizontal heliospectrograph HSFA2 (Horizontal Sonnen Forschungs Anlage) which was originally installed in 1980 as horizontal telescope (Carl Zeiss Jena) with Czerny-Turner solar spectrograph. After more than two decades of exploration it has been recently modernized. The reconstruction of the optical parts of the spectrograph of the HSFA2, which is now overbuilt into a multichannel spectrograph operating simultaneously in several diagnostically important spectral lines, has been done (Klvaňa et al. 2001).

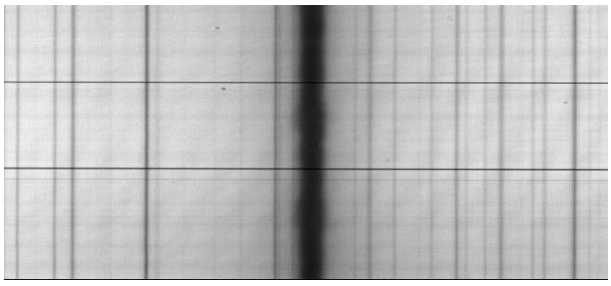

Figure 1: Solar spectrum near the Hα (6562.8 Å) line recorded on July 16, 2007 selected for testing. Vertical axis is the position along slit, horizontal axis is the spectral dispersion (wavelength).

2. DATA PROCESSING

By testing the computer program REDAT.PRO for automatic flat-fielding of a great number of solar spectra an irregularity in its work was found. A necessary condition for using the program REDAT.PRO is parallelism of the reference hairs. We discovered that some of the spectra had unexpected movements of reference hairs. An algorithm for examination of the parallelism of these reference hairs crossing the spectral slit on records of solar spectra was developed. Reference hairs are used for establishing a geometrical scale in the spectra. They are shown as horizontal dark lines in Fig. 1.

First we made a matrix of spectrum and calculated sum of radiation intensity of each row. According to the graphic of this sum (on x-axis are pixels along the slit and on y-axis is sum of radiation intensity in each particular column) the positions of reference hairs were found (Fig. 2).

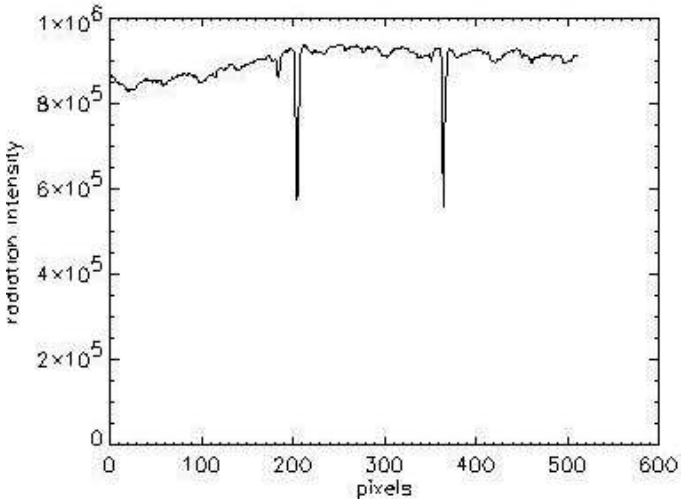

Figure 2: Two narrow depressions represent the reference hairs.

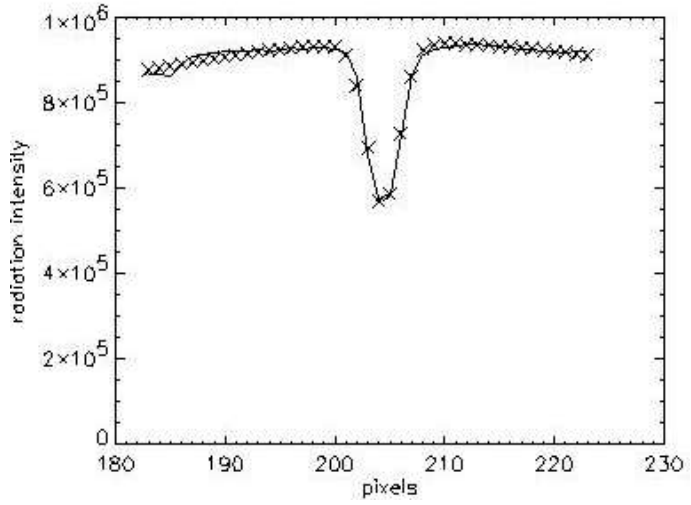

Figure 3: Gaussian for one reference hair. Crosses represent measurements and the line represents fit with Gauss function.

Width of reference hairs is estimated to 20 pixels. Real positions of reference hairs were found as the minimum of the sum of rows in the segment of estimated depressions' width. Fitting with Gauss function (e.g. Đurović 1972) (Fig. 3)

$$G(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-a)^2}{2\sigma^2}} \tag{1}$$

we found statistical dispersion of each hair and calculated real hairs' width using formula

$$\text{width} = 2 * \text{round}(\sigma) + 1.$$

In order to check if hairs were shifted, we calculated positions of hairs in each column using the same method as we mentioned above. This time the sum of radiation intensity of each column was calculated for half picture (division by vertical line) for each hair. The result gives the left and the right marginal positions of the hairs. If the difference between these marginal values is greater than the hair width, the reference hair is shifted and we eliminate this picture from further processing.

Program is semiautomatic because choosing of reference hairs should be done by hand. In order to improve this algorithm of smoothing of spectra, isolation and removal of the harmonic made by a sunspot with multiple elementary transformations of ordinates (Labrouste's transformations, Labrouste and Labrouste 1943) are planed.

3. CONCLUSIONS

By testing the flat-fielding program REDAT.PRO, an irregularity in some pictures was found. We discovered that the irregularities came out of unexpected movements of reference hairs and we developed an algorithm, POLUAUTOMATSKI.PRO, for examination of the parallelism of reference hairs crossing the spectral slit on solar

spectra records. Pictures with irregularities are detected and excluded from further processing. It has been also discovered that reference hair irregularity came out of optical system HSFA2 malfunction. The cause is unknown and expected to be discovered and solved in the future.

Acknowledgements

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