

Oscillations of magnetic field in a sunspot umbra

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Abstract. Oscillations of the magnetic field in sunspot umbra have been detected by Pulkovo CCD spectroheliograph-magnetograph. The manifestations of 3- min oscillations in the power spectra of magnetic field variations are not very strong and can be seen only in a number of larger sunspots. Their power is concentrated in isolated small regions of the boundary between umbra and penumbra of large spots. The waves are produced in short bursts with coherence times of about 10 min. In the sunspot umbra, 30-40 min modes have been also confidently revealed.

Difficulties in measuring the magnetic field oscillations in the sunspot umbra are connected with a low amplitude of these variations and a distorting influence of atmospheric blurring [1, 2]. Besides of that, according to SOHO data [3] these oscillations occur in small segments of a spot. In order to investigate the processes of magnetic field oscillations in the sunspots, we carried out a series of observations with duration of 40-360 minutes. Observations were performed in 1998-2003 with a horizontal solar telescope ACU-5 at Pulkovo, equipped with a CCD spectroheliograph-magnetograph. A quarter-wave plate and a Wollaston prism were used for measurements of polarized light. As a result, we have obtained two-dimensional digital maps, which show the temporal change of velocity and magnetic field distribution along the slit of spectrograph. The slit was adjusted at the center of a sunspot umbra and was held within an accuracy of 2". We have worked out a number of methods for revealing the oscillations of magnetic field, first of all - a method of reduction for atmospheric and instrumental distortions [2]. Both Fourier and wavelet transforms have been applied independently to the analysis of plume oscillations in order to find the most reliable periods. The wavelet analysis allows us to derive the duration as well as the periods of the oscillations. The manifestations of 3- min oscillations in the power spectra of magnetic field variations are not very strong and can be seen only in a number of sunspots. Their power is concentrated in isolated small regions of the boundary between umbra and penumbra of large spots. The waves are produced in short bursts with coherence times of about 10 min. In the sunspot umbra, 30-40 min modes have been also revealed. Fig.1 presents a consecutive scheme of data reduction, similar to Laiton's method. Observation of a sunspot during 180 minutes on 6.07.2001 is given as an example. Time scanning a linear segment of the solar image (sunspot) along entrance slit (in top left panel) and adjusted negative image (in top middle panel). In centre panel - photometric profile and power spectrum image vibration along entrance slit and oscillation of intensity in spot centre. (in top right panel) - time scanning (180 min) of magnetic field signal in FeI 5250A. The results of complex Morlet wavelet analysis are shown in Fig.2 in a form of individual scans. One can see the 3-min and 35-min mode.

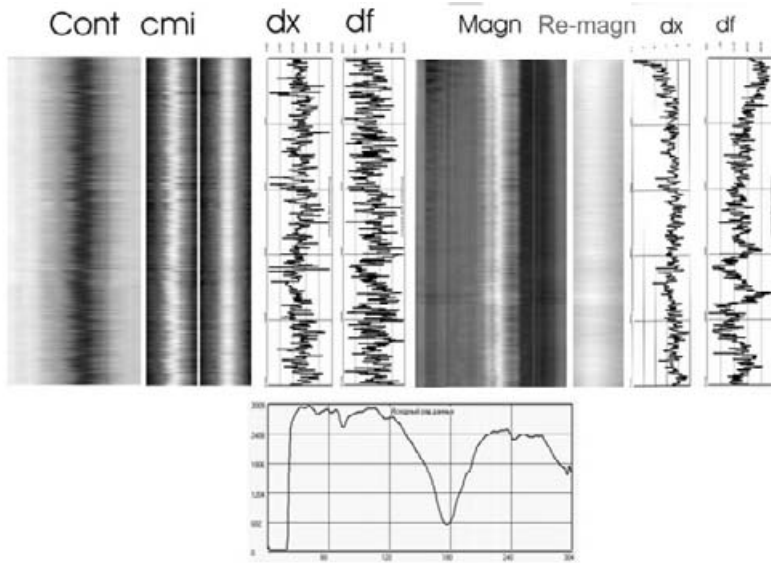


Figure 1.

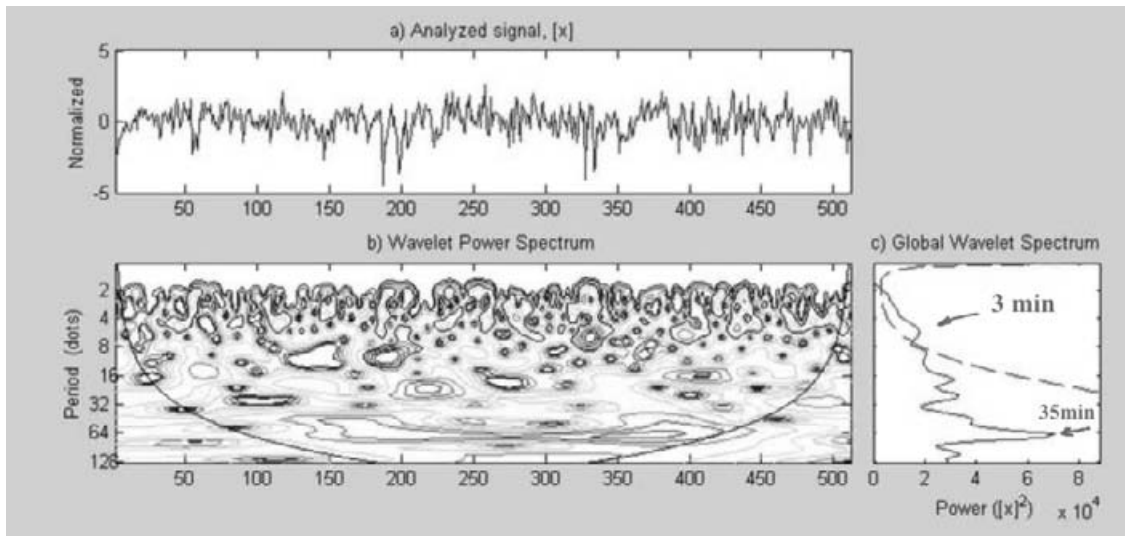


Figure 2.

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