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SUMER/SOHO Observations of Long Period Oscillations in an Active Region Filament

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Abstract. During the MEDOC campaign #4 (October 1999), we observed an active region filament with the SUMER/SoHO spectrometer using the 584.33 Å HeI line. After a description of the HeI line profile in the filament, we present a Fourier analysis of SUMER long time observations. This analysis allows to detect oscillations in several ranges of periodicities : 6–20 min, 40–90 min. We discuss these periodicities in terms of Alfvén and magnetoacoustic waves obtained with a filament model developed by Joarder & Roberts (1993).

1. Introduction

The existence of oscillations in solar prominences are known since several years (Oliver, 1999). Three categories of periods can be defined (Molowny-Horas et al., 1997) : short (< 5 min), intermediate (6–20 min), long (40–90 min) periods. Using SUMER/SoHO observations detailed in Sect. 2, the Fourier analysis of the velocity time series allows to find period oscillations in an active region filament (Sect. 3). Conclusions are drawn in Sect. 4.

2. SUMER observations

The SUMER/SoHO (Wilhelm et al., 1995) observations was obtained from October 13 at 22:20 UT to October 14 at 05:50 UT (i.e., a total duration of 7 h 30 min). We observed the 584.33 Å HeI line with the $0.3'' \times 120''$ slit, with compensation of the solar rotation, an exposure time of 30 s and a spectral resolution of 20 mÅ.

From the intensity time series, we derive the relative Doppler velocity defined by $\frac{v}{c} = \frac{\Delta\lambda}{\lambda_0}$ where the wavelength λ_0 is the wavelength at the maximum intensity deduced from the temporal and spatial averaged profile of the intensity time series. With this definition, negative (positive) velocity corresponds to upwards (downwards) flows. In order to obtain the effective velocity (see Fig. 1 left), the spatial and temporal averaged velocity is substracted from the raw velocity time series. To determine the position of the filament on the velocity time series, we plot the temporal averaged velocity (see Fig. 1 right): the filament is defined between the two vertical lines where the mean velocity is -3 km.s^{-1}. For the sake of reference, a quiet area is defined between the two vertical dashed lines which will provide the oscillation frequencies in the medium out of the filament.

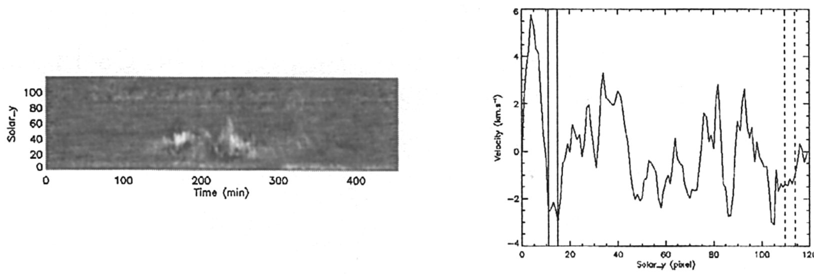

Figure 1. Left: velocity time series derived from SUMER time series observations. The total duration is about 7 h 30 min. Right: temporal average of the velocity time series. The position of the filament (resp. quiet region) is given by the two vertical solid lines (resp. dashed lines).

In Fig. 2 left, the 584.33 Å line profile in the filament is compared to the line profile of the filament environment. In particular, we measure the Gaussian width σ given by $\sigma^2 = \sigma^2_{instr} + \sigma^2_{solar}$ (see Chae et al., 1998). We estimate the ratio of the width of the filament profile and of the width of the filament environment profile: $\frac{\sigma_{fil}}{\sigma_{quiet}} \sim 0.95$. Therefore, the 584.33 Å HeI line profile is narrower in the filament than in its environment.

3. Observed periods in the filament with SUMER

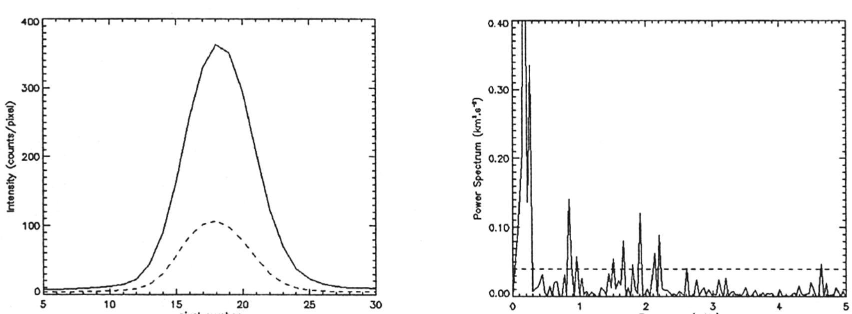

Figure 2. Left: 584.33 Å HeI line profile in the filament (dashed line) and out of the filament (solid line). Right: Power spectrum of the difference between the Fourier transform in the filament and the Fourier transform in the quiet region. The noise level estimated at 0.14 km.s^{-1} is indicated by the horizontal dashed line.

To find the observed periods in the filament, we calculate the power spectrum of the difference between the Fourier transform in the filament and the Fourier transform in the quiet region (see Fig. 2 right). The pics above the noise level are characteristics of the oscillations of the filament. The observed periods

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are summarized in Table 1. We observe periods in the 3 ranges of periods defined by Molowny–Horas (1997), especially periods larger than 40 min.

	frequency (mHz)	period	
long period	0.186	89 min 36 s	ω_1
	0.258	65 min 36 s	ω_2
intermediate period	0.846	19 min 42 s	ω_3
	0.954	17 min 28 s	ω_4
	1.51	11 min 02 s	ω_5
	1.65	10 min 06 s	ω_6
	1.8	9 min 15 s	ω_7
	1.91	8 min 43 s	ω_8
	2.13	7 min 49 s	ω_9
	2.204	7 min 34 s	ω_{10}
	2.606	6 min 24 s	ω_{11}
short period	4.627	3 min 36 s	ω_{12}

Table 1. Frequencies and periods observed in the filament above the noise level. Three ranges of periodicities can be defined: short (< 5 min), intermediate (6–20 min), long (40–90 min).

4. Conclusions

Following the filament model developed by Joarder & Roberts (1993), we interpret the observed periods of oscillations as primary periods of Alfvén or magnetoacoustic modes. For a given width of the filament ($\sim 4\,000$ km) and a given length between the footpoints of the magnetic field lines supporting the filament ($\sim 63\,000$ km), we associate an observed period to each Alfvén and magnetoacoustic mode: ω_1 for the slow sausage mode, ω_2 for the even Alfvén mode, ω_3 for the fast kink mode, ω_5 for the odd Alfvén mode and ω_{12} for the fast sausage mode (the slow kink mode is not detected).

New MEDOC campaign (May 2000) coordinated with THEMIS (Tenerife) observatory should allow to examine the problem more closely.

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