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# PHOTOSPHERIC FLOWS AROUND A QUIESCENT FILAMENT AT LARGE AND SMALL SCALE AND THEIR FFECTS ON FILAMENT DESTABILIZATION

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**Abstract.** We study the influence of large and small scales photospheric motions on the destabilization of an eruptive filament, observed on October 6, 7, and 8, 2004 as part of an international observing campaign (JOP 178). Large-scale horizontal flows are invetigated from a series of MDI/SOHO full-disc Dopplergrams and magnetograms from THEMIS. Small-scale horizontal flows were derived using local correlation tracking on TRACE satellite, Dutch Open Telescope (DOT) and The Dunn Solar telescope (DST) data. The topology of the flow field changed significantly during the filament eruptive phase, suggesting a possible coupling between the surface flow field and the coronal magnetic field. We measured an increase of the shear below the point where the eruption starts and a decrease in shear after the eruption. We conclude that there is probably a link between changes in surface flow and the disappearance of the eruptive filament.

## 1 Introduction

Filaments (prominences seen on the limb) which are common solar features always occur along lines where the underlying photospheric magnetic field changes sign. They represent regions where magnetic fields are interacting with the plasma in a subtle way in the different parts of the solar atmosphere. The filament's existence in the corona is mainly due to magnetic fields that support dense material against gravity inside dipped arcade loops or flux tubes (Kuperus & Raadu 1974). The filaments are structures of the solar corona which are anchored at footpoints in the solar photosphere. Knowledge of photospheric motions over long periods is needed to understand the action of the plasma on the filament. In particular, barbs, footpoints of prominences when observed on the disk, are always associated with parasitic polarities implying a reversal of the transverse horizontal magnetic field. The mechanism generating such magnetic configurations must take into account photospheric motions. Most observational studies of filaments have been carried out to describe their properties and structures in the corona and chromosphere. However, the magnetic field contributing to the formation of the filaments can transfer photospheric perturbations into the corona. Very few papers exist on the determination of photospheric motions beneath and in the vicinity of filaments. Such measurements require multi wavelength observations In this paper we investigate a filament observed over a large field of view with high spatial resolution.

## 2 High spatial and temporal horizontal flows

Our data come from a combination of ground and space based telescopes on October 6, 7 and 8, 2004 during a JOP 178 campaign (http://bass2000.bagn.obs-mip.fr/jop178/index.html).

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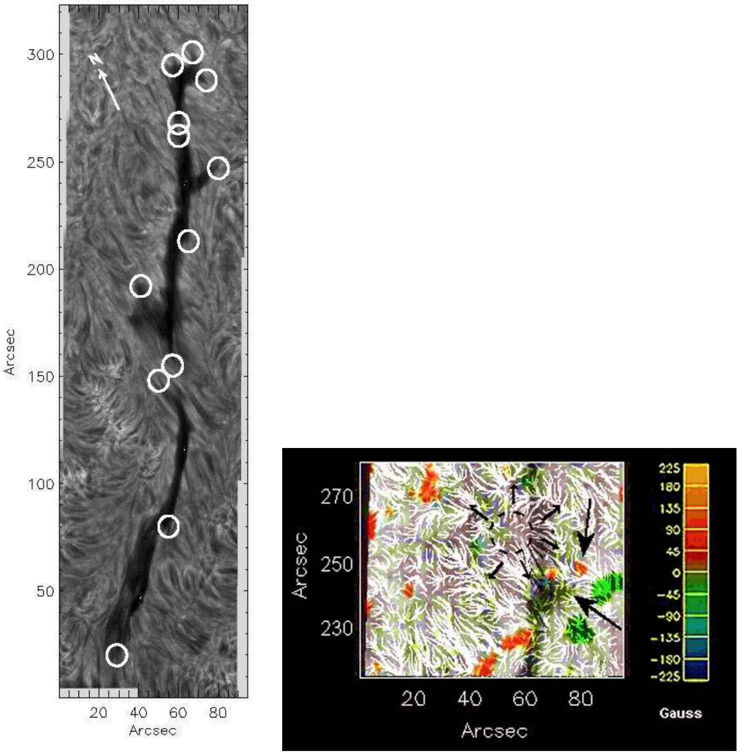

**Fig. 1.** (left) A mosaic of the filament in $H\alpha$ observed with the DOT, made from 6 frames selected at about 8:50 UT on October 6, 2004. The circles indicate the footpoint locations of the filament. The arrow indicates solar north. (right) Detail of a parasitic polarity. The longitudinal magnetic field lies between ±447 Gauss. The thick arrows show two parasitic polarities and the dotted circle indicates roughly the center of the divergence (while thin arrows indicate the direction) of the horizontal flow on the scale of a supergranule.

Fig. 1 (left) shows a mosaic at 8:50 UT of the $H\alpha$ filament structure that was observed in the southern solar hemisphere (S16E11) on October 6, 2004 during the decaying phase of the solar cycle. This filament has a sinistral chirality which is a normal configuration in that hemisphere. The smallest chromospheric features on the image show that the angular resolution is around 0.5 arcsec over the field of view of 95arcsec×323 arcsec. The 5 arcsec radius circles indicate the region of apparent footpoints.Fig. 1(right) shows some of the details between these parasitic polarities and the flow. The dotted circle indicates a center of divergence on the scale of a supergranule, while the small arrows show the direction of the flow field. The large arrows on the right of the figure point towards the parasitic polarity (in red) and the dominant polarity (of the weak background field) in green. The cork trajectories cross beneath the filament indicating that the flow transports corks (and thus flux tubes) across the filament channel and could in this manner create parasitic polarities. Convection could push opposite polarity fields, by the outward dispersal of magnetic flux, through the PILs. Thus supergranule cells could induce a significant flow into the polarity inversion zone thereby transferring field of opposite polarity from one side of the PIL to the other one.

In the south part of the filament Fig. 2(right), we observed the transport of parasitic and normal polarities by a continuous diverging horizontal flow, lasting at least one day, located in the filament gap where the filament starts to disappear. Such a purely horizontal motion could lead to the destabilization of the filament and to the sudden filament disappearance (Lin et al 2001). The second is the mixing of opposite polarities induced by the horizontal flows which in turn implies a reorganization of the magnetic field at the origin of the filament eruption.

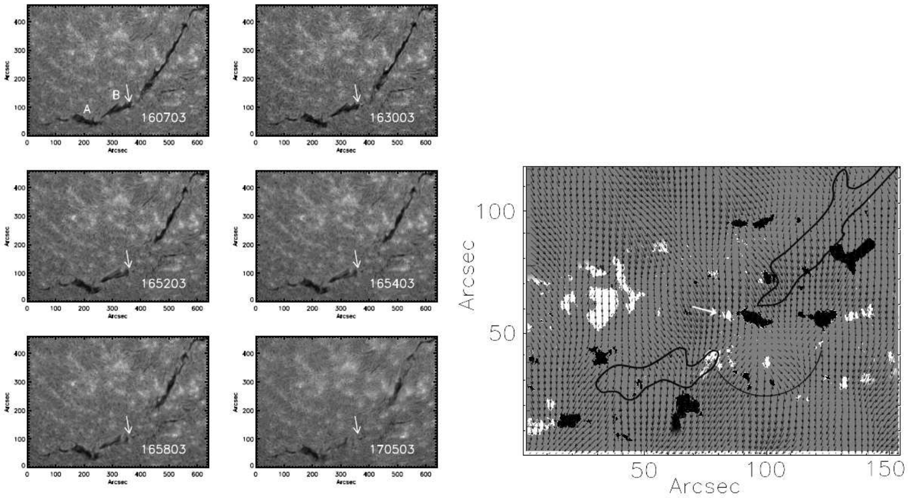

**Fig. 2.** Evolution of the filament during its eruption around 16:30 UT on October 7, 2004. The arrow indicates a fixed position for all the subframes. A and B denote two parts of the filament. Magnetic field measured by THEMIS on October 7, 2004 between 14:30- 15:17 UT, with the SE extremity of the contour of the filament, and with horizontal photospheric flows, measured with TRACE data, superimposed. The arrow indicates a magnetic feature which is observed to move and interfer with the close opposite polarity (on its right) in the MDI magnetograms. The highest absolute values beeing saturated on this map. North is located at the top of the figure.

## 3 Large-scale horizontal flows

In order to map the horizontal component of the large-scale photospheric plasma velocity fields, we applied local correlation tracking (LCT; November 1986) to a set of full-disc Dopplergrams obtained by the MDI instrument onboard SoHO. The aim of this method is to track the proper motion of supergranules that are clearly detectable on Dopplergrams everywhere except for the disk centre

The filament's evolution can be seen in Fig. 2 (left). The North–South stream flow visible in Fig. 3 (left, top) crosses over the part of the filament labeled A. The arrow on Fig. 2 (left) indicates the same fixed point (325 arcsec, 167 arcsec) in all of the subframes. We observe a general southward motion of both the A and B segments of the filament. More precisely, we measure a tilt of these two filament segments at the point of their separation. Between 16:07 UT and 16:58 UT the longaxis of segment A rotates by an angle of 12 degrees (clockwise) relatively to its western end, and the long axis of segment B of the filament rotates by an angle of 5.5 degrees (clockwise) relatively to its western end. These rotations are compatible with the surface flow shown in Fig. 3 (top, left) and in particular the North–South stream flow visible.

Before the eruption Fig. 3 (top left),we can clearly see the North–South stream parallel to and about 10 degrees East of the filament. This stream disturbs differential rotation and brings plasma and magnetic structures to the South. Although differential rotation tends to spread the magnetic lines to the East, the observed North–South stream tends to shear the magnetic lines. After the eruption, only a northern segment of the filament is visible and the North–South stream has disappeared. The evolution in the shear velocity computed as the difference between the mean flow in the two boxes as a function of time is shown in Fig. 3 (bottom). One can see that the shear velocity is increasing before the eruption and decreasing after the eruption.

## 4 Conclusions

We have presented multi−wavelength observation of the evolution and eruption of a filament obtained during the JOP 178 campaign on October 6 through 8, 2004. We analyzed the photospheric motions below and in the immediate neighborhood of the filament to search for systematic flows that could both sustain the filament and lead to its eruption. Our observations show that the supergranules can play a role in the transport of parasitic polarities through the filament channel and thus contribute to the formation of barbs (filament footpoints)

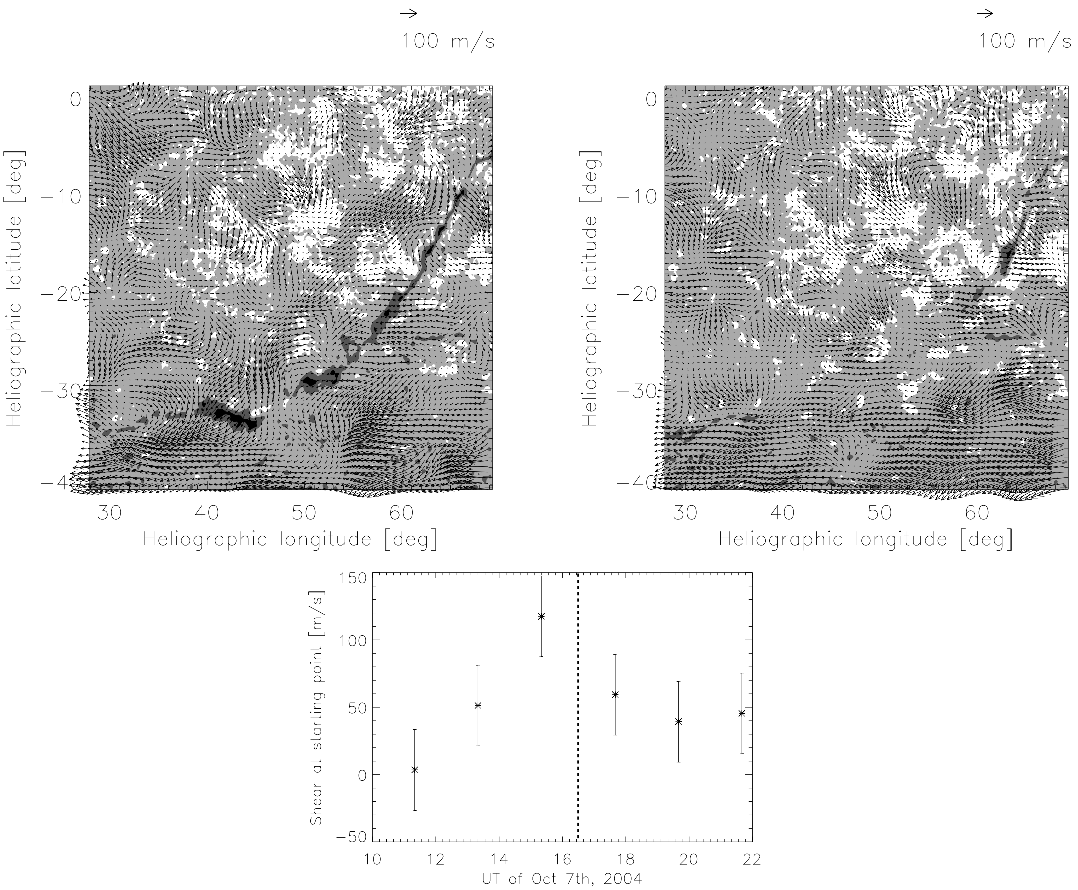

**Fig. 3.** Horizontal motions measured by *LCT-Doppler* before (top left) and after (top right) the eruption over a wide field of view. The filament observed by ISOON on October 7 2004 at 13:30 UT is superimposed. The evolution of the velocity shear in zonal components in time (bottom). The eruption of filament took place at 16:30 UT.

The filament eruption started at about 16:30 UT at the latitude around $-25$ degrees where the measurements of the horizontal flows based on Dopplergram tracking show a modification of the slope in the differential rotation of the plasma. This behavior is not observed in the curves obtained by both tracking the longitudinal magnetic field. This result seems to be a consequence of the presence of a North–South stream along the filament position, which is easily measured by tracing Doppler structures, which is only slightly visible in maps obtained by tracking of magnetic elements. The observed North–South stream has an amplitude of 30–40 $\mathrm{m\,s^{-1}}$. In the sequence of H$\alpha$ image that record the filament's evolution, the part of the filament, which is in the North–South stream, is rotated in a direction compatible with the flow direction of the stream. This behavior suggests that the foot-points of the filament are carried by the surface flows. The influence of the stream is strengthened by differential rotation. We should keep in mind that the filament extends from $-5$ to $-30$ degrees in latitude and that the northern part of the filament is subjected to a larger rotation than the southern part. The North–South stream, along with contribution from differential rotation causes the stretching of the coronal magnetic field in the filament and therefore contributes to destabilizing the filament. The topology of the North–South stream changed after the filament eruption, nearly vanishing.

## References

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