The Magnetic and Velocity Fields of Solar Active Regions
ASP Conference Series, Vol. 46, 1993
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VELOCITY FIELDS IN THE FILAMENT REGIONS: STRUCTURE AND EVOLUTION

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ABSTRACT The velocity structure in the photosphere under the Hα-filaments is analyzed. The results bring to suggestion that the velocity structure are connected with the stability and the type of the filament.

INTRODUCTION

Velocity distribution in the vicinity of Ha-filaments may give a clue to some problems of their formation, such as the filament stability, the mechanism of energy storage, etc. During the recent years, a number of publications have appeared that deal with velocity fields in the vicinity of filaments and their relation to the magnetic field (e.g., see the review by Schmieder 1988) analyze velocity fields in the chromosphere and higher. There are few papers dealing with the relation between photospheric motions and filaments (Martres et al. 1981 B.Ioshpa et al. 1986, 1991; B.Ioshpa and E.Kulikova 1988,1989). The obtained results are not altogether similar. For example, B.Ioshpa et al. (1986) showed that the distribution of radial velocities in the vicinity of a quiescent filament was such that the zero line of radial velocity (Vo-line) cut the filament almost perpendicularly into several parts, so that the regions of ascending and descending matter were stretched across the filament. This result agrees fairly well with that of Martres et al. (1981). However it somewhat differs from the results obtained later for other filaments. We have arrived at the conclusion (B.Ioshpa et al. 1991) that stable parts of filaments are situated at the boundary between the regions of ascending and descending matter. The Vo-line and the neutral magnetic line are closely spaced. But if the stability of filaments is disturbed, then the velocity channels that were earlier stretched along the filament axis, intersect almost perpendicularly the channel of the decayed filament.

All said above makes us suggest that the velocity field structure is somehow related to the filament stability and stage of its evolution. This probably accounts for discrepancies between the results obtained by different authors.

In this work, a further attempt is made to reveal such a relation.

OBSERVATIONS

Observations of the two filaments were performed at the IZMIRAN Tower Telescope using simultaneously the longitudinal magnetograph (FeI λ 5253 A) and the tachometer based on the Fabri-Perot interferometer (Fe I λ 5576 A, Lande factor g=0) The magnetograph sensitivity was ~ 5 G in field and ~ 40 m/s in radial velocity. The sensitivity of the tachometer was ~10 m/s. The spatial resolution was 3 × 5". When processing the velocity data, we made allowance for longitudinal drift during the scanning, as well as for 5-min oscillations.

The first filament in the Boulder AR 6703 crossed the central meridian on July 6-7. The shape of the filament resembled an arc with a relatively stable northern and a highly unstable southern part. For aim of clarity we show on Fig. 1 (a,b) only the relative positions of the zero line of radial velocity (Vo-line) in line λ 5576 A and the filament (from Hα pictures) for 5 and 6 July. On 5 July the northern relatively stable part of the filament borders the region of ascending matter at the north as if outlining the averaged boundary between the ascending and descending flows. However the boundary is somewhat disturbed in A region near the end of filament loop. This displacement of Vo-line corresponds to a similar shift of the magnetic neutral line. The unstable southern part of the filament lies far from the neutral line in the region of descending matter. On the next day (July 6) the general character of disposition between the Vo-line and the filament remains unchanged: the most part of the northern stable branch of the filament lies near the boundary between the ascending and descending flows; the southern part where many variations were observed which were apparently connected with the development of sunspot activity in this part of the active region lies as before in the descending region far from the Vo-line. We do not discuss here the variations in the velocity structure which were observed after the flare July 7. We note only that on July 8 the structure of the region of ascending matter became very fragmentary. Though the northern branch of the filament remained to lie close to the highly discontinuous Vo-line, the relation between this line and the filament became not very obvious.

Fig. 1c illustrates the relative positions of Vo-line and another filament which lay in the old flocculi region and was quiescent and rather spongy. It intersected the central meridian on July 25. Magnetic field around this filament was weak and fragmentary. The neutral magnetic line was not clearly

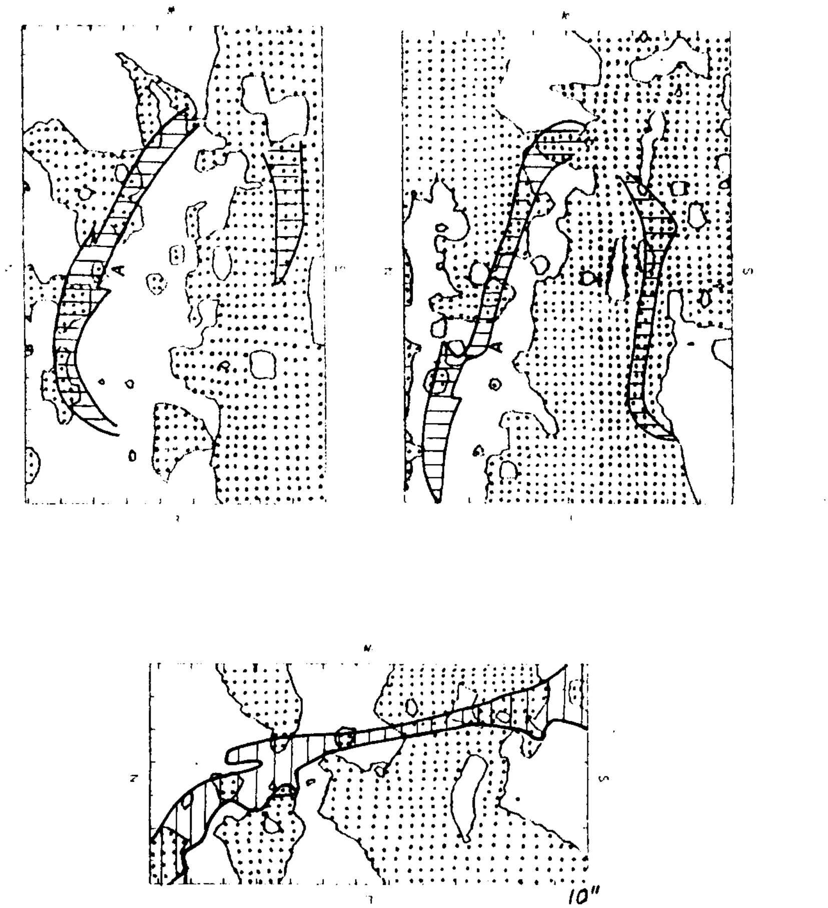

Fig 1. The relative position of the zero line of radial velocity (thin solid line) and Hα - filaments (hatched): a,b - the active region filament with the stable northern part observed 5 (~25°N, 15°E) and 6 July 1991 correspondingly; c - the quiescent old filament in the weak magnetic field region observed 28 July 1991 (~ 20°N, 15°E) 1991. The regions of descending matter are noted by points.

https://doi.org/10.1017/S0252921100028773 Published online by Cambridge University Press

pronounced and did not always coincide with the filament. The velocity structure is obviously different from the considered above in the first filament. The regions of ascending and descending matter intersect the filament rather than being parallel with it. The Vo-line is generally placed not along but across the filament. A similar character of the structure was also observed on the following day.

DISCUSSION

We believe that observations described above corroborate the relation between the photospheric velocity structure and the filament. The velocity field structure seems different for different types of filament. For stable filaments in the active region, the velocity field tends to stretch along the filament; the zero velocity line that separates the regions of ascending and descending matter is almost parallel with the filament coinciding or nearly coinciding with it. For quickly changing filaments, no such relation was definitively established. For another type of filament, i.e. a quiescent spongy filament lying in the weak magnetic field region, the velocity field structure is different. The regions of ascending and descending matter intersect the filament. The Vo-line is nearly perpendicular to the filament.

Of course we outline here only tendency; the real configurations may be very complex. Moreover in some cases it is hard to say what kind of filament we observe. It is necessary to follow in more detail and with best spatial and time resolution the connection between the velocity structure and the magnetic field configuration and intensity.

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