# SMALL SCALE MOTIONS OVER CONCENTRATED MAGNETIC FIELD REGIONS OF THE QUIET SUN

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ABSTRACT. Using a time sequence of filtergrams in the magnetically sensitive $\lambda6103A$ CaI line (with circular polarization measurements), obtained with the SPO Vacuum Tower Telescope and the universal filter we mapped the line of sight velocity and the longitudinal magnetic field in three quiet solar regions. After elimination of the effect of the 5-minute photospheric oscillations we found in two regions of concentrated magnetic field no association with the line of sight velocity, while the third region was associated with small (<300 m/s) downflows.

## 1. INTRODUCTION

The magnetic flux tube is a key to a unified understanding of many solar phenomena (network, spicules, sunspots etc.). Since Howard and Stenflo (1972) inferred the existence of magnetic fluxtubes with strength of the order of KG and characteristic size of 100-300 km (Frazier and Stenflo, 1972, Stenflo, 1973) a lot of work has been carried out by many observers and theoreticians for their study. Flux tubes are believed to be associated to small (0".25) network elements, the filigree, inbedded in the intergranular lanes, although there are observations which show that the magnetic flux is confined in a larger area, of 1-3" (Koutchmy and Stellmacher,1978,Dara and Koutchmy, 1983). The question of compression and maintainance of the magnetic field to kG strengths is still unresolved since the magnetic pressure inside the tube is comparable to the gas pressure in the surroundings. The widely held view is that convective motions sweep the diffuse magnetic field to the supergranule boundaries, forming flux tubes of moderate strength. According to Parker (1978),the field is further compressed as a result of adiabatic cooling of the tube. Therefore, mass motion, in particular downdrafts, associated with magnetic structures, are believed to play an important role in the physics of flux tubes.

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Velocities above 0,5 km s$^{-1}$ have been reported initially by some observers (Stenflo,1973, Giovanelli and Slaughter, 1978; Wiehr, 1985) while more recent observations give small (<300 ms$^{-1}$) or zero velocities in regions of concentrated magnetic field (Stenflo and Harvey, 1985, Dara et al., 1987). In the latter paper we studied the motion in the vicinity of two regions of concentrated magnetic field in the quiet sun using a short (5.5 min) time series of spectra, and we found no convincing evidence of association of the magnetic field regions with downflows.  In this paper we study the velocity and the magnetic field in three quiet regions using filtergrams, which permit the mapping over a two dimensional field of view.


2.  OBSERVATIONS AND DATA REDUCTION

A long (1 hour 16 min) series of high resolution filtergrams in the wings and at the center of the magnetically 6103 CaI line (each wing simultaneously observed in two circular polarizations) were obtained with the Sacramento Peak Vacuum Tower telescope and the universal filter (UBF), on October 19, 1987.  The filter bandwidth was 186 mA, while the scale of the image on the film was 10"/mm.  For the separation of the two circular polarizations a Wollastone prism was used.  The duration of each run was 32 sec and included two pictures in each of the wings, ±0.07 A from the center, and at the center of 6103A line, as well as two at the center of Hα. The field of view was 100 x 200" and the telescope was pointed near the center of the disk, at N18 W12.

Because of the important vignetting effect, flat field pictures were taken with the solar image out of focus. Photometric calibration was performed using a step wedge.  The best of the two pictures at each wavelength was chosen for further processing with the fast microphotometer of the Sacremento peak Observatory.  The micropho-tometer spot size was 0".7 and the step 0".3.

For the present analysis, we selected pictures from six runs, uniformly distributed in a time period of 5.3 min.  Each frame was calibrated, corrected for the vignetting effect, and was rotated so that the orientation of all frames was the same.

The digital subtraction of the two pictures with opposite sense of circular polarization gives a signal proportional to the longitudinal magnetic field for each wing.  The maps of the magnetic field were computed by averaging the magnetic signal from both wings. Moreover, the average of the two pictures in each wing gives the intensity, while subtraction of the intensity in the wings gives a signal proportional to the line of sight velocity. The magnetic and velocity signals were calibrated using a scan of the line profile  obtained with the UBF.

A comparison of the six velocity maps shows that the effect of the photospheric oscillations is very strong and masks any flows associated with the granulation of the magnetic field. Therefore we computed average velocity maps over an interval of 5 minutes, where the effect of oscillations is strongly reduced.  We also computed
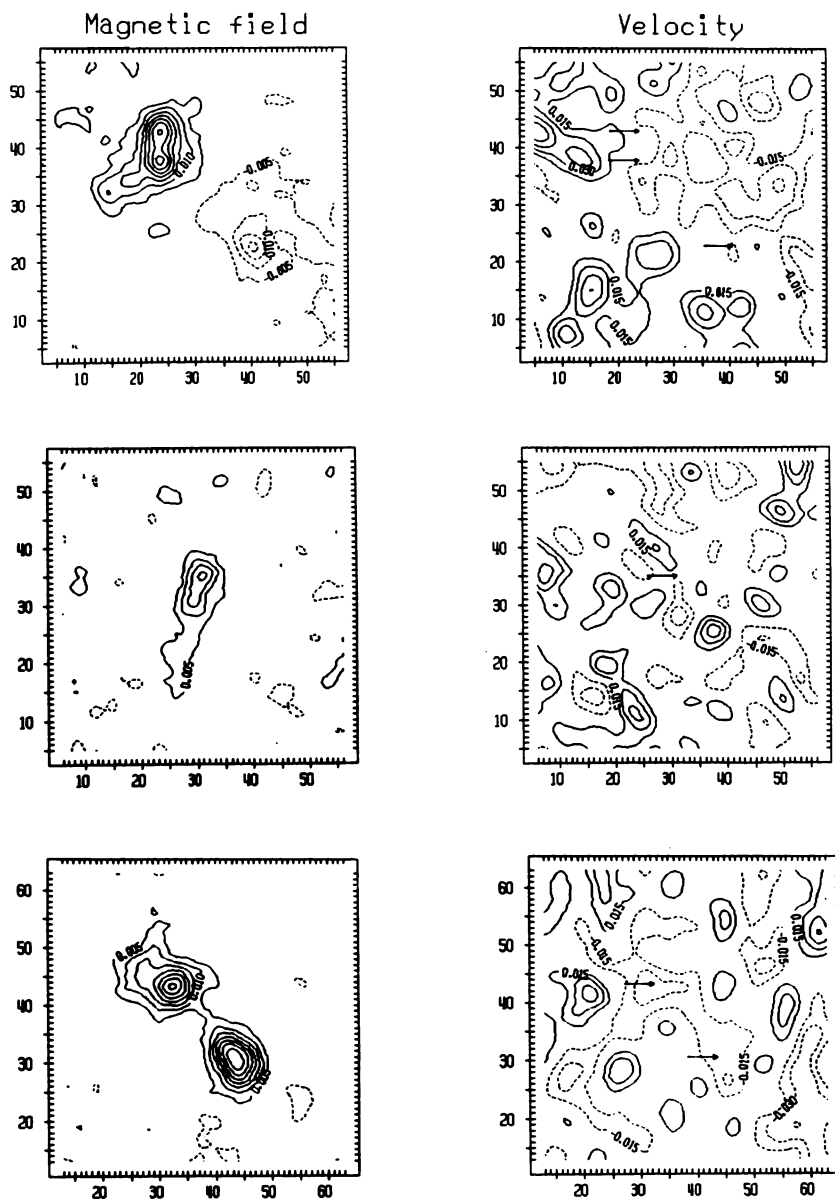
Magnetic field · Velocity



Figure 1. Magnetic field and velocity maps, averaged over 5 minutes. Dashed contours indicate negative values (downflows). Magnetic field contours are in steps of 0.5% contrast (∿40 Gauss) and velocity contours are in steps of 1.5% (∿100 m/sec). Tick marks are every 0.3". The arrows on the velocity maps show the position of the peaks of the magnetic field.

averages of the magnetic field maps in order to improve the signal
to noise ratio.

## 3. RESULTS AND DISCUSSION

Three regions have been selected in the quiet sun for the study
of small-scale motions and the calculation of the corresponding
magnetic fields. Figure 1 shows the average maps of the longitudinal
magnetic field and the corresponding line of sight velocity, after
the elimination of the five minute oscillations.

The first region has a bipolar magnetic field and corresponds
to a rosette in the center of Hα; the two opposite polarity regions
are at a distance of 8", and the magnetic field is almost two times
stronger in one polarity than on the other. The second region is
unipolar and in the center of Hα appears as a bright point. One can
clearly see that in these two regions the velocity corresponding to
the magnetic features is practically zero. The third region is an
extended, single polarity region with two well separated peaks, 5"
apart. At the center of Hα it appears as a rosette with a bright
point in its vicinity. In the velocity map of this region small
downflows ($<300$ ms$^{-1}$)are observed. It is interesting to note that
similar downflows on the velocity map are also observed in regions
without any significant magnetic field; it is clear that, from the
velocity maps alone, one cannot tell whether there are any
concentrated magnetic field structures. This is in good agreement
with our previous results (Dara et al., 1987).

It is evident that downflows cannot play a fundamental role in
the confinement of small-scale magnetic fields, and any modelling of
the tubes should take into consideration this observational result.

## ACKNOWLEDGEMENTS

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