PLASMA OSCILLATIONS INSIDE SMALL FLUXTUBES

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ABSTRACT

Periodic Doppler motions inside small fluxtubes are determined from the zero-crossing point of the circular Zeeman polarization profile (Stokes-V=0). The gas fully participates on the known solar 5min oscillations without affecting amplitude or frequency. Averaging the oscillations, the gas is at rest in an absolute solar scale. Discrepancies with formerly observed redshifts are explained by the systematic westward displacement of the magnetic structure relative to the $Ca^{+}K$ bright point used for guiding.

INTRODUCTION

The investigation of oscillatory motions in presence of magnetic fields is of high interest for the understanding of the interaction between plasma and magnetic field. In the large scale sunspot magnetic fields, a significant damping of the amplitude of 5 min oscillations was reported by several authors (see e.g. Balthasar, Küveler, Wiehr; 1987). In contrast, small fluxtubes, known to be the origin of enhanced network and plage regions, seem to fully participate on the 5 min oscillations as observed by Wiehr (1985).

OBSERVATIONS

In order to verify the latter result at much higher spatial resolution, we took Zeeman spectra of a Ca+K bright point in the right and in the left handed circularly polarized light at the evacuated Gregory-Coudé telescope on Tenerife/Spain. In 1986 both spectra were taken successively (Wiehr, 1986); in 1987 the use of Semel's (1980) polarimeter allowed strictly simultaneous exposures. The spatial resolution achieved during the total

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observing time of 15 and 18 min, respectively, was always better than 1.5 arcsec. After photometry at the Göttingen microdensitometer, corresponding right and left handed spectra were subtracted from each other, thus yielding the Stokes-V profile. The wavelength of the zero-crossing point, V=0, is given as a function of time in Fig. 1.

RESULTS

It can be seen that the 1986 as well as the 1987 data show well pronounced oscillatory Doppler shifts, the amplitudes being comparable to those known from the oscillations of non magnetic solar regions.

In addition, the Fe 6301.5 line always shows smaller shifts than the Fe 6302.5 line. The wavelength difference of 150 m/s equals the one found by Balthasar (1988) for the limb effect of both lines. Hence, when subtracting the corresponding granular blue shift for each line (introduced by the wavelength reference from the non-magnetic neighbourhood) the V=0 for both lines coincide. In addition, this correction procedure yields zero wavelength displacement in an absolute scale for the points No.3 in 1986 and No.6 in 1987 (both being almost free from oscillations). This indicates that, besides the oscillation, gas in the small fluxtube is at rest.

CONCLUSION

This result agrees with Stenflo et al. (1987). Former results of downdrafts in small fluxtubes by Wiehr (1985) are found to orginate from the systematic westward tilt (Wiehr, 1978) of the magnetic maximum with respect to its corresponding CaIK bright point used for pointing. This displaces the fluxtube within the broad spectrograph slit used by Wiehr (1985); for the particular time of observation during optimal seeing (9:30 through 10:30 local time) the westward direction corresponds to a redshift. As a consequence of the absence of downdrafts in small fluxtubes, the explanation of Stokes-V asymmetries in terms of a velocity gradient inside the fluxtube (as e.g. given by Stenflo et al., 1984) has to be reconsidered. A possible solution of this problem has been suggested by Grossmann-Doerth and Schüssler (1988) who consider the gas motion to be located outside the fluxtube; this would support the picture of a fluxtube imbedded in the downstreaming inter-granular lane.

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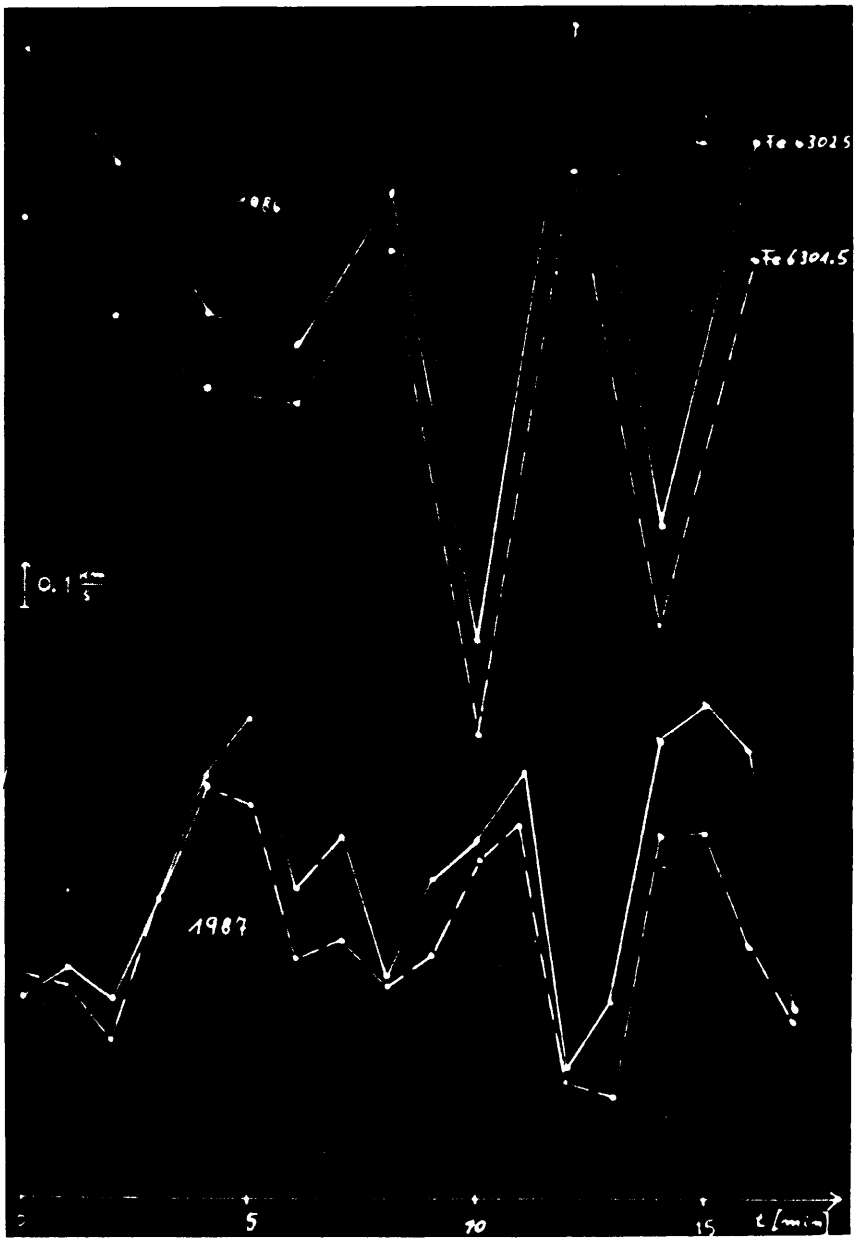

Fig. 1.· Temporal variation of the inversion point V=0 of two Zeeman lines

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