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Evidence for coronal plasma oscillations over supergranular cells

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Abstract. Evidence of coronal oscillations over the interior of supergranular cells was found through SUMER observations. The observations are rasters of quiet Sun regions and the oscillations were detected, in the Ne VIII 770 Å Doppler maps, as a characteristic pattern. It should be noted that the Ne VIII ion has coronal formation temperature (650 000 K) and that reports of oscillations in the quiet Sun corona are scarce. Magnetic extrapolation from MDI magnetogram showed that at the location where the oscillation was detected, the gas and magnetic pressures get equalized (β=1) higher in the atmosphere, compared to the surrounding, non oscillating quiet Sun. This could indicate a non-compressible wave propagating inside the gas dominated medium of the cell causing the detected oscillation.

Keywords. Sun:oscillations, Sun:corona, Sun:UV radiation

1. Introduction

The analysis and interpretation of oscillations is one of the best methods to understand the nature of the solar atmosphere (Carlsson & Stein 1995, Carlsson & Stein 1997, Judge *et al.* 2001). Acoustic oscillations of $3-5$ minute period are ubiquitus from the photosphere up to the transition region, where the sudden temperature increase traps the acoustic waves, so that they cannot propagate into the corona, which seems to have no oscillations outside active regions. However, oscillations with periods of 5-60 minutes have been detected at the boundary of coronal holes in the quiet solar corona (Popescu and Doyle 2004) and may also exist over quiet Sun supergranules (Gontikakis *et al.* 2005). In the present paper we focus on the latter oscillations.

2. Observations and data reduction

We used SUMER rasters in Ne VIII 770 Å line over quiet Sun areas obtained on September 22, 1996 (Gontikakis *et al.* 2005) and on November 3, 1999. As we are interested in a rough comparison of the Doppler and the radiance maps with the magnetic field, we used the closest MDI magnetograms and performed a potential magnetic field extrapolation (Alissandrakis 1981) over a very dark supergranular cell.

3. Results and Conclusions

In the Doppler map one can see vertical stripes aligned with the slit, showing variations from red to blue shift (bright to dark in Fig. 1a) for sequential positions along the

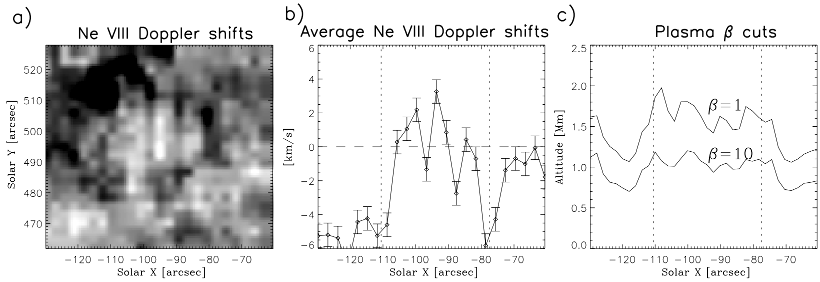

Figure 1. The oscillating region of September 22 1996 in the Ne VIII Doppler map, (a) the corresponding averaged along the slit Doppler shift (b) and the variation of the plasma $\beta = 1$ and $\beta = 10$ levels which are higher in the oscillating than in the surrounding region.

X axis. This indicates an oscillation, which cannot be due to an instrumental effect, which would affect the data all along the slit and not only over small regions of roughly 30″. The region where the vertical stripes are seen in Ne VIII Doppler shift coincides spatially with the inner part of chromospheric supergranular cells, seen in Si II 1533 Å. In Figure 1b we present the average Doppler shift along the slit over one region. We can detect three to four cycles of velocity variations giving an average oscillation period of about 9 minutes. Comparing the location of the oscillation with the magnetic field map and its extrapolation, we find that the oscillation takes place above regions with very weak magnetic field, which implies a rather high altitude of plasma $\beta = 1$ level (Fig. 1c). This would support a mode conversion from the chromosphere into the transition region as suggested in McIntosh *et al.* (2001). However, the oscillation of about 9 min we observe does not match the peak of acoustic or gravity wave power (Rutten and Krijger 2003). Higher frequency oscillations were earlier detected in Doppler shift and not in radiance (Judge *et al.* 1997, Carlsson *et al.* 1997). It was interpreted in terms of longitudinal non-compressible waves. So far, it is not possible to draw a conclusion on the nature of the oscillatory pattern we presented here. It is true that the use of a raster is not appropriate for oscillation studies, since the derived time series are short and spatial and temporal variations mixed. However, our observations give the opportunity to study a large field of view, which cannot be obtained with a fixed slit observation and may help us understand the connection of the chromosphere with the corona above the so-called non-magnetic inter-network.

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