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NUMERICAL STUDY OF MHD WAVE PROPAGATION IN THE SOLAR ATMOSPHERE

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We present a 2D MHD simulation of wave propagation across the solar atmosphere considering the photosphere-chromosphere temperature and density stratification. The system is forced by typical p-mode perturbations. We reproduce observational results from SDO AIA.

The photosphere and chromosphere typical observed periods are 5' (3mHz) and 3' (5mHz), respectively. However, Stenborg et al. (2013) also detected higher periods (7'-9') in the lower corona.

To explain these observed frequencies in active regions we modeled the stratified photosphere, chromosphere and low corona using the ideal MHD code GUACHO considering a force-free magnetic field. The initial configuration is a stratified atmosphere in hydrostatic equilibrium with constant gravity (see Figure 1). To stabilize the equilibrium we implement a method consisting on the separation of the variables into sums of the background equilibrium and their departure from this state: $\rho = \rho_0 + \rho_1$, $p = p_0 + p_1$, $\vec{B} = \vec{B}_0 + \vec{B}_1$ and $\vec{v} = \vec{v}_1$. The physical domain is 10Mm x 10Mm, the resolution is $\sim$ 30km and the dipole is located at the left corner outside the domain. We consider a variable molecular weight from 1 (photosphere) to 0.5 (corona) that follows the temperature profile. The system is perturbed with $vy(t) = v_0 \sin(\omega t)$ where $v_0 = 10$ cm/s, $\omega = \frac{2\pi}{T}$ and T is the driver period. Since the typical p-mode frequencies are of $\sim$ 3mHz and $\sim$5mHz, we apply both separately. We calculate the power spectrum of the emission measure along different field lines of the dipole, assuming an optically thin medium. The figure 2 shows the obtained periods at different heights.

In the photosphere (lower part of the domain) we obtained the proper frequencies of the driver. At greater heights these frequencies are damped due to the action of the cut–off. Also, the field curvature modifies the frequencies leading to larger periods of 7' and 9'. These results are in agreement with the observations from Stenborg et al. (2013). Note that more curved lines (e.g. blue) imply larger amplitudes of the larger periods.

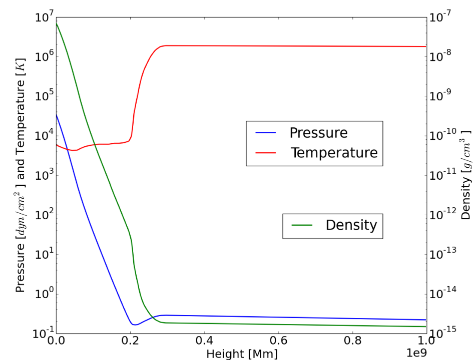

Fig. 1. Temperature, density and pressure profiles.

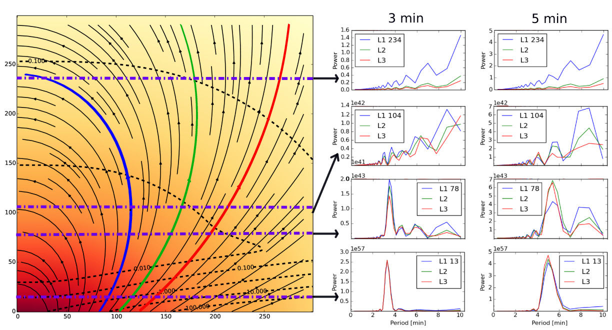

Fig. 2. Dipole magnetic field lines (left panel) and the power spectrum for both drivers (right panel) calculated along the blue (L1), green (L2) and red (L3) lines at different heights (purple dashed lines).1G$\leq |\vec{B}| \leq 10^3$G.

REFERENCES

Stenborg, G., Stekel, T., Vourlidas, A. & Howard, R. 2013, LWS/SDO Science Workshop 2013

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