Magnetic twist

The presence of weak twist changes the character of axisymmetric modes in a significant way as seen in the figure below. Namely, while in the case with no magnetic twist the azimuthal component of the velocity perturbation is zero, in the case with this twist component is almost never zero. This effect is clearly seen, where the relative magnitude of the radial and azimuthal components of the velocity perturbation alternate periodically. Also, given that observations of Alfven waves rely on the apparent absence of intensity (i.e. density) perturbations in conjunction with torsional motion, we suggest an alternative interpretation. Namely, observed waves that appear to be Alfvenic in nature could actually be surface sausage waves (see right panel of the below figure), since due to the localised character of the density perturbation, this perturbation could be below the instrument resolution.

87±26 km/s downwards. The maximum transverse velocity amplitudes in both cases is about 5 km/s. The sausage wave shown here has a period of 197±8 s, a phase speed of 67±15 km/s and maximum transverse velocity amplitude of 1.2-2 km/s. Panel (c) displays a comparison between the detected intensity (blue) and width (red) perturbations resulting from the Gaussian fitting. Sausage waves can naturally cause such anti-phase behaviour. Damping of kink waves due to resonant absorption has been well studied in the coronal waveguides, e.g. in post-flare/CME loops (see e.g., Vankovich et al. 2011f). Now a new era is beginning where we can also start to investigate the damping behaviour of sausage waves in chromospheric waveguides.

Dispersion relation for the Alfven continuum

\[
\frac{d^2\vec{p}_2}{d\phi^2} = 0
\]

\[
\frac{d^2\vec{p}_1}{d\phi^2} + \frac{d}{d\phi} \left( \frac{1}{\mu_0 \rho} \frac{d\vec{p}_1}{d\phi} \right) = \frac{1}{\mu_0 \rho} \frac{d\vec{B}_1}{d\phi}
\]

(Left) Normalised phase velocity. (Right) Normalised absorption coefficient. Parameters: Internal temperature (1,000,000 K), external temperature (400,000 K), density ratio (internal/external density, 10:1), magnetic twist \( B_\theta / B_z = 0.2 \), resonant layer thickness \( \delta = 0.1 r_a \)

Morton et al. (2012) directly observed ubiquitous sausage waves in chromospheric fibrils, concurrent with kink waves. Panel (a) depicts a cropped ROSA IR snapshot containing a pair of dark, and hence dense, chromospheric flux tubes. Using the cross-cut (black line) to extract intensity information, panel (b) displays the resulting time–distance diagram revealing the dynamic motion of the waveguides. Times are given in seconds from the start of the data set, while the overplots are the results from a Gaussian fitting routine to show concurrent kink (red line shows the central axis of the structure) and sausage waves (yellow bars show the measured width of structure). Here there are counter-propagating kink waves with periods of 232 ± 8 s and phase speeds of 71±22 km/s upwards and 87±26 km/s downwards. The maximum transverse velocity amplitudes in both cases is about 5 km/s. The sausage wave shown here has a period of 197±8 s, a phase speed of 67±15 km/s and maximum transverse velocity amplitude of 1.2-2 km/s. Panel (c) displays a comparison between the detected intensity (blue) and width (red) perturbations resulting from the Gaussian fitting. Sausage waves can naturally cause such anti-phase behaviour. Damping of kink waves due to resonant absorption has been well studied in the coronal waveguides, e.g. in post-flare/CME loops (see e.g., Vankovich et al. 2011f). Now a new era is beginning where we can also start to investigate the damping behaviour of sausage waves in chromospheric waveguides.

References