Anatomy of a slow wave in a coronal loop

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Hinode/EIS

Observations of waves with EIS

- Van Doorsselaere et al. (2008)
- Erdélyi & Taroyan (2008)
- Wang et al. (2009a,b)

![Graph showing time vs. velocity (km/s)]
Hinode/EIS Observations

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- Erdélyi & Taroyan (2008)
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EIS observation

Overlay of EIS observing slit (vertical white line) on top of TRACE 195Å observation on the same day. The black diamond indicates the studied pixel.

- Hinode/EIS observations on 07/02/2008
- active region on the limb
- 4 spectral windows
- 1” slit
- cadence time 6.4s

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Velocity and intensity in FeXII 195Å

Left: Velocity + periodogram, Right: Intensity + periodogram

Period: period $314 \pm 84$ s, period $344 \pm 61$ s
Good correlation between the velocity and intensity perturbations leads to an interpretation in terms of running slow waves. This compatible with the orientation of the observed loop and earlier detections of this mode.
Intensity oscillations in other lines

Top panels: Intensity in different spectral windows (FeXII 195Å, FeXIII 203Å, CaXVII 192Å), Bottom panels: periodogram of intensity signal
→ Use for spectroscopy with CHIANTI (Dere et al. 1997)
Density

Use CHIANTI to derive the electron density from the line ratio of the FeXIII spectral lines at 202Å and 203Å.
Use CHIANTI to derive the electron temperature from the line ratio of the FeXII 195Å and FeXIII 202Å spectral lines.
Seismology

From linear theory for 1D sound waves we know:

\[
\frac{\rho'}{\rho_0} = \frac{\nu_{LOS}}{C_{LOS}} \quad (1)
\]

\[
\frac{T'}{T_0} = (\gamma - 1)\frac{\rho'}{\rho_0} \quad (2)
\]

Scatterplot and principle component analysis allows for seismological estimate of \( C_{LOS} \) and \( \gamma \):

\[ C_{LOS} = 14 \text{km/s} \quad \alpha = 85^\circ \quad \gamma = 0.9 \]
Use EIS to observe velocity and intensity oscillations across multiple spectral lines.
Conclusion

- Use EIS to observe velocity and intensity oscillations across multiple spectral lines
- Velocity and intensity are in phase, with a period of 300s
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Oscillation also observed in density (in phase) and temperature (in anti-phase)
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- Seismological estimate of the line-of-sight propagation speed, the inclination angle and $\gamma$
- To do: error analysis