Coronal Seismology

Laurel Farris
New Mexico State University
laurel@laurelfarris.com

ABSTRACT

Coronal seismology involves the investigation of magnetohydrodynamic(MHD) wave and ocillatory phenomenae that arise in the solar corona. Here some of the dominant waves, oscillations, and modes are intimately investigated in the literature. Analysis of data from the Atmospheric Imaging Assembly (AIA) instrument on the Solar Dynamics Observatory (SDO) is also presented, both as stand-alone research and in the broader context of coronal seismology.

Subject headings: Sun: corona - Sun: oscillations - Sun: seismology

1. Introduction

1.1. Motivation

[Motivation: coronal heating, other questions. . .]

1.2. MHD

The heating of the corona by magnetohydrodynamic (MHD) waves is one of two prevalent theories on how it reaches such high temperatures, the other being magnetic reconnection (Srivastava & Dwivedi (2010)).

In §2, several major types of waves and oscillatory modes in the solar corona are described, along with recent investigations into each one. §5 includes a description of a research project and its implications for the broader field of coronal seismology in §6. Conclusions and future work are summed up in §7.

2. Oscillations

$$\xi(x) = \xi(r)e^{i(kx+m\phi)}$$

For kink oscillations, m=1, and for sausage modes, m=0.

2.1. Kink Oscillations

Kink oscillations are commonly associated with coronal loops, and characterize the spacial oscillations that occur over the surface of the loop (Nakariakov & Verwichte (2005)).

Some of the first observations of these spatial variations were carried out by Aschwanden et al. (1999), who utilized some of the first data released from the TRACE mission in order to investigate the oscillations present in coronal loops. Using data taken with the 171Å filter, they modeled five loops that were present with a solar flare in 1998. The resulting model had several qualities characteristic of fast kink modes, including asymmetry and displacements represented by sine curves. As the period of kink modes were already known to correlate with the magnetic field strength of the loop, pinpointing this type of mode as the driver in coronal loops provided a valuable constraint on coronal conditions. The absense of any phase shift along the length of the loops revealed that these were *standing waves*, with nodes located at the loop footpoints.

More recently, Pascoe et al. (2015) investigated the driving mechanism behind the production, and damping of kink oscillations. They compared two possible functional form of the damping profile of the driver: that of a Gaussian and an exponential form. While the noise level of the data was too high to distinguish between the two forms, the simulations followed the form of a Gaussian.

They also considered the effect of the spatial profile of the driver itself on the excitation and subsequent damping of the kink waves. Two different possiblilities were explored here: the effect of a "highly structured" driver, which they found to be unrealistic, and the effects of eddies and photospheric motions around the footpoints of the coronal loops.

2.2. Sausage Oscillations

Lopin & Nagorny (2015) plotted the changes in intensity and cross-sectional area for sausage oscillations in photospheric pores extending up through the solar atmosphere. They used the general cylinder model for the pores, though it is more likely that the cross-sectional area of the waveguide increases with height as the temperature increases and density drops. The relationship between pore size and intensity can indicate

2.3. Acoustic Oscillations

3. Waves

3.1. Propagating Acoustic Waves

3.2. Propagating Fast Waves

4. Modes

4.1. Torsional Modes

4.2. Mixed Modes

5. Data

As part of the general topic of coronal seismology, a small research project was carried out as well, continuing over from several semesters previously.

6. Analysis

7. Conclusion

And we're finished.

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