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Reflection Of Propagating Slow Magneto-acoustic Waves In Hot Coronal Loops

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Corona, the outermost layer of the solar atmosphere, is made up with very hot and taneous plasma material. One of the key questions regarding the coronal physics is to identify the ubiquitous source(s) which can sustain this high temperature profile of the coronal plasma. One of the potential candidates in this case, is the family of magnetohydrodynamic (MHD) waves [Roberts et al. 1984]. These waves can propagate from lower atmosphere to the solar corona and can partially (or fully) dissipate their energy to the surrounding coronal medium. The slow MHD waves which are ubiquitous in the solar corona, act as important tools for understanding the coronal structures and dynamics [Ofman et al. 1997, Krishna Prasad et al. 2011].

In this work, we present a number of observations, from X-Ray Telescope (XRT) on board HINODE and Atmospheric Imaging Assembly (AIA) on board SDO, which show reflecting slow MHD waves in hot coronal loops [>10 Mk]. This is the first report of this kind phenomena as seen from the XRT and simultaneously with the AIA. Analysis of the data shows that the observed wave appears after a micro-flare occurs at one of the loop footpoints [Selwa et al. (2005)]. Such a flare also rapidly heats up the chromospheric plasma and acts as a source for the high speed flows we observed in the coronal channels of AIA [Sterling et al. 2015]. The wave travels back and forth a couple of time to give rise to a reflection like pattern and eventually fades off due to energy dissipation on each cycle [Kumar et al. (2013)].

The differential emission measure (DEM) analysis performed on the AIA image sequence revealed that the loop temperature and density to be 10 MK and ≈10^9 cm^ (−3) respectively. The average speed of propagation, as estimated from the time-distance maps, is lower than or comparable to the sound speed of the local medium estimated from the DEM analysis. This classifies the wave to be a slow propagating mode.

To correctly quantify the observed fast damping of these waves, we follow the wave amplitude with time and find that the damping time (1/e fall from the initial amplitude) is almost equal to the period of the wave. This kind of fast damping has been previously attributed to thermal conduction as the damping mechanism [Wang (2011)]. To cross-validate our proposed scenario, we preforme a 2.5D MHD simulation [Fang et al. (2015)], which uses the parameters obtained from our observation as inputs and performed forward modelling to synthesize AIA 94 Å images. Analyzing the synthesized images, we obtain the same properties of the observables as for the real observation. From the analysis we conclude that a footpoint heating can generate slow wave which then reflects back and forth in the coronal loop before fading out. Our analysis on the simulated data shows that the main agent for this damping is the anisotropic thermal conduction.

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