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Fast and slow MHD waves in heating solar magnetic chromosphere by realistic simulation

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The problem of how to heat the solar chromosphere to maintain the temperature is still under debate. On average, classic semi-empirical solar atmospheric model shows that radiative loss reduces the internal energy in the chromosphere at a rate of 4.5×10^9 erg s^{-1} g^{-1} (Anderson & Athay 1989). Corresponding time scale of radiative loss is 200 s. The time scale of radiative loss is comparable to the transit time of chromospheric MHD wave, which indicates that radiative loss has a significant effect on chromospheric dynamics. The energy source to balance the radiative loss is still unclear especially in the magnetic chromosphere. MHD waves are considered as important energy transporter and make a contribution to chromospheric heating.

The previous studies on the propagation and dissipation of chromospheric MHD waves are divided into two categories. One is a simplified simulation on a prescribed artificial background atmosphere with detailed analysis. The other category is the so-called "realistic" MHD simulations with detailed physics such as radiative energy transfer and non-ideal equation of states. Although these "realistic" models are quantitative, very few studies have focused on the detailed physical processes of the propagation and dissipation of MHD waves.

We use "realistic" MHD code RAMENS (Iijima & Yokoyama 2015) to investigate the propagation and dissipation of MHD waves in the solar chromosphere. The numerical domain extends from the convection zone to the lower corona with MHD waves self-consistently generated by convection. One of the difficulties of analyzing the realistic simulation is that the chromosphere contains different modes of waves. In our simulation, we choose two-dimensional geometry that covers a region of 18 Mm × 18 Mm. We spatially separate fast and slow MHD waves by identifying the relationship between magnetic field and velocity. We further estimate the contribution to the heating through the measurement of local radiative loss by slow and fast magnetoacoustic wave. By statistically comparing the spatial distribution of radiative loss. We conclude that fast wave plays a dominant role on heating the magnetic chromosphere.

References

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