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Fast magnetic wave could heat solar low-beta chromosphere

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The chromosphere is the intermediate layer in the solar atmosphere serving as the channel of energy and mass. The energy balance in the chromosphere is dominated by mechanical heating and radiative loss. What is the heating source is still under debate, especially in the low-beta regions. This chromospheric heating problem is one of the most important problems in solar physics. Magnetohydrodynamic (MHD) waves are candidates for heating the solar chromosphere. However, the detail is still unclear such as which mode of the wave is dominant in heating and how to generate this particular mode. We perform radiative MHD simulation (figure 1) mimicking the quiet region of the solar chromosphere. We identify the mode of the shock waves by using the relationship between gas pressure and magnetic pressure across the shock front and calculate their corresponding heating rate through the entropy jump. Our result reveals that the fast magnetic wave is significant in heating the low-beta chromosphere (figure 2). The low-beta fast magnetic waves are generated from high-beta fast acoustic waves via mode conversion when the waves cross the equipartition layer. Efficient mode conversion is achieved by large attacking angles between the propagation direction of the shock waves and the chromospheric magnetic field.

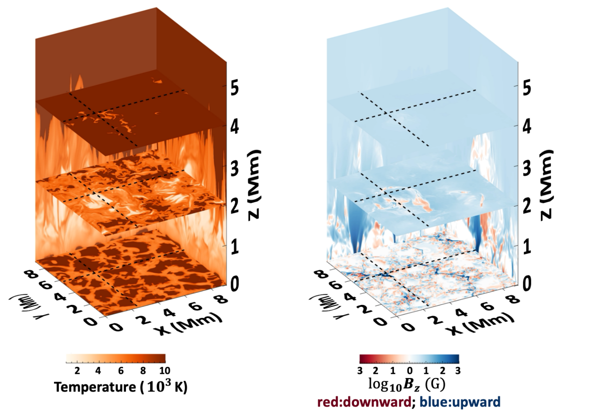

Figure 1: One snapshot of the three-dimensional MHD simulation. Left penal: temperature. Right panel: vertical magnetic field. In both panels, the lateral surfaces show the distributions at the vertical cross-sections marked by the dashed lines.

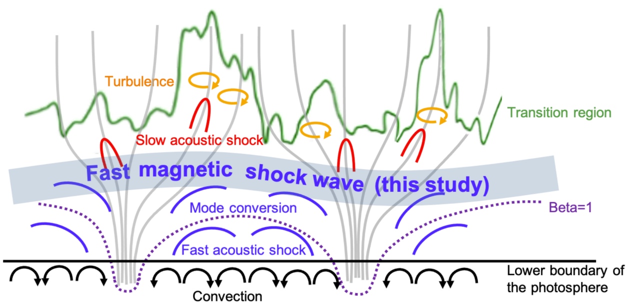

Figure 2: Schematic plot of chromospheric heating mechanisms. This figure emphasizes the new point of our study that the fast magnetic waves are significant in heating the low-beta chromosphere.