16th European Solar Physics Meeting

Contribution ID: **478** Type: **Poster**

Large-amplitude longitudinal oscillations in solar prominences derived from high-resolution simulations

Wednesday 8 September 2021 09:26 (13 minutes)

We aimed to study the damping mechanism of the large-amplitude longitudinal oscillations (LALOs) in solar prominences hidden by numerical dissipation. We performed the numerical simulations of LALOs using the 2D magnetic configuration that contains the dipped region. After the prominence mass loading in the magnetic dips, we triggered LALOs perturbing the prominence mass along the magnetic field. We used the same numerical setup gradually increasing spatial resolution. We obtained a good agreement of the period of LALOs with the pendulum model for the simulation with the highest spatial resolution. The analysis of motions revealed that the damping time is similar in the two experiments with the finest grid-scale, indicating that the further improvement of the spatial resolution does not change the damping time of LALOs in the central and bottom prominence region. This indicates that the physical mechanism is responsible for the attenuation of LALOs in those prominence regions. At the prominence top, the oscillations are amplified in the first minutes and then slowly attenuated. The characteristic time suggests more significant amplification in the experiments with high spatial resolution. We have found that energy losses at the bottom prominence region are caused by wave leakage and the energy exchange between the bottom and top prominence regions. We concluded that the high-resolution simulations are crucial for studying the periods and the damping mechanism of LALOs. Furthermore, numerical diffusion can hide the important physical mechanisms as the amplification of oscillations.

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Session Classification: Poster Session 5.3

Track Classification: Session 2 - The Solar Atmosphere: Heating, Dynamics and Coupling