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Stability of solar atmospheric structures harboring standing slow waves: an analytical model in a compressible plasma

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In the context of the solar coronal heating problem, one possible explanation for the high coronal temperature is the release of energy by magnetohydrodynamic (MHD) waves. The energy transfer is believed to be possible, among others, by the development of the Kelvin-Helmholtz instability (KHI) in coronal loops. Our aim is to determine if standing slow waves in solar atmospheric structures such as coronal loops, and also prominence threads, sunspots, and pores, can trigger the KHI due to the oscillating shear flow at the structure's boundary. We used linearized nonstationary MHD to work out an analytical model in a cartesian reference frame. The model describes a compressible plasma near a discontinuous interface separating two regions of homogeneous plasma, each harboring an oscillating velocity field with a constant amplitude which is parallel to the background magnetic field and aligned with the interface. The obtained analytical results were then used to determine the stability of said interface, both in coronal and photospheric conditions. We find that the stability of the interface is determined by a Mathieu equation. In function of the parameters of this equation, the interface can either be stable or unstable. For coronal as well as photospheric conditions, we find that the interface is stable with respect to the KHI. Theoretically, it can, however, be unstable with respect to a parametric resonance instability, although it seems physically unlikely. We conclude that, in this simplified setup, a standing slow wave does not trigger the KHI without the involvement of additional physical processes.

Student poster?

Primary authors: GEERAERTS, Michaël; Prof. VAN DOORSSELAERE, Tom (KU Leuven)

Presenter: GEERAERTS, Michaël

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