Solar corona as an active medium for magnetoacoustic waves

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The hot solar corona exists because of a delicate balance between energy losses by radiation and thermal conduction and some unknown yet energy re-supply mechanism. Such a thermal equilibrium can be readily perturbed by magnetoacoustic waves which are abundantly detected in the corona, causing a misbalance between heating and cooling processes. Due to it, the wave can experience a back reaction, either losing or gaining energy from the plasma. Thus, the corona acts as an active medium for magnetoacoustic waves.

In this talk, the recently understood importance of this thermodynamic activity of the corona for the dynamics of magnetoacoustic waves and its implication for seismological diagnostics of the enigmatic solar coronal heating function are discussed. The effect of the thermal misbalance is quantified in terms of the characteristic timescales determined by the derivatives of the net energy gain and loss function with respect to the plasma parameters evaluated at the equilibrium. For a broad range of typical coronal conditions, these timescales are shown to be from several to a few tens of minutes, that coincides with the oscillation period of slow magnetoacoustic waves omnipresent in the corona [1]. The wave-induced thermal misbalance causes strong dispersion of slow magnetoacoustic waves, manifested by the dependence of the effective adiabatic index and the wave speed on the wave frequency. This new dispersion of slow waves is not connected with the waveguiding effects traditionally considered in the corona, and is fully attributed to the perturbation of the thermal equilibrium. For typical parameters of the coronal plasma, this effect provides a new mechanism for the formation of quasi-periodic oscillatory patterns in an initially broadband slow wave, with the period about several minutes [3]. Also, the wave could be a subject to either enhanced damping due to the transfer of energy into the plasma or amplification via gaining energy from the heating source. The conditions distinguishing between a thermodynamically stable and unstable corona are linked with the properties of the unknown coronal heating function, allowing one to use observations of damped slow magnetoacoustic waves in typical coronal plasma structures as natural probes of the heating function [1, 2].

References

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