Dynamics of slow magnetoacoustic and entropy modes in flaring coronal loops

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Magnetoacoustic(MA) waves are observed in various regions of the solar corona in the form of intensity variations. The number of observed oscillations and waves makes it possible to use MA waves as a diagnostic tool for coronal plasma and its structures, such as coronal loops.

For practical needs of plasma diagnostics, it is sufficient to use a single-fluid system of MHD equations that describes the fundamental regularities of the macroscopic behavior of a quasi-neutral plasma in terms of its density, velocity, pressure, and magnetic field. Based on the system used, taking into account the thin flux tube approximation and/or an infinitely strong magnetic field approximation, the evolutionary wave equation and the dispersion equation, which is its partial solution, are obtained. The partial solution for magnetoacoustic waves allows us to obtain correct information on the wave parameters, in particular, phase velocities and wave increments. However, the solar corona plasma contains not only magnetoacoustic waves but also entropic waves. The observed perturbation is their superposition, for which the dispersion equation approach is not correct; an exact solution is needed. Thus, the main disadvantage of this method is the loss of important information about the observed phenomena and structures, since there is no exact solution to the evolution of an arbitrary initial perturbation, without which this problem can be solved only numerically.

In our work, we try to contribute to the problem of obtaining accurate analytical models. Within the framework of previous studies, a linear differential equation for slow MA waves in coronal loops has already been derived in the framework of the infinitely strong field approximation, taking into account non-adiabatic processes with given boundary conditions. In addition, the case of a weak influence of heating and cooling processes, as well as a strong influence of thermal conduction, was considered. The exact solution considering this formulation of the problem was obtained using the method of separation of variables (Fourier method) and Duhamel's principle or formula. The obtained solutions were applied to describe the possible dynamics of slow magnetoacoustic and entropy modes in flaring coronal loops.

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