MHD waves with mixed properties / Alfven waves with pressure variations

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This communication reports on recent developments that have been inspired by the observation by A. Hasegawa and C. Uberoi 1982 (The Alfven wave) that the basic characteristic of the ideal Alfven wave is that the total pressure in the fluid remains constant during the passage of the wave as a consequence of the incompressibility condition. For inhomogeneous medium , however, the total pressure, in general, couples with the dynamics of the motion, and the assumption of neglect of pressure perturbations becomes invalid. In a uniform plasma of infinite extent the linear MHD waves are divided in Alfven waves and magneto-acoustic waves. This clear division relies on the presence or absence of pressure variations and zero or non-zero component of vorticity to the equilibrium magnetic field. The Alfven waves are the only waves that propagate parallel vorticity and have no pressure variations, while the magneto-acoustic waves do not propagate parallel vorticity but are accompanied by pressure variations. This presentation shows that in an equilibrium with inhomogeneity transverse to the magnetic field this clear separation is no longer present. In general, all wave variables are non-zero and the MHD waves have properties that on the basis of the analysis for a uniform plasma are attributed to Alfven waves and/or magneto-acoustic waves. The simultaneous presence of pressure variations and parallel vorticity is hard to avoid. This behaviour with mixed properties does not depend on a specific equilibrium configuration; it is caused by non-uniformity transverse to the magnetic field. When a MHD wave propagates through a non-uniform plasma it sees a spatially changing environment . It changes its appearance and can evolve from a mainly fast/slow magneto-sonic wave into a wave that primarily Alfvenic and vice versa . The adjective Alfvenic refers to the fact that the total pressure perturbation is non-zero everywhere. They strongly resemble Alfven waves, with the unfamiliar property that they have pressure variations.

References

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