Shear and fast Alfvén waves in the vicinity of magnetic X-points

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Magnetic X-points play an important role in tokamak experiments, occurring both inside the plasma (due to reconnection) and at the plasma edge. It is likely that a full understanding of X-points will shed light on the basic physics of tearing modes and edge localised modes, both of which have a strong bearing on the fusion performance of tokamak plasmas. We have used analytical and numerical techniques to study the behaviour of shear and fast Alfvén waves for a cold plasma in the vicinity of X-points, with and without a longitudinal guide field B_z. Variations in the longitudinal direction are neglected. For $B_z = 0$ the shear and fast waves are decoupled. The energy of the fast wave, unlike that of the shear wave, is channelled into the X-point null, where it is rapidly dissipated due to non-ideal effects [1]. In the ideal MHD limit, exact analytical solutions exist for both modes when $B_z = 0$. We have found that the shear wave solution exhibits phase mixing, resulting in equilibration of field and kinetic energy, at a rate that increases with the spatial extent of the initial disturbance. We have also derived a pair of equations that describe perturbatively the pumping of fast waves by shear waves in the presence of finite B_z. Numerical solutions of these equations, which will be presented for both the ideal and non-ideal cases, can be used to estimate the rate at which the energy in an MHD disturbance is dissipated by the X-point.

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[1] McClements K.G., Thyagaraja A., Ben Ayed N., Fletcher L. Astrophys. J. **609**, 423 (2004)