Title: “The Dispersion Diagram for Magnetoacoustic Waves in Arbitrarily Structured Solar Waveguides”

Samuel Skirvin, ACSE, The University of Sheffield, UK
Viktor Fedun, ACSE, The University of Sheffield, UK
Gary Verth, SoMaS, The University of Sheffield, UK

Abstract:

The observation of large scale stable solar magnetic configurations, e.g. sunspots have been done over centuries. But only recently, thanks to modern high-resolution observations solar physicists were able to observe small scale solar features and associated plasma processes, i.e. magnetic bright points, spicules, plasma flows, structure of magnetic fields etc. in great detail. Therefore, advanced theoretical modelling becomes essential to explain observational results, allowing magneto-seismology to be conducted and provide more accurate information about MHD wave propagation and solar atmospheric plasma properties. In this work, we discuss a variety of theoretically constructed 2-3D MHD equilibria obtained by considering different magnetic field configurations and internal flow profiles. The dispersion diagrams and eigenfunctions were obtained numerically for the case where the equilibrium plasma density is modelled as a Gaussian profile with a varying inhomogeneous width and also as a sinc(x) function. The analytic dispersion relation is not required, making this numerical approach a very powerful tool. The proposed numerical approach allows the dispersion diagram and eigenfunctions to be obtained for any inhomogeneous magnetic hydrostatic equilibrium with or without plasma flow. To obtain the numerical solution, the shooting method has been used to match necessary boundary conditions on continuity of displacement and total pressure of the waveguide. The proposed methodology has been successfully tested against well-known analytical results obtained for uniform slab and uniform cylinder geometry. We have found that under coronal conditions, with increasing inhomogeneity in the equilibrium, an additional node appears in the resulting eigenfunctions for the slow body sausage mode, which could be misinterpreted by observers as the existence of an entirely different mode.