Transverse loop oscillations: new features from 3D MHD simulations

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Coronal seismology based on magnetohydrodynamic (MHD) waves has been used over the last 20 years as a tool to infer different parameters in the solar corona. Estimations using this method rely on very simple theoretical models which, in most of the cases, are one-dimensional and to a lesser extend two-dimensional. Unfortunately, works based on purely three-dimensional structures are very scarce. The main aim of the present work is to use realistic geometries in the theoretical models for a better understanding of coronal loop oscillations and therefore to perform improved coronal seismology. Here coronal loops are modelled as density enhancements following curved magnetic fields in 3D. The numerical solution of the nonlinear MHD equations using these equilibrium models allows us to investigate the excitation of transverse kink MHD waves in these structures. The results of the 3D simulations are compared with the traditional linear predictions based on 1D and 2D models and it is found that the differences, for example in the period of oscillation and attenuation due to resonant damping, can be significant in some cases. In the nonlinear regime transverse oscillations inevitably generate Kelvin-Helmholtz instabilities at the tube boundary. The results of the simulations are also compared with observed kink oscillations using as the input of our model extrapolated magnetic fields and inferred loop densities that mimic the same reported event.