

Torsional Modes of Coronal Plasma Structures

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Propagating long-wavelength torsional waves guided by solar coronal plasma structures are studied in the extended thin flux tube model. The model accounts for the effects of plasma rotation, the magnetic field twist, and the tube cross-section variation. Dispersion relations linking the phase speed of symmetric torsional ($m=0$) and slow magnetoacoustic perturbations of a straight plasma cylinder with the plasma parameters are derived. The phase speeds are modified Alfvén and tube speeds, respectively. The torsional mode can be considered as a propagating alternate current. It is found that in the cases of the non-negligible magnetic twist or rotation, both modes are compressible. The compressibility of the torsional mode is connected with the perturbation of the total pressure, as the wave is locally oblique to the magnetic field. When both twist and rotation are present, the torsional waves propagating in opposite directions have different speeds. Consideration of quadratically nonlinear effects reveals that in untwisted and non-rotating cylinders propagating torsional waves remain incompressible, as the centrifugal and magnetic tension forces in these waves cancel each other. On the other hand, standing torsional waves of such structures are found to be compressible. Implications of the obtained results for the observational detection of torsional modes of solar coronal structures are discussed.