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Standing MHD Waves in Magnetic Annulus Flux Tube Model.

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Solar magneto-seismology (SMS) is a popular research area that involves the study of MHD waves and oscillations present in structures of the magnetized solar atmosphere. Magnetically confined features such as magnetic slabs or flux tubes are important aspects that have been studied in great detail for more than a decade. Inhomogeneities in the structuring of the magnetic field enables them to act as wave-guides for a variety of the MHD wave modes. A flux tube with a cylindrical core surrounded by a magnetic shell is a good initial model capturing inhomogeneities observed in solar atmospheric waveguides. We investigate standing ideal MHD waves in the magnetic annulus geometry. We consider an annular cylinder of fixed length with appropriate line-tying boundary conditions to derive a dispersion relation for the sausage and kink MHD modes. We find analytical solutions to the dispersion relation by considering the weakly homogeneous flux tube (WHFT) and thin annulus approximations (TAA). Further, we also consider the wide and thin flux tube cases and apply our results to solar magnetic loops from lower atmospheric oscillations (sub-photospheric tubes and chromospheric fibrils) to coronal loops. We find, in general, two purely surface and two body mode solutions in the considered structuring that we use then to determine the period ratio of the fundamental and first excited harmonic, for SMS purposes. We analyze the role of annular structuring on the period ratios of standing waves and discuss its importance in the context of solar magneto-seismology.

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