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Magneto-Shallow Water Waves

It is believed that stars have a thin layer called the tachocline that exists below the convection zone. The thinness of this layer allows for the shallow water approximation to be applied to the magneto-hydrodynamic equations. This yields the Magneto-Shallow Water equations. In this simplified model there are various waves that can co-exist, namely; Poincaré and Rossby waves that are modified by the magnetic field, as well as Alfvén waves that are modified by the hydrodynamics.

In previous work in the literature, analytical expressions were obtained to approximate the dispersion relation of these different waves in both Cartesian and spherical coordinates. This work extends the results in the literature by dropping the approximations necessary to derive analytical solutions and computing these solutions using a spectrally accurate Chebyshev collocation method. The waves that we compute need not be harmonic and in general are trapped. We consider the case where the magnetic field varies sinusoidally with latitude but it is very easy to adapt our method to any field that is longitudinally invariant.