Effect of Core Magnetic Fields on Red-giant Oscillation Modes

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Abstract

Stars during their formation and evolution tend to acquire magnetic fields that thread their interiors and stellar environments. Interpreting the associated oscillations enables us to infer properties of the stellar interior, including their internal magnetic fields. Hanasoge 2017 and Das et al. 2020 used ideas prevalent in terrestrial seismology to develop a rigorous theory to compute the splittings for self and cross-coupled normal modes due to general magnetic-field (**B**) configurations. We construct sensitivity kernels to the Lorentz stress tensor **BB** (Lorentz stress) due to pure self-coupling, invoking the isolated-multiplet approximation. Restricting the analysis to pure poloidal and pure toroidal magnetic fields within the radiative core, we have computed even splittings that would be observed in red giants. Our study shows that the even splittings of g-dominant mixed modes go as $\hat{\nu}\{-3\}$ and $\hat{\nu}\{-3/2\}$ for our chosen poloidal and toroidal field models respectively. We also found that the l=1 and g-dominant l=2 mixed modes' splittings for pure poloidal fields inside RGB cores may be well approximated using a modified version of the formulation of splittings in Hasan et al. 2005. Our code can be used to compute splittings for solar-like oscillators such as MS, SGB, and RGB stars with axisymmetric internal magnetic field models.

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