How Rotation Shapes Acoustic Mode Amplitudes in Solar-like Stars: Evidence from Hydrodynamical Simulations

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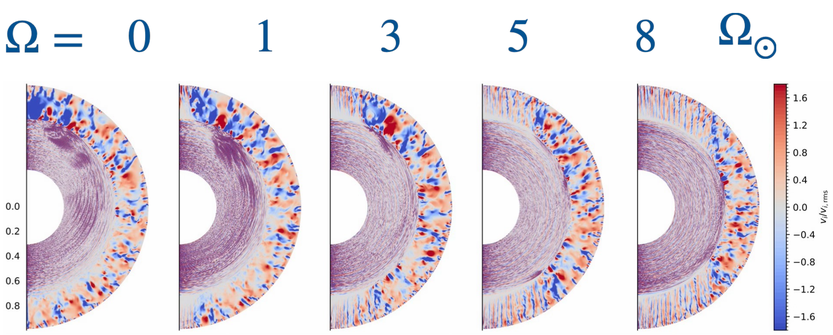
1. INTRODUCTION

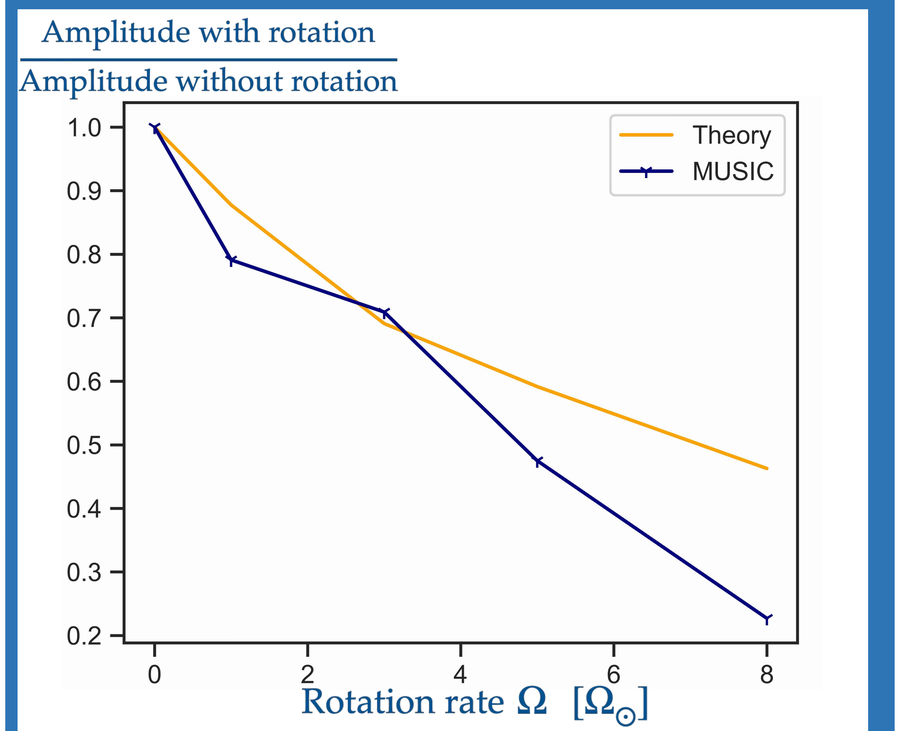
In solar-like stars, acoustic modes provide the main way of probing their internal structure and dynamics. Although these modes are expected to be ubiquitous in stars with convective envelopes, *Kepler* has revealed that almost **half of observed solar-like stars show no detectable acoustic modes**, particularly among rapidly rotating and magnetically active stars (Mathur et al. 2019, FrASS 46, 6). Recent theoretical work by Bessila et al. (2025, A&A 700, 25) has suggested that rotation tend to inhibit the excitation of solar like oscillations.

2. METHOD



We run a series of 5 rotating simulations of solar like model with the fully compressible MUSIC code (Viallet et al. 2016 A&A 586, 153 ; Goffrey et al. 2017 A&A 600, 7 ; Le Saux et al. 2025, SF2A proceedings). These simulations are in a 2.5D setup, which is equivalent to 3D with azimuthal symmetry, and cover rotating rates from 0 to 8 $\Omega_\odot$. The initial stellar 1D model is a 1 $M_\odot$ star with Z = 0.02 with the age of current Sun, 4.6 Gyr.

Rotation, through its effect on convection, significantly reduces the amplitude of acoustic modes, providing a physical explanation for the lack of detection in main-sequence solar-like stars.



Discrepancy between theory and simulations in faster rotators can be explained by an increase in mode damping not accounted for in theory.

Le Saux, Bessila & Mathis (2026), MNRAS 549, 1

Go have a look at the full paper !
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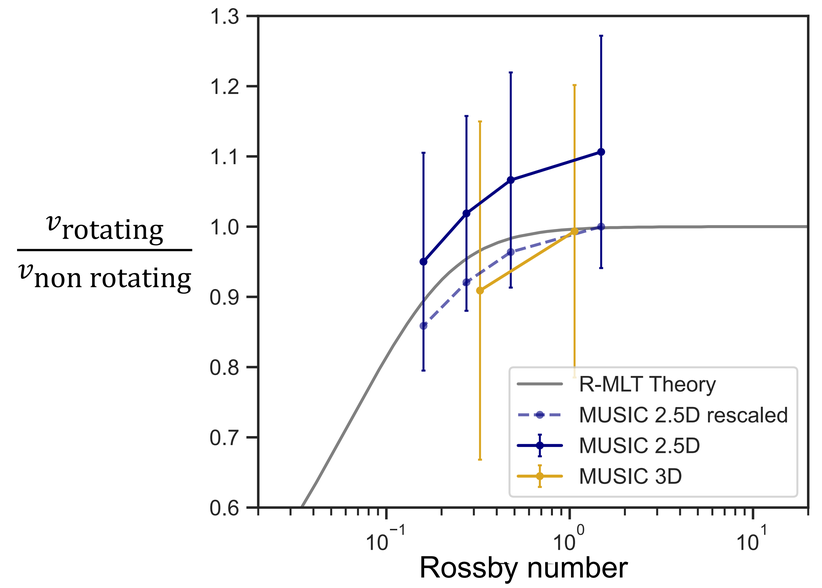
3. CONVECTIVE VELOCITIES

Modulation of the convective velocity predicted by R-MLT (grey curve, Bessila & Mathis 2025, arXiv:2505.14650) and measured in the 2.5D (solid blue curve) and 3D (solid yellow curve) simulations as a function of Rossby number.



4. MODES' DAMPING

The damping rate η of a mode with amplitude A can be directly inferred from the simulations by measuring the linewidth 2Γ at mid-amplitude of the peak of the mode (Belkacem et al. 2019, A&A 625, 20) : $\Gamma = \frac{\eta}{2\pi}$