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The influence of a stably stratified layer on the Earth's outer core waves

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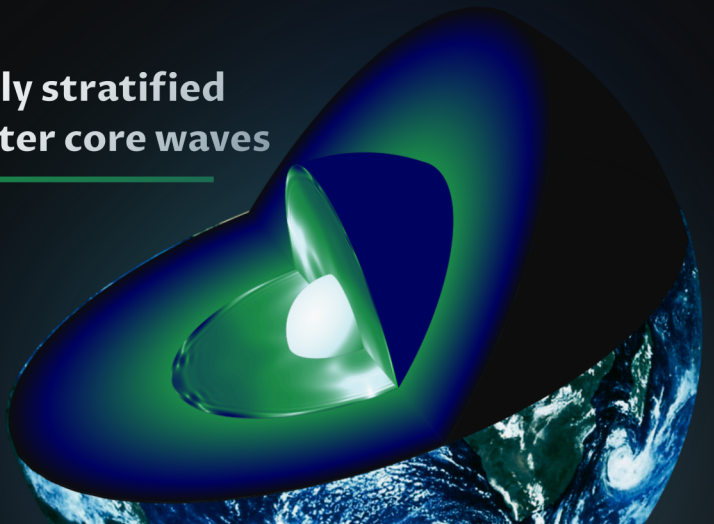
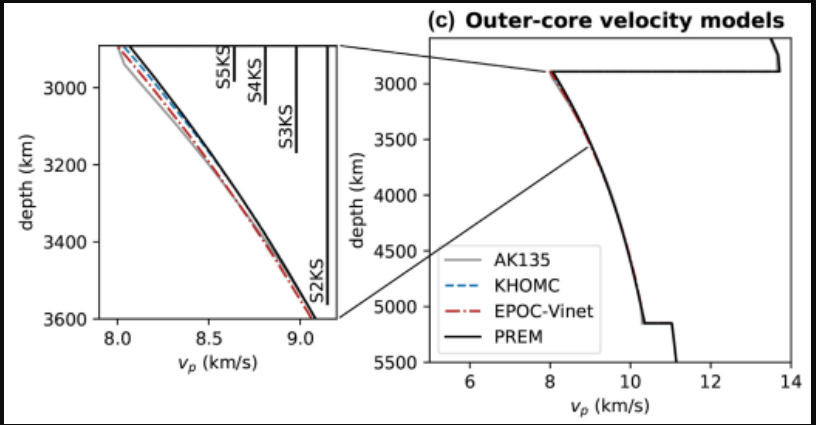


The existence of a stably stratified layer at the top of the Earth's core is still uncertain.



[van Tent et al., 2020]

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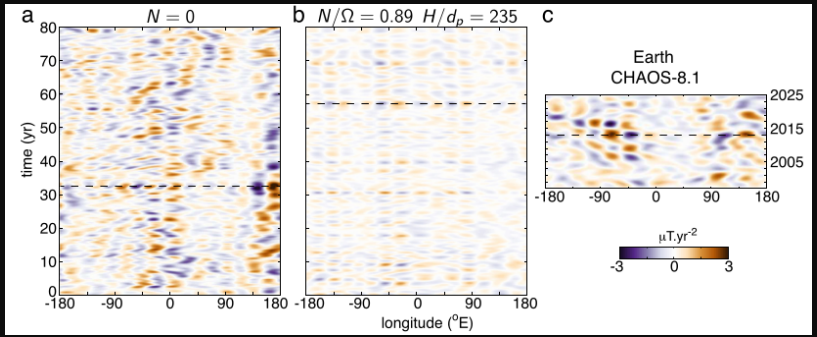


[Aubert, 2025]

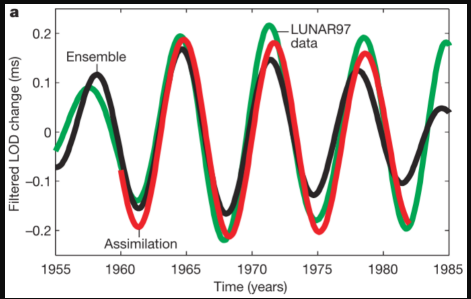
A stably stratified layer can influence the waves that are used to probe the outer core.

1. through interactions with the **Earth's magnetic field**

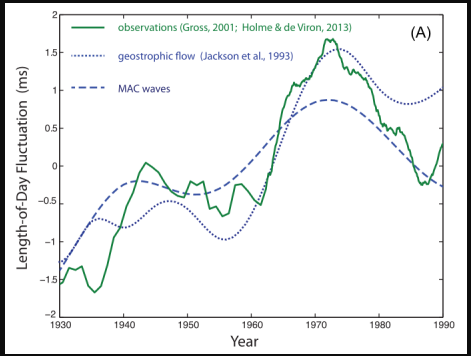
2. through **torques** acting on the core-mantle boundary causing variations in the **Earth's rotation**

Different types of waves could be responsible for the observed data.

- quasi-geostrophic waves, i.e. **torsional Alfvén waves** or **magneto-coriolis (MC) waves**, in a neutrally stratified core
  e.g. [Gillet et al., 2010] or [Gillet et al., 2022]

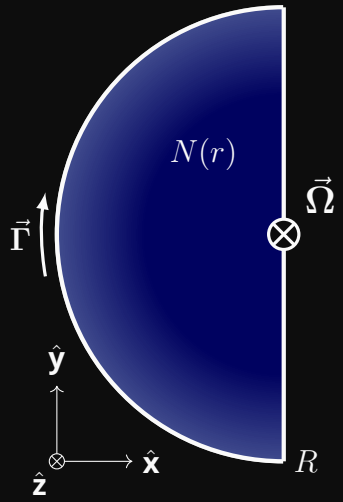


- or **magneto-archimedes-coriolis (MAC) waves** in the top stably stratified layer.
  e.g. [Buffett & Knezek, 2016]

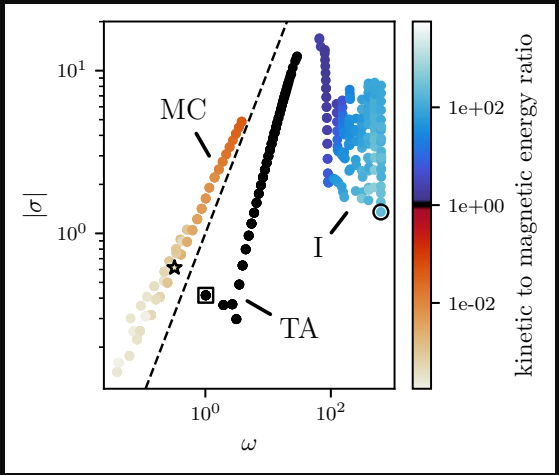


We numerically compute the eigenvalues in a 3D model of the core with a top stable layer.

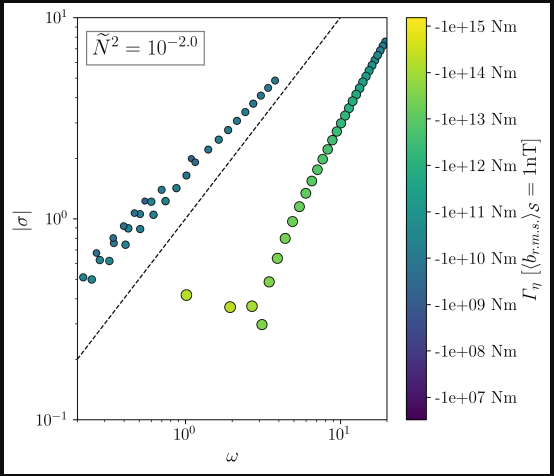
1. homogeneous, viscous, conductive, and incompressible fluid in a **full sphere** with radius R;
2. stratification as a function of the Brunt-Väisälä frequency $N(r)$ governing a thin stable layer (width $d = 0.04R$) **smoothly transitioning** in a neutrally stratified core
3. quadrupolar background magnetic field with a **thin conducting layer** at the bottom of the mantle.
4. no-slip and thin wall conditions at the CMB cause torques $\vec{\Gamma}$ to act on the CMB



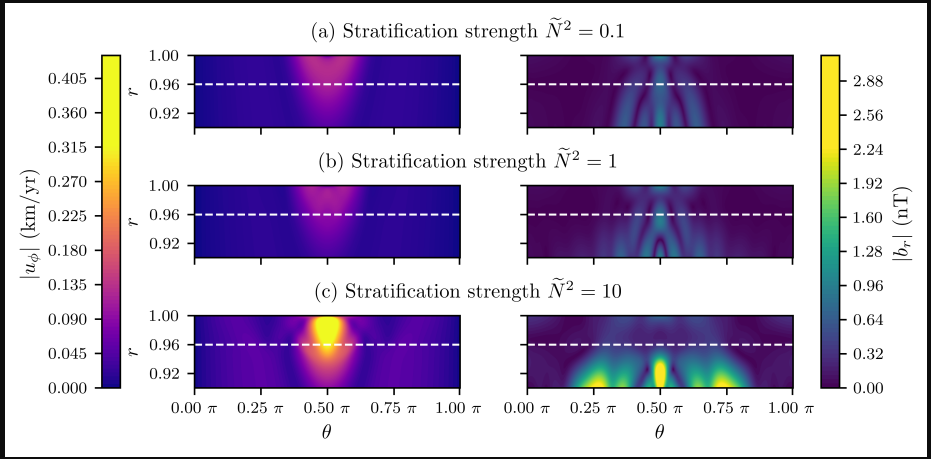
In a neutrally stratified core we recover the division between TA, MC and inertial waves.



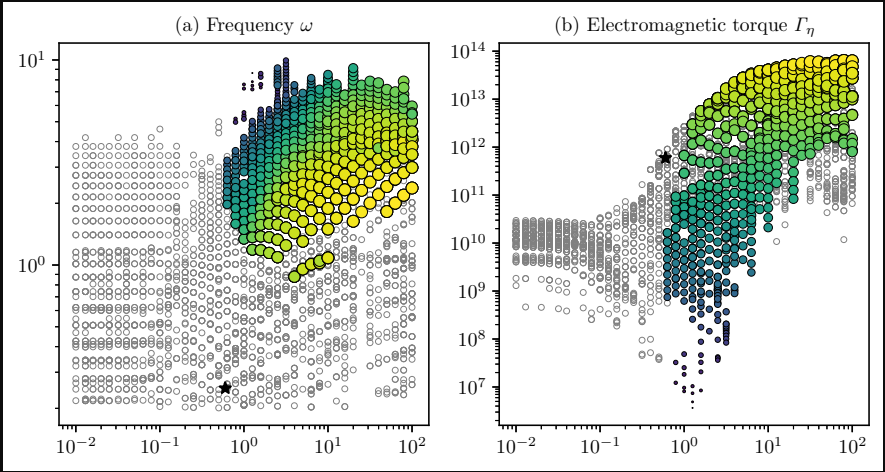
A stratified layer changes the eigenvalue spectrum and their torques on the CMB.



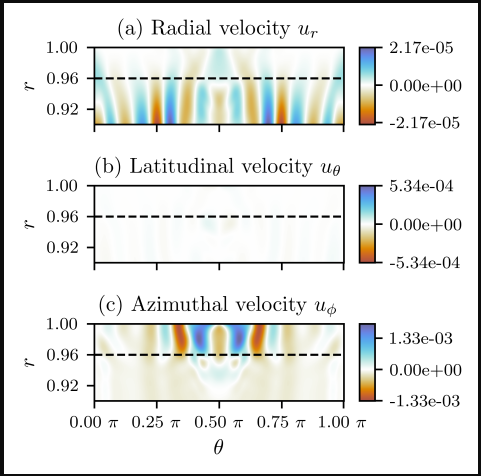
Torsional Alfvén waves are minimally affected by weak to moderate stratification $N^2/\Omega^2 \lesssim 1$.



Spectrum of MC waves changes considerably around $N^2/\Omega^2 \approx 0.1$.



From $N^2/\Omega^2 \approx 0.1$ waves with a dominant signature in the stable layer can be identified.



KORE

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