2nd European Fluid Dynamics Conference (EFDC2)
26 – 29 *August* 2025, *Dublin, Ireland*

Effect of Coriolis force on interface morphology within thermally driven Rayleigh-Bénard convection

Himanshu Dave*, Mohammad Anas*, Xiaojue Zhu*

Melting is an important process in defining surface morphology and subsequently, heat transfer within planetary systems such as the Earth's inner core [1], and icy moons such as Europa, Ganymede, Titan and Enceladus [2]. The latter are of particular interest, especially in understanding the properties of the sub-surface oceans. Recently, both NASA and the ESA have launched the Europa Clipper and JUICE missions, respectively, to study the icy moons of Jupiter [3],[4]. Several forces affect the melting process of ice shelves ranging from thermal and solutal driven convection to mechanical forces such as tides and libration. While the entire process is geophysically complex, idealized models such as Rayleigh-Bénard convection can provide significant insights into the melting process. The involvent of a non-stationary boundary condition, i.e., the melting of the solid phase, makes the problem dynamically varying over time. This is because the equilibrium background is constantly evolving due to the variation in the mean height of the liquid layer as time progresses (see figure 1).

Additionally, the involvment of rotation due to the Coriolis force is a key parameter in understanding melting processes within planetary systems. To the Author's knowledge only two studies exist to date that explore how rotation affects melting within thermally driven convection [5],[6]. In this study we look to further the parameter range to higher Rayleigh numbers and lower Rossby numbers in order to create a more detailed correlation. The parameter study we look to study is at a $\mathrm{Pr} = 10$, and Rayleigh numbers of the order $O(10^6 - 10^{12})$. We choose a convective Rossby number such that we are able to study the rotationally-affected and rotationally-dominated regimes.

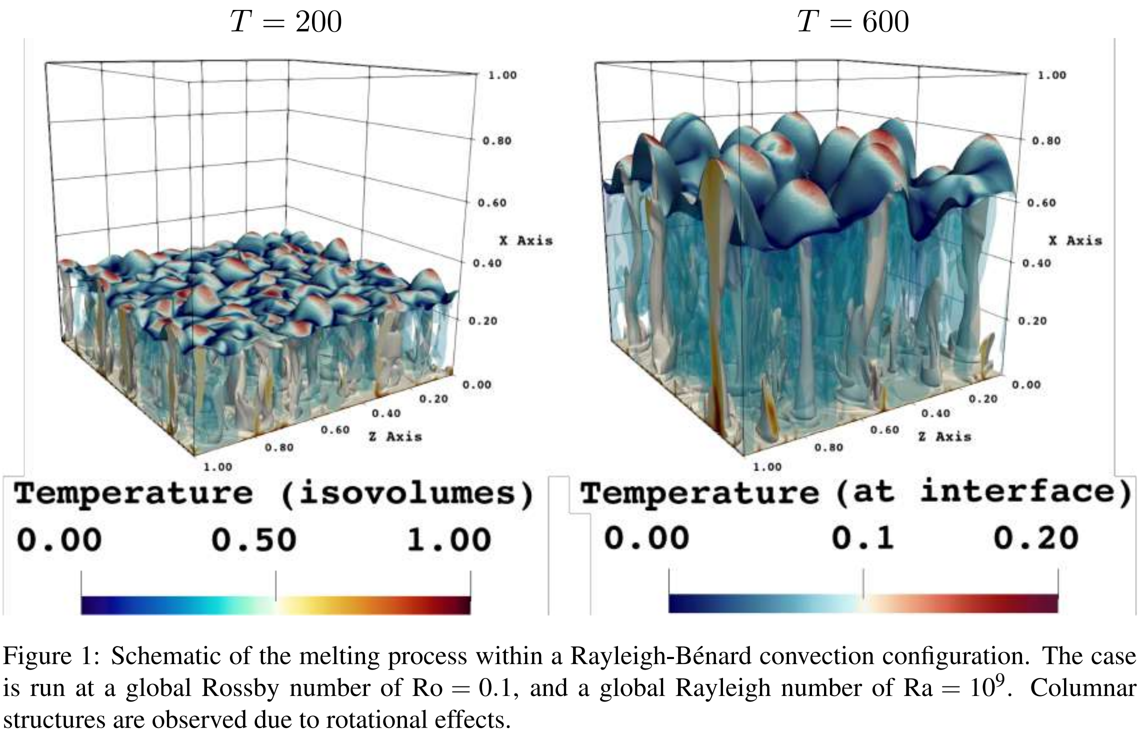

Figure 1: Schematic of the melting process within a Rayleigh-Bénard convection configuration. The case is run at a global Rossby number of $\mathrm{Ro} = 0.1$, and a global Rayleigh number of $\mathrm{Ra} = 10^9$. Columnar structures are observed due to rotational effects.

*Max Planck Institute for Solar System Research, Göttingen, Germany

[1] Alboussière et al., *Nature* **466**, 744 (2010)
[2] Soderlund et al., *Space Science Reviews* **216**, 80 (2020)
[3] Roberts et al., *Space Science Reviews* **219**, 46 (2023)
[4] Van Hoolst et al., *Space Science Reviews* **220**, 54 (2024)
[5] Gastine et al., *Icarus* **429**, 116411 (2025)
[6] Ravichandran et al., *Journal Fluid Mechanics* **916**, A28 (2021)