DY 7: Invited Talk: Basile Gallet (Saclay)

Time: Monday 10:00–10:30 Location: DYa

Invited Talk DY 7.1 Mon 10:00 DYa

Can convective heat transport be more efficient than the so-called 'ultimate' regime? — •Basile Gallet — CEA Saclay, Gif-sur-Yvette, France.

Decades of investigation of the Rayleigh-Bénard (RB) thermal convection setup indicate that the heat transport is restricted by boundary layers near the hot and cold solid plates. This prevents the unambiguous observation of the 'ultimate' scaling-regime of thermal convection, where bulk turbulence controls the convective heat flux independently of molecular diffusivities. In contrast to the RB setup, many geophysical and astrophysical convective flows are driven radiatively: absorption of light by a body of fluid induces local internal heating. We have developed a laboratory experiment that reproduces such radiative heating: heat is directly input inside the bulk turbulent flow and away from the boundary layers.

After providing experimental and numerical evidence that this setup leads to the ultimate regime of thermal convection, I will discuss the maximum theoretical Nusselt number that can be achieved by such internally heated and cooled convection. I will show that there exist steady laminar solutions that transport heat more efficiently than the ultimate regime, with a scaling behavior Nu~Ra. These solutions can be stable in 2D, but they are unstable in 3D and quickly evolve into a turbulent state. I will show that a maximization of the heat transport over turbulent flows only leads to an upper bound on the Nusselt number that is proportional to the square root of the Rayleigh number, in line with the experimental data.