Radiatively heated thermal convection: bypassing the boundary layers to achieve the « ultimate » scaling regime

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The heat flux transported by thermal convection has important implications for geophysical, astrophysical and industrial flows: one seeks a power-law relation between the convective heat flux and the internal temperature gradients. Decades of investigations of the Rayleigh-Bénard (RB) setup indicate that the heat transport is strongly restricted by boundary layers near the hot and cold solid plates. This prevents the observation of the "ultimate" scaling-regime of thermal convection, where bulk turbulence controls the convective heat flux independently of molecular viscosity and thermal diffusivity. In contrast with the RB setup, many geophysical and astrophysical convective flows are driven by radiation: the absorption of an incoming light flux by a body of fluid induces local heating. We have developed a laboratory experiment that reproduces such radiative heating: heat is input radiatively, directly inside the bulk turbulent flow and away from the boundary layers. We will provide experimental evidence that this naturally leads to the ultimate regime of thermal convection.