

Three-Dimensional Rayleigh–Bénard Instability in a Supercritical Fluid by Direct Numerical Simulation

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This paper describes the unsteady convective flow of a supercritical fluid in Rayleigh–Bénard configuration using direct numerical simulation. Two-dimensional earlier studies reported fast temperature equilibrium due to the piston effect and the development of a convective instability when the local Rayleigh number exceeds a critical value. In the present work, a high order 3D finite volume method has been developed and optimized, the code has been thoroughly validated, and to our knowledge, we show for the first time a three-dimensional convective instability in a supercritical fluid. Inspecting the time-evolution of temperature field patterns, we show the time-transition to convection-dominated flow causing the collapse of the boundary thermal layers, we exhibit corner effects and the three-dimensional behavior of the flow, and we show the heating intensity effects on the temperature field structure.

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