Han, Daozhi; **Hernandez, Marco**; **Wang, Quan**

Dynamic bifurcation and transition in the Rayleigh-Bénard convection with internal heating and varying gravity. (English) Zbl 1415.37097

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Summary: In this article, we study the dynamic transition of the Rayleigh-Bénard convection with internal heating and varying gravity. We show that this problem can only undergo a continuous or catastrophic transition, and the specific type is completely determined by the sign of a parameter – referred to as the transition number – that depends on the aspect ratio. Through numerical simulations we compute, for six qualitatively different heating sources, the corresponding value of the transition number, and find that the transition is always continuous. In particular, after transition, the system bifurcates from a basic steady state to a family of stable steady states, homeomorphic to $\mathbb{S}^1$, that describe the heating convection. Furthermore, upon varying the aspect ratio immediately after the first transition has occurred, we find the existence of a second transition, which is always catastrophic. More precisely, there exists a family of discrete values of the aspect ratio, which are the discontinuity points of the transition number, at which the transition is catastrophic and the number of convection rolls changes.

MSC:

37L15	Stability problems for infinite-dimensional dissipative dynamical systems	Cited in **7** Documents
76D10	Boundary-layer theory, separation and reattachment, higher-order effects	
76E06	Convection in hydrodynamic stability	
76E20	Stability and instability of geophysical and astrophysical flows	

Keywords:

Rayleigh-Bénard convection; internal heating sources; dynamic transition; continuous and catastrophic transition; reduced equation

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