Abstract Submitted
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On the transition to chaos of natural convection between two infinite differentially heated vertical plates[1] ZHENLAN GAO, LIMSI-CNRS Universite Pierre et Marie Curie, BERENGERE PODVIN, LIMSI-CNRS, ANNE SERGENT, LIMSI-CNRS Universite Pierre et Marie Curie, SHIHE XIN, CETHIL INSA DE LYON, PATRICK LE QUERE, LIMSI-CNRS, LAURETTE TUCKERMAN, PMMH ESPCI — Natural convection of air between two infinite vertical differentially heated plates is studied analytically in two dimensions (2D) and numerically in two and three dimensions (3D), for Rayleigh numbers Ra up to three times the critical value Ra_c. The first instability is a supercritical circle pitchfork bifurcation leading to steady 2D corotating rolls. A Ginzburg-Landau equation is derived analytically for the flow around this first bifurcation and compared with results from direct numerical simulation (DNS). In 2D, DNS shows that the rolls become unstable via a Hopf bifurcation. As Ra is further increased, the flow becomes quasiperiodic, then temporally chaotic for a limited range of Rayleigh numbers, beyond which the flow returns to a steady state through a spatial modulation instability. In 3D, the rolls instead undergo another pitchfork bifurcation to 3D structures, which consist of transverse rolls connected by counter-rotating vorticity braids. The flow then becomes time-dependent through a Hopf bifurcation, as exchanges of energy occur between the rolls and the braids. Chaotic behavior subsequently occurs through two competing mechanisms: a sequence of period-doubling bifurcations leading to intermittency or else a spatial pattern modulation.

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Zhenlan Gao
LIMSI-CNRS Universite Pierre et Marie Curie

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