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Three-dimensional instability of cylindrical Rayleigh-Benard convection[1] DE-JUN SUN, BO-FU WANG, Department of Modern Mechanics, University of Science and Technology of China, Hefei, Anhui 230027, China, DONG-JUN MA, School of Aerospace Engineering, Georgia Institute of Technology, Atlanta, GA 30332, USA — The instabilities and transitions of flow in a vertical cylindrical cavity with heated bottom, cooled top and insulated side wall are investigated. The fluid is quiescent at small Rayleigh number and becomes axisymmetric or three dimensional flow when the Rayleigh number is increased. We mainly concerned on the transition of the axisymmetric flow to three dimensional flow through a secondary bifurcation. The steady axisymmetric base flow is obtained by direct numerical simulation and Jacobian-Free Newton-Krylov method, and the stability modes are obtained using the global instability analysis technique. The stability boundaries for the axisymmetric flow are derived for Prandtl numbers from 0.02 to 1 for aspect ratio A (=height/radius) equals 1, 0.9, 0.8, 0.7, respectively. Stable axisymmetric flow beyond the second bifurcation was found in certain ranges of Prandtl number for A=1, 0.9 and 0.8, exclusive of the case for A=0.7. There is no new axisymmetric flow after the second bifurcation for A=0.7 case, but there are multiplicity critical modes as Prandtl number changes., where five kinds of steady modes m=1, 2, 8, 9, 10 and three kinds of oscillatory modes m=3, 4, 6 are presented.

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