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Size-Dependent Rayleigh–Bénard Problem AREZOO HAJESFANDIARI, ALI HADJESFANDIARI, GARY DARGUSH, University at Buffalo, State University of New York — Problems of thermoviscous flows are of prime importance for many physical processes. Here the classical Boussinesq equations are modified by including couple stresses, which account for size-dependency. This size-dependency is specified by a material length scale l, which becomes increasingly important as the characteristic geometric dimension of the problem decreases. The modified two-dimensional linear momentum equations become

$$\rho\left(\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}\right)=-\frac{\partial p}{\partial x}+\mu\nabla^2 u-\mu l^2\nabla^2\nabla^2 u$$

$$\rho\left(\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}\right)=-\frac{\partial p}{\partial y}+\mu\nabla^2 v-\mu l^2\nabla^2\nabla^2 v-\rho\alpha\left(T-T_0\right)$$

The stability of natural convection for the Rayleigh–Bénard problem is studied numerically and we consider the onset of convective instability and multiple stable steady states arising within specific ranges of Rayleigh and Prandtl numbers and l.

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