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BOUNDS ON THE VERTICAL HEAT TRANSFER FOR THE RAYLEIGH–BÉNARD CONVECTION IN THE MICROPOLAR FLUID

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ABSTRACT

We consider the Rayleigh–Bénard setting of a horizontal layer of fluids confined by two parallel planes a distance h apart. The fluid is heated at the bottom plane at temperature T_0 and cooled at the top plane at temperature T_1 ($T_0 > T_1$). The dynamic model consists of the advection-diffusion equation for the temperature coupled with the incompressible micropolar fluid equations via a buoyancy force proportional to the temperature.

We establish connections between the heat flux and the energy dissipation for given Prandtl and Rayleigh numbers. Moreover, we obtain physically relevant bounds on the Nusselt number in terms of the Rayleigh number and the nondimensional micropolar parameters and compare them with that for the classical Boussinesq model, namely,

$$\mathrm{Nu} \leq \frac{1}{4}\sqrt{\mathrm{Ra}} - 1.$$

(For the overview of the classical problem cf. references [1–3]).

It occurs that the presence of the microrotation field in the fluid stabilizes the fluid flow (due to internal friction) and even may stop the convective heat transport.

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