A new Oberbeck-Boussinesq approximation with density depending also on the pressure and Bénard problem

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Abstract

In this talk we present the so-called *extended-quasi-thermal-incompressible* model, recently proposed by Gouin & Ruggeri [1] in which it was proved that for thermodynamical stability the compressibility factor β cannot be neglected and has to be greater than a critical value. For this reason in the Oberbeck-Boussinesq approximation we insert a more realistic constitutive equation by putting in the buoyancy term a density which depends not only by the temperature but also on the pressure. The equation for the pressure is then modified by an extra dimensionless parameter $\hat{\beta}$ which is proportional to the compressibility factor. The linear instability of the thermal conduction solution in horizontal layers heated from below (Bénard problem) is investigated [2]. It is shown: i) the rest state pressure profile is different from the parabolic one; ii) if convection arises this happens via a stationary state and the strong principle of exchange of stability holds; iii) convection arises provided that the related Rayleigh number is larger then a critical value and the latter coincides in the limit of vanishing $\hat{\beta}$ with the classical one, and decreases as $\hat{\beta}$ increases.

References

[1] Gouin H., Ruggeri T., *A consistent thermodynamical model of incompressible media as limit case of quasi-thermal-incompressible materials*, Int. J. of Non-Linear Mech. **47** 688−693 (2012).

[2] Passerini A., Ruggeri T., *The Bénard problem for quasi-thermal-incompressible materials: A linear analysis Int. J. of Non-Linear Mech.* **67**, 178−185 (2014).