Influence of depth-dependent Brinkman viscosity on the onset of convection in ternary porous layers

Salvatore Rionero

Department of Mathematics And Applications "R.Caccioppoli". University of Naples "Federico II"

rionero@unina.it

Abstract

In the Darcy-Boussinesq-Brinkman scheme, the onset of convection in a porous horizontal layer $\mathbb{L}$ with depth-dependent permeability and viscosities, is investigated. The linear instability is studied and the global nonlinear stability is investigated via the Auxiliary System Method. By looking for symmetries and skew-symmetries hidden in the Darcy-Boussinesq-Brinkman model, a condition, in closed form, guaranteeing the global nonlinear stability, is furnished. Applications to the earth's mantle and to artificial porous materials are furnished.

Keywords: Porous materials, depth-dependent porosity and viscosities, convection, ternary Brinkman porous layers.

References

[1] Torrance, K.E.; Turcotte, D.L. *Thermal convection with large viscosity variations*. J. Fluid Mech. 47, 113-125, (1971).

[2] Kassoy, D.R.; Zebib, A. *Variable viscosity effects on the onset of convection in porous media*. Phys. Fluids 18, 1649-1651, (1975).

[3] Straughan, B. *Stability Criteria for convection with large viscosity variations*. Acta Mech. 61, 59-72, (1986).

[4] Fontaine, F. Jh., Rabinowicz, M., Boulegue, J. *Permeability changes due to mineral diagenesis in fractured crust*. Earth and Planetary Science Letters, 184, 407-425, (2001).

[5] Nield, D.A., Kuznetsov, A.V. *The effect of a transition layer between a fluid and a porous medium: shear flow in a channel.* Transp. Porous Med., 72, 477-487, (2009).

[6] Rionero, S. *Onset of convection in porous materials with vertically stratified porosity.* Acta Mech., 222, 261-272, (2011).

[7] Nield, D.A., Kuznetsov, A.V. *Optimization of forced convection heat transfer in a composite porous medium channel.* Transp. Porous Med., 99, 349-357., (2013).

[8] Nield, D.A., Bejan, A. Convection in Porous Media, 4th edition, Springer, (2013).

[9] Straughan, B. Stability and wave motion in porous media. Springer Appl. Math. Sc. 165, (2008).

[10] Flavin, J.N.; Rionero, S., Qualitative estimates for partial differential equations: an introduction. Boca Raton (FL): CRC Press, (1996).

[11] Rionero, S. *Multicomponent diffusive-convective fluid motions in porous layers: ultimately boundedness, absence of subcritical instabilities and global non linear stability for any number of salts.* Phys. Fluids, 25, 054-104 (2013).

[12] Rionero, S. *Soret effects on the onset of convection in rotating porous layers via the "auxiliary system method".* Ricerche di Matematica, Vol. 62, Issue 2, 183–208, (2013).

[13] Rionero, S. *Symmetries and skew-symmetries against onset of convection in porous layers salted from above and below.* Int. J. Nonlinear Mech., 47, 61-67, (2012).

[14] Capone, F., Rionero, S. *Inertia effect on the onset of convection in rotating porous layers via the "auxiliary system method".* Int. J. Non-linear Mech., 57, 192-200, (2013).

[15] Capone, F., De Luca, R. *Ultimately boundedness and stability of triply diffusive mixtures in rotating porous layers under the action of Brinkman law.* Int. J. of Non-Linear Mech. 47, issue 7, 799-805, (2012).

[16] Capone, F., De Luca, R. *Onset of convection for ternary fluid mixtures saturating horizontal porous layers with large pores.* Rendiconti Lincei Matematica e Applicazioni, 23 (4), 405–428, (2012).

[17] Rionero, S. *Heat and Mass transfer by convection in multicomponent Navier-Stokes mixtures: absence of subcritical instabilities and global nonlinear stability via the Auxiliary System Method.* Rend. Lincei Mat. Appl., 25, 1, 1-44, (2014).

[18] Rionero, S. *Convection in ternary porous layers with depth-dependent permeability and viscosity.* (2014) (submitted).

[19] Rionero, S. *Influence of depth-dependent Brinkman viscosity on the onset of convection in ternary porous layers.* Transp. Porous. Med. DOI 10.1007/s11242-014-0397-1 (2014).