Linear and nonlinear stability analyses of double-diffusive convection in a porous layer due to the magnetic field and throughflow effects

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ABSTRACT

This study has looked into the beginning of double-diffusive convection in a horizontal fluid-saturated porous layer for both linear and nonlinear cases. Vertical throughflow and the magnetic field effects are taken into consideration during the investigation. The normal mode technique and the energy method are, respectively, employed to analyze the linear and nonlinear stability. The corresponding linear and nonlinear eigenvalue equations were solved numerically via boundary value problem solver *bvp4c* routine in MATLAB (2022a). The critical thermal Rayleigh number and associated wave number are obtained for various flow-governing parameters and shown them graphically. It has been noticed that the system shows more stableness for higher values of the magnetic parameter (Ha^2) and helps to compress the subcritical instabilities region. Increasing the Lewis number (Le) stabilized the fluid motion while the system is destabilized at a high solutal Rayleigh number (Ra_s). Further, the significant impact of the Pèclet number (Pe) on the instability mechanism is discussed due to upward or downward throughflow whether a magnetic field is present or not.

KEYWORDS: Double-diffusive convection, Linear stability, Nonlinear stability, Magnetic field, Vertical throughflow, Porous medium.