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INSTITUT DE MECANIQUE DES FLUIDES - Amphi Nougaro
allée du Professeur Camille Soula, Toulouse

Instabilities of Binary Mixtures in Planar Layers and Thermogravitational Columns

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A theoretical and computational study of Soret separation of a binary mixture contained in a differentially heated inclined infinite layer is presented. We first calculate the basic steady one-dimensional flow taking into account the concentration gradient caused by thermodiffusion. Unstable (stable) stratification is induced at negative (positive) separation ratios (ε). Linear stability of this basic state is performed and the critical Rayleigh number, wave numbers (longitudinal and transverse with the roll axis parallel and perpendicular to the layer, respectively), frequency, and vertical concentration gradient are determined as functions of the Lewis (Le), Parndtl numbers (Pr) and inclination angle (δ). It is shown that negative separation drives long wavelength longitudinal diffusional instabilities with a lower bound that depends on ε, Le, Pr and δ. The heated from below horizontal layers are 2D overstable while the heated from above horizontal layers are 2D double-diffusive unstable at zero wavenumbers. Long wavelength asymptotics are used where appropriate showing excellent agreement with Chebyshev pseudospectral solutions.

Supercritical nonlinear finite volume computations of a particular water-ethanol mixture in vertical boxes of various aspect ratios are in agreement with linear theory and available experiments. Stability restrictions when $\varepsilon < 0$ and recommendations for the operation of the thermogravitational column will be discussed.

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