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Multi-component diffusion and penetrative convection

B. Straughan

Department of Mathematics, University of Tennessee, 121 Ayres HallKnoxville, TN 37996-1300USAUSA

D.W. Walker

Mathematical Sciences Section, Oak Ridge National Laboratory, P.O. Box 2008Oak Ridge, TN 37831-6367USAUSA

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The problem is the investigation of penetrative thermal convection in a three constituent fluid. The stability criteria are derived by a Chebyshev tau method. Very interesting neutral curves are derived including non-perfect “heart shaped” oscillatory curves affording a variety of complex dynamical behaviour, and an isolated oscillatory curve allowing stability in distinct finite regions of the Rayleigh number space. When the penetration effect is increased the closed oscillatory curves become more skew and for certain parameters it is found that the closed curve has the same minimum critical Rayleigh number as the unbounded stationary convection one. This leads to the novel prediction that different types of instability will occur at the same critical Rayleigh number but for different wave numbers. The behaviour of the growth rate is investigated to some extent and we see that an exchange of stabilities is occurring between the leading group of eigenvalues (i.e. the growth rate) whereby the eigenvalue with greatest real part may be a complex conjugate pair which is “overtaken” by a purely real eigenvalue in a suitable part of the Rayleigh number domain.