Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

WITHDRAWN: Compressibility effects on the onset of convection in the Rayleigh-Bénard problem AVSHALOM MANELA, ITZCHAK FRANKEL, Faculty of Aerospace Engineering, Technion-Israel Institute of Technology, Haifa 32000, Israel — For the onset of convection in a compressible fluid in a Rayleigh-Bénard setup the adiabatic expansion of a fluid element rising through the reference hydrostatic pressure field needs to reduce its density below the ambient reference value. This condition is initially satisfied at the upper wall when the Froude number attains some minimal value, $Fr = Fr_0$. Recent studies based on nonlinear simulations of the initial-value problem and linear stability analyses indicate that, with decreasing $\delta = (Fr - Fr_0)/Fr_0$, convection is confined to an increasingly narrower domain adjacent to the upper wall while the corresponding wavenumber becomes increasingly large. These observations are correlated with the above necessary condition via a linear temporal stability analysis for a perfect gas in the limit $\delta \ll 1$ under arbitrary temperature differences. Transition to convection is governed by a single equation for the vertical velocity. This equation differs from the familiar Boussinesq equation in that the 'Rayleigh term' is replaced by a term which is linearly dependent upon the vertical coordinate. Making use of an integral representation we apply the method of steepest descents to satisfy the boundary conditions thereby obtaining the requisite eigenvalue problem. The results showing the width of the convection domain and the critical wavenumber as $O(\delta)$ and $O(\delta^{-1})$, respectively, are in remarkable agreement with those appearing in the literature.

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Date submitted: 07 Nov 2005 Electronic form version 1.4