Abstract Submitted
for the DFD07 Meeting of
The American Physical Society

Rayleigh-Benard-Marangoni instability of a horizontal non-Boussinesq fluid layer with a deformable free surface TATYANA LYUBIMOVA, DIMITRI LYUBIMOV, NIKOLAI LOBOV, Perm State University, IWAN ALEXANDER, Case Western Reserve University — The stability of the conductive state of a horizontal fluid layer with a deformable free surface, a flat isothermal rigid lower boundary and a convective heat transfer condition at the free surface is considered. The fluid is assumed to be isothermally incompressible. In contrast to the Boussinesq approximation, density variations are accounted for in the continuity equation and in the buoyancy and inertial terms of the momentum equations. Three different types of temperature dependence of the density are considered: linear, exponential and ideal gas. The long-wave instability is studied analytically and instability to perturbations with finite wave number is examined numerically. It is found that there is a decrease in stability of the system with respect to the onset of long-wave Marangoni convection. This result could not be obtained within the framework of the conventional Boussinesq approximation. It is also shown that at $Ma = 0$ the critical Rayleigh number increases with Ga (the ratio of gravity to viscous forces or Galilei number). At some value of Ga, the Rayleigh-Bènard instability vanishes. This stabilization occurs for each of the density equations of state. At small values of Ga and when deformation of the free surface is important, results predicted using the Boussinesq approximation be misleading.

Iwan Alexander
Case Western Reserve University

Date submitted: 12 Sep 2007 Electronic form version 1.4