# Nonlinear regimes of monotonic and oscillatory Marangoni convection

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**Alexey A. Alabuzhev***, **Sergey Shklyaev**†, **Mikhail Khenner**‡

* Institute of Continuous Media Mechanics UB RAS
1, Ak. Koroleva, 614013 Perm, Russia
e-mail:alabuzhev@icmm.ru - web page: http://www.icmm.ru

†Department of Chemical Engineering, California Institute of Technology
1200 California Blvd, Pasadena, CA 91125, USA
e-mail: shklyaev@yandex.ru

‡Department of Mathematics, Western Kentucky University
Bowling Green, Kentucky 42101, USA
e-mail: mikhail.khenner@wku.edu - Web page: http://www.wku.edu

## ABSTRACT

In our recent work [1], we derived a novel set of amplitude equations describing a longwave Marangoni convection in a layer with deformable free surface, heated from below. Within this set, based on the unusual scaling for the Biot number $Bi \sim k^2$, where $k$ is the perturbation wavenumber, the unexpected behavior was found. In particular, in addition to the conventional monotonic mode of instability, the oscillatory mode was revealed. Weakly nonlinear analysis on a fixed lattice demonstrates that both steady and time-periodic solutions (Traveling Rolls) are stable near the stability threshold [1].

The present contribution is devoted to further nonlinear analysis of the patterns within this set of amplitude equations. We consider one-dimensional periodic in space solutions and their stability for both the steady Rolls and the Traveling Rolls.

For the monotonic mode the branching solution is stable on a fixed lattice in a wide interval of the Marangoni number. At high enough Marangoni number, the solution loses its stability via the subcritical branching of a Traveling Rolls of vanishing frequency. A similar bifurcation was found, for instance, in binary fluid convection (see [2] and references therein).

Traveling Rolls are shown stable with respect to periodic perturbations only within a narrow interval of the Marangoni number. At higher values of the supercriticality a heteroclinic cycle emerges: the system alternates between attraction and repulsion from two unstable limit cycles, Traveling Rolls and Standing Rolls.

We also perform the stability analysis of the periodic solutions with respect to the space (one-dimensional) modulations. The Busse balloons for Steady Rolls are found, whereas Traveling Rolls are unstable in the entire range of the parameters. For small-amplitude solutions, these results are confirmed within the corresponding sets of Ginzburg-Landau equations.

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