Oscillatory Instabilities in Systems with Interfaces

Ilya B. Simanovskii

Department of Mathematics, Technion - Israel
Institute of Technology, 32000 Haifa, Israel

It is known that the stability problem for the mechanical equilibrium state in a system with an interface is not self-adjoint, thus an oscillatory instability is possible. However, in real situations the minimum value of the Grashof number for the oscillatory instability is higher than that for the monotonic instability. In the present work the oscillatory instability in systems with interfaces is investigated in the framework of linear and nonlinear theories.

1. The influence of the thermocapillary effect on convective oscillations is considered. It is found that under the joint action of the buoyancy and the thermocapillary effect the oscillatory instability may become the most "dangerous". The nonlinear evolution of the oscillatory instability is studied. It is shown that the oscillatory motion is observed in the finite interval of the Grashof number values.

2. Conditions for the appearance of oscillations may be simplified in the presence of the interfacial heat sources or heat sinks. In the case of periodic boundary conditions, regimes of traveling waves and pulsating traveling waves have been revealed. In the case of rigid boundary conditions, symmetric and asymmetric standing waves are observed. Transitions between various oscillatory regimes have been studied. For different types of boundary conditions, the period doubling bifurcation is obtained.

3. The oscillatory instability in systems with two interfaces is investigated. It is shown that the oscillatory instability in multilayer systems is much more widespread than in a two-layer systems. The "indirect" interaction of different mechanisms of instability may lead to the appearance of the specific type of oscillations. The region of the Grashof number values, where nonlinear oscillations take place, is bounded both from below (by the mechanical equilibrium state) and from above (by the steady state).