Oscillatory motion of liquid metals in non- isothermal geometries with converging or diverging walls

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Thermogravitational flows of liquid metals are widespread in technology and related engineering applications. We investigate the typical properties of these flows and associated hierarchy of bifurcations in geometries with converging or diverging walls by solving the Navier Stokes and energy equations in their time-dependent and non-linear formulation. It is shown that an increased variety of oscillatory patterns and waveforms (with respect to classical purely rectangular cavities) is made possible by the new degree of freedom represented by the opposite inclination of the walls with respect to the horizontal direction. Even limited variations in the geometry and/or initial conditions can cause significant changes. An increase (a decrease) in the geometrical expansion (or compression) ratio η from the condition $\eta \cong 1$determines a reduction of the number of rolls, whereas an increase in the Rayleigh number is generally responsible for an increase in the wavenumber m, the angular frequency and the complexity of the frequency spectrum (with the possible coexistence in some circumstances of disturbances operating at different time and spatial scales). The most interesting information provided by our numerical results, however, is the evidence they give about the existence of "multiple states", which can replace each other in given sub-regions of the space of parameters. Observed regimes include: quasi-stationary convection, weakly oscillating rolls, coalescing rolls, traveling waves, and modulated (pulso-traveling) disturbances.

Keywords:
Buoyancy flow, Hydrodynamic instability, CFD