A NUMERICAL INVESTIGATION OF BÉNARD CONVECTION IN SMALL ASPECT RATIO CONTAINERS

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Numerical simulations of combined buoyant and surface-tension-driven (Rayleigh-Bénard-Marangoni) flow are conducted for heated fluid layers of small aspect ratio (defined as the horizontal extent of the domain divided by the depth of the fluid) in polygonal containers. Classical results from linear stability analysis are discussed in the context of small aspect ratio containers, and used to define a significant region of the parameter space spanned by the Marangoni number Ma (a surface tension parameter), the Rayleigh number Ra (a buoyancy parameter) and the aspect ratio Γ. The Galerkin finite element formulation for the coupled incompressible Navier-Stokes and heat transfer equations is given, and implementation aspects are briefly discussed. Numerical results displaying distinct steady-state patterns containing between 1 and 8 convection cells are given for a range of aspect ratios between 3 and 11. The appearance of pentagonal and hexagonal convective cells are discussed, and some of the properties of the transition to the fully hexagonal convection regime are noted. The associated simulations are carried out on PC clusters using a parallel domain decomposition strategy for the coupled thermocapillary viscous flow and heat transfer problem.