

SOLUTOCAPILLARY SPHERICAL CONVECTION

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Marangoni convection can be driven in spherical shells containing a solvent and a solute due to solvent evaporation at the outer surface. The viscosity is a function of the solvent concentration, the inner surface is assumed impermeable and stress free, while non-linear boundary conditions are derived and prescribed at the receding outer boundary due to evaporation with a prescribed mass transfer coefficient. A time-dependent diffusive state is possible and may lose stability because of surface tension dependence on solvent concentration. The Capillary number provides a measure of the deviation from sphericity and as it tends to zero the leading order outer surface evolves with time in a convective state as it does in the diffusive state. A frozen-time or quasi-steady state linear stability analysis is performed to compute the critical Reynolds number and degree of surface harmonics, as well as the maximum growth rate of perturbations at specified parameters. The development of maximum growth rates in time is also computed by solving the initial value problem with random initial conditions. Results from both approaches are in good agreement except at short times where there is dependence on initial conditions. We compute nonlinear, time-dependent, axisymmetric and three-dimensional supercritical motions and companion, compatible free surface deformations in this moving boundary problem subject to random initial conditions. The nonlinear results are compared with those from linear theory and microencapsulation experiments on laser targets used in inertial confinement fusion.