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Three dimensional Solutocapillary Convection in Spherical Shells[1] PRAVIN SUBRAMANIAN, ABDELFATTAH ZEBIB, Rutgers University
— Nonlinear, time-dependent, three-dimensional, variable viscosity, infinite Schmidt number solutocapillary convection in spherical shells is computed by a finite-volume method. The shell contains a solute and a solvent, and the inner boundary is impermeable and stress free. The solvent evaporates at the outer surface into a water-solvent environment with a prescribed mass transfer coefficient. Convection is driven by surface tension dependence on the solvent concentration C. A time-dependent diffusive state characterized by concentration $C_d(r,t)$ and a receding outer surface $r_{2d}(t)$ is possible and is a function of the mass transfer Biot number, a partition coefficient, and ambient solvent concentration C_∞. It loses stability at critical values of the Marangoni number and degree of surface harmonic. In the limit of small Capillary number $Ca \to 0$ the outer radius deviation from sphericity $\delta(\theta,\phi,t)$ is $O(Ca)$ and $r_2(\theta,\phi,t)$ is given by $r_{2d}(t)$ in the $O(1)$ convection. We compute super-critical motions and companion $\delta(\theta,\phi,t)$ in this moving boundary problem subject to random initial conditions and compare nonlinear results with those from linear theory, axisymmetric calculations and available experiments.

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