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Hydrodynamics and evaporation of a sessile drop of capillary size
LEV BARASH, Landau Institute for Theoretical Physics, TERRY BIGIONI, James Frank Institute, The University of Chicago, VALERII VINOKUR, Material Science Division, Argonne National Laboratory, LEV SHCHUR, Landau Institute for Theoretical Physics — Several dynamical stages of the Marangoni convection of an evaporating sessile drop are obtained. We jointly take into account the hydrodynamics of an evaporating sessile drop, effects of the thermal conduction in the drop and the diffusion of vapor in air. The stages are characterized by different number of vortices in the drop and the spatial location of vortices. During the early stage the array of vortices arises near a surface of the drop and induces a non-monotonic spatial distribution of the temperature over the drop surface. The number of near-surface vortices in the drop is controlled by the Marangoni cell size, which is calculated similar to that given by Pearson for flat fluid layers. The number of vortices quickly decreases with time, resulting in three bulk vortices in the intermediate stage. The vortex structure finally evolves into the single convection vortex in the drop, existing during about 1/2 of the evaporation time. Simulation results agree well with the data of evaporation rate measurements for the toluene drop. Computed dependence of contact angle of colloidal sessile droplet during evaporation coincide well with available experimental time dependence of angle of nanocrystal superlattice domains orientation.

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