Marangoni instability in isotropic droplets suspended on a circular frame

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2023

We study thermocapillary instability within small oblate droplet in a presence of the vertical heat flow. This formulation differs from that of the classical problem for a thin layer in two free surfaces and a finite lateral size (or a smooth variation of the layer height). Within the framework of the adiabatic approximation with respect to the small curvature of the drop surface and using the neutral stability curves for infinite plane layer, we obtained:

- correction to the critical temperature gradient ($\delta \mathrm{Ma}_c \sim H/R$);
- localization size of the critical perturbation $\sim \sqrt{HR}$, which being parametrically smaller than the drop size, nevertheless contains many critical vortices.

Using the analytical complete basis for the solutions of Stokes equation in spheroidal coordinates, a numerical solution of a generalized eigenvalue problem was obtained. This allowed us to describe the critical motion in a drop of a finite size, see Fig.1.

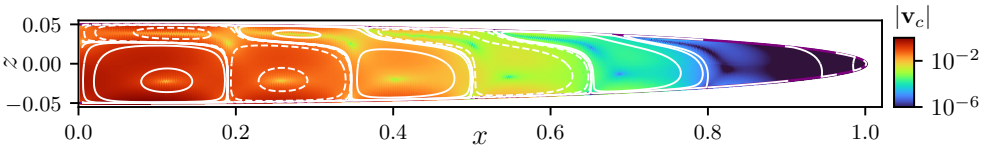

Figure 1: Critical convection motion (the velocity modulus is shown in logarithmic scale) within the strongly oblate free drop.

This work was made in cooperation with K. S. Kolegov, S. A. Pikin, B. I. Ostrovskii, and E. S. Pikina.

References

[1] E. S. Pikina, M. A. Shishkin, K. S. Kolegov, B. I. Ostrovskii, and S. A. Pikin, "Circulating marangoni flows within droplets in smectic films", Phys. Rev. E **106**, 055105 (2022).

[2] M. A. Shishkin, K. S. Kolegov, S. A. Pikin, B. I. Ostrovskii, and E. S. Pikina, "Marangoni instability in oblate droplets suspended on a circular frame", sent to Physics of Fluids.