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On Target Pattern Formation in the CHNS system

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We study the concentration field in a prescribed 2D Cahn-Hilliard Navier-Stokes (CHNS) system, which has similarity to the 2D MHD system. The flow field is a rotating eddy and not affected by the concentration field. We formulate a description for the target pattern formation and pattern merging processes of concentration field, and compare this description with simulation results. Shear-augmented diffusion along prescribed streamlines causes a separation of time scales. The fastest characteristic time scale is the eddy turn over time, while the slowest is the radius-diffusion time. Thus 2D CHNS system can be simplified to a 1D system when time is bigger than eddy turn-over time but smaller than radius-diffusion time. In this 1D system, target pattern formation is induced by linear instability. The waveform of patterns is described by Jacobi Elliptic Functions. The interface (of pattern) migration or coarsening velocity is determined by the derivative of interface curvature. The anomalous migration of inner pattern can be explained by the singularity at the origin and therefore the boundary motion in the quasi-one dimension system. Finally, we derive a simple criterion for when CHNS system becomes dynamic by following similar cases in MHD. The non-passive condition for CHNS system is $\mathrm{M}^2 Rm_e^{3/5} \sim 1$, which is similar to the result in MHD and might relate to the turbulent transport properties of CHNS system.

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Figure 1. There exists a set of solutions with different α and satisfies the Cahn-Hilliard equation, and is the waveform of target patterns.

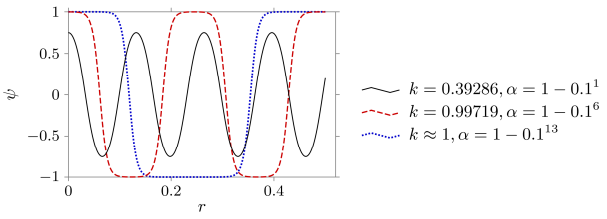

Figure 2. Evolution of interfaces of target patterns can be described with 3 formulas.