

**The Hong Kong Polytechnic University
Department of Applied Mathematics**

Colloquium

A positivity preserving, energy stable finite difference scheme for the Flory-Huggins-Cahn-Hilliard-Navier-Stokes system

By

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Abstract

A finite difference numerical scheme is proposed and analyzed for the Cahn-Hilliard-Navier-Stokes system, with logarithmic Flory-Huggins energy potential. In the numerical approximation to the singular chemical potential, the logarithmic term and the surface diffusion term are implicitly updated, while an explicit computation is applied to the concave expansive term. Moreover, the convective term in the phase field evolutionary equation is approximated in a semi-implicit manner. Similarly, the fluid momentum equation is computed by a semi-implicit algorithm: implicit treatment for the kinematic diffusion term, explicit update for the pressure gradient, combined with semi-implicit approximations to the fluid convection and the phase field coupled term, respectively. Such a semi-implicit method gives an intermediate velocity field. Subsequently, a Helmholtz projection into the divergence-free vector field yields the velocity vector and the pressure variable at the next time step. This approach decouples the Stokes solver, which in turn drastically improves the numerical efficiency. The positivity-preserving property and the unique solvability of the proposed numerical scheme is theoretically justified, i.e., the phase variable is always between -1 and 1, following the singular nature of the logarithmic term as the phase variable approaches the singular limit values. In addition, an iteration construction technique is applied in the positivity-preserving and unique solvability analysis, motivated by the non-symmetric nature of the fluid convection term. The energy stability of the proposed numerical scheme could be derived by a careful estimate. A few numerical results are presented to validate the robustness of the proposed numerical scheme.



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Date: 27 July 2022 (Wednesday)

Time: 10:00-11:00 (Hong Kong Standard Time GMT +8)

Venue: Online Talk via Zoom (Meeting ID: 994 4096 5674)

Speaker: Prof. Cheng Wang, University of Massachusetts Dartmouth

Host: Dr. Xiao Li, The Hong Kong Polytechnic University

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<https://polyu.zoom.us/j/99440965674?pwd=b1dnbGhzUkV4WGFreVVpcWRHYWVnZz09>

***** ALL ARE WELCOME *****

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