Pattern formation in the driven Widom-Rowlinson lattice gas

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This work investigates the interplay between pattern formation and non-equilibrium behavior in physical systems from the viewpoint of non-equilibrium statistical mechanics and pattern formation theory.

The investigation employs two distinct yet complementary approaches: analytical and numerical. The analytical approach focuses on theoretical tools such as pattern-type classification, stability analysis, and dynamical critical phenomena approaches (dynamical renormalization group and the Doi-Peliti mapping). However, for spatially extended systems, key quantities like order parameters evolve into fields described by deterministic and stochastic partial differential equations (PDEs). Since analytical solutions are often intractable, the numerical approach explores advanced techniques for PDE integration.

Our results and objectives will be divided in two parts. In the first part, we validate the developed tools on well-known models, the Cahn-Hilliard (CH) and the Swift-Hohenberg (SH). We find the best numerical integration method to be the pseudo-spectral exponential time differencing (PS-ETD) scheme.

In the second part, we apply these tools to study the driven Widom-Rowlinson lattice gas (DWRLG) [1]. We employ two different field theoretic coarse-grained descriptions to study the model: the Doi-Peliti mapping [2] and a novel phenomenological approach. This combined exploration, leveraging elements from pattern formation and dynamical critical phenomena, presents a new perspective, thus extending the work originally done by the authors.

References

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