

Equilibrium and Out-of-Equilibrium Explorations of Self-Assembled Magnetic Colloids

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Colloidal particles, due to their visualization under an optical microscope, play a pivotal role in understanding microscopic phenomena. The integration of magnetic inclusions in these particles surfaces additional features attributable to the emergence of magnetism and fluidity. These elements enhance the capability of the systems to observe novel features that are beyond conventional colloidal systems. I have conducted the self-assembly of magnetic colloidal particles using the Stockmayer (SM) model, which describes the interparticle interactions comprising the long-range dipolar and Lennard-Jones (LJ) potentials. The model exhibits gas-liquid phase coexistence, as observed experimentally in magnetic fluids. I will present a series of comprehensive computational analysis conducted under equilibrium and non-equilibrium conditions, which can be summarized as follows: (i) Coarsening studies of magnetic fluids to observe the long-awaited inertial growth law predicted by Furukawa. This regime emerged at late simulation times through molecular dynamics simulations, making a significant contribution to the literature. (ii) Investigated the equilibrated aggregates observed in the evolution of phase-segregating phases, leading to the formation of density-driven morphologies with unusual magnetic order. (iii) Designed the cooling protocols to observe the single-domain magnetic crystals from colloidal suspensions of magnetic dipoles. (iv) Examined the glassy features inherent in monodisperse magnetic fluids by conducting a comparative study of LJ and SM fluids.

References

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