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Multiple ferrofluid droplet impact on a solid wall under a uniform magnetic field: A fractional step lattice Boltzmann investigation

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Ferrofluid droplet impact on solid surfaces is a common phenomenon widely encountered in microfluidic manipulation, inkjet printing, and biomedical diagnostics. While single ferrofluid droplet impact has been extensively studied, the complex interfacial behaviors, droplet-droplet interactions, and magnetic field controlling mechanisms of multiple ferrofluid droplets under a uniform magnetic field remain poorly understood. In this work, a magnetic field coupling fractional step lattice Boltzmann (FSLB) model is employed to numerically investigate the impact processes of multiple ferrofluid droplets on a solid wall under the effect of a magnetic field.

The magnetic field is solved by a self-correcting Poisson equation solver, and a geometric surface energy formulation is adopted to handle the wetting boundary condition. The simulation results show that the external magnetic field elongates the ferrofluid droplets along the field direction and slightly accelerates their falling process. Furthermore, the number and distribution of daughter droplets after impact are determined by the strength of the external magnetic field and the wettability of the solid wall. These findings reveal the underlying mechanisms of multiple ferrofluid droplet impact under magnetic fields and provide theoretical guidance for the design and optimization of ferrofluid-based industrial applications.

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