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Interparticle Correlations in FORC Diagrams of Ellipsoidal Multicore Nanoparticles

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In this work, first-order reversal curve (FORC) diagrams were obtained by numerical simulation for several model magnetic nanoparticle systems with increasing structural complexity and interaction strength. The considered systems include noninteracting single-domain particles, moderately interacting particles in a ferrofluid, spherical multicore magnetic nanoparticles, and ellipsoidal multicore magnetic nanoparticles. The aim of the study is to perform a consistent comparison of the corresponding FORC distributions and to analyze the roles of dipolar interactions, multicore structure, and particle shape in the formation of the magnetic response.

Multicore nanoparticles were modeled as rigid assemblies of spherical single-domain subparticles with fixed positions relative to one another, similarly to magnetic inclusions embedded in a nonmagnetic matrix. For the ellipsoidal case, the subparticles were arranged so that their convex hull approximated an elongated ellipsoid of revolution with a prescribed aspect ratio, allowing direct comparison with spherical composite particles.

The simulations were performed using the ESPResSo molecular dynamics package with magnetic anisotropy taken into account. The computational approach was based on the numerical solution of the stochastic Landau–Lifshitz–Gilbert equation in a particle-fixed reference frame, which eliminates precession and Barnett effects. Standard magnetization reversal protocols were used to construct the FORC diagrams for all considered systems.

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