DY 44: Poster: Active Matter, Soft Matter, and Fluids

Time: Wednesday 15:00–18:00 Location: P5

DY 44.1 Wed 15:00 P5

Directed autonomous motion of active Janus particles induced by wall-particle alignment interactions — •Poulami Bag — Presidency University Kolkata

We propose a highly efficient mechanism to rectify the motion of active particles by exploiting particle-wall alignment interactions. Through numerical simulations of active particles' dynamics in a narrow channel, we demonstrate that a slight difference in alignment strength between the top and bottom walls or a small gravitational drag suffices to break upside-down symmetry, leading to rectifying the motion of chiral active particles with over 60% efficiency. In contrast, for achiral swimmers to achieve rectified motion using this protocol, an unbiased fluid flow is necessary that can induce orbiting motion in the particle's dynamics. Thus, an achiral particle subject to Couette flow exhibits spontaneous directed motion due to an upside-down asymmetry in particle-wall alignment interaction. The rectification effects caused by alignment we report are robust against variations in self-propulsion properties, particle's chirality, and the most stable orientation of self-propulsion velocities relative to the walls. Our findings offer insights into controlled active matter transport and could be useful to sort artificial as well as natural microswimmers (such as bacteria and sperm cells) based on their chirality and self-propulsion velocities.

DY 44.2 Wed 15:00 P5

Emergent Interaction in Attractively Coupled Active Particles — •Ritwick Sarkar and Urna Basu — S. N. Bose National Centre for Basic Sciences, India.

We investigate the dynamics of N pair-wise harmonically coupled active Brownian particles (ABPs) in the presence of thermal fluctuations. The harmonic coupling and the bounded nature of the active noise ensure that the relative distance between each pair of particles eventually reaches a stationary state. Depending on the interplay between the active time-scale and the relaxation time-scale associated with the harmonic coupling, three regimes emerge: strong, moderate, and weak coupling. We analytically show that in the strong coupling regime, an effective short-range repulsion emerges between ABP pairs with speed heterogeneity, both in the presence and absence of thermal fluctuations. The short-range repulsion also persists when the ABP pairs are coupled by a generic long-range attractive potential.

Reference

[1] Ritwick Sarkar, Urna Basu, Soft Matter 21, 3595-3603 (2025).

[2] Ritwick Sarkar, Sreya Chatterjee, and Urna Basu, J. Phys. A: Math. Theor. 58 415001 (2025).

DY 44.3 Wed 15:00 P5

AMEP: Analyzing Active and Soft Matter Simulations — •Kay-Robert Dormann[1], Lukas Hecht[1], Kai Luca Spanheimer[2], Aritra K. Mukhopadhyay[1], Mahdieh Ebrahimi[1], Suvendu Mandal[1], and Benno Liebchen[1] — [1]Institut für Physik kondensierter Materie, Technische Universität Darmstadt, Darmstadt, Germany — [2]Institut für Theoretische Physik II, Heinrich-Heine-Universität, Düsseldorf, Germany

AMEP [1] is a Python library that focuses on the fast and user-friendly analysis of active and soft matter simulations. It can natively analyze data from molecular dynamics, Brownian dynamics, and continuum simulations from software such as LAMMPS, HOOMD-blue, and GROMACS. With a plethora of methods for calculating observables and visualizing results, AMEP is suitable for calculating complex observables equally for advanced studies of active and soft matter, as well as for beginners in the field. Computationally expensive methods are parallelized to run on any system from laptops and workstations to high-performance computing clusters.

The methods range from correlation functions and order parameters to cluster detection and coarse-graining methods. Due to the Python-based implementation, the methods can be easily extended and individualized. Information and examples are available at https://amepproject.de. AMEP can be installed via pip and conda.

[1] L. Hecht et al., Comput. Phys. Commun. 309, 109483 (2025).

DY 44.4 Wed 15:00 P5

Environmental Control of Self-Aligning Chiral Bristlebots — •Timo Wagner, Thomas Ihle, and Horst-Holger Boltz — University Greifswald, Institute for Physics, Greifswald

The subject of our work is the interplay of two very topical aspects of active matter systems, self-alignment and chirality, with complex environments. Chirality refers to a handedness of the dynamics manifesting itself in circular trajectories and self-alignment is a specific realization of physical memory in which the direction of the actual velocity and that of the self-propulsion are not identical, but are coupled. We present experimental results of an implementation of self-aligning chiral dynamics by custom augmentation of commercial toy bristlebots (Hexbugs) and extend the accessible parameter range by inferring a numerical model capable of reproducing the observable data. In particular, we study the control of edge currents (cf. Caprini et al, arXiv:2509.05053) by chiral environments. Additionally, we show that this simple system is sufficient to observe mode-switching between collectively moving and arrested states in active solids (cf. Hernandez-Lopez et al, PRL 132, 238303 (2024)).

DY 44.5 Wed 15:00 P5

Stochastic Path Integral for the Active Brownian Particle in a Harmonic Potential — •Mike Brandt[1], Carsten Littek[2], and Falko Ziebert[1] — [1]Institut für Theoretische Physik Philosophenweg 19, D-69120 Heidelberg, Germany — [2]Institut für Theoretische Physik Philosophenweg 12, D-69120 Heidelberg, Germany

We present a path-integral approach for the motion of active particles in harmonic traps, developed in our recent preprint [arXiv:2509.26296]. We apply the Martin-Siggia-Rose formalism to the overdamped Langevin equations of an active Brownian particle (ABP). The associated action can be separated into an exactly solvable passive reference motion and an "activity operator" to be treated perturbatively. This method allows for the calculation of the exact, time-dependent correlation functions for the ABP in a harmonic potential. Furthermore, the probability density can be perturbatively expanded in a series, which already captures important qualitative features of the system at low orders. This is exemplified by discussing the transition between a ring-shaped distribution for a weak potential and a peaked distribution for a strong potential in the long-time limit. Finally, we present full time-dependent expressions for the mean-square displacement of the Brownian circle swimmer (BCS), along with comparisons to simulations.

DY 44.6 Wed 15:00 P5

Continuum models for active matter: Derivation and overview — •Juliette Wegner and Sebastian Heidenreich — Physikalisch-Technische Bundesanstalt Braunschweig und Berlin, Abbestr. 2-12, 10587 Berlin, Germany

Turbulence and collective motion in active matter provide an interesting insight into non-equilibrium systems. Many different models have been suggested to describe the prevalent dynamics, mainly including polar and nematic systems. Each of these systems is developed under different assumptions considering different systems, but their similarities and differences are often not obvious.

In our poster we start from a simple micro-swimmer model to derive a general continuum model incorporating both nematic and polar order parameter equations, following the procedure from [1]. To this general continuum model, we then systematically introduced further restrictions and assumptions to derive more specific models which are in line with popular continuum models from literature. Specifically, we obtain models with nematic and polar symmetries similar to those studied by Saintillan and Shelley, as well as active Nematics, and active Polar suspension. Finally, we also consider theories that only incorporate the overall bacterial motion, such as the Toner Tu equation or the hydrodynamic approach of Slomka and Dunkel.

[1] Henning Reinken, Sabine HL Klapp, Markus Bär, and Sebastian Heidenreich. Derivation of a hydrodynamic theory for mesoscale dynamics in microswimmer suspensions. Physical Review E, 97(2):022613, 2018.

DY 44.7 Wed 15:00 P5

Active Brownian ellipsoids in three spatial dimensions — •Sebenzile Tsabedze and Michael te Vrugt — Institut für Physik, Johannes Gutenberg-Universität Mainz, 55128 Mainz, Germany

We investigate ellipsoidal active Brownian particles with alignment interactions in three spatial dimensions that are propelled orthogonal to their symmetry axis. Their propulsion direction makes the particles biaxial, implying that their dynamics is considerably more complex than in the usually considered case of particles being propelled along their symmetry axis. We use Brownian dynamics simulations and assume the particles to interact via a Gay-Berne potential (for the ellipsoidal repulsion) and a Heisenberg potential (for the interaction).

DY 44.8 Wed 15:00 P5

Dynamics of Aligning Active Matter: Mapping to a Schrödinger Equation and Exact Diagonalization — •Tara Steinhöfel, Horst-Holger Boltz, and Thomas Ihle — University Greifswald, Institute for Physics, Greifswald

We investigate models of Viscek-like particles with long-ranged interactions subject to noise and alignment interactions of polar and nematic symmetries. It is shown how the relevant N-particle Fokker–Planck equation can be mapped onto a Schrödinger equation in imaginary time for arbitrary particle numbers. Focusing on the minimal case of $N = 2$, we construct a complete eigenbasis by exact diagonalization of the corresponding self-adjoint Hamiltonian. In a treatment formally equivalent to standard quantum mechanics, this yields the fully time-resolved relaxation of the N-particle-probability density from arbitrarily correlated initial conditions into the stationary state. By marginalization, the one-particle angular modes which include the usual hydrodynamic modes are obtained; we discuss their relaxation backed by agent-based simulations and give comparisons for the resulting exact relaxation rates to mean-field and to predictions from approximate field theories (G. Spera, C. Duclut, M. Durand, J. Tailleur, PRL 132, 078301 (2024)). Furthermore, we discuss possible extensions of the method to $N \geq 3$ particles, as well as modifications due to non-reciprocal interactions.

DY 44.9 Wed 15:00 P5

Absence of chiral long-range order in the 2d non-reciprocal Vicsek model — •Chul-Ung Woo[1], Heiko Rieger[1], and Jae Dong Noh[2] — [1]Department of Theoretical Physics and Center for Biophysics, Saarland University, Saarbrücken, Germany — [2]Department of Physics, University of Seoul, Seoul, Korea

Nonreciprocal interactions in active matter have been predicted to generate homogeneous chiral phases, in which the polarization order parameter rotates at a constant frequency as a result of a nonreciprocal phase transition. Here we revisit the non-reciprocal Vicsek model in two space dimensions with short-range interactons and ask whether the putative chiral phase survives in the thermodynamic limit. Using large-scale simulations, we show that a spatially homogeneous chiral state, while long-lived in small systems, is generically unstable to the spontaneous nucleation of spiral defects that invade the system and drive it into spatio-temporal chaos. The global chiral order parameter, τ exhibits a robust finite-size scaling $\tau(J_-; L) = J_-\tau_r(LJ_-)$, where $J_= J_{AB} - J_{BA}$ is the anti-symmetric part of the interaction matrix, with the asymptotic behavior $\tau_r(x) \sim x^{-1}$ at large x, implying that global chirality vanishes in the thermodynamic limit. Controlled droplet-seeding experiments and a Boltzmann kinetic description support the droplet nucleation and growth scenario for the breakdown of chiral order. Our results demonstrate that paradigmatic non-reciprocal flocking models display chiral long-range order only in mean-field, whereas it is only metastable in two space dimensions and replaced there by spatio-temporal chaos.

DY 44.10 Wed 15:00 P5

Phase properties of constant density interacting flocks — •Astik Haldar and Heiko Rieger — Center for Biophysics & Department of Theoretical Physics, Universität des Saarlandes, Saarbruecken 66123, Germany

We present a field-theoretic study of a mixture of two polar Malthusian species in two dimensions with distinct aligning and propulsion strengths. The system exhibits rich phase behavior, including oriented flocking states (both parallel and anti-parallel) and a coherently rotating chiral phase. We map the parameter regions for these phases and characterize their universal properties.

DY 44.11 Wed 15:00 P5

Influence of shape on dynamic properties of magnetic active particles — •Ekaterina Novak[1], Elena Pyanzina[1], Tatyana Belyaeva[1], and Sofia Kantorovich[2] — [1]Ekaterinburg, Russia — [2]University of Vienna, Vienna, Austria

This study investigates the influence of shape on the dynamic properties of active magnetic particles. The focus is on ellipsoidal particles of two variations and spherical particles, aiming to understand the relationship between particle shape and motion characteristics. The research is motivated by the need to improve the control and efficiency of active particles, which have significant potential in medical and technological applications, such as precise drug delivery.

Active particles, inspired by natural systems like bacteria, can convert chemical energy into directed motion. However, challenges arise in maintaining precise control over their orientation and direction over time. By introducing a rigidly fixed permanent dipole moment and utilizing a strong external magnetic field, it is possible to minimize thermal fluctuations and achieve precise control.

The study also explores the anisotropic properties of ellipsoidal particles, which can have two possible orientations of the magnetic moment depending on the material. This behavior is analogous to magnetic cubes with integrated nanomotors. The findings from this research contribute to the development of optimal particle shapes for effective transportations, opening new possibilities in various fields.

The work was financially supported by the RSF grant No. 25-22-00327.

DY 44.12 Wed 15:00 P5

Order and shape dependence of mechanical relaxation in proliferating active matter — Jonas Isensee[1,2], •Finn Albrecht[1,2], Lukas Hupe[1,2], and Philip Bittihn[1,2] — [1]MPI for Dynamics and Self-Organization, Göttingen, Germany — [2]Institute for the Dynamics of Complex Systems, University of Göttingen, Germany

The collective behavior of dense, proliferating anisotropic active matter, such as elongated cells or bacteria, arises from an interplay between growth, division, and mechanical interactions, often mediated by particle shape. In classical models of prolate, rod-like growth, flow-induced alignment and division geometry reinforce one another, leading to robust nematic order under confinement. Here we introduce a complementary regime by considering smooth convex particles whose geometry can be oblate for part or all of their growth cycle, creating a tunable competition between these two alignment mechanisms. Using agent-based simulations of particles with tunable curvature profiles in both channel and open-domain geometries, we systematically vary particle shapes to span regimes of cooperation and competition between ordering cues. We find that oblate growth can reverse classical flow-alignment, destabilize microdomain formation in intermediate regimes, and, in combination with variations in curvature, lead to entirely new global order patterns. These findings are then reconciled using an order- and shape-dependent mechanical relaxation interpretation that is supported by explicit measurements.

DY 44.13 Wed 15:00 P5

The impact of particle shape for self-diffusiophoresis — •Leif Peters[1], Benjamin J. Walker[2], and Christina Kurzthaler[1,3,4] — [1]Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Straße 38, 01187 Dresden, Germany — [2]Department of Mathematics, University College London, WC1H 0AY London, UK — [3]Center for Systems Biology Dresden, Pfotenhauerstraße 108, 01307 Dresden, Germany — [4]Cluster of Excellence, Physics of Life, TU Dresden, Arnoldstraße 18, 01062 Dresden, Germany

Self-diffusiophoretic micron-sized particles are paradigmatic examples of synthetic microswimmers where the swimming behavior depends not only on the patterning of the chemically active surface, i.e., the activity and phoretic mobility, but also on the particle shape itself. Accounting for the governing chemical and hydrodynamic equations we investigate how the particle shape influences the self-propulsion velocity and the agent's chemotactic behavior. To derive analytical expressions for anisotropic and curved particles we employ slender body theory and the Lorentz reciprocal theorem. Furthermore, we corroborate our results with a boundary element method. Our numerical framework allows going beyond the slender-particle limit and lays the foundation for addressing the physics of hydro-chemically interacting active agents and the emergent collective phenomena.

DY 44.14 Wed 15:00 P5

Dynamics of thermophoretic Janus particles in homogeneous light fields — •Samad Mahmoudi, Franziska Michaela Braun, and Regine von Klitzing — Institute of Condensed Matter Physics,TU Darmstadt, Hochschulstraße 8 64289 Darmstadt

We study the thermophoretic motion and orientational dynamics of individual Au-polystyrene Janus particles under uniform laser illumi-

nation. Light-driven Janus colloids serve as a model system for active Brownian motion and non-equilibrium transport in soft matter. The particles are illuminated by a defocused, approximately homogeneous laser spot and observed with dark-field microscopy. Image-processing routines in Python yield long-time trajectories, center-of-mass positions and in-plane orientations of the gold cap. From the mean-squared displacement we extract effective self-propulsion velocities and compare them with active Brownian particle models and simple expectations for thermophoretic motion. Our first measurements show that the tracking procedure resolves both translational and rotational motion of single Janus particles and yields thermophoretic velocities in the expected range for micrometer-sized swimmers. In future work, we will use this analysis to study how light gradients and cap design can create transient barriers for Janus particles and control their thermophoretic motion.

DY 44.15 Wed 15:00 P5

Static and dynamic states of compound drops on heated substrates — •Dominik Thy, Jan Diekmann, and Uwe Thiele — Institute of Theoretical Physics, University of Münster, Wilhelm-Klemm-Str. 9, 48149 Münster, Germany

We present a mesoscopic thin-film model for interface dominated compound drops including a vertical temperature gradient [1]. Starting with established findings for the passive case, i.e., (isothermal) gradient dynamics that show relaxation to equilibrated compound drops of different configurations [2], we then drive the system out of equilibrium. To this end, we introduce a vertical temperature gradient that renders the system active by introducing thermal Marangoni flows. We discuss different static and dynamic states.

[1] Pototsky, Bestehorn, Merkt, Thiele. The Journal of Chemical Physics, 2005. doi: 10.1063/1.1927512.

[2] Diekmann, Thiele. Physical Review Fluids, 2025. doi: 10.1103/physrevfluids.10.024002.

DY 44.16 Wed 15:00 P5

Evaporation Induced Salt Precipitation in Porous Media: A Lattice Boltzmann Approach — •Alexander Reinauer[1], Louis Oberer[1], Alexander Schlaich[2], and Christian Holm[1] — [1]Institute for Computational Physics, Stuttgart, Germany — [2]Institute for Physics of Functional Materials, Hamburg University of Technology, Hamburg, Germany

We present a lattice Boltzmann model for simulating coupled evaporation and salt precipitation in porous media. The approach integrates Shan-Chen multiphase flow with a volume-based discretization of salt transport and incorporates a precipitation rule, which converts fluid cells into solid crystals once the local concentration exceeds a crystallization threshold.

The model is validated by reproducing analytical predictions for crystal growth. Besides, it features a tunable evaporation rate, enabling pore-scale studies of evaporation-induced salt precipitation. Investigations of the wettabilities of both the salt and the porous matrix reveal a pronounced impact on precipitation patterns. The simulations show distinct shifts in pore-clogging behavior depending on the relative wetting properties, with highly wetting crystals causing the strongest clogging and the slowest evaporation, arising from how wetting influences the spatial distribution of precipitation.

DY 44.17 Wed 15:00 P5

Power-Law to Maxwell Transition in Soft Glassy Materials under Large Amplitude Oscillations — •Raffaele Mendozza[1], Shanay Zafari[1], Sarah Köster[1], and Peter Sollich[1,2] — [1]Institute for Theoretical Physics, University of Göttingen, Göttingen, Germany — [2]Department of Mathematics, King's College London, London, United Kingdom

Soft glassy materials, such as colloidal suspensions and biological networks, exhibit complex rheological behaviour. We present a modified version of the Soft Glassy Rheology (SGR) model, introducing an upper cutoff on the yield rate that prevents unphysical yield rate increases at large strains. In the nonlinear response to step strains, the modified model exhibits a crossover from short-time exponential (Maxwell-like) relaxation to the power law relaxation obtained in the original model. This qualitatively reproduces results from strain-ramp experiments on actin networks. Under large amplitude oscillatory strain (LAOS) we similarly find Maxwell-like viscoelastic spectra at higher frequencies, crossing over to the original SGR power-law spectrum at low frequencies. We demonstrate that this can be rationalized qualitatively by Fourier transforming the nonlinear step strain results. The nonlinear spectra break the usual phase angle relations for power law (linear) response, however, which we explain using a quasistatic approximation. The stress response to LAOS at fixed frequency becomes more anharmonic for increasing strain amplitudes up to a critical value; beyond this point, harmonicity is eventually restored due to the crossover to Maxwell behavior.

DY 44.18 Wed 15:00 P5

Gelation versus bundling in parallel-aligned directed polymers — •Panayotis Benetatos and Minsu Yi — Department of Physics, Kyungpook National University, Daegu, South Korea

In many soft-matter and biological systems, bundles of similarly charged parallel-aligned filaments form when a short-range attraction overcomes the longer-range electrostatic repulsion. It is also known that permanent cross-links in parallel-aligned directed polymers can yield a directed gel with a finite in-plane shear modulus. Because permanent cross-links effectively act as a short-range attraction, we are motivated to investigate the interplay of gelation versus bundling in such a system. Using the theoretical tools of replica field theory, where the cross-links are treated as quenched disorder following the Deam-Edwards distribution, we show that the effective attraction due to spring-like permanent cross-links is too weak to induce bundling before the gelation transition.

DY 44.19 Wed 15:00 P5

Thermoresponsive liquid-liquid phase behaviour of biomolecular condensates in programmable thermal landscapes — •Ilona Kundi[1], Falko Schmidt[1], Rasmus Krogh Norrild[2], Alexander Kai Büll[2], and Frank Cichos[1] — [1]Peter Debye Institute for Soft Matter Physics, Leipzig University, 04103 Leipzig, Germany — [2]Department of Biotechnology and Biomedicine, DTU, 2800 Kgs. Lyngby, Denmark

Liquid-liquid phase separation (LLPS) of biomolecules drives the formation of membraneless organelles in cells. The LLPS behavior of the intrinsically disordered N-terminal region of the DEAD-box helicase DDX4 (DDX4N) is examined under precisely controlled and reconfigurable local temperature fields.

Locally tunable thermal landscapes are generated by scanning a focused laser beam over an absorbing metal thin film, creating microscale temperature profiles around DDX4N condensates. Here, the spatiotemporal evolution of condensate nucleation, growth, coarsening, and dissolution is tracked, linking local thermal forces to mesoscale LLPS dynamics.

By repeatedly cycling the temperature across the LLPS boundary, kinetic and thermodynamic parameters of the DDX4N phase transition are measured, revealing switching thresholds, hysteresis, and condensate material properties. Controlled microthermal perturbations thus provide a powerful means to probe and program protein LLPS, establishing a versatile platform for testing models of thermoresponsive intrinsically disordered proteins.

DY 44.20 Wed 15:00 P5

Rheology of Semi-Flexible Polymer Networks — •Sanjay Bhandarkar[1] and Peter Sollich[1,2] — [1]Institute for Theoretical Physics, University of Göttingen, Germany — [2]Department of Mathematics, King's College London, London

Semiflexible polymers, both in solution and organized into networks, continue to be a major focus in biological physics owing to their critical relevance to the structural and mechanical functions of living systems. The mechanics of the cytoskeleton emerges from the collective properties of semiflexible biopolymers such as actin filaments, microtubules, and intermediate filaments [1,2]. We investigate the rheology of semiflexible polymer networks using molecular dynamics simulations, performing Small-Amplitude Oscillatory Shear (SAOS) tests on permanently cross-linked systems to demonstrate how filament stiffness and monomer density control the frequency dependence of the complex shear modulus G*. In addition, we examine the connection between power-law rheology and the self-similar structural features observed in biopolymer networks and gels [3,4]. We further analyze how crosslinking dynamics and activity-induced stresses modify the network mechanics. Together, this rheological framework lays the groundwork for future models that incorporate more detailed structural and biochemical complexity.

[1] P. Kollmannsberger and B. Fabry, 2011
[2] Broedersz, C. P. and MacKintosh, F. C., 2014
[3] J. Martin, D. Adolf, and J. P. Wilcoxon, 1989
[4] M. Bantawa et al., 2023

DY 44.21 Wed 15:00 P5

Dynamic magnetic susceptibility of magnetic elastomers taking into account the internal magnetic anisotropy of particles — •Alla Dobroserdova[1] and Sofia Kantorovich[2] — [1]Ekaterinburg, Russia — [2]University of Vienna, Vienna, Austria

Magnetic elastomers are non-magnetic elastic matrices with embedded magnetic particles. These systems can be controlled using an external magnetic field, which provides the basis for their practical applications in both industry and medicine.

The aim of this study is to investigate the dynamic magnetic response of magnetic elastomers. Two previously developed elastomer models suitable for molecular dynamics simulations are used. This study reveals the dependence of the response on the intensity of interparticle interactions, the rigidity of the elastic non-magnetic matrix, and the internal magnetic anisotropy of the particles.

Support by RSF (project 25-22-00270) is acknowledged.

DY 44.22 Wed 15:00 P5

Computer simulation of the dynamic susceptibility of ellipsoidal multicore particles: the effect of inter-core interaction — •Vladimir Zverev[1], Ekaterina Novak[1], Andrey Kuznetzov[2], and Sofia Kantorovich[2] — [1]Ekaterinburg, Russia — [2]University of Vienna, Vienna, Austria

This report presents a study of the magnetic dynamic susceptibility of MNPs under the influence of a low-amplitude alternating plane-polarized magnetic field. We consider ellipsoidal MNPs modeled as a collection of spherical subparticles with fixed spatial positions relative to each other. This corresponds to a scenario where nanoparticles are embedded in a polymer or other rigid non-magnetic matrix. The modeling employs the molecular dynamics simulations using the ESPResSo software package, which accounts for magnetic anisotropy. The model is based on the concept proposed in [1]. The core idea is that the orientation of the magnetic moment in a subparticle is determined by solving the stochastic Landau-Lifshitz-Gilbert equation in a reference frame fixed to the particle body, neglecting precession and the Barnett effect. To form a single-domain-like particle assembly, their common convex hull approximates an elongated ellipsoid of revolution with a preset aspect ratio, enabling comparison with spherical particles.

The work was financially supported by the Russian Science Foundation grant No. 25-22-00338.

[1] Pyanzina E. S. et al. Dynamic Magnetic Response of Multicore Particles: The Role of Grain Magnetic Anisotropy and Intergrain Interactions //Journal of Molecular Liquids. - 2025. - P.126842.