DY 46: Poster Session: Complex Fluids, Soft Matter, Active Matter, Glasses and Granular Materials

Time: Thursday 15:00–18:00 Location: P2

DY 46.1 Thu 15:00 P2

Analysis of liquid distribution in microchannel systems using the electro-hydraulic analogy — •Marius Pätzold[1], Felix Senf[1], Carl E. Krill III[2], and Othmar Marti[1] — [1]Institut für experimentelle Physik, Universität Ulm — [2]Institut für funktionelle Nanosystem, Universität Ulm

The research program investigates the calculation of leakages in hydraulic systems by modelling the latter using electric resistor networks as an alternative to simulations employing computational fluid dynamics.

Based on a rigid geometry that describes a network of channels having rectangular cross sections of constant height, the hydraulic properties of the network are examined. The system is then modelled using an electric resistor network that incorporates these hydraulic properties. For a given pressure drop between the inlet and outlets, the model can be solved and leakages can be calculated using a modified nodal analysis.

The results show that modelling the geometry in this manner can be an efficient alternative to simulations using computational fluid dynamics within the requirements set by the electric-hydraulic analogy. Modelling hydraulic networks that are not within these requirements, like those with very short channels or highly complex channel networks, leads to the propagation of errors through the network, resulting in significant differences between the modelling and simulation approach.

DY 46.2 Thu 15:00 P2

Topological fine structure of smectic grain boundaries and tetratic disclination lines within three dimensional smectic liquid crystals* — Paul A. Monderkamp[1], René Wittmann[1], •Michael te Vrugt[2], Axel Voigt[3], Raphael Wittkowski[2], and Hartmut Löwen[1] — [1]Institut für Theoretische Physik II: Weiche Materie, Heinrich-Heine-Universität Düsseldorf, Universitätsstraße 1, 40225 Düsseldorf, Germany — [2]Institut für Theoretische Physik, Center for Soft Nanoscience, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany — [3]Institut für Wissenschaftliches Rechnen, Technische Universität Dresden, 01062 Dresden, Germany

Based on recent insights into the orientational topology of smectic grain boundaries in two dimensions, we analyse boundaries in three-dimensional confined smectics from the perspective of tetratic symmetry. Monte-Carlo simulations show the emergence of orientational grain boundaries. Using a 3d tetratic order parameter constructed from the Nelson-Steinhardt invariants, we show that the orientational topological fine structure of the planar smectic grain boundaries can be interpreted as a pair of tetratic disclination lines that are located on the edges of the nematic domain boundary [1]. Thereby, we shed light on the fine structure of the orientational topology of grain boundaries in three-dimensional confined smectics.

[1] P. A. Monderkamp et al., Phys. Chem. Chem. Phys. (2022), https://doi.org/10.1039/D2CP00060A

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DY 46.3 Thu 15:00 P2

From a microscopic inertial active matter model to the Schrödinger equation* — •Michael te Vrugt[1,2], Tobias Frohoff-Hülsmann[1], Eyal Heifetz[3], Uwe Thiele[1], and Raphael Wittkowski[1,2] — [1]Institut für Theoretische Physik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany — [2]Center for Soft Nanoscience, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany — [3]Porter School of the Environment and Earth Sciences, Tel Aviv University, 69978 Tel Aviv, Israel

Field theories for the one-body density of an active fluid, such as the paradigmatic active model B+, are simple yet very powerful tools for describing phenomena such as motility-induced phase separation. No comparable theory has been derived yet for the underdamped case. In our work [1], we introduce active model I+, an extension of active model B+ to particles with inertia. The governing equations of active model I+ are systematically derived from the microscopic Langevin equations. We show that, for underdamped active particles, thermodynamic and mechanical definitions of the velocity field no longer coincide and that the density-dependent swimming speed plays the role of an effective viscosity. Moreover, active model I+ contains the Schrödinger equation in Madelung form as a limiting case, allowing to find analoga of the quantum-mechanical tunnel effect and of fuzzy dark matter in the active fluid. We investigate the active tunnel effect analytically and via numerical continuation. [1] M. te Vrugt et al., arXiv:2204.03018

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DY 46.4 Thu 15:00 P2

Inertial Active Particles in Unbiased ac Fields Sediment at the Top Wall — •José Carlos Ureña Marcos and Benno Liebchen — Institut für Physik Kondensierter Materie, Technische Universität Darmstadt, Darmstadt, Germany

A detailed understanding of the controllability of the swimming direction of active particles through external fields is crucial for many of their proposed future applications, from nanomedicine to bioapplications.

While such steering is often achieved with dc fields with a net gradient, we show in this work that the use of rapidly oscillating ac fields allows the steering of inertial active particles even in the absence of a net gradient. To demonstrate this, we develop an analytical framework which shows that fast ac fields can stabilise fixed points in the dynamics of active particles which would otherwise be unstable.

To exemplify the applicability of this scheme, we explore inertial active particles in a gravitational field and observe that, in the presence of a rapidly oscillating ac field, a substantial fraction of them persistently travel in the upward direction and sediment at the top wall of the simulation box.

DY 46.5 Thu 15:00 P2

Rheological properties of Stcokmayer supracolloidal magnetic polymers under shear flow — •Vladimir Zverev[1], Ekaterina Novak[1], and Ivan Novikau[2] — [1]UNIVIE, Vienna, Austria — [2]Ekaterinburg, Russia

Supracolloidal magnetic polymers (SPMs) are polymer-like structures in which magnetic nanoparticles Construction SPMs has recently been made possible. Their advantage is that they keep their structure independently from the temperature. SPMs can be potentially used as an alternative to nanoparticles in magnetic fluids to obtain a desired and easily controlled magnetic or rheological response.

We assume SMPs formed by monodisperse magnetic colloids, modeled as identical spherical beads. We consider SMPs of four different topologies: chain-, Y-, X- and ring-like ones. Using Langevin dynamics simulations, we pay our attention to solutions of filaments, the magnetic nanoparticles in which are not only interacting via dipole-dipole potential but also via short-range attractive forces (Van der Waals force). Such filaments tend to aggregate in dense spherical droplet-like clusters. The resulting composite soft colloid is placed in the microchannel, where its behavior in the shear flow under influence of an external field is investigated, varying a wide range of system parameters. It was found that clusters can demonstrate oscillating in time magnetic response and complex mutual infulence of the flow and the magnetic field.

The work was supported by RSF 19-72-10033.

DY 46.6 Thu 15:00 P2

Experimental study of statistical structures and forces in granular matter — Amelie Mayländer[1], Clara C. Wanjura[2], Lukas Reiter[1], Raphael Blumenfeld[3,2], and •Othmar Marti[1] — [1]Institute of Experimental Physics, Ulm University, D-89069 Ulm — [2]Cavendish Laboratory, University of Cambridge, Cambridge, CB3 0HE, UK — [3]Gonville & Caius College, University of Cambridge, Trinity Street, Cambridge CB2 1TA, United Kingdom

We investigated the structure-forces coevolution in rotational shear of a planar assembly of photo-elastic polyurethane-discs of four different sizes under constant confining stress. Disc positions and contacts were determined using unpolarized red light. A dark-field polariscope, using circularly polarized blue light, detected mechanical deformations and the force network. The experiment ran through: a de-correlation step, initial state preparation, steady-state dynamics.

Repeated measurements of the structure and cell order distribution

of the geometric contact network were carried out, validating theoretical predictions of detailed balance[1] and maximum entropy[2]. Simultaneously detected force chain networks had more cells of higher orders than the geometric network, providing less than maximum entropy. This is attributed to the sensitivity of force detection to low-force contacts. Characteristic differences also existed in the shapes of small cells.

[1] C. C. Wanjura et al., Granular Matter 22, 91 (2020).
[2] X. Sun et al., Phys. Rev. Lett. 125, 268005 (2020)

DY 46.7 Thu 15:00 P2

Ising-like critical behavior of vortex lattices in an active fluid — •Henning Reinken[1], Sebastian Heidenreich[2], Markus Bär[2], and Sabine H. L. Klapp[1] — [1]Technische Universität Berlin — [2]Physikalisch-Technische Bundesanstalt Berlin

Turbulent vortex structures emerging in bacterial active fluids can be organized into regular vortex lattices by weak geometrical constraints such as obstacles [1,2]. Here we show, using a continuum-theoretical approach [3], that the formation and destruction of these patterns exhibit features of a continuous second-order equilibrium phase transition, including long-range correlations, divergent susceptibility, and critical slowing down. The emerging vorticity field can be mapped onto a two-dimensional (2D) Ising model with antiferromagnetic nearest-neighbor interactions by coarse-graining. The resulting effective temperature is found to be proportional to the strength of the nonlinear advection in the continuum model [4].

[1] D. Nishiguchi, I. S. Aranson, A. Snezhko, and A. Sokolov, Nat. Commun. **9**, 4486 (2018)
[2] H. Reinken, D. Nishiguchi, S. Heidenreich, A. Sokolov, M. Bär, S. H. L. Klapp, and I. S. Aranson, Commun. Phys. **3**, 76 (2020)
[3] H. Reinken, S. H. L. Klapp, M. Bär, and S. Heidenreich, Phys. Rev. E **97**, 022613 (2018)
[4] H. Reinken, S. Heidenreich, M. Bär, and S. H. L. Klapp, Phys. Rev. Lett. **128**, 048004 (2022)

DY 46.8 Thu 15:00 P2

Cohesive rotation of particles with misaligned perception-dependent motility — •Rodrigo Saavedra, Gerhard Gompper, and Marisol Ripoll — Institute of Biological Information and Institute for Advanced Simulation, Forschungszentrum Jülich, Germany

Systems of agents with discontinuous motility that activate according to visual perception rules have been found to aggregate into cohesive groups. Here we study the formation of rotating cohesive clusters by considering the particles' vision cone to have a fixed misalignment with respect to the self-propulsion direction. Together with the motility rule, we find this mechanism to facilitate both cohesion and rotation of the cluster. The presence of steric interactions translates into a compact cluster which might eventually be driven by particles in its outer layer. We systematically explore the effect of misalignment and perception on the cluster morphology by means of particle-based numerical simulations. We find good agreement of the results with a proposed coarse-grained model.

DY 46.9 Thu 15:00 P2

Diffusion in a sulfonated co-polynaphthoyleneimide proton exchange membrane studied by NMR — •Celine Wolter, Alexei Privalov, and Michael Vogel — TU Darmstadt, Institut für Physik kondensierter Materie, Darmstadt, Germany

Nowadays, most fuel cells are based on proton-exchange membranes such as Nafion, which contain fluorine and therefore have some disadvantages for disposal. One alternative are flourine-free hydrocarbon-based polymers. Their respective characteristics for use in fuel cells are similar to Nafion membranes, but they are easier and cheaper to produce and recycle. An important parameter for these systems is the proton diffusion coefficient, since it is related to charge transfer across the membrane and removal of the resulting water. We investigated self-diffusion in a sulfonated co-polynaphthoylenimide proton exchange membrane using ^{1}H static field gradient (SFG) nuclear magnetic resonance (NMR). The polymer under study has a ratio of hydrophilic to hydrophobic groups of 60:40, and the saturation humidity of the samples varies from 31% to 100%. For this polymer, the magnetization transfer effects between protons in the membrane framework and water protons must be taken into account. To do this, we applied a model that accounts for such exchange phenomena and were able to determine the diffusion coefficients within a few percent uncertainty in the temperature range from 190 K to 365 K. We found a significant decrease in diffusion at low water concentrations and an increase in activation energy below 250 K, indicating a change in the diffusion mechanism.

DY 46.10 Thu 15:00 P2

Non-mechanical Electrowetting Pump On a Chip — •Sebastian Bohm[1,2], Hai Binh Phi[2], Lars Dittrich[2], and Erich Runge[1] — [1]Technische Universität Ilmenau, Theoretische Physik 1, Weimarer Str. 25, 98693 Ilmenau — [2]5microns GmbH, Ehrenbergstr. 11, 98693 Ilmenau

Numerical simulations suggests that by using the EWOD (electrowetting-on-dielectric) effect a micropump can be manufactured, that works completely without any moving components [1,2]. The volume stroke is generated by the periodic movement of liquid-vapor interfaces in a large number ($\approx 10^6$) of microcavities ($\Delta V \approx 1$ pl per cavity). Passive Tesla-Diodes are used to rectify the resulting volume stroke to completely forgo any moving parts. Even though our simulation suggests a high efficiency comparable to that of conventional designs in particular for small pumps, the actual realization poses multiple challenges. In this work, first experimental results of the characterization of the micropump are presented. The manufacturing process is described, which is based on an smart combination of processes commonly used in microsystems technology. This enables a cost-effective manufacturing that can be carried out entirely on wafer level. In addition, the direct integration of the pump into wafer-based microfluidic or lab-on-a-chip applications is facilitated. Possible use cases are presented and discussed.

[1] Bohm, S., Dittrich, L., Runge, E.; COMSOL Conference 2020 Europe, 14-15. Oct. 2020 online
[2] Hoffmann et al.; patent DE 11 2011 104 467 (2012)

DY 46.11 Thu 15:00 P2

Collective Behaviour of Active Assemblies Induced by Internal Feedback — •Lisa Rohde and Frank Cichos — Molecular Nanophotonics Group, Peter Debye Institute for Soft Matter Physics, Leipzig University, Linnéstr. 5, 04103 Leipzig, Germany

Collective phenomena and self-organising processes in nature such as structure formation of cells or flocking of birds are generated by physical interactions between autonomous objects ruled by feedback, information processing or sensing. Recently there has been an increasing interest in studying the collective behaviour of artificial active particles that provide the basic functionality of self-propulsion on the microscale. Here, we introduce physical interactions between artificial microswimmers in a crowded environment by implementing feedback rules to mimic the self-organisation of their living counterparts. We use differently shaped Janus particles capped with a thin gold layer. They are driven by self-thermophoresis, which we control by heating the gold layer with a laser. Depending on the shape of the Janus particle we observe different clustering behaviour as a result of a positive feedback mechanism by which Janus particles are attracted due to a temperature increase of a growing cluster. Our system reacts on hydrodynamic flow fields that are internally induced by other components by showing for example, a polarised motion of particles when being subjected to the feedback loop. We investigate and quantify the role of shape dependent hydrodynamic flow fields on the feedback mechanism by dedicated experiments on the clustering of active assemblies.

DY 46.12 Thu 15:00 P2

Bacterial swimmers' motility under external and light-induced flows — •Valeriia Muraveva[1,2], Robert Grossmann[1], Marek Bekir[2], Svetlana Santer[2], and Carsten Beta[1] — [1]Biological Physics, University of Potsdam, Potsdam, Germany — [2]Smart Soft Matter, University of Potsdam, Potsdam, Germany

We report on changes in the swimming strategy of rod-shaped bacteria under flow conditions.

To swim bacteria utilise lash-like organelles on the cell body, flagella. The model organism for this study is the soil bacterium Pseudomonas putida, which has a rod-shaped body and multiple flagella located at one pole of the cell, so they can act in concert to drive the bacterium in a single direction. The strategy of switching between different swimming modes in bulk was well described. Here, we study the cells' locomotion strategy under flow to better understand the processes of infection spreading and biofilm formation in a natural environment.

To create shear stress conditions hydrodynamic flows are used. For varying the geometry of flow patterns on the micron-scale we also use light-induced flow technics (in particular thermo-osmosis on a gold surface) to create flow locally and to advect or trap swimming bacteria.

To analyse the well-known "run-and-turn" strategy, we concentrate

on characteristic features of the swimming pattern: changes in the run-time and turn angle distributions. We also study mutant cell lines under flow (cells with partial or total deficiency in motor function) to elucidate the role of the different components of the motility apparatus in this process.

DY 46.13 Thu 15:00 P2

Phase behaviour of mixtures of attractive rods and spheres — Anja Kuhnhold and •Eleonora Foschino — nstitute of Physics, Albert-Ludwigs-University Freiburg, Germany

The aim of this project is to study a mixture of anisotropic rod-shaped particles and spherical particles in a bulk by means of Monte Carlo simulations. The goal is to find regions in the parameter space that show stable de-mixed phases in three-dimensional systems and stable mixed phases in two-dimensional systems. This would be preliminary to the study of thickness-dependent de-mixing during film growth, which was observed and studied in experiments with blends of organic molecular semiconductors (JR. Banerjee et Al., "Evidence for Kinecally Limited Thickness Dependent Phase Separaon in Organic Thin Film Blends", 2013).

The simulation is based on an implementation of the Metropolis algorithm in a box with periodic boundary conditions. Rod-shaped particles are modelled as hard spherocylinders and spherical particles as hard spheres, and the spheres/rods composition is kept constant, as well as the volume of the simulation box. All particles interact through hard-body repulsion and an additional pair potential, to mimic van der Waals interactions between molecules in the mixture. The parameter space includes the rod-shaped particles' dimensions (the spherocylinders' diameter with respect to the spheres' diameter and the aspect ratio), as well as the strengths and ranges of the attractive interaction.

DY 46.14 Thu 15:00 P2

Electrophoretic mobility of liquid droplets — •Alexander Reinauer and Christian Holm — Institute for Computational Physics, Stuttgart, Germany

Electrophoresis of liquid droplets displays many complex phenomena with applications for phase separation and transport in biological systems. It is significantly more complex than particle electrophoresis due to the mobility of the surface charges as well as the non-rigid nature of the fluid-fluid interface. To investigate the different contributions we conduct a lattice Boltzmann (LB) simulation study of freely suspended liquid droplets under application of an external electric field. We use the Color-Gradient multicomponent LB extension which is coupled to a lattice electrokinetics model for dissolved charged chemical species. Our ongoing study intends to quantify the influence of the viscosity ratio, the salt concentration as well as the charge of the droplet on the measured electrophoretic mobility.

DY 46.15 Thu 15:00 P2

Capacitive Density Functional Theory – C++ support for classical Density Functional Theory implementations — •Moritz Bültmann, Philipp Pelagejcev, and Andreas Härtel — Institute of Physics, University of Freiburg, Germany

CapDFT is a C++ library and provides functional implementations and methods to implement classical Density Functional Theory (DFT) calculations. It is currently developed in our Statistical Physics of Soft Matter and Complex Systems group at the University of Freiburg and we would be happy to discuss ideas and concepts at our poster.

DY 46.16 Thu 15:00 P2

The Scallop Theorem and Swimming at the Mesoscale — •Maxime Hubert[1], Oleg Trosman[1], Ylona Collard[2], Alexander Sukhov[3], Jens Harting[3], Nicolas Vandewalle[2], and Ana-Sunčana Smith[1,4] — [1]PULS group, FAU Erlangen-Nürnberg, Erlangen, Germany — [2]GRASP, University of Liège, Liège, Belgium — [3]Helmholtz Institute Erlangen-Nürnberg for Renewable Energy (IEK-11), Forschungszentrum Jülich, Nürnberg, Germany — [4]Group for Computational Life Sciences, Ruđer Bošković Institute, Zagreb, Croatia

By comparing theoretical modeling, simulations and experiments, we show that there exists a swimming regime at low-Reynolds number solely driven by the inertia of the swimmer itself. This is demonstrated by considering a dumbbell with an asymmetry in coasting time in its two spheres. Despite deforming in a reciprocal fashion, the dumbbell swims by generating a non-reciprocal Stokesian flow, which arises from the asymmetry in coasting times. This asymmetry acts as a second degree of freedom, which allows for recasting the scallop theorem at the mesoscopic scale at the lowest level of theory.

DY 46.17 Thu 15:00 P2

Fisher-Widom line for systems with competing repulsive and attractive interaction — •Matthias Gimperlein and Michael Schmiedeberg — FAU Erlangen-Nuremberg, Germany

We study colloid-polymer mixtures interacting via a Double-Square-Well potential (DSW-potential) consisting of hard core repulsion, short range attraction and longer range repulsive interaction. The Fisher-Widom line (FW-line) can be used as an indicator for the interplay between repulsion and attraction in the system. It seperates regimes of monotonically (attraction dominates) or oscillatory (repulsion dominates) decaying pair correlation function in the phase diagram.

Solving the Ornstein-Zernike equation we find that the regime of monotonically decaying pair correlation function decreases. On the high density side of the phase diagram repulsion dominates (hard core interaction), but the introduction of the longer range repulsive step leads to a dominance of repulsion also on the low density side of the phase diagram. Only for intermediate densities and temperatures close to the critical temperature attraction dominates the system.

Further research includes a detailed check and analysis of the theoretical results by Brownian Dynamics simualtions. The intersection of the binodal and the FW-line could be interesting for the structure of systems below the binodal line and eventually for gel network formation.

DY 46.18 Thu 15:00 P2

Self-propelled Ellipsoidal Swimmers — •Gordei Anchutkin[1], Viktor Holubec[2], Artem Ryabov[3], and Gordei Anchutkin[1] — [1]Molecular Nanophotonics Group, Peter Debye Institute for Soft Matter Physics, Leipzig University, 04103 Leipzig, Germany — [2]Institute for Theoretical Physics, Leipzig University, 04103 Leipzig, Germany — [3]Department of Macromolecular Physics, Faculty of Mathematics and Physics, Charles University, CZ-180 00 Praha, Czech Republic

The active motion of microswimmers has attracted broad interest for the last decades. A variety of active particles with different shapes and designs have been demonstrating various applications from biosensing to synergistic drug delivery most of them, though, with spherical particles involving a single orientational relaxation time. To generalize the complexity of active microswimmers* behavior, we investigate the fundamentals of active motion for microswimmers with multiple timescales of rotational diffusion. We investigate Janus ellipsoids thermophoretically propelled along the short axis of the ellipsoid. We report three different motion regimes of Janus ellipsoids: the active ballistic motion, run and tumble, and the diffusive regime. Using mean squared displacement analysis, we describe each regime and the corresponding time scales and show the coupling between translational and orientational motions. Our experimental results are compared to a theoretical model of an active ellipsoid motion. The different modes of active motion on different timescales deliver interesting perspectives to explore the interaction with obstacles and other particles at different densities.

DY 46.19 Thu 15:00 P2

Hyperspace-simulations of quasicrystalline structures on periodic substrates — •Johannes Schöttner and Michael Schmiedeberg — FAU, Erlangen, Deutschland

We perform Monte Carlo simulations a toy model where particles move on a hyperlattice. Therefore, jumps in hyperspace corresponding to phasonic flips are considered while phononic noise is not taken into account. Note that the interaction energy is determined after the particles have been projected onto the physical space. This approach can be used to learn about the stability and other physical properties of quasicrystals. Our work here is motivated by experiments [1] where quasi-crystalline structures grows self-organized on a crystalline surface. Therefore, we consider an external periodic potential that acts in our toy model. Our goal is to investigate how phasonic modes are influenced by the external periodic potential. A major advantage of our approach is that by construction we know all hyperspace positions of all particles. Furthermore, phasonic excitations due to the external potential can be determined without ambiguity. [1] Förster et al., Nature, 502:215*218, 10 (2013)

DY 46.20 Thu 15:00 P2

Theory of scanning gate Microscopy in graphene — •Xianzhang Chen[1,2], Guillaume Weick[2], Dietmar Weinmann[2], and Rodolfo Jalabert[2] — [1]Lanzhou Center for Theoretical Physics, and Key Laboratory for Magnetism and Magnetic Materials of MOE, Lanzhou University, Lanzhou, Gansu 730000, China — [2]Université de Strasbourg, CNRS, Institut de Physique et Chimie des Matériaux de Strasbourg, UMR 7504, F-67000 Strasbourg, France

The conductance of graphene nanoribbons and quantum point contacts under scanning gate microscopy tip has been systematically studied. The first- and second-order conductance corrections caused by the tip potential disturbance in armchair graphene are expressed in terms of the scattering states of the unperturbed structure using a scattering approach for a noninvasive probe. The second-order term prevails in the conductance plateaus for armchair graphene strips, but the first-order corrections dominate everywhere at the conductance steps for graphene shaped in quantum point contact. For the stronger tip, where the perturbation approach breaks down, we discovered that conductance corrections exhibit resonance effects at specific values of the tip potential width and strength, which can be regarded as carriers trapped below the tip. Additionally, the numerical results for zigzag graphene also follow the weak probe theory.

DY 46.21 Thu 15:00 P2

Characterization and control of traffic-jam transition for self-propelled particles with q-fold discrete symmetry: The restricted Active Potts Model — •Swarnajit Chatterjee[1], Mintu Karmakar[2], Matthieu Mangeat[1], Heiko Rieger[1], and Raja Paul[2] — [1]Saarland University, Saarbrücken, Germany — [2]Indian Association for the Cultivation of Science, Kolkata, India

We undertake comprehensive numerical simulations of the q-state active Potts model (APM) [EPL **130**, 66001 (2020); Phys. Rev. E **102**, 042601 (2020)] applying distinct volume exclusions to the self-propulsion of the active particles in the quest to explore the characteristics of the emerging phases, kinetic arrest, and jamming transitions. We broadly explore two scenarios where (a) the population of a lattice site is prearranged (hard-core restriction) and (b) particle movements are governed by a local repulsive field (soft-core restriction) and show that such effects lead to a surprisingly rich variety of self-organized spatial patterns. While bands and lanes of moving particles commonly occur without or under weak volume exclusion, strong volume exclusion along with low temperature, high activity, and large particle density facilitates traffic jams. Through a number of phase diagrams, we identify the phase boundaries separating the jammed and free-flowing phases and study the transition between these phases which provide us with both qualitative and quantitative predictions of how jamming might be delayed or dissolved. We further validate our numerical findings with a hydrodynamic model description.

DY 46.22 Thu 15:00 P2

Polar flocks with discretized directions: the active clock model approaching the Vicsek model — •Matthieu Mangeat, Swarnajit Chatterjee, and Heiko Rieger — Universität des Saarlandes, Saarbrücken, Germany

We study the off-lattice two-dimensional q-state active clock model (ACM) as a natural discretization of the Vicsek model (VM) [Phys. Rev. Lett. **75**, 1226 (1995)] describing flocking. The ACM consists of particles able to move in the plane in a discrete set of q equidistant angular directions, as in the active Potts model (APM) [EPL **130**, 66001 (2020); Phys. Rev. E **102**, 042601 (2020)], with a local alignment interaction inspired by the ferromagnetic equilibrium clock model. A collective motion emerges at high densities and low noise. We compute phase diagrams of the ACM and explore the flocking dynamics in the region, in which the high-density (polar liquid) phase coexists with the low-density (gas) phase. We find that for a small number of directions, the flocking transition of the ACM has the same phenomenology as the APM, including macrophase separation and reorientation transition from transversal to longitudinal band motion as a function of the particle self-propulsion velocity. For a larger number of directions, the flocking transition in the ACM becomes equivalent to the one of the VM and displays microphase separation and only transverse bands, i.e. no reorientation transition. Concomitantly also the transition of the $q \to \infty$ limit of the ACM, the active XY model (AXYM), is in the same universality class as the VM. We also construct a coarse-grained hydrodynamic description for the ACM and AXYM akin to the VM.