frontiers | Frontiers in Physics

TYPE Editorial
PUBLISHED 06 December 2022
DOI 10.3389/fphy.2022.1097453

OPEN ACCESS

EDITED AND REVIEWED BY
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SPECIALTY SECTION
This article was submitted to Soft Matter Physics,
a section of the journal
Frontiers in Physics

RECEIVED 13 November 2022
ACCEPTED 18 November 2022
PUBLISHED 06 December 2022

CITATION
Fernandez-Nieves A and Planet R (2022), Editorial: Active and externally driven granular matter.
Front. Phys. 10:1097453.
doi: 10.3389/fphy.2022.1097453

Editorial: Active and externally driven granular matter

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KEYWORDS

granular, shear, driven matter, active, suspensions

Editorial on the Research Topic
Active and Externally Driven Granular Matter

Active and externally driven granular matter are examples of heterogeneous systems that can spatiotemporally respond in a multitude of non-trivial ways. They exhibit both remarkable self-organization and collective behaviors. Their governing parameters are often the packing fraction and interparticle interactions. However, mixtures of particles and their geometry and/or chiral nature can provide additional ways to affect the many-particle behavior. Some of these aspects are explored in this Research Topic, with an emphasis on the overall emergent behavior and system-wide structural and dynamical features. The article by Lopez-Castaño et al. is an experimental study, reporting on the occurrence of vortex flow in binary mixtures of self-propelled disks. The authors find that this collective chiral mode is not only related to the spin of individual disks, but also depends on the local particle structure, illustrating how many-body effects conspire to result in a system-wide collective behavior. The article by Zhao et al. reports simulations on rachet-like particles driven by an imposed shear or extensional flow. The results suggest that, apart from chiral active fluids, chirally-shaped passive particle systems also exhibit a non-zero, odd viscosity, which indicates the mixed properties of conventional complex fluids and chiral viscous fluids. Gao et al. present theoretical work ultimately aimed at addressing furrow formation in cell populations. The authors build on prior active granular fluid models for cell constriction and consider cell size fluctuations. The study demonstrates that shape changes result from coordinated intercellular dynamics, where mechanical feedback plays an important role. The work illustrates how generation of tissue architecture can be driven by intricate collective effects governed by mechanical forces. Megías and Santos develop a theory, which they test with computer simulations, on granular gases in order to develop protocols that allow a system with a higher initial temperature to relax to a steady state quicker than another system with a lower initial temperature, a phenomenon known as the Mpemba effect. A key aspect of the work is the addition of stochastic forces and torques at the particle level which effectively inject energy into the particle translational and rotational degrees of freedom. Saitoh and Kawasaki perform simulations on dense suspensions driven by shear, and study, among other things, the properties of dynamical heterogeneities in the system. The authors find scaling behaviors with packing fraction, that are different from those typically seen in conventional glass-forming liquids, as their temperature is decreased. A key aspect of the simulations is the contact force model associated with interparticle interactions. The article by Kozlowski et al. reports beautiful experiments on the traditional classical-mechanical textbook example of a block sliding on a substrate, but that is explicitly granular rather than uniform. The authors observe force chains of highly stressed particles, which are responsible for energy storage, and study how failure of the force chain structure depends on the grain shape. The results show that more angularly shaped grains can effectively support stress to a greater extent, delaying slip due to force chain restructuring. Finally, Malbranche et al. perform simulations on both monodisperse samples and binary mixtures and address the lubrication-to-friction transition scenario, re-framed in the language of the so-called crossover scaling, which describes the shear thickening transition in terms of a crossover between two critical points where the viscosity diverges; these points correspond to random close packing and to the corresponding packing fraction in the presence of friction. In the scaling analysis performed in the article, the viscosity is expressed in terms of the fraction of frictional contacts. This study represents the first application of crossover and Cardy scaling to simulated suspension rheology data. Overall, the seven articles in this Research Topic illustrate the breadth of systems, techniques, approaches, and topics encompassed by the study of active and driven granular systems, and how this breadth can be broadened to include questions on particulate suspensions.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Funding

We thank support from MCIN/AEI/10.13039/501100011033/ FEDER, UE (Grant No. PID2021-122369NB-100).

Publisher's note