DY 25: Franco-German Session on Granular Matter II

Granular media exhibit rich collective behavior arising from simple interactions such as friction, collisions, elasticity, and confinement. This session brings together experimental, numerical, and theoretical studies addressing key transitions in granular systems, including jamming, viscous-to-inertial regimes, clustering, gas cooling, and impact dynamics, highlighting the links between microscopic mechanisms and macroscopic responses.

Organized by Baptiste Darbois Texier (Paris) and Franco Antonio Tapia Uribe (Dresden)

Time: Tuesday 14:00–15:30 Location: HÜL/S186

DY 25.1 Tue 14:00 HÜL/S186

Avalanches of a granular medium reinforced with flexible fibres — •Baptiste Darbois Texier, Georges Gauthier, and Ladislas Wierzchalek — FAST, CNRS UMR 7608, University Paris-Saclay

Debris flows and landslides are catastrophic geophysical events that typically occur on sloped terrains and involve a large amount of granular materials in motion. At the laboratory scale, such events can be studied by observing avalanches of granular materials flowing down a slope and analyzing the factors that influence their initiation and cessation. In this study, we explore the effect of incorporating flexible fibres into granular media as a strategy to attenuate avalanches and stabilize granular piles. While fibre reinforcement has been shown to enhance the mechanical strength of soils, its influence on avalanche dynamics remains largely unexplored. We perform rotating-drum experiments at low rotation speeds using mixtures of grains and flexible fibres with varying volume fractions and aspect ratios. We measure the angles at which avalanches start and stop, as well as the relaxation dynamics following individual events. Increasing the fibre content or aspect ratio systematically raises both start and stop angles and broadens their distributions, accompanied by a marked rise in the number of small-amplitude avalanches. Analysis of relaxation curves further shows that fibres enhance dissipation, leading to slower, more gradual avalanche decay compared with pure grains. These findings provide quantitative evidence of the stabilizing effects of fibres on granular slopes and their role in dissipating energy during avalanches.

DY 25.2 Tue 14:15 HÜL/S186

Magnetic-Field Controlled Self-Diffusion and Clustering in Ferrogranular Mixtures — •Oksana Bilous[1], Kirill Okrugin[1], Ali Lakkis[2], Richter Reinhard[2], and Sofia Kantorovich[1] — [1]Computational and Soft Matter Physics, University of Vienna, Vienna, Austria — [2]Experimental Physics 5, University of Bayreuth, Bayreuth, Germany

We investigate self-diffusion in ferrogranular mixtures of magnetic and glass beads via Langevin/molecular dynamics of quasi-2D Stockmayer spheres mixed with repulsive non-magnetic ones, complemented by mm-scale experiments. We vary out-of-plane magnetic induction and total area fraction. The field aligns dipoles and reduces in-plane aggregation by inducing repulsion, while dipole-dipole interactions and central attractions (or susceptibility in experiments) drive chain-like and compact clustering. Increasing area fraction counteracts field-induced suppression and stabilizes larger clusters. Single magnetic particles and glass beads remain mostly diffusive, with diffusion only weakly concentration dependent, whereas particles embedded in clusters show persistent subdiffusion. The field also alters diffusion type: cluster-bound particles exhibit robustly non-Gaussian dynamics that amplify with area fraction and field. At sufficiently high induction and crowding, the glass component becomes non-Gaussian, revealing field-driven dynamical freezing of the non-magnetic species. Simulations and experiments consistently show how external fields, dipolar self-assembly, and crowding govern transport in ferrogranular layers.

DY 25.3 Tue 14:30 HÜL/S186

Angular Velocity of Spherical Particles in a Granular Gas under Microgravity during Granular Cooling — •Mahdieh Mohammadi[1], Raúl Cruz Hidalgo[2], Dmitry Puzyrev[3], Ralf Stannarius[1,3], and Kirsten Harth[1,3] — [1]Department of Engineering, Brandenburg University of Applied Sciences, Magdeburger Str. 50, 14770 Brandenburg an der Havel, Germany — [2]Departamento de Física y Matemática Aplicada, Facultad de Ciencias , Universidad de Navarra, Pamplona, Spain — [3]MARS and MTRM, Otto von Guericke University Magdeburg, Universitätsplatz 2, 39106 Magdeburg, Germany

We investigate the rotational dynamics of spherical particles in a granular gas in microgravity, which allows a clean realization and observation of collisional kinetics. The system starts in a highly excited state and undergoes dissipative collisional cooling (loss of mean kinetic energy). Patterned spheres were tracked from video data using two cameras, their 3D trajectories and velocities were extracted. Surface markers enable 3D orientation reconstruction via feature-based and projection-consistent analysis. Continuous angular trajectories are obtained by interpolating missing orientation data. From these, we extract angular velocities and analyze their evolution across different cooling intervals.

Our studies are funded within by the German Aerospace Center (DLR) projects PARADYSE, KORDYGA and EVA-II (50WM2542, 50WM2242, 50WK2348).

DY 25.4 Tue 14:45 HÜL/S186

Granular gas mixtures: Experiments and numerical simulations — •Dmitry Puzyrev[1], Kirsten Harth[2,1], Torsten Trittel[2,1], Raúl Cruz Hidalgo[3], and Ralf Stannarius[2,1] — [1]Otto von Guericke University, Magdeburg, Germany — [2]Brandenburg University of Applied Sciences, Brandenburg an der Havel, Germany — [3]University of Navarra, Pamplona, Spain

Granular gases are ensembles of free-moving macroscopic particles which collide inelastically, which leads to effects like unusual heating (gain of mechanical energy from external sources) and cooling (dissipative loss of mechanical energy), clustering, and spontaneous collective movement. Such systems can exist in different dynamical regimes depending on filling fraction, particle shapes and material properties, as well as external energy input. Our investigation is focused on 3D microgravity experiments with ensembles of non-spherical, rod-shaped particles [1] and their mixtures [2]. Machine learning-aided software used for particle detection, 3D matching and tracking is available as an open-source package [3] and can be applied to other multiparticle tracking problems. In addition to previously published results for a mixture of thinner and thicker rods [2], we present the initial results for a short/long rods mixture. Our studies are funded within by the German Aerospace Center (DLR) projects EVA-II, VICKI, KORDYGA and PARADYSE (50WK2348, 50WM2252, 50WM2242, 50WM2542).

[1] K. Harth et al., Rev. Lett., 120, 214301 (2018) [2] Puzyrev et al., npj Microgravity, 10, 36 (2024) [3] A. Niemann et al., github.com/ANP-Granular/ParticleTracking, JOSS 10(109), 5986 (2025)

DY 25.5 Tue 15:00 HÜL/S186

Granular gases of non-convex particles: Experiments and numerical simulations — Torsten Trittel[1,2], Mohammad Enezz[1], Dmitry Puzyrev[2], Kirsten Harth[1], Raúl Cruz Hidalgo[3], and •Ralf Stannarius[1,2] — [1]Brandenburg University of Applied Sciences, Brandenburg an der Havel, Germany — [2]Otto von Guericke University Magdeburg, Magdeburg, Germany — [3]University of Navarra, Pamplona, Spain

Granular gases are dilute ensembles of macroscopic particles that are not in permanent contact. Owing to the low packing fraction, they interact only by random inelastic collisions. Consequences are permanent dissipative loss of mechanical energy (granular cooling) and spontaneous clustering. Most experiments and numerical simulations so far considered spheres. The present study investigates spatial crosses (hexapods). They add more complexity in the particle interactions, and alter the role of the collisions in the exchange of translational and rotational kinetic energies. We present experiments performed in microgravity on a suborbital rocket flight [1], demonstrate particle tracking from the optical video data [2], and show results of DEM simulations of these systems. The study is funded within by DLR within projects EVA-II and JACKS (50WK2348, 50WM2340).

[1] https://sscspace.com/six-science-projects-to-space-from-sweden/

[2] A. Niemann et al., JOSS 10(109), 5986 (2025)

General Discussion