DY 39: Particulate Matter II: From microscopic interactions to collective motion (Focus session)

Time: Wednesday 15:00–16:15 Location: ZEU 118

Invited Talk DY 39.1 Wed 15:00 ZEU 118

Granular Materials: From solid to fluid with a variable jamming density — •Stefan Luding — MSM, UTwente, Enschede, NL

Soft, disordered, micro-structured materials are ubiquitous in nature and industry, and are different from ordinary fluids or solids, with unusual, interesting static solid-like and dynamic, fluid-like flow properties.

The transition from fluid to solid (at the so-called jamming density) features a multitude of complex mechanisms, (creep, relaxation, jamming, un-jamming and shear-jamming, or shear-thickening) but there is no unified theoretical framework that explains them all. In this talk, a simple yet quantitative and predictive model is presented, which allows for a variable, changing jamming density, encompassing the memory of the deformation history and explaining a multitude of phenomena at and around jamming.

The jamming density, a new state-variable, changes due to the deformation history and relates the systems macroscopic response to its micro-structure. The packing effciency can increase logarithmically slow under gentle tapping or repeated compression, leading to an increase of the jamming density. In contrast, shear deformations cause anisotropy and change the packing effciency exponentially fast with either dilatancy or compactancy as consequence. The memory of the system near jamming can be explained by a micro-statistical model that involves a multiscale, fractal energy landscape and links the microscopic particle picture to the macroscopic continuum description, providing a unified explanation for different deformation modes.

DY 39.2 Wed 15:30 ZEU 118

Tribo-electric charging in granular matter — •André Schella[1], Stephan Herminghaus[1], and Matthias Schröter[1,2] — [1]Max-Planck Institut für Dynamik und Selbstorganisation (MPIDS), Am Faßberg 17, 37077 Göttingen — [2]Institut für Multiskalensimulation, Nägelsbachstrasse 49b, 91052 Erlangen

If granular particles touch either walls or other beads, they do tribocharge. The charge modifies the way these particles interact, causing e. g. lightnings in dust storms, clogging of pipes or even dust explosions [1]. Despite its ubiquity in nature and technology, little is known about the mechanisms behind tribo-electric charging [2]. In our contribution, we will show that tribo-charging in shaken granular media can be controlled via the ambient humidity [3]. Even though the charging of a single bead is related to microscopic processes, it has consequences for the physics of the entire bed: First, charging in binary mixtures can be strong enough to overcome segregation mechanisms. Second, charges alter the structural properties, like the contact number and Voronoi volumes, of the grains. And third, same-sized binary mixtures form macroscopic, granular crystals. [1] J. Duran, Sands, Powders, and Grains, Springer, New York, 2000 [2] L. McCarty and G. Whitesides; Angew. Chem. Int. Ed. 47 2188 (2008) [3] A. Schella et al., arXiv:1609.04639

DY 39.3 Wed 15:45 ZEU 118

Triboelectric charging of surface treated granular media — •Jan Haeberle[1], André Schella[2], Matthias Schröter[3], Matthias Sperl[1], and Philip Born[1] — [1]Institut für Materialphysik im Weltraum, Deutsches Zentrum für Luft-und Raumfahrt, 51170 Köln, Germany — [2]MPI Dynamics and Self-Organization, Am Fassberg 17, 37077 Göttingen, Germany — [3]Institute for Multiscale Simulation, Nägelsbachstrasse 49b, 91052 Erlangen, Germany

Triboelectric charging of granular media has important consequences for the bulk behaviour. Effects such as powder flowability or cluster formation due to charging are everyday experiences [1]. Recently, triboelectric charging has also been linked to segregation [2] and suggested as a tool for structure formation in granular media [2,3]. In order to change charging behaviour and contact angle, we applied surface treatments to glass beads (d=0.5mm). We study the effect of these treatments in a custom-made Faraday cup setup, that allows the automated measurement of hundreds of individual particles over time periods of hours. In addition, we can control the humidity in a climate chamber to study the effect of water layers on the charging behaviour. We show that we can indeed measure the charge distribution, which can be tuned by surface treatment.

[1] Duran, J., Sands, Powders, and Grains, Springer, New York (2000)

[2] Schella, A. et al., arXiv:1609.04639 (2016)

[3] Cademartiri, R. et al., Soft Matter 8, 9771 (2012)

DY 39.4 Wed 16:00 ZEU 118

Flow Curves for Granular Matter at Finite Density and Shear Rate — •Till Kranz[1], Fabian Frahsa[2], Annette Zippelius[3], Matthias Fuchs[2], and Matthias Sperl[1] — [1]Institut für Materialphysik im Weltraum, DLR Köln — [2]Theorie der Weichen Materie, Uni Konstanz — [3]Institut für Theoretische Physik, Uni Göttingen

A fundamental understanding of the stress-strain relation is crucial for the rational description of granular flows in nature and industry. Experiments and simulations have shown a nontrivial rheology with a Newtonian-fluid regime at low shear rates and densities, a yield stress at high densities, and both shear thinning and shear thickening away from the linear response regime. At high shear rates the granular fluid displays Bagnold scaling. To describe all these regimes in a unified theoretical framework poses a considerable challenge.

We will discuss a recently developed integration through transients theory for the shear stress in a far from equilibrium granular fluid at high densities and finite shear rates which complements the established low-density, linear response results derived from the Boltzmann equation. We will show that with this theory we cover the full range of rheological regimes introduced above using numerical solutions of the granular mode-coupling equations and we will present kinetic expressions for the transport coefficients. In addition, we will discuss what determines the regimes and the range of validity of our approach.