# DY 50: Granular Matter and Granular Dynamics II

Time: Thursday 10:00–11:45 Location: ZEU 160

DY 50.1 Thu 10:00 ZEU 160

**Granular Rheology from First Principles** — •Till Kranz[1], Olfa Lopez[2], Olivier Coquand[2], and Matthias Sperl[2,1] — [1]Institut für Theoretische Physik, Uni Köln — [2]Institut für Materialphysik im Weltraum, DLR Köln

We have recently demonstrated that the *Granular Integration Through Transients* (GITT) formalism allows to derive a constitutive equation for the shear stress $\sigma$ as a function of the shear rate $\dot{\gamma}$ for arbitrary shear rates and high densities [1] of a granular fluid. Here we extend the formalism to derive a constitutive equation for the pressure $p(\dot{\gamma})$. This allows us to discuss flow curves at constant pressure and the *effective friction* $\mu = \sigma/p$. The phenomenological $\mu(I)$ rheology [2] relates the friction $\mu$ to the dimensionless inertial number $I$. We will discuss the relation between the GITT expressions and $\mu(I)$ rheology. In addition, we will present experimental stress measurements on fluidised glass beads covering several orders of magnitude in shear rate and displaying all the rheologigcal regimes predicted by GITT, namely, Newtonian rheology, as well as shear thinning and shear thickening behaviour.

[1] W. T. Kranz, F. Frahsa, A. Zippelius, M. Fuchs and M. Sperl, PRL **121**, 148002 (2018); arXiv:1710.04475
[2] GDR Midi, EPJ E **14**, 341 (2004)

DY 50.2 Thu 10:15 ZEU 160

**Is Janssen's effect still valid when simply filling a silo with non-moving bottom?** — •Diego Sancho Martinez[1], Ralf Stannarius[1], Robin Shädel[1], and Tamas Börzsönyi[2] — [1]Otto von Guericke Universität, Magdeburg, Germany — [2]Wigner Institute for Solid State Physics, Budapest, Hungary

Grain storage has been a matter of special interest during the past centuries. In former times storage containers were small compared to current silos. The biggest problem that occurs in large silos is that the walls bear much of the weight contained in it. The saturation of the pressure at the base of the silo with height in a granular system was described in detail by Janssen and supported by posterior studies. Several recent studies show, that with mobilized contact forces (realized e.g. by slowly moving the silo wall upwards) the pressure saturates at small filling heights (comparable to the silo diameter D). Without mobilization the pressure depends on the history of the system. Here, we investigate the case of simple filling (without moving walls) for different materials: soft and nearly frictionless hydrogels, soft and highly friction round-shaped sponges as well as hard particles such as glass beads and airsoft beads. We find that the pressure at the bottom of the silo as a function of filling height does not saturate up to filling heights of 20D, but keeps increasing. The rate of increase appears to be constant above filling heights of about 3D.

DY 50.3 Thu 10:30 ZEU 160

**Applyig Edwards' theory for a 2+$\epsilon$ dimensional frustrated granular system** — •Sára Lévay[1], David Fischer[2], Ralf Stannarius[2], Tamás Börzsönyi[3], Ellák Somfai[3], and János Török[1,4] — [1]Budapest University of Technology and Economics, Budapest, H. — [2]Otto-von-Guericke-University, Magdeburg, G. — [3]Wigner Research Centre for Physics, Budapest, H. — [4]MTA-BME Morphodynamics Research Group, Budapest, H.

Despite the inherent athermal features of granular materials, treating jammed granular systems in analogy to thermal equilibrium statistical mechanics was proposed by Edwards by using a volume ensemble of equiprobable jammed states, and introducing a configurational temperature named compactivity. Since then this concept was successfully used to derive the volume fraction of random loose and random close packing. We use Edwards' theory to describe a 2+$\epsilon$ dimensional frustrated system of monodisperse spherical particles. This is a flat cuboid cell at the transition between two and three dimensions: slightly thicker than the diameter of a particle. If the container is only slightly larger than the particle diameter, the optimal packing is a triangular lattice in two dimensions and particles are building alternating stripes in the third direction. It was observed that the system does not reach its ground state using mechanical agitation by shaking. In order to understand this puzzle we performed analytic calculations of the volume and the expected number of specific local configurations of particles in our system according to Edwards' theory, and successfully matched them with numerical simulations and experiments.

DY 50.4 Thu 10:45 ZEU 160

**Configuration statistics of sphere packings in geometrical confinement** — •David Fischer[1], Jonas Schulze[1], Ralf Stannarius[1], Sára Lévay[2], Tamás Börzsönyi[3], and János Török[2] — [1]Otto von Guericke University Magdeburg, Germany — [2]Budapest University of Technology and Economics, Hungary — [3]Wigner Research Centre for Physics, Budapest, Hungary

While regular packings of spheres in 2 and 3 dimensions are satisfactorily understood today, random packings still bear unsolved mysteries. Granular materials are athermal, thus temperature and free energies are not appropriate parameters to describe the statistics of local configurations. Edwards introduced a different concept with local volumes of configurations replacing energies and compactivity replacing temperature. We apply this concept to a 2+epsilon dimensional spatially restricted system, a cuboid cell filled with monodisperse spheres slightly smaller than the cell thickness. Experiments and numerical simulations are compared.

DY 50.5 Thu 11:00 ZEU 160

**Flow study for transparent model system of concrete and cement paste** — •Himanshu P Patel[1] and Günter K Auernhammer[1,2] — [1]Leibniz-Institut für Polymerforschung Dresden e. V., Hohe Straße 6, D-01069 Dresden, Germany — [2]Max Planck Institute for Polymer Research, Ackermannweg 10 - D-55128 Mainz, Germany

The study of internal dynamics and particle migration in a complex granular suspension, such as flowing concrete, poses couple of scientific challenges. Concrete due to opacity restricts the possibility of optical observations of the flow induced particle migration (FIPM). Non-optical techniques such as ultrasonic velocity profiler and sliper test provides limited understanding.

We here demonstrate the development of highly transparent model system for concrete. The system is an optically transparent dense granular suspension (42% to 48% by volume) that mimics rheology behavior of concrete on the parameters of yield stress and plastic viscosity. Further, we analyze the flow in continuous phase using specific experimental setup. The setup allows flow analysis, to understand shear and plug flow in addition to insight about segregation of particles. The study is part of understating FIPM for dense granular suspensions.

The flow profile and FIPM of model concrete is observed using high-speed camera and Laser sheet Microscopy.

DY 50.6 Thu 11:15 ZEU 160

**Is the hourglass always flowing with a constant speed?** — •Tamás Börzsönyi[1], Tivadar Pongó[1,2,3], Viktória Stiga[1], János Török[3], Sára Lévay[3], Balázs Szabó[1], and Ralf Stannarius[4] — [1]Wigner Research Centre for Physics, H-1525 Budapest, Hungary — [2]Universidad de Navarra, Pamplona, Spain — [3]Institute of Physics BME, Budapest, Hungary — [4]Otto-von-Guericke-University, D-39106 Magdeburg, Germany

For usual granular materials the discharge rate from a bin is known to be time independent (constant flow rate). This is opposed to the case of a liquid for which the decreasing height leads to decreasing pressure, resulting in gradually decreasing flow rate during a discharge process. We performed laboratory experiments and numerical simulations with traditional (frictional hard) granular materials, grains with reduced surface friction and hardness, as well as non-spherical particles which develop orientational ordering during flow. We show, that grains with a small ($<0.1$) surface friction coefficient discharge with decreasing flow rate, while for frictional elongated grains the development of orientational ordering leads to increasing flow rate.

DY 50.7 Thu 11:30 ZEU 160

**Dunes of frozen methane sand on Pluto** — •Eric Josef Ribeiro Parteli — Department of Geosciences, University of Cologne

Sand dunes, which require a supply of granular particles at the surface and a boundary layer of sufficient efficacy to enable transport of these particles by fluid forces, have been detected in surprising locations of our solar system, including Mars, Venus and Saturn's moon Titan.

Continuum simulations of wind-blown sand transport have been pushing forward our understanding of dune physics on Earth and these extra-terrestrial environments. In this talk I will report the discovery of dunes on Pluto, where the atmosphere is 100,000 times less dense than the Earth's. While terrestrial dunes consist of quartz grains, Pluto dunes are made of methane ice grains. I will present insights about the formative wind regime, particle size of Pluto dunes and the characteristics of sediment transport on Pluto from numerical simulations, which I developed in the framework of a collaboration with the New Horizons Science Team. Moreover, I will present challenging open questions about dune physics, and discuss how dune modeling will help us to improve climate simulations and our understanding of sediment landscape dynamics on Earth and extra-terrestrial environments.