DY 24: Granular matter II

Time: Thursday 10:00–12:30 Location: MA 004

DY 24.1 Thu 10:00 MA 004

Experimental study of the freely cooling granular gas — •Corinna Maass, Nathan Isert, Christof Aegerter, and Georg Maret — Fachbereich Physik, Universität Konstanz, Universitätstrasse 10, 78457 Konstanz

In the study of granular gases, the cooling state has considerable importance as the ground state of the driven system. Theoretical studies of this state consist of Haff's cooling law for the isotropic case and modifications including inhomogeneous clustering or speed-dependent restitution coefficients. In our experiment, we diamagnetically levitate granular gases consisting of 50 – 100 bismuth shots. The particles are excited in two different ways by either periodically changing the levitation field or by mechanical vibration with a loudspeaker. The resulting velocity distributions are recorded using video microscopy and particle tracking. With this setup we have done an experimental investigation of Haff's cooling law using a variation of Haff's law incorporating a time-dependent number density, as well as a comparative study of the small velocity range of velocity distributions for different types of heating.

DY 24.2 Thu 10:15 MA 004

Phase separation in driven granular systems — •Nathan Isert, Corinna Maass, Christof Aegerter, and Georg Maret — Universität Konstanz, Germany

Granular matter can show counterintuitive behavior, such as a separation induced by undirected shaking, a phenomenon known as Maxwell's demon. In the theoretical description of this effect, gravity plays an important role for the prediction of the observed bifurcation. Here, we investigate this role of gravity directly, by altered gravity up to a microgravity environment using diamagnetic levitation of grains. Our results show profound differences in the gravity dependence when compared to the predicted bifurcations, thereby strongly suggesting a modification of the present theoretical approach.

DY 24.3 Thu 10:30 MA 004

Model for pattern formation of granular matter on vibratory conveyors — •Michael Grevenstette and Stefan Jakob Linz — Institut für Theoretische Physik, WWU Münster, Wilhelm-Klemm-Straße 9, D-48149 Münster, Germany

Recently, Götzendorfer et al. [Powders and Grains '05, 1181 (2005)] have observed subharmonic propagating surface wave patterns if granular material on a trough is subject to a combination of vertical *and* horizontal periodic driving. The observed structures are non-stationary in space, drift with a constant mean velocity along the trough and oscillate subharmonically with half the driving frequency. We present a phenomenological model [1] for the surface evolution of the granular material that qualitatively reproduces and explains important aspects of the experimentally observed patterns.

[1] Grevenstette M, Linz SJ, Model for pattern formation on a vibratory conveyor, Chaos, Solitons & Fractals (2007), doi:10.1016/j.chaos.2007.06.101

DY 24.4 Thu 10:45 MA 004

Granular convection, stripe pattern segregation and collective dynamics observed in a single experimental setup — •Frank Rietz and Ralf Stannarius — Otto-von-Guericke-Universität Magdeburg, Abteilung für Nichtlineare Phänomene

Pattern formation in continuously driven granulates has been studied extensively in recent years, but the observed phenomena are far from being well understood. In loosely packed (fluidized) granulates, dynamics of axially segregated stripes have been investigated in horizontally rotating mixers. Convection rolls have been found in vibrated containers. The fluid-like mobility of individual granular particles is restricted at dense pack, one observes a collective motion (dynamic glass transition) instead.

All these phenomena are found in combination in a single experiment, which is introduced here [1]. A flat container (Hele-Shaw cell) is filled with a granular mixture and afterwards rotated continuously about its horizontal long axis. The filling fraction is crucial for the observed effects. At partial filling, a pattern of axially segregated stripes appears, which undergoes slow coarsening. Periodically travelling stripes are observed, too. In an almost densely packed container regular convection rolls appear instead. The densely packed granulate moves in collective clusters and a serpent like segregation pattern appears.

[1] F. Rietz & R. Stannarius: On the brink of jamming: Granular convection in densely filled containers; *Phys. Rev. Lett.*; submitted

DY 24.5 Thu 11:00 MA 004

Granular Hydrodynamics and Pattern Formation in Vertically Oscillated Granular Disk Layers — •José A. Carrillo[1], Thorsten Pöschel[2], and Clara Salueña[3] — [1]ICREA (Institució Catalana de Recerca i Estudis Avançats) and Departament de Matemàtiques, Universitat Autònoma de Barcelona, Bellaterra, Spain — [2]Universität Bayreuth, Physikalisches Institut, Germany — [3]Departament de Enginyeria Mecànica-ETSEQ, Universitat Rovira i Virgili, Tarragona, Spain

The hydrodynamic simulation of granular flows is challenging, particularly in systems where dilute and dense regions occur at the same time and interact with each other. We demonstrate that hydrodynamic approaches, derived from inelastic kinetic theory, give fairly good descriptions of rapid granular flows even if they are way beyond their supposed validity limits. A numerical hydrodynamic solver is presented for a vibrated granular bed in 2D. It is based on a highly accurate Shock Capturing scheme applied to a compressible Navier-Stokes system for granular flow. As a benchmark experiment we investigate the formation of Faraday waves in a 2D thin layer exposed to vertical vibration in the presence of gravity. The results of the hydrodynamic simulations agree quantitatively with those of event-driven Molecular Dynamics. To our knowledge, these are the first hydrodynamic results for Faraday waves in 2D granular beds that accurately predict the wavelengths of the standing waves as a function of the excitation amplitude.

[1] J. A.Carrillo, T. Pöschel, and C. Salueña, arXiv:cond-mat/0612276, J. Fluid Mech. (in press)

DY 24.6 Thu 11:15 MA 004

Wet granulates under shear — •Seyed Habibollah Ebrahimnazhad, Martin Brinkmann, Jürgen Vollmer, and Stephan Herminghaus — MPI for Dynamics and Self-Organization, 37073 Göttingen

Small amounts of a wetting liquid render sand a stiff and moldable material. Cohesion between wet grains is caused by the presence of capillary bridges formed at the points of contact. The finite strength of these liquid bonds is responsible for a transition from a quiescent to a fluidized state under applied shear stress. This fluidization transition is studied in a MD-type simulation in a two dimensional assembly of bidisperse discs under the action of a spatially heterogeneous external force. Capillary interaction is modeled as a short ranged but hysteretic attractive force between discs with soft core repulsion. Besides the fluidization threshold we studied the spatial and temporal distribution of granular temperature, shear rate, stress, local packing fraction, and density of capillary bridges in both the fluidized and the quiescent state. The local viscosity η of the fluidized state is dominated by the local packing fraction ρ and diverges as $\eta \propto (\rho_c - \rho)^{-1.1}$ upon approaching random close packing ($\rho_c \approx 0.85$).

DY 24.7 Thu 11:30 MA 004

The phase diagram of static granular media — •Matthias Schröter[1], Trey Suntrup[1], Charles Radin[2], and Harry L. Swinney[1] — [1]CNLD, UT Austin, Texas — [2]Math, UT Austin, Texas

The idea of an ensemble approach to static granular media was first discussed by Edwards & Oakeshott in 1989 (Physica A **157**, 1080). However, the difficulty to control the underlying state variables of pressure p and volume fraction ϕ hampered experimental tests of this idea until recently. We show that the preparation of granular samples with flow pulses in a fluidized bed allows an independent control of ϕ and p. The so determined phase diagram is the test case for the still developing statistical mechanics of static granular media.

DY 24.8 Thu 11:45 MA 004

Macroscopic stress and displacement response functions of static granular layers — •Pradip Roul and Klaus Kassner — Institute für Theoretische Physik,Otto-Von-Guericke-

Universität,Magdeburg,Postfach-4120,D-39106,Magdeburg

We investigated numerically the averaged stress and displacement response functions to a local force perturbation of assemblies of grains that have been constructed by a layer-wise deposition of particles. We apply a load to a single grain of the top layer of the granular packing with a force small enough to not cause any rearrangement of the layer structure. This study has been done by use of a DEM numerical simulation generating granular packings with different packing order consisting of soft convex polygonal sand particles. The simulation was performed in two-dimensional systems. The shape of the vertical normal stress response function depends upon the packing order of the granular aggregate. Mono-disperse packings of round particles show double peak shapes underneath the point where the external force is applied, a behaviour predicted for hyperbolic continuum equations. For bidisperse packings, double peaks are also present, but much less pronounced, whereas there is only asingle peak present packings of pentagonal particles. Stress responses are compared qualitatively with experimental results by Junfei Geng et al. of photo elastic material. Our simulation results show good agreement with these experiments. Moreover, the calculation of the macroscopically averaged displacement response functions inside the granular aggregates will be presented.

DY 24.9 Thu 12:00 MA 004

Grain coarsening effects in granular statics and dynamics — •Claas Bierwisch and Michael Moseler — Fraunhofer-Institut für Werkstoffmechanik IWM, Wöhlerstraße 11, 79108 Freiburg, Germany

The influence of grain coarsening on static and dynamic properties of frictional and cohesive grains has been studied using discrete element simulations. Volume fraction, coordination number and angle of repose have been studied as static fingerprints of the systems while the outflow rate through an orifice reflects dynamic behavior. The effect of coarsening dependend model parameters is analyzed. Surface and boundary effects in both static and dynamic regimes are highlighted and quantified. Furthermore, similarities between complex shaped particles and spheres without rotational freedom are discussed.

DY 24.10 Thu 12:15 MA 004

Stress-birefringence for granular particles in three dimensions — Andreas Wandert and •Matthias Sperl — Institut für Materialphysik im Weltraum, DLR, Köln

It has been shown repeatedly how stress-birefringence can be used to analyze forces in granular packings in two dimensions [see e.g. Majmudar/Sperl/Luding/Behringer, Phys. Rev. Lett. 98, 058001 (2007)]. In this contribution it is shown how this method can be extended to three dimensions.