DY 19: Granular matter I

Time: Wednesday 14:30–16:30 Location: MA 004

DY 19.1 Wed 14:30 MA 004

Formation of sand ripples in weakly turbulent flows — •Christof Krülle[1], Mustapha Rouijaa[2], Tobias Edtbauer[1,2], and Nuri Aksel[2] — [1]Experimentalphysik V, Universität Bayreuth, D-95440 Bayreuth — [2]Technische Mechanik und Strömungsmechanik, Universität Bayreuth, D-95440 Bayreuth

One of the most fascinating examples of pattern formation in nature are the dunes and ripples formed in sand, caused either by wind or by shear flows in water. Laboratory studies have focused mainly on the surface profile of the granular layer, describing the ripples and their instability in terms of global parameters. Here, we present an experimental study of ripple generation in an annular channel at rather low Reynolds numbers in weakly turbulent flow. We characterize the fluid velocity field at the onset of ripple generation by utilizing a laser doppler anemometer. These experimental studies show that the local rapid increase of velocity fluctuations close to the sandy bottom initiate the motion of particles and thus will finally lead to the formation of ripple patterns with finite amplitude.

DY 19.2 Wed 14:45 MA 004

A unified hydrodynamic model for dilute and dense granular flow — •Arnulf Latz and Sebastian Schmidt — Fraunhofer Institut für Techno- und Wirtschaftsmathematik, Kaiserslautern

A continuum model for granular flow is presented, which covers the regime of fast dilute flow as well as slow dense flow up to vanishing velocity. Our model is at small and intermediate densities equivalent to a kinetic model of granular flow. The existence of an inherent instability in the kinetic model due to the vanishing kinetic pressure for small granular temperatures requires a cross over from a kinetic pressure to an athermal yield pressure at densities close to random close packing. The viscosity diverges for small temperatures analogous to the diverging viscosities of liquids close to the glass transition. The model is able to recover many features of granular flow. As examples we show simulations of sandpiles with predictable slopes, Hopper simulations with mass and core flow and angle dependent critical sand heights in granular flow down an inclined plane. We solve the system of the strongly nonlinear singular hydrodynamic equations with the help of a newly developed nonlinear time stepping algorithm together with a finite volume space discretisation. The numerical algorithm is implemented using a finite volume solver framework developed by the authors which allows discretisation on cell-centred bricks in arbitrary domains.

DY 19.3 Wed 15:00 MA 004

2D barchan dunes made in the lab — •Christopher Groh[1], Andreas Wierschem[2], Nuri Aksel[2], Ingo Rehberg[1], and Christof Krülle[1] — [1]Experimentalphysik V, Universität Bayreuth, D-95440 Bayreuth, Germany — [2]Technische Mechanik und Strömungsmechanik, Universität Bayreuth, D-95440 Bayreuth, Germany

For a long time people are fascinated by the dynamics of sand dunes. And so it is not surprising that there are a lot of field studies, which give an overview about the facts of the formation of dunes in the desert or at the beach. In recent years scientists looked for theoretical models to give answers to the basic questions of the physical mechanisms of dune formation and migration.

In our setup we are able to investigate a well defined two-dimensional single barchan dune under the force of a shearing water flow. Thus we have a basic access to the dynamic of a barchan dune. This allows easily the validation of the existing two-dimensional theoretical models with our experimental data.

DY 19.4 Wed 15:15 MA 004

Rheological Transition in Granular Media — •Zahra Shojaaee, Lothar Brendel, and Dietrich E. Wolf — Department of Physics, University of Duisburg-Essen, 47048 Duisburg, Germany

The **C**ontact **D**ynamics method is being applied to investigate a two-dimensional non-cohesive granular material. The particles are hard discs, and Coulomb friction and volume exclusion forces are the only forces being exerted. The particles are confined between two parallel walls at the top and the bottom. The walls are being pushed inwards by the same perpendicular forces. They move horizontally with the same constant velocity in opposite directions.

The velocity profile is being studied. In the case of a bidisperse system the flow as function of the shear velocity shows characteristics comparable to a *phase transition*. The key quantities are the velocity of the center of mass of the system as well as its fluctuations. A *finite size analysis* suggests that it is a discontinuous *"phase transition"*. At high shear velocity the symmetry between the upper and lower wall is not spontaneously broken, whereas at slow shear rate the granular material has different slip at the two walls. For large systems the *ergodic time* seems to diverge exponentially below the critical shear velocity.

DY 19.5 Wed 15:30 MA 004

Impact Compaction of a Cohesive Granular Medium — Jens Boberski, •Lothar Brendel, and Dietrich Wolf — Computational Physics, Universität Duisburg-Essen, Deutschland

The collision between a slab of cohesive granular media and an impacting plate is investigated, focussing on the emerging compaction front. The propagation of the latter is analytically derived, taking into account a constitutive law which relates the powder's volume fraction and stability algebraically. The results are compared to Contact Dynamic simulations of the collision, which confirm the constitutive law and which agree well with the analytic treatment.

DY 19.6 Wed 15:45 MA 004

In-situ investigation of the mechanical and electrical properties of nanosized Silicon powders during compaction — •Ingo Plümel[1,2], Hartmut Wiggers[2], and Axel Lorke[1] — [1]Experimental Physics and CeNIDE, Universität Duisburg-Essen, Duisburg, Germany — [2]Institute of Combustion and Gas Dynamics, Universität of Duisburg-Essen, Duisburg, Germany

Nominally doped and undoped nano- and microsized Silicon powders were characterized by determining in-situ the conductance, impedance, and the change of porosity while applying a uniaxial mechanical pressure ranging from 7.5 to 750 MPa. The conductance shows an exponential dependence on the applied pressure for nanosized particles and a power law for microsized particles. Simple scaling considerations with respect to the particle size cannot explain this fundamentally different behavior. A slow time dependent change in conductance together with a decrease in porosity was observed while applying a constant pressure, suggesting friction-limited compaction of the powder. For a constant external force, the comparison of samples with different particle size leads to a clear power law dependence between the conductance of pressed samples and their mean particle diameter. This size effect spans seven orders of magnitude in conductance while the particle size changes by only a factor of ten. The conductance clearly exceeds any influence of the doping concentration and the variation of the sample mass. In agreement with the observed compaction of the powder, impedance spectra show a strong increase of the sample capacitance and conductance as a function of the applied pressure.

DY 19.7 Wed 16:00 MA 004

Asymptotic Structure of Nanopowders — Thomas Schwager[1], Dietrich E. Wolf[2], and •Thorsten Pöschel[3] — [1]Charité Berlin, Institut für Unfallchirurgie — [2]Universität Duisburg-Essen, Fachbereich Physik — [3]Universität Bayreuth, Physikalisches Institut

We investigate the asymptotic structure of a nano-powder as it evolves as a result of a repeated break-and-deposition process. By means of numerical simulations we found that a two-dimensional packing of adhesive rigid particles converges to a loosely packed structure whose properties are determined by the fragment size. We characterize the asymptotic structure and the relaxation to the final state by means of the density, correlation function, coordination number and fractal dimension. Surprisingly, it was found that a) the final packing density is independent of the initialization, b) the short-range correlation function is independent of the fragment size, and c) the fractal dimension of the asymptotic structure is close the one, in agreement with a scaling argument.

DY 19.8 Wed 16:15 MA 004

Three dimensional model reconstruction from two dimensional micrographs — •Bibudhananda Biswal[1], Vikaran Khanna[1], Thomas Zauner[1], and Rudolf Hilfer[1,2] — [1]ICP, Universität Stuttgart, Pfaffenwaldring 27, 70569 Stuttgart, Germany — [2]Institut für Physik, Universität Mainz, 55099 Mainz, Germany

A novel and practical method for reconstructing pore scale microstructure of multiscale porous media is presented. The method combines crystallite information from two dimensional high resolution micrographs with primordial crystallite correlations from three dimensional low resolution μ–CT to produce models with calibrated porosity, correlation and transport properties. A laboratory scale model of carbonate rock is generated and synthetic μ–CT discretizations of the reconstructed model are compared with experimental μ–CT models at different resolutions. This reconstruction method has possible application across many disciplines where three dimensional macroscopic reconstruction from insufficient microscopic information is necessary.