DY 24 Granular Matter

Zeit: Samstag 14:00–16:45 Raum: TU H2032

Hauptvortrag

DY 24.1 Sa 14:00 TU H2032

Lambert diffusion in porous media in the Knudsen regime — •Stefanie Russ[1], Armin Bunde[1], and Jörg Kärger[2] — [1]Institut fuer Theoretische Physik III, Justus-Liebig-Universitaet Giessen, D-35392 Giessen — [2]Fakultaet fuer Physik und Geowissenschaften, Universitaet Leipzig, D-04103 Leipzig

We study analytically and numerically molecular diffusion in nanopores with different types of roughness under the exclusion of mutual molecular collisions, i.e., in the so-called Knudsen regime. The diffusion problem can be mapped onto Levy walks, whose asymptotic behaviour decisively depends on the pore dimensionality and the angle distribution after molecular collisions with the pore walls. We calculate the roughness dependence of the diffusion coefficients D_s and D_t of self- and transport diffusion, respectively. In two-dimensional smooth pores, both types of diffusion are anomalous, i.e. D_s and D_t depend logarithmically on time t and system size L, respectively, $D_s \sim \ln t$ and $D_t \sim \ln L$. In rough pores and in $d = 3$, on the other hand, the logarithmic corrections are absent. We show, how this counterintuitive behavior can be understood from the Levy distribution of the jump lengths. Finally, we show that both diffusion coefficients decrease significantly when the roughness is enhanced, in remarkable disagreement with the previous literature.

DY 24.2 Sa 14:30 TU H2032

Solid - fluid transition of a monolayer of particles: Experiments — •Andreas Götzendorfer[1], Jennifer Kreft[1,2], Christof Krülle[1], and Ingo Rehberg[1] — [1]Experimantalphysik V, Universität Bayreuth — [2]Center for Nonlinear Dynamics, University of Texas at Austin

We study the fluidization of a monolayer of glass beads in a shaken annular container. In our experiment we superpose a vertical vibration with an angular oscillation around the axis of symmetry such that every point of the support follows a circular trajectory. As long as the maximum acceleration of the support is lower than the acceleration of gravity, the monolayer performs a sick-slip motion with respect to the support and moves as a solid block. Forcing with maximum accelerations above 1.5 times the acceleration of gravity fluidizes the monolayer completely. That means the individual particles jump high and the particle concentration is much lower than in the condensed phase. At intermediate forcing intensity we find that the two phases coexist. A block of condensed material travels around the ring at velocities of several cm/s, whereas in the rest of the ring the granular material is in a gas like state. The size of the condensed block and its speed vary with the forcing intensity.

DY 24.3 Sa 14:45 TU H2032

Can one hear the state of a granulate? — •C.A. Krülle and A. Garcia-Sanchez — Experimentalphysik V, Universität Bayreuth, D-95440 Bayreuth

If an ensemble of macroscopic particles is mechanically agitated, for example by vertical vibrations, the energy input is dissipated into the system by multiple inelastic collisions. As a result, the granular material can exhibit several physical states, like a gaseous phase for high energy input or a condensated state for low agitation. The transition between these two phases can be identified clearly by the different noise level and its dominant frequency range. We introduce a new method for quantifying this acoustical response of the granular system which allows us to identify critical parameters of the phase transition.

DY 24.4 Sa 15:00 TU H2032

Sound propagation in dense granular media — •Stefan Luding and Orion Mouraille — Particle Technology, DCT, TUDelft, Julianalaan 136, 2628 BL

The goal of the presented research is to understand information propagation in dense assemblies of spherical, polydisperse granular media. Using a discrete element method (DEM) simulation, the wave propagation is studied. After relaxation to an isotropic static equilibrium state, a wave is agitated by moving one side wall. First, the effect of the contact force-law is examined for a cubic sample; second, the effects of singular and periodic agitations are studied with Fourier analysis; third, pressure effects and an-isotropy are examined.

DY 24.5 Sa 15:15 TU H2032

Volume fluctuation measurements towards a granular statistical mechanics — •Matthias Schröter, Daniel Goldman, and Harry Swinney — Center for Nonlinear Dynamics, The University of Texas at Austin

Edwards and Oakeshott (Physica A 157, 1080 (1989)) proposed a statistical mechanics approach to static granular media based on the idea that each mechanically stable configuration of particles corresponds to a microstate of the system. We explore this granular phase space using flow pulses in a fluidized bed. This way of driving results in a steady state with a volume fraction ϕ which is controlled by the flow rate of the pulses. These steady states are shown to be history independent. ϕ exhibits Gaussian fluctuations with a standard deviation σ_ϕ which has has a parabolic minimum as a function of ϕ. Interpreting this result in terms of statistically independent regions leads to a better understanding of the geometrical properties of particle packings. The knowledge of σ_ϕ allows also to determine for the first time the compactivity X of a granular system. X is a temperature-like state variable introduced by Edwards and coworkers.

DY 24.6 Sa 15:30 TU H2032

Collective Behavior in Size Segregation of Granular Materials — •Stephan Ulrich, Matthias Schröter, and Harry L. Swinney — CNLD, University of Texas at Austin

Shaking a bidisperse mixture of particles can cause the large ones to rise (Brazil-nut effect) or to sink (reverse Brazil-nut effect). Studies of size segregation are often done in the limit of a single large intruder. However, theories based on granular temperatures (e.g. [1]) require collective interplay of many particles. Using image analysis, we experimentally investigate the importance of collective effects. Therefore the fraction of large particles is changed from a single intruder to equal layer heights. Furthermore, the influence of the total layer height is examined. We find the reverse Brazil nut effect to be strongest in the single intruder limit, where segregation is not driven by collective effects like fluidization

[1] D. C. Hong, P. V. Quinn, and S. Luding, Phys. Rev. Lett. **86**, 3423 (2001)

DY 24.7 Sa 15:45 TU H2032

Temperature-dependent resistivity of and compacted and sintered metal powders — •Martin Gabl, Norbert Memmel, and Erminald Bertel — Institute of Physical Chemistry, University of Innsbruck, Innrain 52a, A-6020 Innsbruck, Austria

Compaction and sintering of powders are two essential steps in the powder- metallurgical production process. Various empirical approaches have been developed in order to control these processes and to characterize the properties (such as porosity or mechanical strength) of the sample by easy to apply methods, such as resistivity measurements. Since the sample resistivity depends not only on the porosity, but also on the sample purity and the nature of the contacts between individual grains a single measurement of resistivity cannot provide sufficient information to charcterize the compacted and sintered metal powder. In the present work we demonstrate that the measurement of resistivity Rho as a function of temperature T allows separating the influence of sample purity and grain-to-grain contacts on the one hand from porosity on the other hand. The latter is uniquely related to the temperature dependence dRho/dT. We further show that dRho/dT as a function of porosity is correctly described by percolation theory.

DY 24.8 Sa 16:00 TU H2032

Dynamic Scaling of Dune Evolution — •Sebastian Fischer and Klaus Kroy — Abteilung Theorie, Hahn-Meitner Institut, Glienicker Str. 100, 14109 Berlin, Germany

The beautiful shape of desert dunes is borne out by the complicated interaction between turbulent wind flow and sandy topography. In the case of unidirectional winds and limited sand supply highly mobile crescent–shaped dunes – so–called barchans – form.

In a recent approach, the key mechanisms governing barchan morphology and dynamics were identified and put into a 'minimal model for aeolian sand dunes'. The scale invariance of the turbulent flow is broken by the characteristic scale provided by the sand transport process. As an implication of broken scale invariance we distinguish two kinds of

solutions, small sand heaps and larger dunes with a slip face.

We present solutions obtained for various wind and influx conditions. Fixed points of the system, corresponding to shape invariantly moving profiles, are found to be unstable. Dunes of a given volume that are oversupplied (undersupplied) with respect to this steady state grow (shrink). Interestingly, all trajectories obtained for a prescribed influx collapse (up to transients) on a single master curve. Thus the a priory very high–dimensional complexity of state space is significantly reduced. Universal scaling functions that neatly comprise growth kinetics are theoretically derived and numerically confirmed.

DY 24.9 Sa 16:15 TU H2032

Verdichtung kohäsiver Granularer Materie — •Lothar Brendel[1], Martin Morgeneyer[2], Dirk Kadau[1] und Lars-Oliver Heim[3] — [1]Universität Duisburg-Essen, Fachbereich Physik — [2]Technische Universität Braunschweig, IMVT — [3]Max-Planck-Institut für Polymerforschung, Mainz

Einer der elementarsten und am häufigsten vorkommenden Vorgänge im Kontext der Untersuchung der Spannungs/Dehnungs-Relation kohäsiver Schüttgüter ist die (einaxiale) Verdichtung. Dennoch ist in der Literatur keine Einhelligkeit hinsichtlich eines generischen funktionalen Zusammenhangs zwischen Verdichtungsspannung σ und Feststoffanteil ν bzw. Porosität $E = 1 - \nu$ zu finden [1,2]. Wir vergleichen Experimente an unterschiedlichen Modellsubstanzen (Carbonyleisenpulver, Kalkstein, Marmor) mit Computersimulationen und kommen zum Ergebnis, dass dabei dieser Zusammenhang als $E = (\sigma/\sigma^*)^\alpha + E_\infty$ über bis zu drei Dekaden zu beschreiben ist. Einflüsse auf den Exponenten α werden diskutiert.

[1] Denny, P.J.: "Compaction equations: a comparison of the Heckel and Kawakita equations", Powder Technology **127**, 162-172 (2002)

[2] Kawakita, K. and Lüdde, K.H.: SSome considerations on powder compression equations", Powder Technology **4**, 61-68 (1969)

DY 24.10 Sa 16:30 TU H2032

Influence of particle elasticity during steady state flow — •Dominik Schwesig[1], Dirk Kadau[1], Jörg Theuerkauf[2], and Dietrich E. Wolf[1] — [1]Department of Physics, Duisburg-Essen University, D-47048 Duisburg, Germany — [2]The Dow Chemical Company, Solids Processing, Freeport TX 77541, USA

Mechanical behavior of granular matter is often charachterized by using shear testers. Here, the steady state flow of non-cohesive powders plays an important role. It can be obtained in an experimental setup using a combination of strain and stress control. We present a simulation of such a biaxial shear tester. We use two complementary discrete element methods: the soft particle molecular dynamics models elastic particles whereas contact dynamics one can simulate perfectly rigid particles. Thus, one gets insight of the influence of particle elasticity on the steady state flow behavior of the powder.