10828

Bridging the gap between particulate systems and continuum theory

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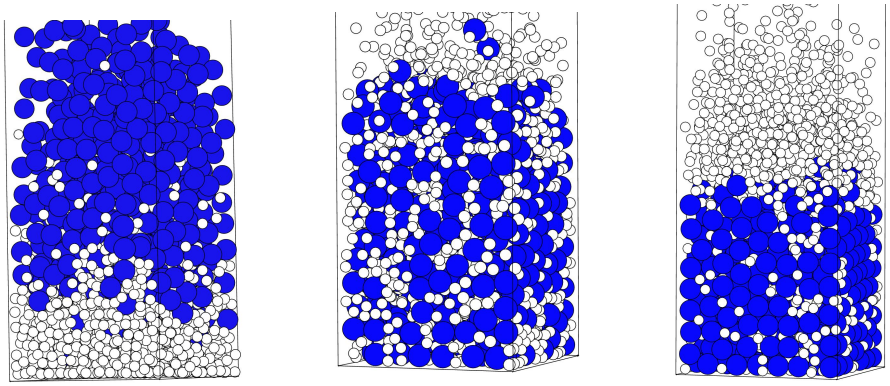
NWO stw *VICI 2011-2014,…* msm

soil, sand,
powders,
concrete,
ceramics,
cells, blood,
…

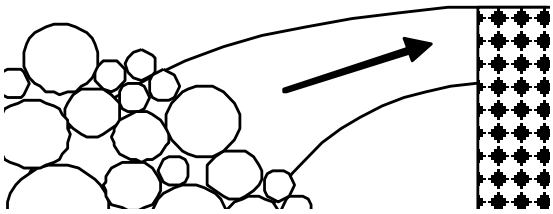
particulate systems

NWO stw *VICI* msm

Example: Segregation/Mixing



P. V. Quinn, D. Hong, SL, PRL 2001



Bridging the **gap** between
particulate systems
from microscopic understanding
and continuum theory
towards macroscopic applications

NWO stw *VICI 2009* msm

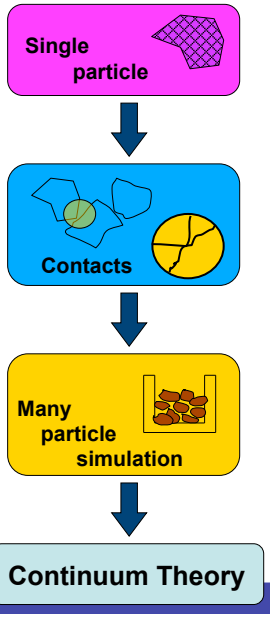
Why?

- Particle Methods (Micro-Details)
- Method: Micro-Macro Transition
- Continuum Theory (Applications)

Continuum Theory

Approach

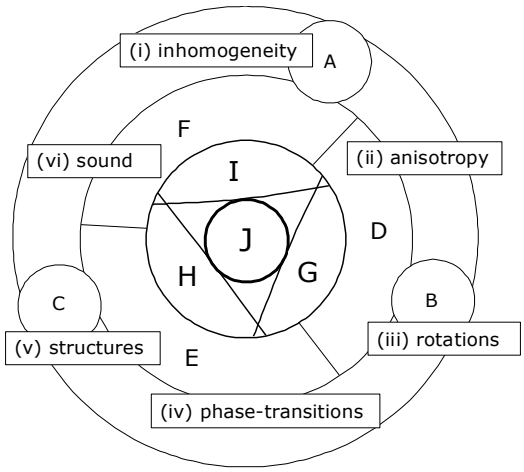
- Particle Methods
- Micro-Macro Transition
- Towards Continuum Theory
- Applications



Continuum Theory

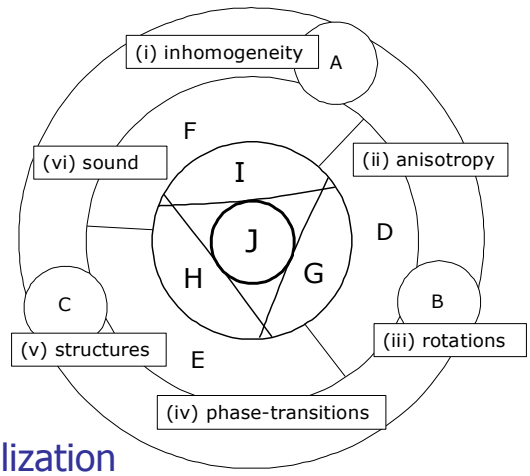
Topics ...

- inhomogeneity
- anisotropy
- rotations
- phase-transitions
- structures
- sound
- …



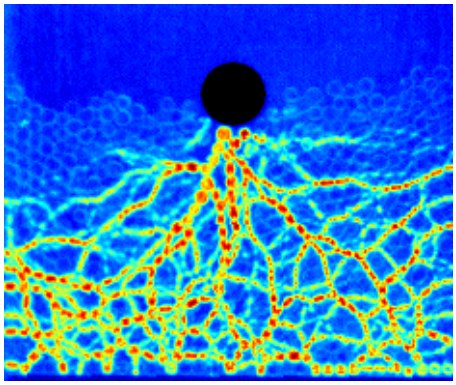
Topics ...

- inhomogeneity
- anisotropy
- rotations

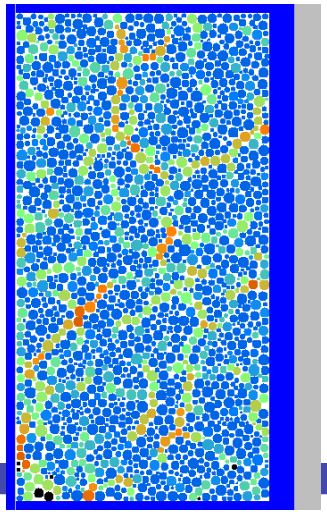


Example:
Instability &
Shear band Localization

Force-chains
experiments - simulations



2D Exper. Behringer, Duke, USA

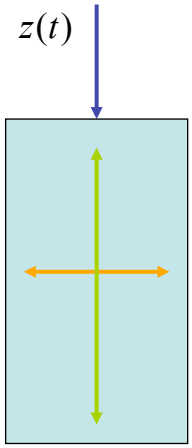


... 3D Exp. Sperl, DLR, Germany

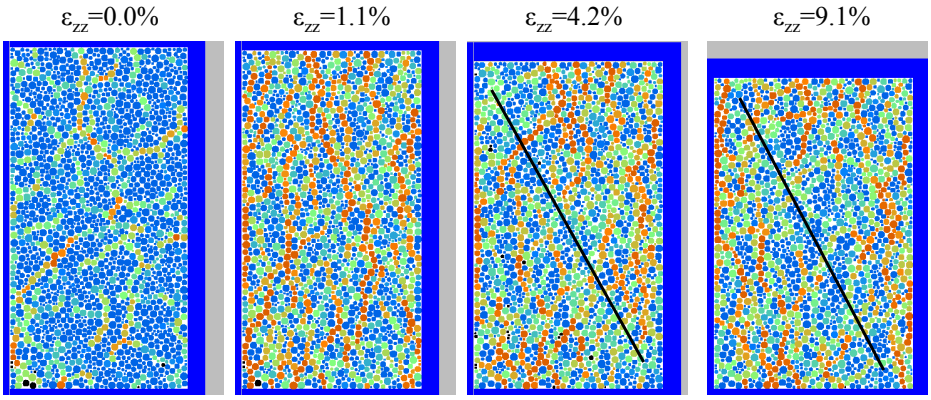
Biaxial box set-up

- Top wall: strain controlled
- Right wall: stress controlled

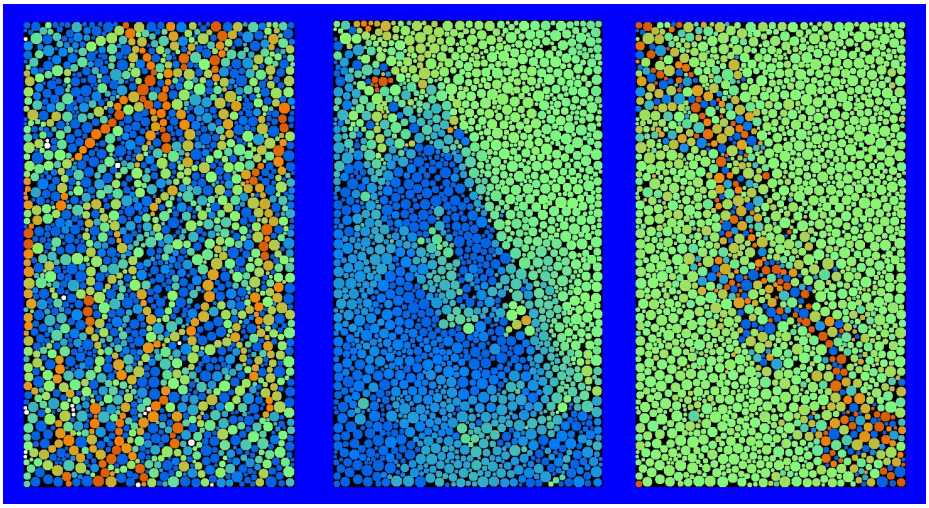
$\sigma_{xx} = \text{const.}$ →



Simulation results (closer look)



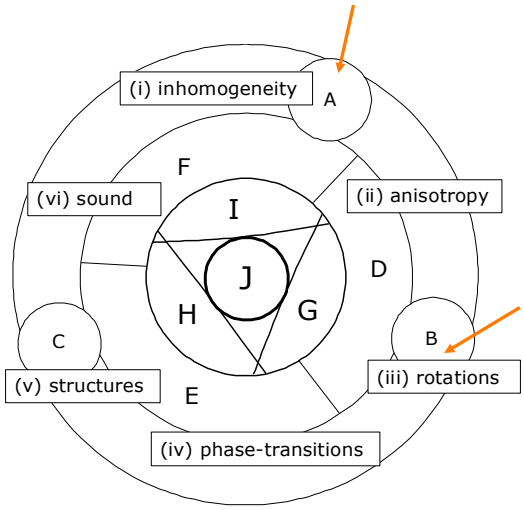
Multiple micro-mechanisms



inhomogeneity & anisotropy, instabilities & structures, rotations

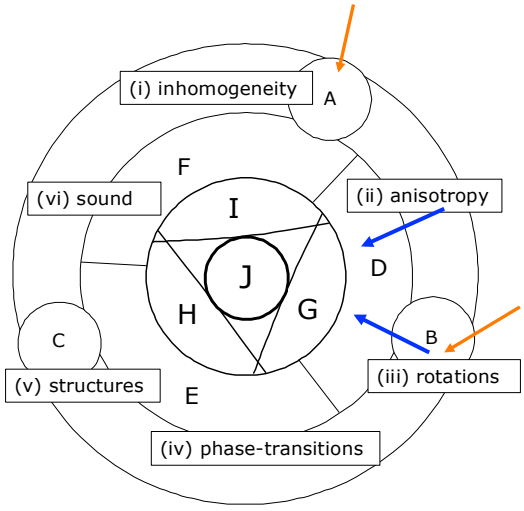
How?

- inhomogeneity
- anisotropy
- rotations



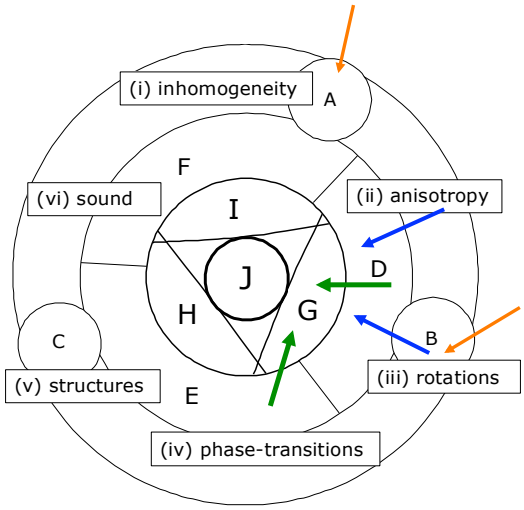
How?

- inhomogeneity
- anisotropy
- rotations



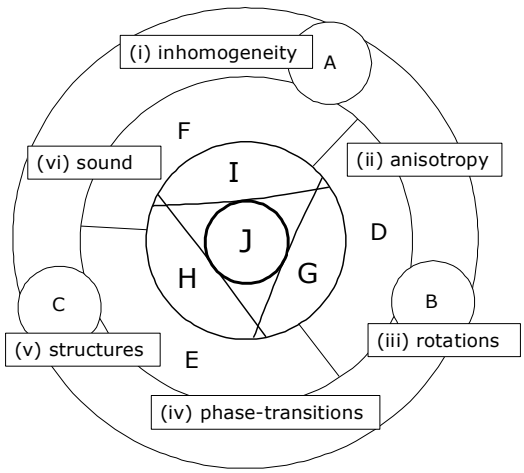
How?

- inhomogeneity
- anisotropy
- rotations



Themes worked on?

- inhomogeneity
- anisotropy
- rotations
- phase-transitions
- structures
- sound
- mixing
- …



Themes worked on?

- inhomogeneity, non-affine motion, master-pdf(force)
- anisotropy continuum model
- rotations (contact+particle => continuum)
- phase-transitions (fluid-solid, jamming)
- structures (micro+macro, analysis => prediction)
- sound/waves
- mixing/polydispersity/multiscale
- …

Overview – who and what?

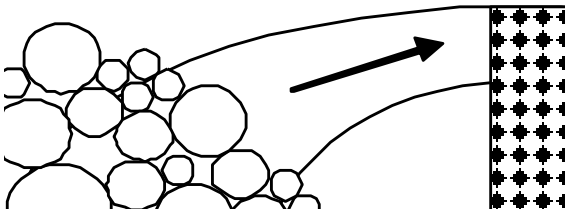
- inhomogeneity (A. Singh, K. Saitoh, N. Rivas)
- anisotropy (T. Weinhart, D. Krijgsman, R. Hartkamp, A. Singh)
- rotations (A. Merkel, T. Weinhart, V. Magnanimo)
- phase-transitions/jamming: (N. Rivas, K. Saitoh, T. Weinhart, N. Kumar (PARDEM))
- structures (micro: A. Singh, macro: N. Rivas)
- sound (B. Lawney, A. Merkel, V. Magnanimo, MSc: L. de Mol, S. Emmerich, S. Sterl, …)
- mixtures (N. Rivas, D. Krijgsman, T. Weinhart, A. Thornton, D. Tunuguntla (STW), …)
- …

Overview – who is new?

- inhomogeneity ()
- anisotropy (O. I. Imole, N. Kumar, …)
- friction+rotations
  (S. Khamshee, O.I.Imole, V. Magnanimo, …)
- phase-transitions/jamming:
  (S. Frank-Richter, N. Kumar, …)
- structures ()
- sound (new student on SHELL/FOM R. Kumar)
- mixtures (M. Lantman, …)
- …

How?

- Particle methods numerics and validation
- Micro-macro methods, combining
  statistical physics and mechanics
- Fluid and Solid Mechanics
- Continuum Theory for Applications



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