Role of Networks in Dense Suspension Rheology

- Beyond microstructure characterized by positions of particles, contact networks, forces at contacts play a role: e.g., frictional vs lubricated
- Nature of networks controlled by boundary conditions/protocol
- Characterization of networks: spatiotemporal
- What aspects of rheology are controlled by networks, which are mesoscopic structures: e.g., viscosity, shear rigidity, flow instabilities
- Fragile matter (Cates 1998) networks determine solid/liquid
- Role of constraints in determining network patterns
- How to properly characterize the networks
- Networks persistent but not-necessarily particle identities in the networks. Hence the networks that are relevant to the rheology may be determined not only by particle short range interactions, but also (and may be mainly, all the way to the granular limit) by the imposed load/load-rate/geometry.

Connecting microscopic contact properties to networks (mesoscopic structures)

- How different origin of the microstructure, in terms of particle-particle or grain-grain interactions, affect network characteristics: morphology, spatio temporal fluctuations etc? Do networks originated by attraction/adhesion/friction look the same? We already know hydrodynamics/friction in DST don't, what about stress-bearing networks in yielding soft solids repulsive/attractive etc? and what about DST with adhesion/attraction?
- Adhesion, roughness, friction: do they affect the rheology only through the static properties of the networks ? Or do we need to go to the microscopic scale?
- What microscopic features determines the onset stress in DST or the yield stress/strain ? And the related spatial inhomogeneities?

Incorporating network information into constitutive relations and continuum theories

- In DST, for example, viscosity is not a material property: different regions can have different viscosities (spatiotemporal fluctuations). Same thing may be happening with local rigidity or elasticity in yielding of soft solids (distributions of local yield strains or elastic moduli are ingredient of elastoplastic mescoscopic models)
- The role of microstructure in rheology has been explored: the analog in the systems being discussed here are the contact networks. In non-granular (colloidal) systems, there may be a more complex role of microstructure, that is not necessarily contained in only "contact networks". Hydrodynamics may play a role in shaping the network, as well as other shorter-range interactions (screened electrostatics, depletion…). Which of these aspects need to be included in the constitutive models and how?
- DST: Wyart-Cates theory highly successful. Need to go beyond ? Which are the indications that there is such need: spatio-temporal fluctuations, spatial inhomogeneities, wall-slip and boundaries.
- We do not have a microscopic theory for the mu(J) rheology: Wyart theory
- Full tensorial description
- Strain rate and accumulated strain: transients vs steady state

Interactions between boundary and bulk

- Experiments show slip at boundary and various influences of boundaries. Very little theory: if there is a wall-slip dynamics, how much of it is determined by local interactions at the boundary vs network dynamics (e.g. contact or lubricated or elastic) in the bulk?
- How do networks respond to boundary slip? Do they contribute to it and, if yes, in which conditions? How do we investigate this aspect? Could one explore different scenarios theoretically, by building models where such coupling could be investigated?
- Interplay between boundary and bulk: normal stress differences. Can we relate measurements of normal stress differences to an interplay between boundary and bulk? If we wanted to do so, which experiments should be done and which theory shoud be explored? Which simulations?