



EUROMECH Colloquium 622

Suspension flows and rheology: inertia, shape and roughness matter

June 26th to 30th, 2023 - Château Valrose, Nice - France



Particle-laden flows span scales ranging from the microscopic fluid-structure interactions observed in cellular biology and microsystems, to the large-scale transport of sediments by turbulent environmental flows and engineering processes. The coupled dynamics of the continuous fluid phase and the particles has been a longstanding topic of research in physics and (mechanical, chemical, aerospace) engineering departments. Recent outcomes were achieved by comparing dedicated experiments to numerical simulations which became more and more realistic due to new algorithms and their accurate and scalable implementation on high performance computing facilities.

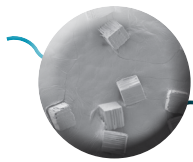
Although particulate flows are involved in large scale applications, the complex nature of their behaviour originates at the particle length scale, making the characteristic Reynolds number to be small or moderate. At the scale of particles, many physical effects drive the response of the suspension including multi-body hydrodynamic interactions, lubrication and non-hydrodynamic effects such as friction and DLVO forces (repulsion or attraction). The very small particles also experiencing Brownian diffusion which couple with hydrodynamic interactions. Fundamental to understanding these processes are computational methods and numerical techniques that enable large-scale simulation of scenarios that span different flow regimes from Stokesian dynamics to granular media dominated by particle contacts. These techniques must account for experimental evidence that

relates the local nature of particle interactions to a continuum-level rheological model. In particular, small variations in physical-chemical properties (e.g. particle surface roughness, van der Waals forces) may result in drastic changes of the suspension dynamics such as particle migration together with aggregation, shear-thinning or discontinuous shear-thickening.

The past 30 years have seen great progress in a diverse set of computational techniques, including LBM, IBM, FCM, DPD, SPH, SD and others, as well as the development of new experimental methods including local rheometry (X-ray, MRI, suspension imaging), controlled particle pressure measurements, microscopic contact law determination... However, there is a lack of discussion and interaction between the groups of researchers developing these experimental or numerical methods. Yet these could lead to a better picture of the relevant mechanisms in suspension flows and a global perspective of the advantages and disadvantages of each numerical method and its specific validity regime in terms of Reynolds number, volumetric concentration of particles, surface roughness or physico-chemical properties.

The purpose of this colloquium will be to gather the leading experts in experimental and computational methods for low Reynolds number particulate flows to share the state-of-the-art progress and compare techniques and results.

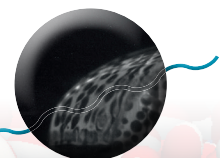
Scientific committee



- **Arezoo ARDEKANI - Purdue Univ. , USA**
- **Gerhard GOMPPER - Forschungszentrum Jülich, Germany**
- **Sarah HORMOZI - Cornell Univ. , USA**
- **Lucio ISA - ETH Zurich, Switzerland**
- **Fredrik LUNDELL - KTH Stockholm, Sweden**
- **Romain MARI - LIPhy Grenoble - France**
- **Bloen METZGER - IUSTI Marseille - France**
- **Ignacio PAGONABARAGA - EPFL Lausanne, Switzerland**

Scientific topics

- ▶ **Low Reynolds suspensions: from single particle to collective behavior**
 - Brownian and Non-Brownian particles
 - Colloidal dispersion
 - Effect of non-hydrodynamic forces
 - Active suspensions
- ▶ **Effect of particle shape**
 - Non-spherical particles
 - Polar or nematic order
 - Deformable objects (droplets, cells, soft particles ...)
- ▶ **Particle migration**
 - Inertial effects
 - Shear or concentration induced migration
- ▶ **Solid contact (roughness, friction, adhesion, rebound)**
- ▶ **Non viscosimetric flows (extension, jet, ...)**
- ▶ **Non-Newtonian fluids**



> Monday, June 26th

18:30 to 20:00 Festive gathering at Terrasse des Ecureuils, close to Théâtre de Valrose (colloquium venue). We will have a friendly meeting with drinks and appetizers and possibly Jazz music. Everyone is welcome.

> Tuesday, June 27th

08:00	09:00	Registration at Chateau de Valrose	
09:00	09:20	Welcome address by Micheline Abbas, Eric Climent and Elisabeth Lemaire	
09:20	10:00	Corinna Maas	Collective effects in active emulsions
10:00	10:30	Simon Mendez	Simulation of flows of deformable red blood cells: a challenge in modeling, numerics and physics
Coffee Break			
Session 1 : Soft particles			
10:50	11:20	Hugues Bodiguel	Rheology of soft attractive microcapsules
11:20	11:40	Blaise Delmotte	Viscosity ratio across interfaces controls the stability and self-assembly of microrollers
11:40	12:00	Badr Kaoui	Squeezing multiple soft particles into a constriction: Transition to clogging
12:00	12:15	Andy Le	Blood rheology in microcirculation
12:15	12:30	Lars Kool	Compressional rheology of a dense suspension of soft particles
Lunch			
14:00	14:30	Emmanuela Del Gado	Flow induced rigidity percolation in shear thickening suspensions
Session 2 : DST			
14:30	14:50	Francisco Rocha	Drag of a shear-thickening suspension on a cylinder
14:50	15:10	Yan Grasselli	Discontinuous shear thickening(DST)transition with spherical magnetic particles coated by adsorbed brush polymer
15:10	15:30	Jeffrey Morris	Contact-induced rigidity and shear thickening in dense suspensions
15:30	15:50	Alexis Bougouin	Shear-thickening suspension in a pipe : a jammed soliton controls the flow
Coffee break			
16:30	17:00	Ryohei Seto	Pressure-driven flows of frictional dense suspensions: migration, jammed plug, and diffusion
Session 3 : Migration			
17:00	17:20	Bhanu Prasad Bhowmik	Scaling description of dense suspension rheology under inhomogeneous flow
17:20	17:40	François Peters	Simulation of pressure-driven flow of non-brownian suspension: local constitutive laws
17:40	18:00	Willian Hogendoorn	Particle migration in dense suspensions

> Wednesday, June 28th

09:00	09:40	George Petekidis	Tuning and training of colloidal gels by external fields: Inducing memory and manipulating properties
Session 4 : Effect of particle shape			
09:40	10:00	Kenta Ishimoto	Hydrodynamic shape in a low-Reynolds-number flow
10:00	10:20	Clément Moreau	Shapes optimising grand resistance tensor entries for a rigid body in a Stokes flow
Coffee break			

10:50	11:10	Lorenzo Botto	Extreme anisotropy: orientational microstructure and rheology of a graphene suspension
11:10	11:25	Mahdi Rezaei Adariani	Numerical investigation of the influence of drag force on magnetic micro-particle aggregate steering with magnetic resonance navigation for tumor embolization
11:25	11:35	Jules Tampier	Suspension flow of star-shaped particles in two dimensional hopper
Session 5 : From single particle to collective behavior			
11:35	11:55	Graziano Frungieri	Colloidal aggregates breakup: insights from DNS and Stokesian dynamics simulations
11:55	12:10	Pappu Acharia	Minimum dissipation by cruising in dense suspensions
12:10	12:30	Ignacio Pagonabarraga	Hydrodynamically-induced morphologies in active and driven matter
Lunch			
14:00	14:30	Francesco Bonnacci	Contact drives mechanical ageing in dense and attractive colloidal suspensions
Session 6 : Solid contact			
14:30	14:45	Nathan Vani	Clogging by bridging in dilute and dense confined particulate suspensions
14:45	15:00	Chenlin Zhu	The effects of microstructure and particle roughness on the rheology of non-colloidal suspensions
15:00	15:20	Stany Gallier	How does friction increase viscosity in sheared non-colloidal suspensions?
15:20	15:40	Enzo d'Ambosio	The Role of Rolling Resistance in the Rheology of Wizarding Quidditch Ball Suspensions
15:40	16:00	Mehdi Habibi	Universal Transition to Wide Shear Zones and Strain Stiffening in Frictional Beads and Entangled Chains
Coffee break			
Session 7 : From single particle to collective behavior			
16:30	16:50	Frédéric Risso	Effect of particle inertia on the sedimentation velocity and stability of homogeneous suspension
16:50	17:10	Laurence Girolami	Sedimentation of a concentrated suspension during a dam-break flow
17:10	17:25	Bethany Clarke	Bifurcation Analysis of Active Filament Models
17:25	17:40	Hang Su	Accelerated force-coupling method and applications
17:40	18:00	Sophie Marbach	"Fancy Counting": dynamic properties from fluctuations in finite volumes
> Thursday, June 29th			
09:00	09:45	Anke Lindner	Suspensions of elongated particles : from flexible fibers to bacteria
Session 8 : Stokes flow			
09:45	10:05	Hugo Perrin	Morphology instabilities in the Stokes regime: flapping of a thin elastic disk in shear flow
10:05	10:25	Rohan Vernekar	Rheology and scaling of frictionless non-Brownian suspensions across jamming
Coffee break			
Session 9 : Non-Newtonian fluids			
10:55	11:15	Romain Mari	Rheology of dense suspensions under shear rotation
11:15	11:35	Marine Aulnette	Spheres and fibers transported in a three dimensional microfluidic vortex flow
11:35	11:55	Fredrik Lundell	Structure and rheology of nanofibril dispersions: insights from a digital twin
11:55	12:10	Luc Debono	Particle-based modelling of dilute linear polymer solutions and suspensions in pure shear and kinematically-mixed extensional-dominated flows
12:10	12:30	Rudy Valette	Impact of non-spherical viscoplastic drops on a liquid
Lunch			

14:00	14:30	Bloen Metzger	A new osmotic-like rheometer reveals the dual rheology of shear thickening suspensions
Session 10: From single particle to collective behavior			
14:30	14:50	Martin Trulson	Directional shear jamming in dense flows of elliptical particles
14:50	15:10	Régis Turuban	Mixing in and by sheared suspensions
Session 11 : Migration			
15:10	15:30	Anubhab Roy	Instability of sediment-laden shallow free-surface flows
15:30	15:45	Tamar Zemach	The propagation of polydisperse particulate gravity currents into a stratified ambient in a channel of general cross-section
15:45	16 :05	Franck Pigeonneau	Tuning oxide nanoparticles in optical fibres using phase separation and Rayleigh-Plateau instability
16:05	16:20	Benjamin Monnet	Bubbles rising in laterally-confined granular suspensions
Coffee break			
16:40	16:55	Fabian Kleischmann	Micro-gravitational particle interaction in oscillatory flow
16:55	17:10	Prateek Anand	Beyond the Segre-Silberberg pinch: Finite-size effects in inertial migration
17:10	17:25	Sina Hassanzadeh Sarae	Fully resolved CFD-DEM simulation to consider particle migration
Session 12: Effect of particle shape			
17:25	17:45	Maria Ekiel-Jezewska	Short-time dynamics of elastic filaments in shear flow
17:45	18:05	Pavan Kumar Singee-tham	Orientation dynamics of anisotropic particles in viscoelastic shearing flows for small but finite Reynolds numbers
> Friday, June 30th			
09:00	09:30	Ganesh Subramanian	Rheology and dynamics of dilute inertial suspensions
Session 13: From single particle to collective behavior			
09:30	9:50	Timm Krueger	Formation and stability of heterogeneous particle pairs in inertial microfluidics
9:50	10:10	Denis Esipov	Numerical simulation of the flow of viscous fluid with one and two spherical particles in the flat channel
10:10	10:30	Leonardo Puggioni	Flocking turbulence and giant vortex dynamics of microswimmers in confined domains
10:30	10:50	Jerzy Blawdziewicz	Macroscopic transport and microstructural evolution in emulsion imbibition
Coffee break			
11:20	11:40	Aleksandar Donev	Hydrodynamics and rheology of fluctuating, semiflexible, inextensible, and slender filaments in stokes flow
Session 14: Effect of particle shape			
11:40	12:00	Piotr Zdybel	Buckling of elastica in a shear flow
12:00	12:20	Li Heng	Hydrodynamic interactions change the buckling threshold of parallel flexible sheets in shear flow
12:20	12:30	Clément Rigal	Melting of a phase change material in a moving capsule: A parametric study
Lunch			