EUROPEAN MECHANICS SOCIETY

Colloquium n. 588 – Coupling Mechanisms and Multi-Scaling in Granular-Fluid Flows

Dates and location

2 October — 5 October 2017, Toulouse, France

Chairperson

Laurent LACAZE

Co-chairperson

Diego BERZI

Conference fees

- Registration fee: **300.00 €**

What other funding was obtained?

CNRS - 2k€
University Toulouse III (UPS) - 1K€
Institut National Polytechnique de Toulouse (INPT) - 800€
ANR (ANR-SIMI9-JCJC2012- MODSED) - 2k€

What were the participants offered?

bag - note book - pens - book of abstracts - flyer - metro tickets - toulouse map and toulouse tour program for all the participants
Each talk has been recorded thanks to a dedicated system in the conference room (recordings will be available soon).
A participation to the lunch buffet was covered thanks to the funding mentioned above.

Registration, hotel, travels were offered to the invited keynote colleagues (O. Pouliquen, J. Jenkins, J. McElwaine, E. Lajeunesse) and the Scientific committee (F. Charru, J. Magnaudet, T. Bonometti, D. Berzi, L. Fraccarollo). Note that these colleagues do not appear on the registration page for this reason.

Applicants (members)

1. Meheboob Alam
2. Pascale Aussillous
3. Aman G. Kidanemariam
4. Laurent Lacaze
5. Marco Mazzuoli
6. Jose Alberto Rodriguez Agudo
7. Nathalie Vriend
8. Andreas Wierschem

Applicants (non members)

1. Anais Abramian
2. Francesco Ballio
3. Léa Boittin
4. Alexis Bougouin
5. Julien Chauchat
6. Marco Colombini
7. Enrique D. Fernández-Nieto
8. Luigi Fraccarollo
9. Benjamin Fry
10. Cyril Gadal
11. Joe Goddard
12. Philippe Gondret

13. Ramandeep Jain
14. Paul Jarvis
15. Chris Johnson
16. Matthew Kesseler
17. Serge Nahed Kiki Sandoungout
18. Florent Lachaussée
19. Baptiste Lambert
20. Michele Larcher
21. Raphael Maurin
22. Anne Mongruel
23. Wei-Jay (Wei-Chieh) Ni
24. Thomas Pähtz
25. Pierre Philippe
26. Jean-Lou Pierson
27. Alessio Radice
28. Germain Rousseaux
29. Alban Sauret
30. Oliver Scorsim
31. Tomas Trewhela
32. Barbara Turnbull
33. Alexandre Valance
34. Bernhard Vowinckel
35. Dandan Yu
36. Gianluca Zitti

Scientific report

Euromech 588 : coupling Mechanisms and Multi-Scaling in Granular-Fluid Flows
IMFT, 2-5 October 2017

Granular flows are encountered in many geophysical and industrial applications. The transport of sand in rivers, oceans, deserts and oil pipes, debris flows, snow avalanches are some examples where the dynamics of the flow are controlled by the physical processes induced at the grain scale. Contrary to classical fluids, the size of the elementary constituents of granular materials is not infinitesimal with respect to the mesoscopic deformation scale, such as, e.g., the length of ripples and dunes in sediment transport or run-out in avalanches, which makes their continuous description questionable. Yet, in the case of dry granular flows for which the effect of the surrounding fluid can be neglected, phenomenological rheological models and more fundamental approaches based on kinetic theory have been developed during the last decades and have shown to be relevant in many situations. When interactions with the fluid are significant, the problem becomes more complex as the fluid can flow in the granular medium, leading to strongly coupled dynamics between the two phases. Extending continuous models towards such configuration and thus modelling granular fluid flows at the different scales remain a challenging task. The description of granular-fluid dynamics has been an increasingly attractive field of research for the last ten years, say, leading to a substantial stream of publications, including field measurements as well as laboratory experiments, numerical modelling at various scales and theoretical developments.
The aim of this colloquium was to gather the European scientific community to exchange on recent developments regarding the coupling mechanisms in granular fluid flow at all scales, from that of the grain to that of the whole system.
The main topics were:
- Macro-phenomena: bedload and saltation; collisional suspensions; turbulent suspensions; debris flows and granular-fluid avalanches.
- Micro-processes: turbulence modulation; relaxation processes; rheology; boundary conditions.

The colloquium has been held from the 2 October 2017 to the 5 October 2017 at the Institut de Mécanique des Fluides de Toulouse.
There were more than 50 participants and 41 presentations including 4 keynote lectures given by Olivier Pouliquen (Marseille), Jim McElwaine (Durham), Jim Jenkins (Cornell University, Ithaca, USA) and Eric Lajeunesse (Paris); full program

and the list of participants are available on the website.

Each day was dedicated to a specific scientific topic, introduced by one of the keynote lecture abovementioned. Scientific issues addressed and discussed during these days were:

• Fluid-particle interaction and rheology: the modelling of fluid-particle flows encountered in applications remains a key issue. Continuum models need constitutive equations to describe the coupled system. These rheological models should work for situations as complex as the ones observed in nature, that is involving irregular particle shapes and unsteady, inhomogeneous flow configurations. On the other hand, discrete numerical simulations, such as DNS for the fluid coupled with DEM for the particles, which could be used to test the continuum, rheological models, need to account for the local interaction/contact between particles. As the scale of this interaction is small compared to the size of the system, this short-range modelling remains challenging, in particular when particle shape is complex, while being a key ingredient for continuum models in dense configurations. The presentations proposed the first day of the colloquium highlighted the new results obtained on these issues. In particular, they showed results on models for the rheology of suspensions of solid particles as complex as fibres, the role of turbulence on the rheology, the influence of surface roughness and shape on the local particle-particle interaction, the integration of lubrication models into DNS simulations at the micro-scale. An important data set obtained from idealized experimental configurations has been shown to be available to support rheological models, which can now also be confronted to numerical models resolved at the scale of the particles. This will be a major progress for the parametrization of large scale models to predict more complex flows.

• Granular avalanches: most of avalanches and landslides observed at the surface of the Earth can be modelled as granular flows interacting with a surrounding ambient fluid. The community is seeking for a closer collaboration between field measurements and idealised laboratory experiments/simulations. The keynote of this session was focused on field observations and key questions associated with these observations. Laboratory experiments and numerical modelling showed in the different presentations focussed on some of these questions such as friction models, topographic effect, dilatancy and pore pressure. From a modelling point of view, it was shown that upscaling from micro-scale to depth-integrated models is now possible for these fluid-particle flows. All the tools (numerical, experimental, field measurement) are available for a conscientious confrontation on avalanche flows. This should reinforce collaborations between the different communities involved on the topic.

• Sediment transport: sediment transport modelling remains difficult as the range of scale encountered covers several orders of magnitude. The upscaling from the dynamics of the single grain to sheet flow is, for instance, not obvious. Numerical modelling developed in the recent years allow to access these different scales. Together with theoretical models and experiments, the aim is to be able to model the motion of sediment from the onset up to intense transport. The methods that have been presented during this session were dedicated to the description of this configuration at local scale. The key contributions addressed the modelling of the turbulent flow over the rough bed, the development of dedicate experimental technique to track each individual grain in the coupled fluid-grain system, and DEM simulations from the onset to intense transport with links to local rheology of the granular material. Different approaches have been proposed to tackle these key questions, and new collaborations are expected to emerge from this conference.

• Morphodynamics: there is still a great interest in the community in understanding how the motion at the grain scale affects macroscopic quantities such as the morphological characteristics of rivers and/or the development of instabilities at

the surface of a granular bed, evolving into ripples and dunes. During the colloquium it has been shown how experiments in wind tunnels and water flumes, and numerical simulations (DNS for the fluid coupled with DEM for the particles) can provide deep insights on the physics that drives the evolution of the interface between the fluid and the granular medium. Key questions such as the definition of ripples and dunes observed in experiments and the physical process at their origin are still unclear. Recent numerical modelling will allow to improve our knowledge on these processes.

To finish with, the colloquium was divided in four main topics, involving different scientific communities. It appeared that the interactions between the different topics allowed to considering new approaches to several unsolved problems. We hope that these interactions will lead to several new collaborations to address the questions revealed during the colloquium.

Note that 27 participant applied for a one year membership and 1 participant to a five years membership to the EUROMECH.

Number of participants from each country

Country	Participants
France	21
Italy	7
United Kingdom	5
Germany	3
United States	2
China	2
India	1
Spain	1
South Korea	1
Switzerland	1
Total	**44**