

Editorial: Powders & Grains 2017

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Abstract. Granular materials challenge researchers and engineers in various fields not only because they occur with a broad variety of grain sizes, shapes, and interactions in nature and industry, but also because they show a rich panoply of mechanical states. Despite their polymorphism, all these different types of soils, powders, granules, ores, pharmaceutical products, etc., are instances of granular matter with the same least common denominator of being sandlike (psammoid in Greek), i.e., solid grains interacting via frictional contacts. With nearly 400 research papers, this volume provides a general picture of current research on granular materials across the world. The topics covered by this volume range from small deformations of particles interacting through enduring frictional-elastic contacts to rapid flows of particles that exchange momentum and energy in multiple collisions, either in single phase or particle-fluid multi-phase flows. Applications range from powder processing to chemical engineering and modeling of geomaterials. This volume also covers four emerging sectors of research: particle shape effects (with broad scopes for designing innovative behaviors), granular suspensions (bridging between the two distinct communities of non-Brownian suspensions and immersed granular flows), particle breakage (with crucial relevance to most fields of application), material instability (implying failure mechanisms under various loading conditions), and environmental granular processes (including bio-stabilization of slopes, root-soil interactions, large-scale geological processes and astrophysics of, e.g., asteroids).

1 Powders and Grains: goals and scope

The main scope of the *Powders and Grains* conference is to communicate recent developments for a better understanding of particle-scale interactions and microstructure in granular materials, and their upscaling to macroscopic scales. Understanding the behavior of granular materials from a micromechanical perspective is of fundamental importance in many areas of science and technology. On one hand, granular materials are key elements in a wide variety of industrial and natural processes. On the other hand, they provide a rich model for all non-equilibrium systems of interacting particles at

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all scales. For this reason, the micromechanics of granular materials is a common meeting ground for applied mathematics, geology, and physics, as well as chemical, civil and mechanical engineering.

The papers published in this volume were presented during the conference *Powders and Grains 2017* held in *Montpellier, France on 3-7 July 2017*. This is the 8th International Conference on the Micromechanics of Granular Media organized under the auspices of the Association pour l'Etude de la Micromécanique des Milieux Granulaires (AEMMG). Earlier conferences were held in 1989 at Clermont-Ferrand, France; 1993 at Birmingham, UK; 1997 at Durham, North Carolina, USA; 2001 at Sendai, Japan; 2005 at Stuttgart, Germany; 2009 at Golden, Colorado, USA; 2013 at Sydney, Australia.

The proceedings of the last two conferences can be accessed following the links

PG2009: <http://aip.scitation.org/toc/apc/1145/1?expanded=1145>

PG2013: <http://aip.scitation.org/toc/apc/1542/1?expanded=1542> .

The present PG2017 collection includes 10 review papers. The papers have been organized in the following sections:

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|--------------------------------|---|
| 1. Review papers | 9. Fluids and particles |
| 2. Granular solids | 10. Material instability |
| 3. Granular flow | 11. Continuum modeling |
| 4. Granular gas | 12. Geomaterials |
| 5. Particle properties | 13. Powder processing |
| 6. Particle shape effects | 14. Environmental granular processes |
| 7. Particle breakage | 15. Particle simulations and particle-based methods |
| 8. Cohesive granular materials | 16. Miscellaneous |

Despite this classification, meant to highlight the central research question investigated in each paper, most papers potentially belong to two or more sections. For example, several papers considered in "Particle simulations and particle-based methods" are actually on the rheology of granular flows. In the same way, the papers in "Miscellaneous" could well be distributed in other sections. The only exception is the one dealing with the statistics of publications on granular materials, showing both the extent and impact of this research direction in one particular well-known journal.

In fact, all papers deal in some way with one or more of the first three items: granular solids, flows, and gases. All other sections may therefore be considered as papers focusing on one feature of granular rheology. The item "Environmental granular processes" is new and concerns natural phenomena in which granular materials play an important role. It includes plant-soil interactions, large-scale geological processes and even astrophysical systems such as asteroids. Although there are only a few papers in this section, they reflect important research fields that may benefit from progress in understanding the micromechanics of granular materials.

The papers were reviewed by the members of the Scientific Committee, Invited Speakers, selected experts, and members of the Organizing Committee. The editors needed nearly four months to get all papers reviewed, and would like to sincerely acknowledge the help and efforts of all reviewers, some of whom reviewed more than 30 papers! Without such strong support, this volume would not have appeared in time. Our special thanks go to Heinrich Jaeger, Ferenc Kun, François Nicot, Felix Darve, Jeffrey Morris and Guillaume Ovarlez, who accepted to handle papers related to the focus sessions.

We also thank graduate students P. Schumacher and L. Amarsid from the LMGC for their help with the processing of papers.

2 Organizing Committee

2.1 AEMMG Association

The “Association pour l’Etude de la MicroMécanique des Milieux Granulaires” (AEMMG) is an association created to promote the Powders and Grains meeting every four years. It was created by Roland Gourvès in 1989 in France. The board is composed of

- Stefan Luding, President
- Antoinette Tordesillas, Secretary
- Jean-Noël Roux, Treasurer

The committee is composed of international researchers working on granular materials. See www2.msm.ctw.utwente.nl/msm_www/AEMMG. The committee meeting takes place every four years during the conference. The members of the committee act as the Scientific Committee for the conference. Here is the full list:

- Tomaso Aste
UK, University College London
- Katalin Bagi
Hungary, Budapest University of Technology & Economics
- Jean-Pierre Bardet
USA, University of Miami
- Bob Behringer
USA, Duke University
- Bernard Cambou
France, Ecole Centrale de Lyon
- Ching S. Chang
USA, University of Massachusetts Amherst
- Felix Darve
France, Institut polytechnique de Grenoble
- Olivier Dauchot
France, ESPCI
- Itai Einav
Australia, University of Sydney
- Pierre Evesque
France, Ecole Centrale Paris
- Mojtaba Ghadiri
UK, University of Leeds
- Nico Gray
UK, University of Manchester
- Gerd Gudehus
Germany, Universität Karlsruhe
- Takahiro Hatano
Japan, University of Tokyo
- Hisao Hayakawa
Japan, University of Kyoto
- Hans Herrmann
Switzerland, ETH-Zurich
- May Hou
China, Chinese Academy of Sciences
- Heinrich M. Jaeger
USA, University of Chicago
- Jim Jenkins
USA, Cornell University
- Mingjing Jiang
China, Tongji University
- Luigi La Ragione
Italy, Politecnico di Bari

- Mario Liu
Germany, University of Tübingen
- Stefan Luding
Netherlands, University of Twente
- Kenichi Maeda
Japan, Nagoya Institute of Technology
- Hernan Makse
USA, City University of New York
- Anita Mehta
India, Bose National Centre for Basic Sciences
- Francisco Melo
Chile, Universidad de Santiago de Chile
- Hans Muhlhaus
Australia, University of Queensland
- Masami Nakagawa
USA, Colorado School of Mines
- Prabhu Nott
India, Indian Institute of Science, Bangalore
- Catherine O'Sullivan
UK, Imperial College London
- Luc Oger
France, Université de Rennes 1
- Jin Ooi
UK, University of Edinburgh
- Thorsten Pöschel
Germany, University of Erlangen-Nuremberg
- Olivier Pouliquen
France, CNRS, Université d'Aix-Marseille
- Farhang Radjai
France, CNRS, Université de Montpellier
- Rasmussen Keld
Denmark, Aarhus University
- Jean-Noël Roux
France, Université Paris-Est
- Mark Shattuck
USA, City University of New York
- Rodrigo Soto
Chile, Universidad de Chile
- Colin Thornton
UK, University of Birmingham
- Antoinette Tordesillas
Australia, University of Melbourne
- Gioacchino Viggiani
France, Université Joseph Fourier
- Aibing Yu
Australia, Monash University
- Iker Zuriguel
Spain, Universidad de Navarra

With this we also want to commemorate two of our members who recently passed away, namely Jürgen Tomas, Germany, and Antonio Castellano, Spain.

2.2 Local Committee

The local organizing committee of the *Powders and Grains 2017* conference was mainly composed of the members of the Réseau MiDi (Milieux Divisés), a local network of researchers and laboratories in Montpellier, working on granular materials (see www.reseau-midi.org). It was extended to several scientists from other laboratories in France. Here is the list:

- Farhang Radjai (*chair*)
LMGC, CNRS, University of Montpellier
- Jean-Yves Delenne (*co-chair*)
IATE, INRA, University of Montpellier

- Emilien Azéma
LMGC, University of Montpellier
- Ludovic Berthier
L2C, CNRS, University of Montpellier
- Gael Combe
3SR, University of Grenoble Alpes
- Carole Delenne
Hydrosiences, University of Montpellier
- Agnès Duri
IATE, INRA, University of Montpellier
- Thierry Fourcaud
AMAP, CIRAD, Montpellier
- Xavier Frank
IATE, INRA, University of Montpellier
- Claire Mayer
IATE, INRA, University of Montpellier
- Serge Mora
LMGC, University of Montpellier
- Saeid Nezamabadi
LMGC, University of Montpellier
- François Nicot
IRSTEA, Grenoble
- Luc Oger
IPR, University Rennes 1
- Olivier Pouliquen
IUSTI, CNRS, University Aix-Marseille
- Vincent Richefeu
3SR, University of Grenoble Alpes
- Jean-Noël Roux
Navier, IFSTTAR, University Paris-Est
- Thierry Ruiz
IATE, University of Montpellier
- Lydie Staron
Institut Jean Le Rond d'Alembert, University
Pierre and Marie-Curie
- Alfredo Taboada
Geosciences, University of Montpellier

3 Invited speakers

The invited talks of the *Powders and Grains 2017* conference were:

- Malcolm Bolton, University of Cambridge, UK
Geo-phenomena: finding the granular mechanism
- Karen Daniels, North Carolina State University, USA
The role of force Networks in granular materials
- Elisabeth Guazzelli, Aix-Marseille University, France
Rheology of dense suspensions of non colloidal particles
- Ken Kamrin, Massachusetts Institute of Technology, USA
A hierarchy of granular continuum models: Why flowing grains are both simple and complex?
- Jim Jenkins, Cornell University, USA
Dense, collisional, shearing flows of compliant spheres
- Takashi Matsushima, University of Tsukuba, Japan
The granular processes in planetary surfaces
- Vanessa Magnanimo, University of Twente, Netherlands
Micromechanics of complex granular materials: a focus on small strain behavior

- Thorsten Pöeschel, Universität Erlangen-Nürnberg, Germany
History and structure of granular packings
- Roland Pellenq, Massachusetts Institute of Technology, USA
The potential of mean force concept for bridging (length and time) scales in the modeling of complex porous materials
- Matthias Schröter, Friedrich-Alexander University in Erlangen, Germany
A local view on the role of shape and friction
- Matthieu Wyart, École Polytechnique Fédérale de Lausanne, Switzerland
Unifying suspension and granular flows near jamming
- Runyu Yang, University of New South Wales, Australia
Discrete modelling of compaction of non-spherical particles
- Iker Zuriguel, Universidad de Navarra, Spain
Clogging and unclogging of many-particle systems passing through a bottleneck

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- Région Occitanie (www.laregion.fr)
- University of Montpellier (www.umontpellier.fr)
- LabEx Numev (www.lirimm.fr/numev)
- Laboratoire de Mécanique et Génie Civil (www.lmgc.univ-montp2.fr), University of Montpellier
- Laboratoire Charles Coulomb (www.coulomb.univ-montp2.fr), University of Montpellier
- HydroSciences (www.hydrosciences.org), University of Montpellier
- Agropolis Fondation (www.agropolis-fondation.fr)
- Laboratoire de Micromécanique et Intégrité des Structures (www.irsn.fr/FR/Larecherche/Organisation/equipes/combustible-situations-accidentelles/MIST)