

# Colloquium n. 596 - Numerical simulations of flows with particles, bubbles and droplets

## Dates and location

9 May — 11 May 2018, Venice, Italy

## Chairperson

Luca Brandt

## Co-chairperson

Francesco Picano

## Conference fees

- Early Registration: **390.00 €**
- Late Registration: **440.00 €**

## What other funding was obtained?

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## What were the participants offered?

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## Applicants (members)

1. Francesco Battista
2. Jeremie Bec
3. Lorenzo Botto
4. Wim-Paul Breugem
5. Pedro Costa
6. Mikhael Gorokhovski
7. Paolo Gualtieri
8. Christophe Henry
9. Lyes Kahouadji
10. Jungwoo Kim
11. Baptiste LAMBERT
12. Jean-Paul Mollicone
13. Mehdi Niazi Ardekani
14. Jean-Lou Pierson
15. Gaetano Sardina
16. Alfredo Soldati
17. DANIELA TORDELLA
18. Brian White
19. Sagar Zade
20. Rémi Zamansky
21. zhentong zhang

## Applicants (non members)

1. Sellier Antoine
2. Arezoo Ardekani
3. Malik BELOT
4. Niclas Berg
5. Jaehee Chang
6. Long CHEN
7. Haecheon Choi
8. Sadegh Dabiri
9. Gaetano D'Avino
10. Diego Dotto
11. Amir Eshghinejadfard
12. Mirko Gallo

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14. Nils Erland L. Haugen
15. Adam Kajzer
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17. Katarzyna Karpińska
18. Kiyoung Kim
19. Martin Leskovec
20. Tian Ma
21. Martin Maxey
22. Andrea Mazzino
23. Chong Shen Ng
24. Giovanni Soligo
25. Hamid Tabaei Kazerooni
26. Thibault XAVIER

## Scientific report

The aim of the colloquium was to discuss the latest advancements in numerical simulations of flows with particles, bubbles and droplets, and the new possible interactions between experiments and simulations aiming to best exploit these advances.

Indeed, the development of high-fidelity numerical algorithms and computational power has recently enabled fully resolved simulations of suspensions of rigid and deformable particles, twofluid systems and elastic/porous media, including heat and mass transfer, phase change and different short-range interactions, e.g. depletion forces.

These studies are becoming more frequent and have received a significant attention. It is well recognized that the biggest new development in multiphase flow research has been the use of interface-resolved simulations and that these simulations are already starting to have a major impact for modeling as well as for gaining new fundamental insights. However, we are still exploring the potential of these new tools and how to take advantage of and complement the parallel development of new experimental techniques; there are therefore plenty of opportunities

to improve our understanding of the different physical processes involved. The challenge is to exploit at best the new capabilities, collect results for more and more complex systems and to advance the modeling of these systems.

The exchange of ideas on these aspects constituted the main goal of the Colloquium that, in our opinion, has been achieved with a great success. Indeed, it was recognized that each numerical approach has some more specific range of applications and that comparison of the different methods can bring new relevant knowledge. Including new physics, e.g. surfactants in the liquid phase, is perhaps the main challenge ahead of us.

About 55 scientists attended the meeting, with about 50 top-notch talks; among those three keynote lectures, namely prof. Jochen Fröhlich, prof. Christian Poelma and prof. Sebastien Tanguy. In addition, prof. Alfredo Soldati, Editor in chief of the International Journal of Multiphase Flows coordinated a final concluding discussion on the perspectives in this research area. The full program is attached as appendix at the end of the present report.

The first day dealt with particle-laden flows. We started by presentations and discussions on finite-size particles in turbulence: the role of rotational motion and particle size, shape, as well as enhanced heat transfer effects, turbulence modulation for more dilute systems (two-way coupled systems), both with finite-size and point particles. The rest of the afternoon was dedicated to computational modeling: multiphysics aspects (water droplets in clouds, reacting flows, rarefied gases), and subgrid-scale modelling. Finally, we discussed the specific computational challenges related to contact lines in three-phase systems such as particle-drop interactions, contacts with solid surfaces, and complex geometries.

The second day focused on bubbly flows and droplet-laden flows, with presentations on methods to accurately predict coalescence and breakup, droplet collisions, and the effect of surfactants. Both Eulerian and Euler-Lagrange based methods were

discussed, in particular diffuse interface methods. The invited talk introduced experimental challenges in multiphase flow measurement due to opacity and what quantities can be measured in dense flows. To be consistent, the afternoon was dedicated to studies concerning comparisons between experimental and numerical results, and the associated challenges.

The third day of the colloquium started with the invited talk by Sebastien Tanguy about liquidvapor phase change in the presence of external flows. The day was then dedicated to simulating and modeling the physics of complex multiphase flow. The first session discussed non-Newtonian effects such as viscoelasticity-induced ordering, and collective motion of micro-organisms. The second session focused on non-isothermal flows, such as drag reduction under non-isothermal conditions and heat transfer in particle beds.

The fruitful discussions originated after each talk and during the coffee breaks have been a crucial milestone of the present workshop, justifying also its relevance. The participants agreed to organize another meeting with the same objectives and format in a couple of years and hopefully in the same location. In addition, from the final discussion it has been decided to establish well controlled benchmarks that researchers in this community can perform with different methods exchanging the outcomes and providing reference test cases. Finally it is worth mentioning that it

has been agreed with the Editorial Board of Meccanica to collect the best papers presented at the Colloquium in a dedicated Special Issue to be printed in 2019.

## Number of participants from each country

<b>COUNTRY</b>	<b>PARTICIPANTS</b>
France	10
Italy	9
Sweden	7
United States	4
South Korea	4
Germany	3
United Kingdom	2
Netherlands	2
Poland	2
Austria	2
China	1
Norway	1
<b>TOTAL</b>	<b>47</b>