

## Colloquium Final Report

### N. 648 -- Collective Dynamics of Particles, Bubbles and Droplets

Dates and location: **20/05/2024-22/05/2024, Toledo, SPAIN**

Chairperson **Filippo Coletti**  
Co-Chairperson **Javier Rodríguez Rodríguez**

#### Conference fees

- Regular registration: **605.00 €**

What other funding was obtained? **None**

What were the participants offered? **All plenary speakers were offered free accommodation and had their flights paid Lunch, dinner and two coffee breaks per day for all participants Organizers were offered free registration (two chairpersons and two postdocs/PhD students)**

Number of members of Euromech (reduced registration fee) **14**

Number of non-members of Euromech (full registration fee) **20**

#### Applicants (members)

- Verzicco, Roberto
- Rosti, Marco Edoardo
- Watteaux, Romain
- RUIZ-RUS, JAVIER
- ROIG, veronique
- Martinez-Bazan, Carlos
- Moriche Guerrero, Manuel
- van der Meer, Roger
- Hogendoorn, Willian
- Bagheri, Gholamhossein
- Holzner, Markus
- ERN, PATRICIA
- Lohse, Detlef
- Morris, Jeffrey
- Bourgoin, Mickael
- Verhille, Gautier
- Krug, Dominik
- biferale, luca

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- Supponen, Outi
- Deike, Luc
- Zamansky, Remi
- Marin, Alvaro
- Huisman, Sander
- casciola, carlo massimo
- Villafane, Laura
- Shaik, Subhani
- Flapper, Mees
- Meiburg, Eckart
- Poelma, Christian
- Risso, Frédéric
- Richter, David
- Ni, Rui
- Garcia-Villalba, Manuel

## **Applicants (non-members)**

- Rosti, Marco Edoardo
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- Flapper, Mees
- Meiburg, Eckart
- Poelma, Christian
- Risso, Frédéric

- Richter, David
- Ni, Rui
- Garcia-Villalba, Manuel
- Machicoane, Nathanael
- Shaw, Raymond

## **Plenary speakers (free registration)**

- Alfredo Soldati
- Elizabeth Guazzelli
- Valeria Garbin

## **Organization staff (free registration)**

- Filippo Coletti
- Javier Rodríguez Rodríguez
- Lorène Champougny
- Javier Martínez Puig

## **Scientific Report**

Particles, bubbles, and droplets are often small enough that the flow at the scale of the inclusion is predominantly viscous, even when the large-scale dynamics is inertial. This simplifies the governing equations and makes the problem somewhat more tractable. However, in many practical situations, the number of suspended objects is so large, and/or their concentration so high, that they can hardly be treated as isolated elements.

The choice between discrete and continuous representation of the dispersed phase is highly influenced by the tools available to the researcher, from the theoretical, experimental, and numerical standpoint. Those tools rapidly evolve in time, as the great relevance of this class of flows has motivated major recent advances.

This Colloquium will bring together international experts in multiphase dispersed flows, and focus on the following topical questions:

- Under which conditions can the discrete object dynamics be up-scaled to represent collective behaviour?
- What are the most suitable strategies for the continuous description of the dispersed phase in the various regimes?
- Which numerical and experimental methodologies are emerging as the most appropriate for dispersed flows?

The colloquium on "Collective Dynamics of Particles, Bubbles, and Droplets" brought together leading experts to discuss the latest advancements in understanding the complex behaviors of particles, bubbles, and droplets in various fluid dynamics scenarios. The conference showcased a wide range of topics, from fundamental theoretical insights to innovative experimental methodologies and practical applications.

The opening talk on the preferential orientation and rotation of microfibers highlighted the significant impact these dynamics have on overall flow behavior. This was followed by a presentation on the largely unexplored territory of small non-spherical particles falling in air, which shed light on their unique falling patterns and interactions with the surrounding medium. Discussions continued with an examination of how particle shape affects the clustering behavior during settling processes, providing deeper insights into the mechanisms driving particle aggregation. Another intriguing presentation explored the growth of particles within Taylor–Couette turbulence, emphasizing the complex interplay between turbulent flows and particle dynamics.

The behavior of massive, chiral particles in homogeneous isotropic turbulence was another focal point, revealing their distinctive dynamic properties and potential applications. This theme of particle behavior in turbulent environments was further explored in talks on the aggregation of fibers, clustering through pair interactions in swimming zooplankton, and the dynamics of particle clusters in turbulent channel flows.

Innovative experimental techniques were a highlight of the colloquium. A presentation on using positron emission particle tomography to study dense suspensions demonstrated the power of these advanced methods. Additionally, data-driven tools for analyzing Lagrangian turbulence showcased the potential of these methodologies in advancing our understanding of turbulence.

Several talks focused on turbulence modulation, including how high particle seeding affects flow structure and behavior, and the dynamics of finite-size particles in homogeneous isotropic turbulence. The collective evolution of bubbles in regular and irregular pore networks was explored, revealing implications for various industrial processes.

The interactions between evaporating or dissolving droplets were discussed, highlighting their significance in numerous natural and industrial contexts. The strategies for promoting indefinite bubble growth in water and water-oil systems presented intriguing possibilities for various applications.

The characteristic scales of turbulence induced by interacting bubble wakes and the spectral properties of turbulent bubbly flows were thoroughly analyzed, providing new insights into the dynamics of such systems. Experimental modeling of bubble coalescence in a Hele Shaw cell and a new model for predicting bubble-particle collision rates based on bubble slip motion were also significant contributions.

The conference delved into the coalescence mechanisms of bubbles in turbulence, offering valuable theoretical and practical insights. Various nucleation processes, including cavitation, boiling, and condensation, and their interactions with larger scale dynamics were discussed in detail.

Advances in modeling cavitation and acoustic bubble cloud dynamics were presented, with an emphasis on improving model efficiency. The oscillatory behavior of a confined cylinder falling in fluid and the impact of inertial cylinder shape on group dynamics in resting liquids were also explored, revealing new insights into fluid-structure interactions.

The dynamics of particle clouds falling in vortical flows and the complex interactions between particles and vortical structures were analyzed, highlighting the intricate behaviors observed in these scenarios. Talks on minimal models, simulations, and experiments related to cloudy Rayleigh-

Benard convection provided a comprehensive overview of this fundamental fluid dynamics phenomenon.

Innovative methods for incorporating collective effects of particles, drops, and bubbles into coarse-grained simulations were presented, showcasing significant advancements in simulation techniques. The formation of high-speed sprays was investigated using synchrotron X-ray techniques, providing new insights into spray dynamics, while the generation of sea spray through collective bursting bubbles offered implications for environmental and climate models.

Further discussions covered the migration forces acting on solid particles moving parallel to a deformable liquid-liquid interface in a micro-channel, and the counterintuitive "faster-is-slower" effect observed in noncohesive constricted suspension flows. The dynamics of particle migration in pipe flows and new models for particle settling in wall-bounded turbulent flows were also examined.

Finally, the conference explored the development of rigidity in shear-thickening suspensions and the collapse behavior of submerged cohesive granular materials, providing insights into both natural and industrial phenomena.

Overall, the colloquium provided a comprehensive overview of current research on the collective dynamics of particles, bubbles, and droplets, fostering discussions and collaborations that are expected to drive future advancements in the field.

The conference spanned three days, featuring a series of in-person talks that allowed ample time for in-depth discussions following each presentation. This structure facilitated a rich exchange of ideas and fostered collaboration among participants. Additionally, we provided several opportunities for attendees to engage in relaxed and informal conversations. To this end, two cocktail receptions and numerous long coffee breaks were organized, creating a convivial atmosphere conducive to networking and informal discussions. This blend of structured sessions and informal gatherings ensured a well-rounded and productive conference experience for all participants.

## Number of participants from each country

<b>COUNTRY</b>	<b>PARTICIPANTS</b>
Netherlands	10
France	8
United States	7
Spain	5
Italy	3
Switzerland	3
Austria	3
Germany	1
Japan	1
<b>TOTAL</b>	<b>41</b>