MSCA-ITN-EID COMETE 813948

COMETE - FINAL CONFERENCE

MARCH 28-29, 2023

Scientific Programme

Tuesday, March 28, 2023 (Venue: CISM, Piazza Garibaldi 18, Udine)

16:00 – 16:05 Welcome from the local organizers
16:05 – 16:20 Overview of the COMETE project (Cristian Marchioli)
16:20 – 16:45 Invited talk (Gregory Lecrivain – Direct numerical simulation of a flexible fiber interacting with a fluidic interface)
16:45 – 17:10 Coffee Break
17:10 – 17:35 ERS presentation (Kevin Miranda – Freezing/defreezing in VCHPs)
17:35 – 18:00 Invited talk (Jure Ravnik - Recent results in modelling and simulation of particle laden flows)

Wednesday, March 29, 2023 (Esteco, Galleria Padriciano 99, Trieste)

09:30 – 09:45 Welcome from the local organizers
09:45 – 10:10 Invited talk (Francesco Zonta - Surface and internal waves in turbulence)
10:10 – 10:35 ESR presentation (Eleonora Spricigo – SPH for multiphase flows)
10:35 – 11:00 Coffee Break
11:00 – 11:25 ERS presentation (Francesca Mangani – Turbulent bubbly flows)
11:25 – 11:50 Invited talk (Alessio Roccon - Water-lubricated channel flow)
11:50 – 12:00 Closure
12:00 – 13:30 Lunch Break
13:30 – 14:30 Lab tour

Invited talks:

Title: **Direct numerical simulation of a flexible fiber interacting with a fluidic interface**
Speaker: **Gregory Lecrivain** (Institut für Fluiddynamik, Helmholtz-Zentrum Dresden-Rossendorf)

Abstract: The dynamics of fibers at a fluidic interface is of significant importance in various processes, among which stand out textile flotation, stabilization of emulsions, micro-folding of elastic structures, and clogging of feather fibers by oil droplets. A consistent formulation for the direct numerical simulation of a flexible fiber interacting with a fluidic interface is presently suggested. The fiber is geometrically decomposed into a chain of spherical beads, which undergo stretching, bending, and twisting interactions. The capillary force, acting at the three-phase contact line, is calculated using a ternary diffuse-interface model. Each ingredient of the model was validated against theoretical solutions. Partial and complete wrapping of an immersed three dimensional drop is successfully simulated. The results show that the fiber curvature increases linearly with the square of the elasto-capillary length, for both low and large structural deformation, in-line with previously experimental observations.

Title: **Recent results in modelling and simulation of particle laden flows**
Speaker: Jure Ravnik (Chair for Power, Process and Environmental Engng, University of Maribor)

Abstract: In my talk I will present recent advances in the modelling and simulation of particle-laden flows. First [1,2,5,6], I will focus on the simulation of aerosol particles inhaled in the human respiratory tract. I will show the deposition rates in different parts of the human lung as a function of the subject's respiratory activity, the environment in which the subject is exposed to the aerosol, the subject's gender and age, and the subject's physical activity. Secondly [3,4], I will present a model for estimating the force and torque on super ellipsoidal particles in flows. The model is based on the simulation of different creeping flow patterns around a particle, taking into account the contributions of uniform, rotating and shear flows. Expressions for the force and torque are proposed by introducing translational, rotational and deformation resistance tensors that capture each of the flow patterns individually. A parametric study has been carried out considering a wide range of non-spherical particles determined by the parametric superellipsoid surface equation. Based on simulation results, the model was derived that can be added to any existing Lagrangian tracking scheme that tracks the position and rotation of particles. Finally, a proposition of superellipsoid particle – particle and particle – wall interaction model will be made and some preliminary results in this regard will be presented.

References:
1. Wedel, J., Steinmann, P., Štrakl, M., Hriberšek, M., & Ravnik, J. (2023) Int. J. Multiphase Flow, 158, 104283. doi:10.1016/j.ijmultiphaseflow.2022.104283
2. Wedel, J., Steinmann, P., Štrakl, M., Hriberšek, M., Cui, Y., & Ravnik, J. (2022) Comput. Methods Appl. Mech. Eng., 401, 115372. doi:10.1016/j.cma.2022.115372
3. Štrakl, M., Hriberšek, M., Wedel, J., Steinmann, P., Ravnik, J. (2022) J. Mar. Sci. Eng. 2022, 10, 369. doi:10.3390/jmse10030369
4. Štrakl, M., Wedel, J., Steinmann, P., Hriberšek, M., Ravnik, J. (2022) Int. J. Comput. Methods Exp. Meas. (2022), Vol 10, Pages 38-49, doi:10.1016/10.2495/CMEM-V10-N1-38-49
5. J. Wedel, P. Steinmann, M. Štrakl, M. Hriberšek, J. Ravnik (2021) Arch. Comput. Methods Eng. (2021), doi:10.1007/s11831-021-09613-7
6. J. Wedel, P. Steinmann, M. Štrakl, M. Hriberšek, J. Ravnik (2021) Comput. Mech., doi:10.1007/s00466-021-01988-5

Title: **Surface and internal waves in turbulence**
Speaker: Francesco Zonta (Institute of Fluid Mechanics and Heat Transfer, TU Wien)

Abstract: In a number of industrial, geophysical and environmental situations, waves develop at the interior or at the interface of fluids (internal or surface waves) and significantly alter the overall efficiency of mass, momentum and energy transfer of these systems. In this seminar, I will review some recent results obtained by Direct Numerical Simulations of turbulence in presence of sharp or continuous density gradients.

Title: **Water-lubricated channel flow**
Speaker: **Alessio Roccon** (DPIA, University of Udine)

Abstract: We use direct numerical simulation (DNS) to study the problem of drag reduction in a lubricated channel, a flow instance in which a lubricating fluid (e.g. water) is injected in the near-wall region of a plane channel, so to favor the transportation of a primary fluid (e.g. oil). All DNSs are run within the constant power input (CPI) approach, which prescribes that the flow-rate is adjusted according to actual pressure gradient so to keep constant the power injected into the flow. The CPI approach has been purposely extended here for the first time to the case of multiphase flows. As this drag-reduction technique is tailored toward the transport of viscous

fluids like oils, we study the drag-reduction performance of these systems considering different types of oils, from less viscous ones to very viscous ones, and different flow configurations.
As these systems are also characterized by the presence of contaminants and surfactants, which act by locally reducing the local value of the surface tension, we also consider the possible presence of surfactants. For all the different tested configurations, we unambiguously show that a significant drag reduction can be achieved. Upon a detailed analysis of the turbulence activity in the two lubricating layers, the interfacial wave dynamics and their interplay, we are able to characterize the effects of surface tension forces, surfactant concentration and viscosity contrast on the drag reduction performance.