Hydrodynamic interactions between two flexible fibers settling under gravity in a viscous fluid

5:25 pm – 5:38 pm

Presenter: Maria L. Ekiel-Jezewska (Institute of Fundamental Technological Research, Polish Academy of Sciences)
Authors: Harish Mirajkar (Institute of Fundamental Technological Research, Polish Academy of Sciences), Chandra Shekhar (Institute of Fundamental Technological Research, Polish Academy of Sciences), Yevgen Melikhov (Institute of Fundamental Technological Research, Polish Academy of Sciences), Piotr Zdybel (Institute of Fundamental Technological Research, Polish Academy of Sciences)

The dynamics of two flexible fibers, settling under gravity in a viscous fluid, are investigated experimentally and numerically. In the experiments, two ball-chains sediment in a highly viscous silicon oil at a Reynolds number much smaller than unity. In our numerical simulations, elastic fibers are modeled as chains of identical beads, with the consecutive centers connected by springs and exhibiting elastic resistance to bending. Their motion is determined by the multipole expansion of the Stokes equations, implemented in the precise Hydromultipole numerical code. In the experiments, the ball-chains are initially straight and close to a parallel horizontal configuration. In the numerical simulations, a wide range of initial positions and orientations is considered.

In both experiments and simulations, we find that relatively short fibers tend to stay together and approach a configuration with their end-to-end lines parallel to each other and horizontal (named `aligned' configuration). In the numerical simulations, we demonstrate that the basin of attraction to the aligned configuration is large, and not limited to symmetric configurations studied by Bukowicki and Ekiel-Jezewska, Soft Matter, 46, 9379, 2019. Longer fibers have complex shapes and exhibit different behavior; they often separate from each other vertically or horizontally.

Funding acknowledgement

This work was supported in part by the National Science Centre in Poland under grant 2021/41/B/ST8/04474.

Contributed Session: Particle-Laden Flows: Deformable Particles
Time and date: 5:25 pm – 6:30 pm, Sunday November 23
Location: Session J24 // George R. Brown Convention Center, 362AD
Chair: Maria Ekiel-Jezewska, Institute of Fundamental Technological Research Polish Academy of Sciences