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Monday, November 21, 2022 8:00 AM- 10:10 AM
Session L36 : Particle-Laden Flows: Non-Spherical and Deformable Particles I
244 - Paul Millett, University of Arkansas
8:00AM L36.00001:
Three-dimensional dynamics of elastica in a shear flow *

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We analyze three-dimensional dynamics of an elastic filament in a shear flow of a viscous fluid at low Reynolds number and high Peclet number. We solve the eigenproblem for the Euler-Bernoulli beam (elastica) model by the Chebyshev spectral collocation method. We reduce it to a description in terms of a single parameter X, dependent on the filament flexibility (relative to the shear rate) and its orientation. In this way we show that the solution is the same as in case of the two-dimensional elastica dynamics in shear flow [Becker and Shelley, Phys. Rev. Lett. 2001], and the three-dimensional elastica dynamics in the compressional flow [Chakrabarti et al., Nature Physics, 2020]. We analyze the odd and even eigenfunctions, and provide their simple analytic approximation, dependent on two parameters, m and the wave number k, that scale as the square root of X. The spectrum is shown to be linear in X. These scalings, together with other properties, are reproduced by the results of our numerical simulations for elastic fibers of a non-zero thickness, made of beads interacting hydrodynamically with each other. The numerical simulations are performed by the precise Hydromultipole numerical codes, based on the multipole expansion of the Stokes equations, corrected for lubrication.

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