Implementation of a fully resolved immersed boundary solver for particle-laden viscoelastic flows

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Fluid-particle transport present significant practical relevance in several engineering applications, such as oil sands mining and polymer processing. In numerous cases it is essential to consider that the fluid, in which the particles are dispersed, follows a viscoelastic constitutive model. For this aim, a novel numerical algorithm was implemented on an open-source finite-volume viscoelastic fluid flow solver coupled with an immersed boundary method, by extending the open-source computational fluid dynamics library CFDEMcoupling. The code is able to perform fully resolved simulations, wherein all flow scales, associated with the particle motion, are resolved. Additionally, the formulation employed exploits the log-conformation tensor approach, to avoid high Weissenberg number issues. The accuracy of the algorithm was evaluated by studying several benchmark flows, namely: (i) the sedimentation of a sphere in a bounded domain; (ii) rotation of a sphere in simple shear flow (see the figure below); (iii) the cross-stream migration of a neutrally buoyant sphere in a steady Poiseuille flow. In each case, a comparison of the results obtained with the newly developed code with data reported in the literature is performed, in order to assess the code accuracy and robustness. Finally, the capability of the code to solve a physical challenging problem is illustrated with the shear-induced three particle alignment in a wall-bounded flow. The role of the fluid rheology and finite gap size on both the approach rate and pathways of the solid particles are described.