A benchmark for fluid rigid body interaction with standard CFD packages

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The interaction between a fluid flow and rigid bodies appears in many physical applications. The flow around a free rigid body causes both displacement and rotation of that body while the motion of the body causes changes in the flow. The complexity that comes with coupling models for fluid and rigid bodies and the numerical challenges due to the interaction make reliable and benchmark computations necessary though difficult to perform. The presented benchmark targets the free rotation of a spherical object in a flow channel. This setup extends the benchmark *flow past a cylinder* [1] and is accessible to standard CFD software.

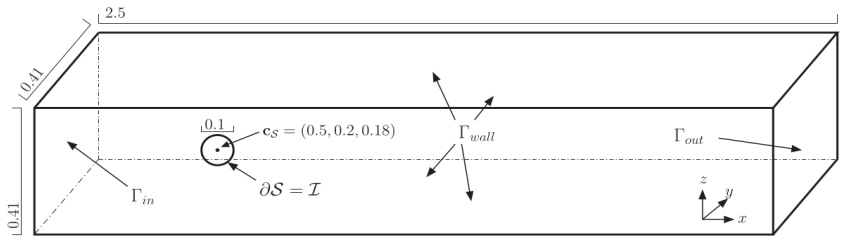

Figure 1: Spatial configuration of the 3D setup.

In this setup the flow applies a torque force on the object. The induced rotation then couples back to the flow via the boundary conditions. The proposed benchmark configurations comprise two and three spatial dimensions and quasi-stationary (low Reynolds-number) and periodic (high Reynolds-number) regimes. For a discretization independent comparison of the results, we also propose a set of significant, nondimensionalized characteristic values. The benchmark cases were solved numerically with various approaches and software tools so that the computed characteristic values could be reported within a reasonable confidence interval.

In this talk, we introduce the mathematical model, discuss the characteristic and challenges of the benchmark cases, and present the various implementation and their particular advantages. The codes that were reported on in our work [2] as well as the raw data and postprocessing routines are available [3] for further exploration and for reproduction.

References

[1] M Schäfer and S Turek: *Benchmark computations of laminar flow around a cylinder.* Flow Simulation with HPC II. DFG priority research program results 1993-1995, 1996.

[2] H von Wahl et al.: *Numerical benchmarking of fluid-rigid body interactions*. Computers & Fluids, 2019.

[3] DOI:10.5281/zenodo.3253455