Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

A complex-valued Stokes solver for simulation of time-periodic creeping flows CHENWEI MENG, MAHDI ESMAILY, Cornell University — The computational cost of a standard CFD solver is proportional to the number of time steps. This dependence leads to costly solutions for the time-periodic flows, such as blood flow in the circulatory system, where a large number of time steps are required for accurate time integration. To lower this cost, we propose an alternative approach by transforming the incompressible unsteady Stokes equations into spectral domain based on Fourier series, which results in Stokes equations with a complex-valued source term. In comparison with a traditional spatio-temporal solver, this new formulation significantly decreases the computational cost since solving for a few modes rather than thousands of time steps suffices for accurate time-reconstruction of the solution. Additionally, the accuracy of this method is independent of that of the time integration schemes. This new formulation avoids instabilities caused by the time integration scheme when contrasted against a traditional scheme. Due to the orthogonality of solutions associated with each mode, the proposed scheme is embarrassingly parallelizable and thus highly scalable. The accuracy and computational efficiency of the proposed method are demonstrated by comparing it against a traditional spatio-temporal finite element solver.

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Date submitted: 07 Aug 2020 Electronic form version 1.4