6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

A HIGH ORDER HYBRIDIZABLE DISCONTINUOUS GALERKIN APPROACH FOR FLUID STRUCTURE INTERACTION WITH WEAKLY COMPRESSIBLE FLUIDS

A. La Spina, M. Kronbichler and W.A. Wall

Technical University of Munich, Institute for Computational Mechanics, 85748 Garching bei München
{laspina,kronbichler,wall}@lnm.mw.tum.de, http://www.lnm.mw.tum.de

Keywords: *Finite element methods, Hybridizable Discontinuous Galerkin method, Weakly compressible flow, Fluid-structure interaction*

We present a weakly compressible formulation of the Navier–Stokes equations for Newtonian viscous fluids under isothermal conditions, making use of the Murnaghan–Tait equation of state for the evaluation of density changes with pressure. In the recent work [1] we have demonstrated how this formulation can be beneficially used in the simulation of fluid-structure interaction problems. It alleviates the instability related to the artificial added mass effect and considerably reduces the number of coupling iterations required in each time step. Furthermore, adding some compressibility to the fluid is also a better representation of actual physics in case the fluid-structure interface undergoes topological changes, like an opening valve, where a purely incompressible formulation can be plagued by large pressure variations.

In this contribution, the formulation is translated into a high-order hybridizable discontinuous Galerkin (HDG) approach, derived from an extension of the original work in [2] in order to include weak compressibility effects. The HDG method allows to considerably reduce the linear system size by eliminating all the degrees of freedom inside the elements, which increases the efficiency of the solver stage. Following the algorithm layout in [3], we develop the ingredients to the HDG solution in terms of the local problems for the elemental variables and the global problem that includes the trace of the velocity and the element-average of the pressure. Different strategies are under investigation for the achievement of the optimal converge for the velocity, the pressure and the velocity gradient and the superconvergence for the postprocessed solution.

REFERENCES

[1] A. La Spina, M. Kronbichler and W.A. Wall, A weakly compressible formulation for fluid-structure interaction problems, 2018.

[2] N.C. Nguyen, J. Peraire and B. Cockburn, An implicit high-order hybridizable discontinuous Galerkin method for the incompressible Navier-Stokes equations. *Journal of Computational Physics*, Vol. **230**, pp. 1147–1170, 2011.

[3] G. Giorgiani, S. Fernández-Méndez and A. Huerta, Hybridizable Discontinuous Galerkin with degree adaptivity for the incompressible Navier-Stokes equations. *Computers & Fluids*, Vol. **98**, pp. 196–208, 2014.