Implementation of the DPG Method in a FE Code Supporting $\boldsymbol{H}^1, \boldsymbol{H}(curl), \boldsymbol{H}(div)$, and $\boldsymbol{L}^2$-Conforming Finite Elements

Leszek Demkowicz and Stefan Henneking
leszek@oden.utexas.edu, stefan@oden.utexas.edu

Oden Institute for Computational Science and Engineering, UT at Austin

Venue: PUT, Poznań, Campus Warta, bldg A-2, room 139
Time: 14 – 15 June 2022

The 6 lectures course is addressed to practitioners of a standard Finite Element (FE) method familiar with basic variational formulations, (Bubnov-) Galerkin method and the standard technology of FEs. The class combines a short introduction to the Discontinuous Petrov-Galerkin (DPG) Method with Optimal Test Functions with a crash course on the energy spaces forming the exact sequence and the corresponding FE discretizations. We will introduce the participants to the *parhp3D* – a 3D MPI/openMP code supporting *hp*-discretizations of the exact sequence elements on hybrid (tets+cubes+prisms+pyramids) meshes and demonstrate how to implement the DPG method in such a framework.

On the application side we will focus on wave propagation problems: time-harmonic acoustics, Maxwell equations, and elastodynamics.

Day One, 14 June 2022

1. Examples of variational formulations with symmetric and non-symmetric functional setting. Energy spaces.

2. A crash course on $\boldsymbol{H}^1, \boldsymbol{H}(curl), \boldsymbol{H}(div)$ and $\boldsymbol{L}^2$-conforming finite elements.

3. Introduction to the *parhp3D* code. Examples of applications of the Bubnov-Galerkin method.

Day Two, 15 June 2022

4. A crash course on the DPG method.

5. DPG element computations - examples of applications.

6. Implementation in *parhp3D* code.

The class will be based on [2, 1, 3]. The lectures will be complemented with an informal discussion session in the afternoon.

References

1. L. Demkowicz. Lecture notes on Energy Spaces. Technical Report 13, ICES, 2018.
2. L. Demkowicz. Lecture notes on mathematical theory of Finite Elements. Technical Report 11, Oden Institute, June 2020. `https://www.oden.utexas.edu/media/reports/2020/2011.pdf`
3. S. Henneking and L. Demkowicz. Computing with hp Finite Elements III. Parallel hp Code. 2022. in preparation, 120 pages and growing.