The DPG Method for Convection-Reaction Problems

Leszek Demkowicz
Oden Institute, The University of Texas at Austin
leszek@oden.utexas.edu

Seminarium Sekcji Method Obliczeniowych Komitetu Mechaniki PAN
April 16, 2021

We present a progress report on the development of Discontinuous Petrov-Galerkin methods for the convection-reaction problem in context of time-stepping and space-time discretizations of Boltzmann equations [1].

The work includes a complete analysis for both conforming (DPGc) and non-nonconforming (DPGd) versions of the DPG method employing either globally continuous or discontinuous piece-wise polynomials to discretize the traces.

The results include construction of a local Fortin operator for the case of constant convection and a global discrete stability analysis for both DPGc and DPGd methods.

The theoretical findings are illustrated with numerous numerical

experiments in two space dimensions.

This is a joint work with Nathan Roberts from Sandia National Laboratories.

[1] L. Demkowicz, N. Roberts, ``The DPG Method for the Convection–Reaction Problem Revisited", Oden Institute Report 2021/05.

Bio:

Leszek F. Demkowicz is Assistant Director of the Oden Institute for Computational Engineering and Sciences and holder of W. A. ``Tex" Moncrief, Jr. Chair in Computational Engineering and Sciences II at ICES. He is a Professor in the Dept. of Aerospace Engineering and Engineering Mechanics and a Professor in the Dept. of Mathematics, at the University of Texas at Austin.

Dr. Demkowicz authored a monograph on adaptive methods (in Polish, 1986), co-authored with J.T. Oden a textbook on Functional Analysis (CRS Press, 1996, second edition - 2010, third edition - 2018), two volume monograph on ``Computing with hp-Adaptive Finite Elements" (Chapman & Hall/CRC, 2006,2007) and, more recently, two monographs - ``Energy Spaces" (2018), and ``Mathematical Theory of Finite Elements" (2020). Dr. Demkowicz has also authored and co-authored over 200 journal articles, conference proceedings, book chapters and technical reports in the general area of computational mathematics and mechanics.

His work and scientific interests span across numerical analysis, adaptive finite element methods, wave propagation problems, and CFD. In the last decade his work focused mainly on the Discontinious Petrov Galerkin Method, co-invented with Jay Gopalakrishnan from Portland State University. He graduated 23 Ph.D. and numerous M.Sc. students.

For his research on higher order methods, he was awarded Zienkiewicz Medal by PACM, Computational Science Award by USACM, ICES Distinguished Research Award, and the Computational Mechanics Award by IACM in 2014. He is a Fellow of both IACM and USACM and an honorary member of PACM. Since 2013, he is a foreign member of the Polish Academy of Arts and Sciences.