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Professor William Martin
Editor,
Journal of Computational Physics

Dear Professor Martin,

Please find attached a copy of our manuscript titled "Discontinuous Diffusion Synthetic Acceleration for S_n Transport on Arbitrary Polygonal Meshes" for submission to the *Journal of Computational Physics*.

Some years ago (starting circa 2003), a piecewise linear *discontinuous* (PWLD) finite element discretization of the S_n transport equation has been proposed by Marv Adams et al. Their PWLD discontinuous finite element discretization can be advantageously employed with arbitrary polygonal and polyhedral meshes and satisfies the thick diffusion limit. However, in thick and diffusive configurations, the standard iterative techniques for S_n transport can be slowly converging and need to be preconditioned, usually via a Diffusion Synthetic Acceleration (DSA) scheme.

This manuscript presents a DSA scheme that is fully compatible with a PWLD discretization for arbitrary polygonal meshes. The DSA diffusion matrix is SPD, thus amenable to efficient solution techniques such as PCG and we present results with algebraic multigrid (AMG) as the preconditioner for CG. Our DSA scheme is based on a common interior penalty technique for the discontinuous finite element discretization of the diffusion equation. Numerical results are provided for grids with arbitrary quadrangles, arbitrary polygons, a mesh with a juxtaposition of triangles, rectangles and hexagons, and a locally refined mesh as obtained in adaptive mesh refinement. Cells with high-aspect ratios are also considered and the proposed DSA scheme performed quite well, especially with CG preconditioned with AMG.

This work follows closely prior works on DSA schemes for DFEM discretizations of the transport equation, for instance, works by Jim Morel (LANL, now TAMU), Jim Warsa (LANL), Teresa Bailey (LLNL), Marvin Adams (TAMU), and Todd Palmer (OSU).

Thank you for considering this manuscript for publication in JCP.

Best regards,

Bruno Turcksin and Jean Ragusa