A Discontinuous Galerkin Method for Simulations in Complex Domains

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Abstract: In the simulation of physical, biological and chemical processes one often has to deal with complex shaped domains. In such simulations a good approximation to the geometrical shape of the domain is crucial to good quality of the numerical results, while on the other hand interest often focuses on a small number of unknowns.

A new approach for solving PDEs in complex domains will be presented. The method uses a Discontinuous Galerkin discretization and a structured grid to construct the test and trial functions. Boundary and transmission conditions along the complex shape of the domains are imposed weakly via the Discontinuous Galerkin formulation. This method offers a discretization where the minimal number of unknowns is independent of the possibly very complicated shape of the domain, while it still allows the provision of fine structures of the domains shape, even if their size is significantly smaller than the grid cell size.

The method is implemented using the DUNE framework (Distributed and Unified Numerics Environment). Using C++ techniques DUNE offers fine grained interfaces with a very low overhead. The method benefits from the flexible design of the framework and is thereby applicable to a wide range of problems.

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