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Using Discontinuous Galerkin Methods for Numerical Upscaling in Porous Media

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For the simulation of transport processes in porous media effective parameters for the physical processes on the target scale are required. Numerical upscaling, as well as multiscale approaches can help where experiments are not possible, or hard to conduct.

For multiscale simulations a good approximation of the geometrical shape of the solid phase is crucial to obtain reliable numerical results, while the interest on the other hand lies only in a coarse solution, which would allow a smaller number of unknowns.

A new discretization scheme for solving PDEs in complex domains, e.g. on the pore scale, was developed. It is based on a Discontinuous Galerkin (DG) discretization on a structured grid. The degrees of freedom are determined by the structured grid, while the fine structures of the domains shape are preserved by limiting the support of the shape functions to the intersection of the structured grid cells and the domain. This method allows the minimal number of unknowns to be independent of the shape of the domain, even if their size is significantly bigger than that of the structures in the shape of the domain.

The numerical approach will be presented and it will be shown how it can be used for numerical upscaling. This allows a more efficient estimation of parameters on the continuum scale from pore scale processes.