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A stable discontinuous Galerkin-Petrov method in space and time for the non-stationary convection diffusion problem

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ABSTRACT

We consider as a model problem the non-stationary convection diffusion equation with a one-dimensional spatial domain. Using Rothe's method, we first discretize in time by an A-stable time discretization based on a discontinuous Galerkin-Petrov method in time. Here, the ansatz functions in time are globally continuous and piecewise linear or quadratic and the test functions are globally discontinuous and piecewise constant or linear leading to a time discretization which is A-stable and of second or forth order accurate in time.

To get a fully discrete approximation, we have to solve on each time interval a singularly perturbed space problem which consists of one or a coupled system of two convection diffusion equations in space. As a stable method we apply again a discontinuous Galerkin-Petrov method which uses globally continuous piecewise polynomial ansatz functions in space and globally discontinuous piecewise polynomial test functions.

We present some estimates of the discretization error with respect to space and time. The numerical experiments show that the fully discrete solution is accurate and free of oscillations in space and time.

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