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Complete flux scheme for nonconstant velocity fields with applications to coupled systems of equations

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In this work, we consider an advection-diffusion equation, coupled to a Poisson equation for the velocity field. This type of coupling is typically encountered in applications, such as the coupling between the electric field and the electron-ion densities in plasma physics, or Darcy's law for porous media flow. For these applications, the source term for the Poisson equation is usually zero almost everywhere in the domain, except for a small region for which a very steep source term is present. In this work, we propose a post-processing of the velocity field, which allows us to obtain a second-order numerical scheme which is robust, despite the steepness of the source term.

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