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A highly accurate extended discontinuous Galerkin method for multiphase problems with contact lines

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We present a highly accurate extended discontinuous Galerkin method (XDG) for the simulation of multiphase problems with contact lines. Characteristically, singularities are observed at interfaces and three-phase contact lines between distinct phases, e.g. a jump in pressure or surface tensions. This offers a significant obstacle for high order methods, where generally smooth functions are required to obtain a high order of convergence. By employing a flexible discontinuous polynomial ansatz space, we overcome this restriction and create a method that resolves interface and contact line discontinuities while maintaining a high order of convergence.

We will briefly outline the basic concepts of the XDG method and then concentrate on its central component: interfaces and contact lines. In the XDG method, interfaces are defined implicitly by the zero isocontours of a group of level sets. Each level set describes the interface between two phases, three-phase contact lines are situated at the intersection of two level sets. To elaborate, we will outline algorithms involved in evolving and regularizing the interfaces. Then, we will detail the numerical coupling approach at fluid-fluid and fluid-solid interfaces by means of examples, e.g. the Navier slip boundary conditions on the interface or Neumann's law at the three-phase contact line. We follow the discontinuous Galerkin approach, where terms are linked at boundaries by partial integration and boundary conditions are enforced by penalties. Finally, we will show preliminary results of the simulation of a fluid droplet sitting on a flexible substrate.

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