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LOCAL DISCONTINUOUS GALERKIN METHOD FOR INKJET DROP FORMATION AND MOTION

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Liquid jets are columnar streams of matter that are encountered in many areas of industry and nature, such as manufacturing, engine technology and inkjet printing. The numerical approximation of an axisymmetric free surface jet can be calculated using lubrication theory. In this presentation we consider the Eggers-Dupont model, which are the 1D Navier-Stokes equations in combination with surface tension.

The goal of this research is to develop a higher order discontinuous Galerkin (DG) method for the Eggers-Dupont model and to apply this to inkjet printing. The numerical method is a combination of a local discontinuous Galerkin and an Interior Pentalty (IP) method. Since the resulting equations are very stiff we use a Diagonally Implicit Runge-Kutta (DIRK) method in combination with a Newton method to solve the nonlinear algebraic equations resulting from the time integration method. This provides a stable and very accurate time integration method.

As advantages of this approach we can name ones such as:

- auxiliary variables are introduced to approximate first and second derivatives, which gives a very accurate computation of the surface tension contribution;
- in each element a local polynomial approximation is used with only a weak coupling to neighboring elements using numerical fluxes, which is beneficial for local mesh refinement when the liquid jet breaks up into droplets;
- a higher order positivity preserving limiter in combination with an implicit time integration method is used to prevent non-physical solutions.

Results of numerical tests are presented that show the high-order accuracy and good stability properties of the method. Also, simulations of inkjet droplet formation are presented.