3D TWO-PHASE FLOW SIMULATIONS USING XFEM

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ABSTRACT

Two-phase systems play an important role in chemical engineering, for example mass transport between bubbles and a surrounding liquid (liquid-liquid system) or heat transfer in falling films (liquid-gas system). The velocity and pressure field are smooth in the interior of each phase, but undergo certain singularities at the interface Γ between the phases. Surface tension induces a pressure *jump* across Γ, and a large viscosity ratio leads to a *kink* of the velocity field at Γ, especially for liquid-gas systems.

If interface capturing methods (like VOF or level set techniques) are applied, the finite element grid is usually *not aligned with the interface*. Then for standard FEM the approximation of functions with such singularities leads to poor $\mathcal{O}(\sqrt{h})$ convergence. The application of suitable extended finite element methods (XFEM) provides optimal approximation properties [1, 3], essentially reducing spurious currents at the interface. Figure 1 shows the pressure jump of a static bubble using a standard and an extended finite element space.

In this talk we consider 3D flow simulations of such two-phase systems on adaptive multilevel tetrahedral grids. We present a pair of XFEM spaces which is very suitable for the approximation of velocity and pressure in incompressible two-phase flow problems. Different enrichment strategies for the velocity [2] and pressure [1] space and their implementation in the 3D two-phase flow solver DROPS are discussed. Convergence rates are analyzed for some test cases featuring the mentioned types of discontinuities. At the end of the talk, some application examples of 3D droplet and falling film simulations are presented.

REFERENCES

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Figure 1: Pressure jump of a static bubble using piecewise linear FEM (left) and suitable XFEM (right).