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High-order space-time approximations of dynamic poroelasticity models

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The accurate high-order approximation in space and time is of fundamental importance for the simulation of dynamic poroelastic models which include coupled fluid flow, deformation and wave propagation.

Dynamic poroelastic models appear for example Lithium-ion battery fast-charge simulations and include sharp concentration and pressure gradients, high mechanical stresses, elastic wave propagation, memory-effects on the permeability, multi-phase behaviour and electro-chemical reactions.

In this contribution our high-order space-time discretisations, including mixed finite elements (MFEM) for the flow variables and interior-penalty discontinuous Galerkin finite elements (IPDG) for the displacement and velocity variables, are presented. For the discretisation in time we use a high-order accurate discontinous Galerkin dG(r) discretisation.

The arising linear block systems are solved with our sophisticated monolithic solver technology with flexible multi-step fixed-stress preconditioning. Inside the preconditioner highly optimised system solvers for low order approximations can be used. Additionally, our solver technology allows for parallel-in-time application.

The performance properties and their potiential for battery simluations and further applications are illustrated by challenging numerical experiments.

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