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High-order discontinuous Galerkin methods for multi-physics flow simulations on exascale computing systems[1] MATTHIAS IHME, KIHIRO BANDO, ERIC CHING, ALEX AIKEN, Stanford University — High-order discontinuous Galerkin (DG) methods have emerged as attractive techniques for simulating complex flows. In particular, these methods combine features of variational finite-element methods with finite-volume discretizations, thereby (i) allowing for arbitrarily high order of accuracy, (ii) enabling the discretization of complex geometries on irregular meshes, (iii) providing advanced refinement strategies, and (iv) the large degree of structured computations and data locality introduce a high level of parallelism, making these methods particularly suitable for high-performance computing on exascale machines. This presentation will discuss recent advancements on developing high-order DG-methods for complex flows that involve chemical reactions and multiphase flows. Following a theoretic consideration of performance gains of high-order schemes on exascale systems, we will discuss algorithmic developments and programming techniques for enabling the application of these high-order methods to turbulent reacting flows and hypersonic particle-laden flows. The presentation will close by discussing open research needs on programming paradigms and the utilization of emerging architectures with heterogeneous processors and complex memory hierarchies.

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