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Multiscale Simulations Using Particles

Michael Bergdorff[(1)], Georges-Henri Cottet[(2)], **Petros Koumoutsakos**[(1)]

(1) *Institute of Computational Science, Swiss Federal Institute, Zurich, Switzerland*
(2) *Université Joseph Fourier, Grenoble, France*

We present multilevel particle methods with extended adaptivity in areas where increased resolution is required. We present two complementary approaches as inspired by r-adaptivity and adaptive mesh refinement (AMR) concepts introduced in finite difference and finite element schemes. For the r-adaptivity a new class of particle based mapping functions is introduced while for the particle-AMR mappings the methods use particle remeshing as a key element. The advantages and drawbacks of the proposed particle methods are illustrated on a number of applications. With the proposed techniques we show that rephrasing in terms of particle methods concepts inherited from adaptive finite-element or finite-difference methods can lead to methods that while keeping essential advantages of particle methods such as robustness when dealing with convection dominated problems may also maintain a high accuracy. Finally the implementation of particle methods for multiscale simulations as dictated by multiple physical phenoemena is discussed.

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