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A high order multi-resolution solver for the Poisson equation with application to vortex methods MADS MLHOLM HEJLESEN, HENRIK JUUL SPIETZ, Technical University of Denmark, JENS HONORE WALTHER, Technical University of Denmark and ETH Zurich — A high order method is presented for solving the Poisson equation subject to mixed free-space and periodic boundary conditions by using fast Fourier transforms (FFT). The high order convergence is achieved by deriving mollified Green's functions from a high order regularization function which provides a correspondingly smooth solution to the Poisson equation. The high order regularization function may be obtained analogous to the approximate deconvolution method used in turbulence models and strongly relates to deblurring algorithms used in image processing. At first we show that the regularized solver can be combined with a short range particle-particle correction for evaluating discrete particle interactions in the context of a particle-particle particle-mesh (P^3M) method. By a similar approach we extend the regularized solver to handle multi-resolution patches in continuum field simulations by super-positioning an inter-mesh correction. For sufficiently smooth vector fields this multi-resolution correction can be achieved without the loss of convergence rate. An implementation of the multi-resolution solver in a two-dimensional re-meshed particle-mesh based vortex method is presented and validated.

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