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The Multiscale Perturbation Method for Reservoir Simulation

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Abstract:
In the formulation of multiscale methods based on domain decomposition procedures for second order elliptic equations (see MMMFEM[1], MuMM[2], MRC[3], MHM[4] and references therein), the computational domain is divided into non-overlapping subdomains and for each subdomain a set of multiscale basis function is constructed. Consider the application of one of these procedures to the numerical solution of a multiphase porous media flow problem where, through an operator splitting algorithm, the velocity-pressure and transport equations are solved sequentially. From a time step to the next the multiscale basis functions should be recomputed because of the coupling of the underlying PDEs. Instead of recomputing all multiscale basis functions every time step of a numerical solution we propose the Multiscale Perturbation Method (MPM). In MPM an approximate solution of velocity and pressure for a new time is obtained by combining regular perturbation theory with multiscale basis functions computed in an earlier time. We focus the discussion on the MuMM, but the proposed method is also applicable to the other multiscale procedures mentioned above. The connection of MPM with state-of-the-art uncertainty quantification procedures will also be indicated. This is joint work with A. Alsadig, H. Mankad (UT Dallas, USA) and F. S. Sousa (USP, Brazil).

References:
[1] T. Arbogast et.al. *Multiscale Model Simul.*, 6(1):319–346, 2007.
[2] A. Francisco et. al. *Math. Comput. Simul.*, 99:125–138, 2014.
[3] R. Guiraldello et. al. *J. Comput. Phys.*, 355:1–21, 2018.
[4] R. Araya et. al. *SIAM J. on Numer. Anal.*, 51(6):30505–3531, 2013.