PLENARY LECTURES

Multiscale domain decomposition methods for large-scale computation of flows in heterogeneous porous media.

Fabrício Simeoni de Sousa
Institute of Mathematics and Computational Sciences (ICMC) USP- Brazil

Tuesday, February 06, 2024.
11h - 12h

FT - Auditorium

Abstract.

Mathematical sciences have a significant impact on the economy. Developed countries are already gathering data that prove this claim, generating valuable reports in the last decade. Unfortunately, Brazil is still in the dark about the importance of Mathematical Sciences, but we are starting to see good initiatives in this direction. We will discuss the CeMEAI - Centre for Mathematical Sciences Applied to Industry initiatives, with examples of interaction with Industry. Furthermore, we will talk about a project with Brazillian Oil Company Petrobras, that led to the development of the MRCM.

The Multiscale Robin Couple Method (MRCM) is a multiscale domain decomposition method based on a mixed finite element formulation that allows for efficient solutions of second-order elliptic equations in a coarse scale, incorporating fine grid details of the solution through the efficient parallel computation of independent multiscale basis functions. The coupling between subdomains is performed by imposing Robin-type boundary conditions in the computation of the multiscale basis functions, ensuring that compatibility conditions are enforced on a large scale. This procedure generalizes the discrete version

of well-known multiscale mixed methods via the suitable choice of the Robin boundary parameter and interface spaces. While generalizing those methods, it also introduces the possibility of adaptivity, resulting in accurate solutions compared to the undecomposed fine grid solution and other multiscale procedures based on the lowest order Raviart-Thomas finite element spaces. We will present the latest developments of the MRCM, in terms of interface enrichment and adaptivity, focusing on the accuracy of the decomposition, applications to complex porous media flow models, preconditioning, and speedup results on high-performance computations involving billions of fine grid cells.