ACMS Applied Math Seminar

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154 Hurley Hall

3:30 PM – 4:30 PM

A Reinterpreted Discrete Fracture Model for Darcy-Forchheimer Flow in Fractured Porous Media

We propose a novel hybrid-dimensional model for the Darcy–Forchheimer flow in fractured rigid porous media, with a natural applicability to non-conforming meshes. Motivated by the previous work on the reinterpreted discrete fracture model (RDFM) for Darcy flows, we extend its key idea to non-Darcy flows. Coupling the Darcy's law in the matrix and the Forchheimer's law in the fractures through the introduction of the Dirac-functions to characterize the fractures, we derive a relationship between the total flow velocity in the porous media and the fluid velocity in the fractures. With this relation, it is natural to model the Darcy–Forchheimer flow in the whole computational domain by one equation. The local discontinuous Galerkin (LDG) method is applied for numerical discretization of the steady-state single-phase flow problem and a time-marching method is adopted to find the solution of the resulting nonlinear system. Besides, we construct a direct solver for the nonlinear equation of the fluid velocity in fracture to save computational cost. As an application, we discuss a simple transport model coupled with the flow equation. Several numerical experiments validate the performance of the model with its effectiveness on non-conforming meshes. We observe that the Darcy–Forchheimer model effectively reduces the flow rates and makes the predictions more realistic in case of excessive fracture velocities.

The Department of Applied and Computational Mathematics and Statistics

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