Moving Boundary Problems in Fluid-Poroelastic Structure Interaction

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Abstract

This is joint work with Sunčica Čanić (University of California, Berkeley) and Boris Muha (University of Zagreb).

In this talk, we discuss recent progress in the well-posedness of moving boundary models of fluid-poroelastic structure interaction. Poroelastic materials are porous substances whose porous properties are coupled to their elastodynamics, and these include materials such as biological tissues and soil. There are many important applications of poroelasticity to fluid dynamics problems in biomedical engineering and geosciences, and hence, it is of particular interest to study the coupled dynamics of how poroelastic materials interact with surrounding fluid flows.

We introduce a fully coupled moving boundary model for an immersed poroelastic material (modeled by the Biot equations of poroelasticity) interacting with a viscous fluid (modeled by the incompressible Navier-Stokes equations), where deformations of the poroelastic material are rigorously accounted for, through a moving boundary model. We introduce a new regularized interface method, which uses a minimal regularization of the fluid-poroelastic interface to define a notion of solution, in order to establish the existence of a suitable notion of (finite energy) regularized interface weak solutions to this coupled and highly nonlinear moving boundary problem of mixed type. The proof of this existence result uses geometric bounds on Lagrangian maps to control moving domain behavior, in addition to a constructive splitting scheme and compactness arguments, for showing convergence of suitable approximate solutions. We conclude by discussing recent progress in showing how regularized interface weak solutions relate to classical solutions when such classical solutions exist (weak-classical consistency), in the sense of convergence to a classical solution as the regularization parameter tends to zero.

References

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