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Fractional Modeling of Viscoelasticity in Brain Aneurysms YUE YU, Lehigh University, GEORGE KARNIADAKIS, Brown University — We develop fundamental new numerical methods for fractional order PDEs, and investigate corresponding models for arterial walls. Specifically, the arterial wall is a heterogeneous soft tissue with complex biomechanical properties, and its constitutive laws are typically derived using integer-order differential equations. However, recent simulations on 1D model have indicated that fractional order models may offer a more powerful alternative for describing arterial wall mechanics, because they are less sensitive to the parameter estimation compared with the integer-calculus-based models. We study the specific fractional PDEs that better model the properties of the 3D arterial walls, and for the first time employ them in simulating flow structure interactions for patient-specific brain aneurysms. A comparison study indicates that for the integer order models, the viscous behavior strongly depends on the relaxation parameters while the fractional order models are less sensitive. This finding is consistent with what is observed in the 1D models for arterial networks (Perdikaris & Karniadakis, 2014), except that when the fractional order is small, the 3D fractional-order models are more sensitive to the fractional order compared to the 1D models.

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