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A NONLOCAL POROELASTIC APPROACH TO FLUID DRIVEN FRACTURE.

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The study of deforming continuous media is a well developed branch of solid mechanics which typically relies on models that assume displacements within the media are sufficiently smooth such that they can be modeled with partial differential equations. However, observations of nature show that some displacements exist where the spatial partial derivatives cannot be evaluated, most notably at the tip of a moving crack. Without regularization, simulations of crack propagation or other forms of material localization utilizing the common discretizations of these PDE's will produce results that are extremely mesh dependent. Generalized, nonlocal, continuum mechanics can be used as a replacement for the classical PDE's and can regularize numerical simulations of localization and can include other features of heterogenous materials such as wave dispersion. Peridynamics [1, 2] is generalized nonlocal continuum theory that has shown usefulness in the modeling material failure will be presented along with a recently developed nonlocal model for convection-diffusion [3]. These two models have been coupled to create a nonlocal poroelastic model. The natural discretization of this coupled model is a strong-form meshfree collocation approach that can be shown to produce regularized mesh independent simulation results. This presentation will introduce the audience to the coupled nonlocal theory, including a discussion of how non-locality at macroscales arises due to modeling decisions that exclude heterogeneity in microstructures and can lead to interesting phenomena such as characteristic length-scales in solid media and anomalous dispersion in fluid flow. Examples and large-scale simulations related to hydraulic fracturing as shown in figure 1 will be discussed.

REFERENCES

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Figure 1: Fluid driven fracture in the presence of natural fractures. Note crack turning, intersecting, and being influenced by the presence of natural fractures. Contours of pressure are shown on the left and contours of damage are shown on the right.

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