On the Equations of Nonlinear Single-Phase Poroelasticity

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In this talk we present a study the equations of nonlinear poroelasticity derived from mixture theory. They describe the quasi-static mechanical behavior of a fluid saturated deformable porous medium. The nonlinearity arises from the compressibility of the fluid and from the dependence of porosity and permeability on the divergence of the displacement. We point out analytical difficulties with the model. In our approach we discretize the quasi-static formulation in time and first consider the corresponding incremental problem. For this, we prove existence of a solution using the theory of pseudo-monotone operators. Generalizing Biot's free energy to the nonlinear setting we construct a Lyapunov functional for the model and prove stability. It allows constructing bounds that are uniform with respect to the time step. In the case when dissipative interface effects between the fluid and the solid are taken into account, we consider the continuous time case in the limit when the time step tends to zero. This yields existence of a weak free energy solution.

It is a joint work with C.J. van Duijn (Darcy Center Eindhoven-Utrecht, The Netherlands)