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Current research developments grounding on or including the theory of porous media

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Physical systems to which the laws of thermodynamics are applicable and which can be interpreted as deformable bodies can be modeled and simulated using a continuum mechanical theory (including soil and fluid mechanics and gas theory). This theory serves as a foundation for the preparation and implementation of the systems into numerical computational concepts. Originating to Bowen, de Boer, and Ehlers as an extension of the classical mixture theory by integrating the concept of volume fractions, the well-established Theory of Porous Media (TPM) provides a suitable tool to formulate a macroscopic continuum mechanical model of multiphase porous media. It offers a thermodynamically consistent investigation of the mechanical behavior by considering the porous medium as a smeared model without neglecting the interactions of the single phases. The classical ternary (solid, liquid, gas) Theory of Porous Media has been extended by introducing mixtures also for homogenized macroscopic constituents so that simulations of, e.g., chemical mixtures and reactions or osmotic effects are possible.

The multiphase porous body of investigation and thus the area of application may be of various types. A huge field is given by the formulation of multi-physical problems of soil mechanics since the multiphase setup of the framework of the TPM perfectly fits to describe and simulate initial boundary value problems (IBVPs) of saturated or partially saturated soils. However, soil mechanics is not the only area of application, as other multiphase natural systems can be satisfactorily modeled with this theory as, e.g., the field of biomechanics. In this research discipline, the TPM is used, e.g., for simulations of organs like livers and hearts or soft tissues like cartilage and tumors. The TPM can furthermore be applied on environmental and climate-relevant topics like gas production in landfills, thawing of permafrost soils or modeling the growth of sea ice as a porous medium.

Serving as a basic concept for the description of coupled partial differential equations (PDEs) to set up computational numerical models, the TPM can easily be combined with other theories like, e.g., coupling to phase-field theory for phase transitions or fracture simulations and or be used in cooperation with uncertainty quantifications or model reduction techniques. This minisymposium invites scientists to present their projects and research ideas grounding on or including the Theory of Porous Media in current developments of research areas.