Master degree in physics of porous media - proposal:

From statistical distribution of the two-phase system to the overall permeability

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Background The two-phase flow in porous media has recently been described by a new set of equations [1]. The equations, which can be used to describe this intricate flow on the macroscopic level, are derived assuming only that the porous media can be regarded as homogeneous on a certain level. It follows that the system is also ergodic, and that this ergodicity can be described by a distribution of an ensemble of flows through the various links available.

This probability distribution can be generated from a) network models, b) laboratory controlled models or from c) real systems. The aim is to describe the performance of real macroscopic systems from their microscopic patterns. The steps a) and b) are necessary steps to achieve this. We have so far studied the flow pattern using a distribution obtained from computers of a) [2].

From the DeProF model [3], which is based on a glass-etched chamber-and-throat type network model [4], one can obtain the ensemble of physically permissible solutions of the flow problem.

Problem formulation We would now like to compare the ensemble distribution generated with the DeProF-model to the distribution obtained from the network model. There are several interesting question to answer in this context. Under which conditions are the two formulations equivalent? For instance, does the DeProF model hold the property that the probability distribution follows an 1/q dependence, where q is the volume flow through a link. If so, the integration to the macroscopic level is facilitated.

Organisation of the work The work is suitable for a candidate with good background in statistical thermodynamics and computer simulations. The work, which can start any time, will be carried out in the PoreLab group at NTNU, which is an interdisciplinary group. Part of the work can be carried out as an Erasmus project in Athens with ass. prof. Valavanides. Contact: alex.hansen@ntnu.no

[1] Alex Hansen, Santanu Sinha, Dick Bedeaux, Signe Kjelstrup, Isha Savani, Morten Vassvik, A new set of equations describing immiscible two-phase flow in homogeneous porous media, Transport in Porous Media, submitted

[2] Isha Savani, Santanu Sinha, Alex Hansen, Dick Bedeaux, Signe Kjelstrup, Morten Vassvik, A Monte Carlo Algorithm for Immiscible Two-Phase Flow in Porous Media, Transport in Porous Media, accepted

[3] Valavanides, M.S., 2012. Steady-State Two-Phase Flow in Porous Media: Review of Progress in the Development of the DeProF Theory Bridging Pore- to Statistical Thermodynamics- Scales. *Oil & Gas Science and Technology* **67**(5), 787-804, http://dx.doi.org/10.2516/ogst/20120562012

[4] Avraam, D.G., Payatakes, A.C., 1995. Flow Regimes and Relative Permeabilities during Steady-State Two-Phase Flow in Porous Media. *J. Fluid Mech.* **293**, 207-236, https://doi.org/10.1017/S0022112095001698