Onsager Symmetry in immiscible two-phase flow in porous media

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We have recently proposed a new approach to steady-state immiscible two-phase flow in porous media based on equilibrium statistical mechanics [1]. Here, "steady state" refers to the macroscopic parameters describing the flow fluctuating around well-defined and constant averages. The central idea behind the new approach is to consider the statistics of fluid configurations in cuts orthogonal to the flow direction and the flow direction as a pseudo time axis. Under steady-state flow, the statistics of the fluid configurations in the cuts will be in equilibrium.

We are now attempting to go beyond steady-state flow. If this is to succeed, it is necessary to verify whether Onsager symmetry - i.e., time reversal symmetry - applies to the extensive variables that appear in the theory.

This MSc project consists of using a dynamic pore network model to check whether the symmetry is obeyed or not.

[1] A. Hansen, E. G. Flekkøy, S. Sinha and P. A. Slotte, *A statistical mechanics framework for immiscible and incompressible two-phase flow in porous media*, Adv. Water Res. 171, 104336 (2023); https://doi.org/10.1016/j.advwatres.2022.104336.