

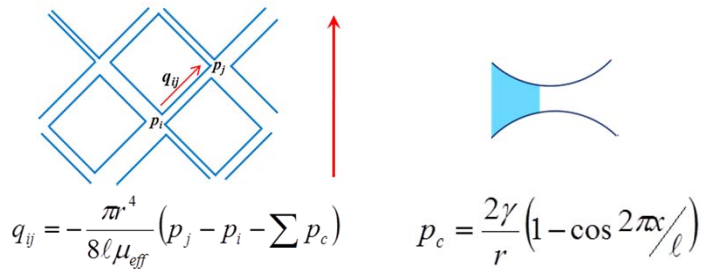
Two-phase flow in porous media: Multifractality in flow distribution

Santanu Sinha and Alex Hansen

Department of Physics, Norwegian University of Science and Technology, NO-7491 Trondheim, Norway

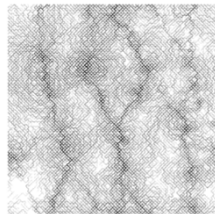
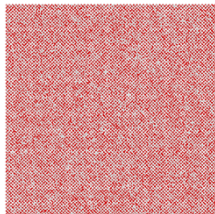
Two-phase flow in porous media shows highly complex characteristics due to the system disorder, wettability and fluid instabilities. Here we investigate steady-state two-phase flow characteristics in terms of Multifractal analysis.

Transport network of disordered tubes

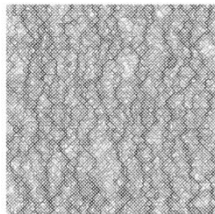
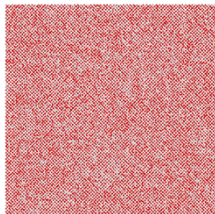


Steady-state flow patterns

Ca = 3.4×10^{-4}



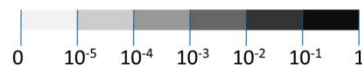
Ca = 3.4×10^{-3}



Fluid distribution

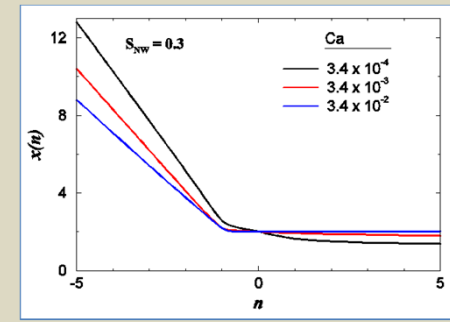
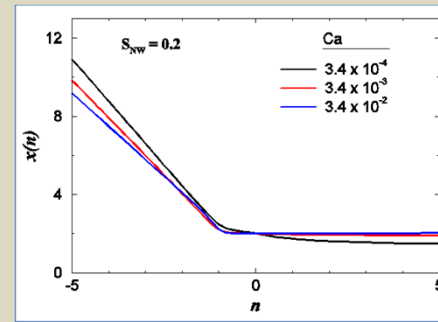
Flow distribution

Non-wetting fluid
 Wetting fluid

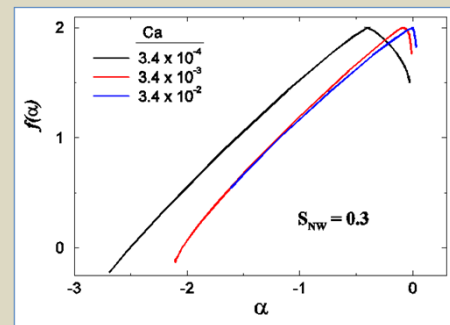
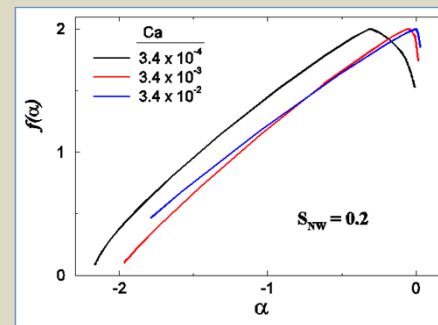


Multifractality

$$M(n, L) \sim L^{-x(n)}, \quad M(n, L) = \sum_i |q_i|^n$$



$$\alpha(n) = -\frac{d x(n)}{d n}, \quad f(\alpha) = x(n) + n\alpha(n)$$



Moments of flow distribution show anomalous behaviour at low capillary number, resulting a spectrum of fractal dimensions as shown by the $f(\alpha)$ curve.