Flow Percolation in non homogeneous Hele-Shaw flows

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The wetting front zone where water invades and advances into an initially dry porous material plays a crucial role in solute transport through many environmental flows, such as the unsaturated zone. The leaching of chemicals by wetting fronts seems influenced by two major factors, namely: the irregularity of the fronts and the heterogeneity in the distribution of chemicals, both of which have been described using fractal techniques. This works presents an experimental and theoretical framework for studying the physical interplay between a stationary wetting front of fractal dimension D with different porous materials. Simple wetting experiments are easy to compare with theoretical studies defining the physical interations between a stationary wetting front of maximum fractal dimension D and a multifractal distribution of chemicals around it with a singularity spectrum f(α). If D1 is the entropy dimension of the distribution and α0 is the point where f(α) attains its maximum value, then, as revealed by mathematical analysis, the fractal curve must have a fractal dimension D equal to or greater than the entropy dimension D1 of the distribution for a positive amount of mass to be accommodated inside it. Also, α0 − D constitutes a scaling exponent for the likely mass inside an ε -covering of the curve reflecting the potential for leaching on the sole basis of the physical interplay between the wetting front and the surrounding chemical molecules. Different shapes of the multifractal D(c) curves are compared.