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Gradient Percolation and the geometry of diffusion fronts

We discuss a model of inhomogeneous medium, called "Gradient Percolation". This model, first introduced by physicists, is a percolation-type model where the density of occupied sites depends on the location in space. The macroscopic interface (separating occupied sites and vacant sites) that appears was used to model phenomena like diffusion or chemical etching. This interface remains localized in regions where the density of occupied sites is close to the percolation threshold p_c, and its macroscopic behavior is related to near-critical standard percolation. We show in particular that its fluctuations and its length can be described via the critical exponents of standard percolation, and that it is locally asymmetric (on every scale). We finally study a natural two-dimensional model where many particles that start at the origin diffuse independently, that provides a natural example where critical fractal geometries spontaneously arise.