From large deviations around porous media, to PDEs with irregular coefficients, to gradient flow structures

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We consider the large deviations of the rescaled zero-range process about its hydrodynamic limit, the porous medium equation. This leads to a variational characterization of solutions to the porous medium equation, and to the analysis of the skeleton equation, an energy-critical, degenerate PDE with irregular drift. We then present a robust well-posedness theory for such PDEs based on concepts of renormalized solutions, the equation's kinetic form, and commutator estimates. The relationship of such large deviations principles to a gradient flow interpretation of the porous medium equation will be demonstrated by deducing an entropy dissipation equality from the large deviations and reversibility.