

Fat-tailed waiting-time distributions for anomalous dispersion in porous media (poster)

Although Stokes' equation governing laminar flow is linear, the complex geometry of porous media induces nonlinear behaviour for particle ensembles being advected by the flow field in such geometries. In particular, the heterogeneous velocity distribution in the flow field implies that particles can be trapped in stagnant zones for arbitrarily long times, before being transported large distances in fast channels. Depending on the pore-space geometry, this may lead to anomalous (non-Fickian) transport properties: superdiffusion in the longitudinal direction (that of the applied pressure gradient) and subdiffusion in the transversal direction.

In this work, we present a comprehensive statistical analysis of simulated particle trajectories in flows in realistic three dimensional porous media. Tracking of individual trajectories allows us to go beyond the mean-square displacement and single-point probability densities which are insufficient to fully describe the geometrically induced anomalous behaviour of such stochastic processes. We investigate the role of pore-space geometry and diffusivity for dispersion in porous media, and obtain waiting-time distributions for given displacements in longitudinal and transversal directions. We then examine the applicability of continuous-time random walks, with the waiting-time distributions as input, to model the anomalous fluctuations of particles in such random environments, and show that fat-tailed waiting-time distributions entail anomalous dispersion.