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Scaling Microbial Dynamics in Fractal Porous Media

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Motivated by the need to understand the movement of microbes in natural porous systems and the evolution of their genetic information, a renormalization procedure for motile particles in media with fractional functionality is developed and applied to Levy particles. On the smallest scale the particle trajectories are the solution to an integrated stochastic ordinary differential equation (SODE) with Markov, stationary, ergodic drift subject to Levy diffusion. The Levy diffusion allows for self-motile particles. On the intermediate scale the particle trajectories are the solution to an integrated SODE with Levy drift and diffusion arising from the small scale asymptotics. The Levy drift is associated with the fractal character of the Lagrangian velocity. On the largest scale the process is driven by the asymptotics of the intermediate scale. Scaling laws, generalized central limit theorems and renormalized diffusion equations are obtained.