Brownian particle confined by rigid walls.

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Brownian motion is the erratic movement of microscopic particles when immersed into a fluid. Thanks to Einstein and his successors, it is generally possible to describe Brownian motion using simple equations. However, once confined near a wall, a particle moves much slower due to the no-slip boundary conditions at the wall. The mobility is thus modified by confinement-induced effects.

My thesis work consists in numerically modeling how boundaries affects Brownian motion. I first consider the problem of a sphere diffusing between two walls. The presence of the walls modifies the mobility, which depends on the particle-wall distance (hindered diffusion). Moreover, as negative charges build-up on surfaces, we also observe electrostatic interactions.

Such interactions induce interesting modifications of the bulk theory described by Einstein. Indeed, the displacement probability density functions become non-Gaussian. Due to the latter fact, we observe non-zero high-order cumulants. To validate our recent theoretical predictions I simulate 3D Brownian trajectories by numerically integrating the Langevin equations, taking into account the hindered diffusion and interactions. As a perspective, the numerical tools developed will be used to study Brownian dynamics in various confinements situations, such as near soft boundaries.