Narrow escape: How long does it take for a camel to go through the eye of a needle?

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The narrow escape problem (NEP) is a common problem in biology and biophysics. It deals with Brownian particles confined to a given domain with reflecting borders and only a small escape window where particles are absorbed. The mean first passage time, the time it takes a set of particles to escape, can be analytically calculated in 2D and 3D for several geometries. It depends on three parameters which are the area of the domain, the size of the escape window as well as the diffusion coefficient of the particle. We aim to systematically test the analytical solution of the NEP in 2D by variation of the relevant parameters. Experiments are being complemented by matching Monte Carlo simulations. For the experimental test, we prepared micro-patterned phospholipid bilayers from a combination of colloid lithography and vesicle fusion. We imaged fluorescently labeled lipids diffusing in circular membrane patches with diameters of 5-10 μm using single-molecule fluorescent microscopy at 100 Hz and a localization precision of 15 nm. While the area of the membrane was tuned during colloid lithography, the size of the escape window was adjusted in the course of the analysis.
We will present our first results on membrane patterning as well as a comparison of our experimental and simulation results with the theoretical prediction for the mean first passage time.