Geometry affects drift and diffusion across entropic barriers

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An understanding of particle diffusion in the presence of constrictions is essential in fields as diverse as drug delivery, cellular biology, nanotechnology, materials engineering, and spread of pollutants in the soil. When a driving force is applied, displacement of particles occurs as well as diffusion.

A paper in the *Journal of Chemical Physics* quantifies the effects of periodic constrictions on drift and diffusion in systems experiencing a driving force.

In a uniform cylinder, both the mobility and the diffusion coefficient of the particle are independent of the driving force. This is not true, however, when the cylinder diameter varies. Constrictions provide periodic entropic barriers, which slow down drift and diffusion when the driving force is weak. This research examined two types of cylinders.

In the first, a tube consisted of sequential spherical compartments connected by small circular openings. The driving force suppressed the slowdown due to the constrictions. The particle subjected to a strong driving force showed no change in effective diffusion coefficient or mobility as a result of the periodic restrictions. In a tube of cylindrical chambers, however, the results were dramatically different. Under a strong driving force, mobility decreased while the diffusion coefficient became extremely large due to intermittency that occurred in the particle transitions between openings connecting neighboring compartments.

While author Alexander Berezhkovskii of the National Institutes of Health acknowledges that the original idea for the project was inspired by devices that deliver drugs locally in small amounts, he looks at the research as a quest for a broader understanding. "Nature is very complicated because of geometry, but we are looking for something simple that underlies the complexity," he says.

More information: The article, "Drift and diffusion in a tube of periodically varying diameter. Driving force induced intermittency" by Alexander Berezhkovskii et al will appear in the Journal of Chemical Physics. jcp.aip.org/

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