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Anomalous single-particle diffusion in a tilted washboard potential KE XIAO, YAEL ROICHMAN, Center for Soft Matter Research of New York University, SANGHYUK LEE, University of California, Berkeley, DAVID GRIER, Center for Soft Matter Research of New York University — A corrugated optical vortex acts as a tilted washboard potential for micrometer-scale colloidal particles. A single particle circulating around a corrugated optical vortex undergoes normal diffusion in the limit of strong driving and high temperatures. In the opposite limit, a particle becomes localized. When the effective barrier height is comparable to the thermal energy scale, the particle switches intermittently between stationary and running states. This intermittent switching results in a giant enhancement of the particle's effective self-diffusion coefficient, which has been predicted theoretically and demonstrated experimentally. The observed enhancement is at least one order of magnitude larger than predicted. Simulations of this system reveal that, contrary to predictions, the single particle undergoes anomalous diffusion, and that this explains the unexpectedly large enhancement of the thermally driven fluctuations. In particular, we show that giant diffusivity arises from the competition between sticking and running states, and can be related to the anomalous diffusion characteristics. We show that the system crosses over from superdiffusive behavior to subdiffusion as the driving increases relative to the barrier height, in agreement with experiments.

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