Occurrence of normal and anomalous diffusion in polygonal billiard channels

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Abstract

We present results [1] on the diffusive properties of irrational polygonal billiard channels, where non-interacting particles bounce within periodic quasi-one-dimensional channels having polygonal boundaries and irrational angles. Such models are not chaotic in the usual sense, having a zero Lyapunov exponent.

Surprisingly, as in the standard Lorentz gas, which has circular scatterers and is strongly chaotic, we find normal diffusion, with linear growth of the mean squared displacement in time. For channels with an infinite horizon, we find marginally anomalous diffusion ($t \log t$ growth), also as in the Lorentz gas.

The exception to this is when the unit cell contains accessible *parallel scatterers*. In this case, we instead find super-diffusion. The explanation for this is the existence of many families of propagating periodic orbits due to the parallel scatterers.

When a configuration with parallel scatterers is approached there is a crossover from normal to anomalous diffusion, consistent with a simple scaling form, with the diffusion coefficient exhibiting a power-law divergence.

[1] David P. Sanders & Hernán Larralde (2006). Occurrence of normal and anomalous diffusion in polygonal billiard channels. *Phys. Rev. E* **73**(2), 026205.