



سمینار هفتگی گروه ماده چگال نرم

Artificial Brownian motors: Controlling transport on the nanoscale*

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In systems possessing spatial or dynamical symmetry breaking, Brownian motion combined with unbiased external input signals, deterministic and random alike, can assist directed motion of particles at submicron scales. In such cases, one speaks of “Brownian motors.” In this review the constructive role of Brownian motion is exemplified for various physical and technological setups, which are inspired by the cellular molecular machinery: the working principles and characteristics of stylized devices are discussed to show how fluctuations, either thermal or extrinsic, can be used to control diffusive particle transport. Recent experimental demonstrations of this concept are surveyed with particular attention to transport in artificial, i.e., nonbiological, nanopores, lithographic tracks, and optical traps, where single-particle currents were first measured. Much emphasis is given to two- and three-dimensional devices containing many interacting particles of one or more species; for this class of artificial motors, noise rectification results also from the interplay of particle Brownian motion and geometric constraints. Recently, selective control and optimization of the transport of interacting colloidal particles and magnetic vortices have been successfully achieved, thus leading to the new generation of microfluidic and superconducting devices presented here. The field has recently been enriched with impressive experimental achievements in building artificial Brownian motor devices that even operate within the quantum domain by harvesting quantum Brownian motion. Sundry akin topics include activities aimed at noise-assisted shuttling other degrees of freedom such as charge, spin, or even heat and the assembly of chemical synthetic molecular motors. This review ends with a perspective for future pathways and potential new applications.

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