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## Brownian Asymmetric Simple Exclusion Process

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We present a model of a Brownian asymmetric simple exclusion process (BASEP) with underdamped Brownian Dynamics, which is an extension on the well-known asymmetric simple exclusion process (ASEP) defined on a discrete lattice. In the BASEP, particles of size  $\sigma$  with hardcore interaction are driven by a constant drag force through a one-dimensional cosine potential with period  $\lambda$ . The amplitude of the cosine potential is much larger than  $k_B T$ , leading to an effective hopping motion of particles between potential wells. Under periodic boundary conditions, the system reaches a non-equilibrium steady-state (NESS) with a constant particle current. In general, the character of these NESS is strikingly different from the one in the ASEP. Compared to the particle current in a system of non-interacting particles, we observe an enhancement for small  $\sigma/\lambda$  ratios, caused by a barrier reduction effect arising from multi-occupation of potential wells. Larger ratios lead to a suppression of the current because of strong blocking effects. Surprisingly, an exchange-symmetry effect leads to a current-density relation identical to that of non-interacting particles for the commensurable length  $\sigma = \lambda$ . A current-density relation similar to the ASEP is obtained only for a limited parameter regime. The rich behavior of the current-density relation is reflected in non-equilibrium phase-diagrams for open-systems, which can exhibit up to five phases. The topology of these phase diagrams changes with varying  $\sigma/\lambda$  ratio. We furthermore discuss transition times and splitting probabilities for a tagged particle in the BASEP. These quantities exhibit a remarkable asymmetry, which we relate to the collective particle motion in the NESS.

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