A master thesis proposal in computational statistical physics

Effect of particle interactions on driven Brownian transport along channels

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Supervisor 2: **Dr. M. Ebrahim Foulaadvand**, University of Zanjan and Institute for Research in Fundamental Sciences (IPM), Teheran, Iran.

The successful candidate will pass the master courses in the first year in Iran and spend a period of three months (minimum) at Osnabrück university during the second year to conduct the research. Osnabrück can provide accommodation and partial support for the living expenses. It is expected that travel expenses is covered by the Iranian university. Interested student should contact Dr. Foulaadvand at **foolad@iasbs.ac.ir.**

Motivation

Transport occurring in the micro-scale domain is strongly influenced by fluctuations and geometry. It is connected to the occurrence of several intriguing, noise-assisted phenomena, such as Brownian ratchets, stochastic resonance, entropic splitters , or intracellular transport. Recently it has been shown that the geometry of the transport channel can play a significant role. The effect of confinement can be described by means of an effective entropic potential resulting from the variation of accessible space to particles along the transport direction. The interplay of noise, confining geometry and drive on the particles can give rise to novel features and may enhance the average velocity, reverse the natural transport direction, or induce anomalous transport processes. Here we aim to study effect of particle interactions particles on the transport in confined corrugated geometries.

Model system and phenomenology of the problem

A classical system of interacting particles performing Brownian motion in a corrugated narrow channel is studies. For the interaction we will consider a short-range repulsive potential. The particles are subjected to a constant force along the channel direction and an additional time-periodic force. The particle interactions with the corrugated channel walls are described by a potential, which is spatially periodic along the channel. Based on the Fick-Jacobs approximation, one can eliminate the transverse dependence in favour of an effective one-dimensional potential. This is often referred to as the entropic potential. Main quantities of interest are the particle current, the mobility and local particle density inside the channel. For certain parameter sets, it would be possible to establish a negative current opposite to the constant bias. The aim is to obtain insight into the effect of particle interactions on the transport behavior.

Objectives

1) A survey on the existing literature, reviewing of the basic papers and learning the concepts.

2) Learning the method of Fick-Jacobs and extending it to the case of interacting particles.

3) Developing a code to simulate the problem in the presence of interactions.

References

- P. S. Burada *et al*.,, Biased diffusion in confined media, Phys. Rev. E **75**, 051111 (2007).
- P. Hanggi *et al.*, Asymmetry in shape causing absolute negative mobility, Phys. Rev. E **82**, 041121 (2010).
- D. Reguera *et al.*, Entropic splitter for particle separation, Phys. Rev. Lett. **108**, 020604 (2012).