Research Record (Non-equilibrium Physics)

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Contents

1 Fall 2023 (4^{th} Semester)

1.1 August 2023

1.1.1 August 26th (Sat), 2023

1. After discussion with professor, we decided to search for negative drag on AOUP particles in quartic polynomial external potential, unlike linear potential which we have been doing so far.

2. We make this decision after referring to an article which shows that the AOUP reaches equilibrium if their smooth interaction potential has zero third derivatives.[1]

3. The revised external potential with n^{th}-order polynomial is as follows

$$\begin{cases} V(x) = \frac{f\Lambda}{2}\left[1 - \left|\frac{2x}{\Lambda}\right|^n\right] & |x| < \Lambda/2 \\ V(x) = 0 & \text{else} \end{cases} \tag{1.1.1.1}$$

4. Running simulation under following parameters:

# ptcl	# ens	bound	Γ	T	τ	D_a	δt	init	sample	gap	order
1000	1000	5.0	1.0	1.0	1.0	1.0	0.001	10,000	100	1,000	4

slope f	lambda λ	velocity v
$0.1 \sim 0.5$	$0.1 \sim 0.5$	$0.001 \sim 10.0$

5. Markov process is independent of history and depends only on the current status

6. The dimensionless parameter is as follows

characteristic time	propulsion force	persistence length	typical velocity
τ	$\Gamma\sqrt{\frac{D_a}{\tau}}$	$\sqrt{D_a \cdot \tau}$	$\sqrt{\frac{D_a}{\tau}}$

1.1.2 August 28th (Mon), 2023

1. Running simulation for 1000 ensembles with 4th-order external potential, no sign of negative drag

1.1.3 August 29th (Tue), 2023

1. Running simulation for 5000 ensembles with 4th-order external potential, no sign of negative drag

2. After consulting with Prof. Yongjoo Baek, we decided to change the external potential from concave to convex.

3. The revised n$^{\text{th}}$-polynomial potential is given as follows:

$$V(x) = \begin{cases} \frac{F\Lambda}{2}\left(1 - \left|\frac{2x}{\Lambda}\right|\right)^n & |x| \leq \Lambda/2 \\ 0 & |x| > \Lambda/2 \end{cases} \tag{1.1.3.1}$$

References

[1] L. L. Bonilla. Active ornstein-uhlenbeck particles. *Phys. Rev. E*, 100:022601, Aug 2019.