Underdamped Brownian Engines: The Resonant Phenomena

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Collisional Brownian engines have been proposed as alternatives for nonequilibrium nanoscale engines. However, most studies have focused on the simpler overdamped case, leaving the role of inertia much less explored. In this work, we introduce the idea of collisional engines to underdamped Brownian particles, where each stage is sequentially subjected to a distinct driving force. A succint comparison between the performance of underdamped and overdamped Brownian work-to-work engines has been undertaken, where the last were already studied in previous works. The results show that underdamped Brownian engines generally outperform their overdamped counterparts. A key difference is the presence of a resonant regime in underdamped engines, in which both efficiency and power output are enhanced across a broad set of parameters ***simultaneously***. Our study highlights the importance of carefully selecting dynamics and driving protocols to achieve optimal engine performance.

References

[1]Gustavo A. L. Forão, Fernando S. Filho, Bruno A. N. Akasaki and Carlos E. Fiore, Thermodynamics of underdamped Brownian collisional engines: New insights and resonant phenomena (submitted). arXiv:2406.19365

[2] K. Proesmans and C. Van den Broeck, Chaos: An Interdisci- plinary Journal of Nonlinear Science 27 (2017).

[3] F. S. Filho, B. A. N. Akasaki, C. E. F. Noa, B. Cleuren, and C. E. Fiore, Phys. Rev. E 106, 044134 (2022).

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