Powerful Ordered Collective Heat Engines

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In this talk we discuss a class of stochastic engines introduced by the reference [1] in which the regime of units operating synchronously can boost the performance. Our approach encompasses a minimal setup composed of N interacting units placed in contact with two thermal baths and subjected to a constant driving worksource. Such characteristics are ingredients of a non-equilibrium thermodynamics system that reaches a non-equilibrium steady state and can transform a heat flux into useful power [2,3]. The interplay between unit synchronization and interaction are crucial to such transformation and leads to an efficiency at maximum power between the Carnot η_C and the Curzon-Ahlborn bound η_{CA}. Moreover, these limits can be respectively saturated maximizing the efficiency, and by simultaneous optimization of power and efficiency. We show that the interplay between Ising-like interactions and a collective ordered regime is crucial to operate as a heat engine. The robustness of our findings extends beyond the all-to-all interactions and paves the way for the building of promising nonequilibrium thermal machines based on ordered structures.

References

[1] Powerful ordered collective heat engines, Fernando S. Filho, Gustavo A. L. Forão, Daniel M. Busiello, B. Cleuren, and Carlos E. Fiore, Phys. Rev. Research 5, 043067 (2023).

[2] Stochastic thermodynamics, fluctuation theorems and molecular machines, Udo Seifert, Rep. Prog. Phys. 75 126001 (2012).

[3] Collective effects enhancing power and efficiency, H. Vroylandt, M. Esposito, and G. Verley, Europhys. Lett. 120, 30009 (2017).

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