Periodic potential can enormously boost free particle transport induced by active fluctuations

Karol Białas, Jerzy Łuczka, **Jakub Spiechowicz**
University Of Silesia, Katowice, Poland

Active fluctuations are detected in a growing number of systems due to self-propulsion mechanisms or collisions with an active environment. They drive the system far from equilibrium and can induce phenomena that are forbidden at equilibrium states by, e.g., fluctuation-dissipation relations and detailed balance symmetry. Understanding their role in living matter is emerging as a challenge for physics. Here we demonstrate a paradoxical effect in which a free-particle transport induced by active fluctuations can be boosted by many orders of magnitude when the particle is additionally subjected to a periodic potential. In contrast, within the realm of only thermal fluctuations, the velocity of a free particle exposed to a bias is reduced when the periodic potential is switched on. The presented mechanism is significant for understanding nonequilibrium environments such as living cells, where it can explain from a fundamental point of view why spatially periodic structures known as microtubules are necessary to generate impressively effective intracellular transport.

References

[1] K. Białas, J. Łuczka, J. Spiechowicz, Phys. Rev. E 107, 024107 (2023).