[Talk 16] Quantifying the heat dissipation from a molecular motor's transport properties in non-equilibrium steady states

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Theoretical analysis, which maps on unicyclic Markov processes the single molecule time trajectories of an active molecular motor, allows us to evaluate the heat dissipated from the motor and to elucidate its dependence on the mean velocity and diffusivity. Unlike passive Brownian particles in equilibrium, the velocity and diffusion constant of molecular motors are closely related to each other. In particular, our study makes it clear that the increase of diffusivity with the heat production is a natural outcome of active particles, which is reminiscent of the recent experimental premise that the diffusion of an exothermic enzyme is enhanced by the heat released from its own catalytic turnover. Compared with free exothermic enzymes, one-dimensionally ratcheted kinesin-1 is highly efficient in transforming the conformational change into a locally directed motion, thus displaying a significantly higher enhancement in diffusivity with its turnover rate. The heat dissipation, velocity, and diffusivity quantified from our analysis also allow us to evaluate the energetic cost to extract information from time trajectories of a transport motor. Compared to myosin-V or dynein, less energetic cost is required to extract information from kinesin-1's trajectories. We also find that this energetic cost is a non-monotonic function of ATP and load.