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Generalized Michaelis-Menten equation for conformation-modulated monomeric enzyme catalysis[1] JIANLAN WU, Physics Department, Zhejiang University, China, JIANSHU CAO, MIT — The conformational fluctuations induce complex enzymatic catalytic behaviors, which can be investigated by single-molecule experiments. We introduce a kinetic network model to describe conformation-modulated monomeric enzyme catalysis and formulate a generalized Michaelis-Menten (MM) rate equation for non-equilibrium steady-state turnover reactions. Using the flux balance method, we map the original kinetic network to a flux network with unbalanced population currents and derive the general substrate concentration dependence for the average turnover rate of non-equilibrium steady-state enzymatic reactions. In addition to the standard MM term, the generalized MM equation includes non-MM correction terms, which share the same functional form of substrate-dependence. Each non-MM correction term corresponds to a non-equilibrium unbalanced population current induced by conformational fluctuations. Under detailed balance conditions without population currents, non-MM terms vanish and the classical MM equation is recovered. With non-MM terms, the generalized MM equation provides a systematic approach to investigate non-MM behavior and predicts cooperativity, inhibition, and multiple-stability.

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