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Noise effects in bacterial motor switch

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The clockwise (CW) or counter clockwise (CCW) spinning of bacterial flagellar motors is controlled by the concentration of a phosphorylated protein CheY-P. In this talk, we represent the stochastic switching behavior of a bacterial flagellar motor by a dynamical two-state (CW and CCW) model, with the energy levels of the two states fluctuating in time according to the variation of the CheY-P concentration in the cell. We show that with a generic normal distribution and a modest amplitude for CheY-P concentration fluctuations, the dynamical two-state model is capable of generating a power-law distribution (as opposed to an exponential Poisson-like distribution) for the durations of the CCW states, in agreement with recent experimental observations of Korobkova et al (Nature, 428, 574(2004)). In addition, we show that the power spectrum for the flagellar motor switching time series is not determined solely by the power-law duration distribution, but also by the temporal correlation between the duration times of different CCW intervals. We point out the intrinsic connection between anomalously large fluctuations of the motor output and the overall high gain of the bacterial chemotaxis system. Suggestions for experimental verification of the dynamical two-state model will also be discussed.