How to connect time-lapse recorded trajectories of motile microorganisms with dynamical models in continuous time

We provide a tool for data-driven modeling of motility, data being time-lapse recorded trajectories. Several mathematical properties of a model to be found can be gleaned from appropriate model-independent experimental statistics, if one understands how such statistics are distorted by the finite sampling frequency of time-lapse recording, by experimental errors on recorded positions, and by conditional averaging. We give exact analytical expressions for these effects in the simplest possible model for persistent random motion, the Ornstein-Uhlenbeck process. Then we describe those aspects of these effects that are valid for any reasonable model for persistent random motion. Our findings are illustrated with experimental data and Monte Carlo simulations.

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