Statistical physics of biological motion: Crawling cells and foraging bumblebees

Rainer Klages

Queen Mary University of London, School of Mathematical Sciences

We statistically analyze experimental data of two types of systems exhibiting biological motion and construct stochastic models reproducing their dynamics. First, we study the experimentally observed trajectories of single kidney cells crawling on substrates. We find a superdiffusive increase of the mean squared displacement, non-Gaussian probability distributions of the positions and power-law decays of the velocity autocorrelations. These experimental findings are reproduced from a fractional Klein-Kramers equation generating anomalous diffusion [1]. We then analyze 3D flight paths of bumblebees searching for nectar in a laboratory experiment with and without predation risk from artificial spiders. For the flight velocities we find mixed probability distributions reflecting the access to the food sources while the threat posed by the spiders shows up only in the velocity correlations. The bumblebees thus adjust their flight patterns spatially to the environment and temporally to predation risk. Key information on response to environmental changes is thus contained in the velocity autocorrelation functions, as is reproduced from a generalized Langevin equation [2].

[1] P.Dieterich, R.Klages, R.Preuss, A.Schwab, PNAS **105**, 459 (2008).

[2] F.Lenz, T.Ings, A.V.Chechkin, L.Chittka, R.Klages, Phys.Rev.Lett. **108**, 098103 (2012)