The Physics of Foraging: Bumblebee Flights under Predation Risk

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The ‘physics of foraging’ is driven by the question whether biologically relevant search strategies can be identified by statistical data analysis and mathematical modeling. A famous paradigm within this field is the Lévy hypothesis, which states that under certain conditions Lévy flights provide an optimal search strategy for foraging organisms. I first review recent developments in this field. This sets the scene for discussing a laboratory experiment in which 3D flight paths of bumblebees searching for nectar in an artificial carpet of flowers have been recorded [1]. In a second stage of the experiment, some of the flowers have been randomly equipped with artificial spiders modeling predation risk. Surprigingly, we find that the threat posed by the spiders does not show up in the velocity distributions but only in the velocity correlations, that is, the topology of the flight paths is changed in view of predation risk but not the average speed. We qualitatively reproduce these findings from a simple stochastic mathematical model, which includes a repulsive interaction between bumblebee and spider. For the pure foraging flights without spider interaction we construct a second, more detailed stochastic model from experimental data analysis by generalizing correlated random walks [2].

This is joint work together with F.Lenz, T.C.Ings, L.Chittka, and A.V.Chechkin.

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

[2] F.Lenz, A.V.Chechkin, R.Klages, PLoS ONE 8, e59036 (2013)