AKB 17 Population Dynamics

Time: Wednesday 14:30–15:30 Room: ZEU 260

AKB 17.1 Wed 14:30 ZEU 260

Swarm formation of anisotropic self-propelled particles — •Fernando Peruani[1,2], Markus Baer[3], and Andreas Deutsch[2] — [1]Max-Planck Institute for the Physics of Complex Systems — [2]ZIH, Technische Universität Dresden — [3]Physikalisch-Technische Bundesanstalt

We study clustering (swarming) in biologically motivated systems of asymmetric self-propelled particles interacting through volume exclusion. Through simulations, we give numerical evidence of a transition to swarming. At the same time, we show that clustering effects can be captured by a mean field approach. We find that clustering is controlled by the particle aspect ratio κ and the packing fraction η. We report a transition from unimodal to bimodal cluster size distribution which is triggered by a critical κ_c. We show κ_c is a function of the packing fraction η. The applicability of these finding to bacterial swarming is also discussed.

AKB 17.2 Wed 14:45 ZEU 260

Coevolutionary dynamics: From finite to infinite populations — •Jens Christian Claussen[1], Arne Traulsen[2], and Christoph Hauert[2] — [1]Institut für Theoretische Physik und Astrophysik, Universität Kiel, Germany — [2]Center for Evolutionary Dynamics, Harvard

Traditionally, frequency dependent evolutionary dynamics is described by deterministic replicator dynamics assuming implicitly infinite population sizes. Only recently, stochastic processes have been introduced to study evolutionary dynamics in finite populations. However, the relationship between deterministic and stochastic approaches remained unclear. Here we solve this problem by explicitely considering the limit of infinite populations. In particular, we identify different microscopic stochastic processes that lead to the standard or the adjusted replicator dynamics. Moreover, differences on the individual level can lead to qualitatively different dynamics in asymmetric conflicts and, depending on the population size, can even invert the direction of the evolutionary process.

[1] J.C. Claussen & A. Traulsen, Phys. Rev. E 71, 025101(R)
[2] Arne Traulsen, Jens Christian Claussen, Christoph Hauert, Phys. Rev. Lett (2005, in print; arXiv.org e-print cond-mat/0409655)

AKB 17.3 Wed 15:00 ZEU 260

Vicious walkers in one-body potentials — •Karen Winkler[1] and Alan J. Bray[2] — [1]Arnold Sommerfeld Center for Theoretical Physics (ASC) and Center of Nanoscience (CeNS), LMU München — [2]Department of Physics and Astronomy, University of Manchester, Manchester M13 9PL, U.K.

Vicious walkers are short-ranged interacting random walkers which annihilate each other on meeting. The backward Fokker-Planck equation is an elegant tool to derive the asymptotic behavior of the probability that all N vicious walkers have survived. We introduce a method to compute the survival probability of N vicious walkers in general one-body potentials. Using this method we are able to give results for N vicious walkers on a semi-infinite line with reflecting boundary at the origin [1].
We also derive explicit results for three vicious walkers in an inverted harmonic potential, which can be interpreted as a new predator-prey problem [2].

[1] A.J. Bray and K. Winkler, J. Phys. A **37**,5493 (2004)
[2] K. Winkler and A.J. Bray, J. Stat. Mech.(2005) PO2005

AKB 17.4 Wed 15:15 ZEU 260

Phase Transitions and Fluctuations in Stochastic Lattice Lotka-Volterra Models — •Mauro Mobilia[1,2], Ivan T Georgiev[2], and Uwe C Taeuber[2] — [1]Arnold Sommerfeld Center for Theoretical Physics, Ludwig-Maximilians-Universität München — [2]Virginia Polytechnic Institute and State University, Blacksburg, USA

Modeling dynamics of interacting species has received considerable attention in the fields of biology and ecology since Lotka and Volterra's pioneering work. In this contribution we report on the general properties of stochastic two-species competing populations with Lotka-Volterra type interactions defined on a d-dimensional lattice.

Introducing spatial degrees of freedom and allowing for stochastic fluctuations generically invalidates the classical, deterministic mean-field picture. Already within mean-field theory, however, spatial constraints, modeling locally limited resources, lead to the emergence of a continuous phase transition. Field-theoretic arguments, supported by numerical results, indicate that this transition, which represents an extinction threshold for the predator population, is governed by the directed percolation universality class. In the active state, where predators and prey coexist, the classical center singularities with associated population cycles are replaced by either nodes or foci. In the vicinity of the stable nodes, the system is characterized by clusters of predators in a sea of prey. Near the stable foci, however, the stochastic lattice Lotka-Volterra system displays complex spatio-temporal patterns. We discuss the irregular oscillations of the population densities associated to spatial fluctuations and the robustness of the overall scenario.