BP 11: Evolutionary Game Theory II (joint SOE, BP)

Time: Tuesday 11:15–12:30 Location: H44

BP 11.1 Tue 11:15 H44

Evolutionary dynamics, intrinsic noise and cycles of co-operation — •Alex Bladon, Tobias Galla, and Alan J McKane — Theoretical Physics, School of Physics and Astronomy, The University of Manchester, Manchester M13 9PL, United Kingdom

The puzzle of how co-operation emerges in evolving populations subject to natural selection is unsolved, and the dynamic interaction of co-operation and defection is a current topic of wide interest in game theory. Periodic cycles between co-operation, defection and retaliation have been reported in numerical simulations of the iterated prisoner's dilemma in small populations of evolving agents [PNAS, 102, 31, 10797-10800, 2005]. Using tools from statistical mechanics and nonlinear dynamics we here provide an analytical underpinning of these numerical observations and show that such cycles are the signature of amplified coherent oscillations sustained by demographic noise. We derive effective Langevin equations describing these oscillations and compute their power spectra analytically in the limit of large, but finite populations and in excellent agreement with numerical simulations. Our analytical theory reveals that the amplitude of these stochastic oscillations is, to a large degree, set by the inverse real part of the relevant eigenvalue of the deterministic dynamics, and that it can hence become singular near a Hopf bifurcation. Macroscopic oscillations are then observed even at large system sizes. Our analysis extends to cases in which errors of the 'trembling hand' type are considered, and where the strategy space includes a win-stay, lose-shift action.

BP 11.2 Tue 11:30 H44

Evolutionary adaptation of a social norm optimizes node degree and investments on an adaptive network — •Johannes Hoefener and Thilo Gross — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden, Germany

Humans established complex networks of cooperation, which are essential for our modern society. Cooperating with just a single person is not efficient and cooperating with everyone is not even possible. Thus every individual has to decide if and how much it should invest into a certain cooperation. Because the payoff provided by a cooperation is usually not known when the investments have to be done, individuals may base their decision on heuristics or social norms. These, for instance may follow the statement: "Get more. Give more." Here we study a continuous prisoner's dilemma game on an adaptive network, where the investment into cooperation is determined by a social norm function. We assume that the general form of the function is fixed, but allow the function to be modified by evolutionary adaptation of it's parameters. We show that this adaptation not only establishes stable cooperation but also optimizes the node degree as well as the investments in the remaining cooperations.

BP 11.3 Tue 11:45 H44

A Homclinic Route to Full Cooperation in the Snowdrift Game on Adaptive Networks — •Gerd Zschaler[1], Arne Traulsen[2], and Thilo Gross[1] — [1]Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany — [2]Max-Planck-Institut für Evolutionsbiologie, Plön, Germany

We consider the evolutionary dynamics of a cooperative game on an adaptive network, where the strategies of agents, cooperation or defection, feed back on their local interaction topology. While mutual cooperation is the social optimum, unilateral defection yields a higher payoff and undermines the evolution of cooperation. Although no a priori advantage is given to cooperators, an intrinsic dynamical mechanism can lead asymptotically to a state of almost full cooperation. In finite systems, this state is characterized by long periods of strong cooperation interrupted by sudden episodes of predominant defection, suggesting a possible mechanism for the systemic failure of cooperation in real-world systems.

BP 11.4 Tue 12:00 H44

Deterministic evolutionary game dynamics in finite populations — •Philipp M. Altrock and Arne Traulsen — MPI f. Evolutionary Biology, Plön, Germany

Evolutionary game dynamics describes the spreading of successful strategies in a population of reproducing individuals. Typically, the microscopic definition of strategy spreading is stochastic, such that the dynamics becomes deterministic only in infinitely large populations. Here, we introduce a new microscopic birth–death process that has a fully deterministic strong selection limit in well–mixed populations of any size. Additionally, under weak selection, from this new process the frequency dependent Moran process is recovered. This makes it a natural extension of the usual evolutionary dynamics under weak selection. We analytically find simple expressions for the fixation probabilities and average fixation times of the new process in evolutionary games with two players and two strategies. For cyclic games with two players and three strategies, we show that the resulting deterministic dynamics crucially depends on the initial condition in a non–trivial way.

[1] Goel & Richter-Dyn, *Stochastic Models in Biology*, Academic Press, NY, (1974).

[2] Altrock & Traulsen, Phys. Rev. E **80**, 011909 (2009).

BP 11.5 Tue 12:15 H44

Evolutionary Quantum Game Theory — •Matthias Hanauske[1] and Jennifer Kunz[2] — [1]Institute of Information Systems — [2]Chair of Controlling and Auditing, Goethe-University, Frankfurt/M.

Quantum game theory is a mathematical and conceptual amplification of classical game theory. The space of all conceivable decision paths is extended from the purely rational, measurable space in the Hilbertspace of complex numbers. Trough the concept of a potential entanglement of the imaginary quantum strategy parts, it is possible to include corporate decision path, caused by cultural or moral standards. If this strategy entanglement is large enough, then, additional Nash-equilibria can occur and previously present dominant strategies could become nonexistent. The main equation of evolutionary game theory, the Replicator equation, gets a more complex structure and other evolutionary stable strategies can appear. In addition to a detailed introduction in evolutionary quantum game theory several examples of applications will be presented during this talk. The current financial crisis will be discussed using a quantum extension of an anticoordination game, the different publication patterns of scientist will be studied and the evolution of social norms in firms will be explained using a quantum coordination game.

(http://evolution.wiwi.uni-frankfurt.de/Lyon2009/, ArXiv: 0904.2113, arXiv: physics/0612234)