SYDN 1: Game theory in dynamical systems

Time: Friday 10:10–13:00 Location: H 0105

Invited Talk SYDN 1.1 Fri 10:10 H 0105

Volunteering and Punishment in Public Goods games — •Christoph Hauert — Harvard University, USA

Understanding the evolution of cooperation represents a major challenge in biology and social sciences. Cooperative behavior is costly to the cooperator while providing benefits to other individuals. Since groups of cooperators are better off than groups of non-cooperating defectors this generates a conflict of interest between the individual and the group. Cooperation can be stabilized by punishing defectors. Punishment is ubiquitous in animal and human societies - ranging from toxin producing microorganisms to law enforcement institutions. However, it remains unresolved how initially rare and costly punishment behavior can gain a foothold and establish a social norm in a population. In nature, animals and humans often carefully select their interaction partners or adjust their behavioral patterns in response to them. In the simplest case they simply refuse to participate in risky enterprises. Such voluntary participation in social endeavors is an efficient mechanism to prevent deadlocks in states of mutual defection and thus represents a potent promoter of cooperation but fails to stabilize it. However, the combined efforts of punishment and volunteering are capable of changing the odds in favor of cooperation - but only in finite populations. Under the stochastic dynamics of finite populations with mutation and selection the freedom to withdraw leads to prosocial coercion. This implements Hardin's principle to overcome the Tragedy of the Commune: "mutual coercion mutually [and voluntarily] agreed upon".

SYDN 1.2 Fri 10:50 H 0105

Learning to play random games: effects of memory-loss and mutation — •Tobias Galla — The University of Manchester, School of Physics and Astronomy, Schuster Building, Manchester M13 9PL, UK

The dynamics of players with finite memory capacities learning to play a two-person game can be described by the so-called Sato-Crutchfield equations, a modification of the standard replicator dynamics. In this talk we will present a statistical mechanics analysis of such dynamics in the context of games with large random payoff matrices. Our main tool are here generating functionals drawn from spin glass physics, and a subsequent fixed point and stability analysis. A transition is found between a stable ergodic fixed point phase at large memory loss rate, and an unstable, potentially chaotic phase at slow memory-loss. We will also discuss the influence of copying errors in the reproduction process, as modelled by random replicator-mutator equations.

SYDN 1.3 Fri 11:05 H 0105

Über die Anwendbarkeit von Quanten-Spieltheoretischen Konzepten in realen 2x2-Entscheidungssituationen — •Matthias Hanauske — Johann Wolfgang Goethe-Universität, Institut für Wirtschaftinformatik, Mertonstr. 17, 60054 Frankfurt am Main

Während die Vorhersagen der Quanten Spieltheorie (QST) durch Quantencomputer-Experimente erfolgreich bestätigt werden konnten, ist eine Überprüfung der Anwendbarkeit der QST in realen 2-Spieler-2-Strategien-Entscheidungssituationen bisher nur in Ansätzen betrachtet worden. Die Operationalisierung der Entscheidung, die Erweiterung des Entscheidungsraumes mittels komplexwertiger Strategien und nicht zuletzt das Konzept der Verschränkung der Spielerstrategien läßt Zweifel an der Anwendbarkeit der QST bei realen Spielen begründet erscheinen. Anhand von menschlichen Experimenten zum 2-Spieler-Gefangenendilemma lässt sich zeigen, dass eine Quanten-Spieltheoretische Beschreibung die Kooperationsbereitschaft der Spieler besser vorhersagen kann als eine rein klassische Vorhergehensweise. In diesem Vortrag soll neben diesen Ergebnissen eine mögliche Interpretation des Verschränkungsgrades der Spielerstrategien diskutiert werden.

[1] M. Hanauske, S. Bernius, and B. Dugall, Physica A 382, 650 (2007), arXiv:physics/0612234v1 [physics.soc-ph].

SYDN 1.4 Fri 11:20 H 0105

Anomalous finite-size effects in the Battle of the Sexes — •Jonas Cremer, Tobias Reichenbach, and Erwin Frey — Arnold Sommerfeld Center for Theoretical Physics, Ludwig-Maximilians Universität München

We investigate finite-size fluctuations in Dawkins Battle of the Sexes. This game describes mating behavior of males and females, where males can be either philanderer or faithful, females are fast or coy. The replicator dynamics is cyclic with a deterministic drift towards coexistence of all four strategies. In contrast to this behavior, we show that finite-size fluctuations unavoidably lead to extinction of two strategies in the population [1]. The typical time until extinction occurs, however, strongly prolongs with increasing system size. During this emerging time window, a quasi-stationary probability distribution forms that is non-Gaussian in the vicinity of the coexistence state. As we show, this behavior originates in a vanishing linear deterministic drift near the coexistence fixed point. We provide an analytical approach for this distribution and the mean extinction time.

[1] Jonas Cremer, Tobias Reichenbach, and Erwin Frey, submittted to EPJB, arxiv.org/abs/0709.0225

SYDN 1.5 Fri 11:35 H 0105

Evolutionary game dynamics: From infinite to finite populations and back — •Arne Traulsen — Max-Planck-Institute for Evolutionary Biology, Plön, Germany

Evolutionary game dynamics is traditionally considered in infinite populations, based on the replicator dynamics. These nonlinear differential equations have given rise to a wealth of beautiful mathematical results. In finite populations, surprising effects arise from the interplay of stochasticity and weak selection. For example, the 1/3-rule connects the position of an unstable equilibrium in coordination games with the fixation probabilities under weak selection. Cooperation in group structured populations is only nontrivial for a finite number of finite groups. Costly punishment of uncooperative individuals does not emerge in infinite populations, but can dominate when the population is finite. In the appropriate limits, the usual results of the replicator dynamics can be reproduced, with added insight on the system parameters.

SYDN 1.6 Fri 11:50 H 0105

Discrete stochastic dynamics in dynamical systems with limit cycles — •Richard Boland, Tobias Galla, and Alan McKane — The University of Manchester

Chemical systems are often described by a set of reaction equations between discrete numbers of particles. Similarly, models in population dynamics can be formulated on the level of individuals, who may reproduce or feed upon each other. In the limit of infinite system size a continuous mean-field description can be derived in terms of a set of ordinary differential equations for the concentrations of different chemicals or species. Stochastic effects in systems with finite size have recently been shown to be relevant in, for example, prey-predator systems, where the mean field theory predicts a stable fixed point and no persistent oscillations. At finite size, however, systems can show coherent oscillations via a resonant amplification of inherent noise due to discretisation. In this talk we focus on systems where the attractor of the mean field-dynamics is a limit cycle (e.g. the Brusselator), and address finite-size stochastic effects by means of an expansion of the master equation in the inverse system size, resulting in a stochastic Langevin equation for the fluctuations about the limit cycle. We demonstrate how analytical progress can be made in a co-moving frame, and compute the power spectra of the transverse and longitudinal components.

SYDN 1.7 Fri 12:05 H 0105

Mobility and pattern formation in rock-paper-scissors games — •Tobias Reichenbach[1], Mauro Mobilia[2], and Erwin Frey[1] — [1]Arnold Sommerfeld Center for Theoretical Physics (ASC) and Center for NanoScience (CeNS), Department of Physics, Ludwig-Maximilians-Universität München, Theresienstrasse 37, D-80333 München, Germany — [2]Mathematics Institute and Warwick Complexity Complex, The University of Warwick, Gibbet Hill Road, Coventry CV4 7AL, United Kingdom

Self-formation of noisy patterns governs species coevolution in spatially extended, biodiverse ecosystems. Individuals that organize into such patterns are often mobile: bacteria run and tumble, and animals migrate from place to place. We show that mobility has intriguing

impact on form and size of the self-forming spatial structures, and thereby on the possibility of species diversity. Employing a specific model for cyclic (rock-paper-scissors-type) competition of species, we show that, under the influence of mobility, surprisingly regular, geometric patterns form. Namely, a noisy entanglement of rotating spiral waves self-organizes in the course of time. A critical value of mobility separates this biodiverse scenario from a uniform one where only one species survives.

[1] Tobias Reichenbach, Mauro Mobilia, Erwin Frey, Nature 448, 1046-1049 (2007)

[2] Tobias Reichenbach, Mauro Mobilia, Erwin Frey, Phys. Rev. Lett. in print (2007)

Invited Talk SYDN 1.8 Fri 12:20 H 0105

Inequity Concerns in Social Networks — •Pablo Branas-Garza — Dpto. de Teoria e Historia Economica, Universidad de Granada, Spain

This paper explores the role of social integration on inequity concerns. Using a three-phase experimental protocol we first elicit a social network from a group of undergraduate students in Economics; in the second phase, 169 of these subjects have to assign a fixed amount of money to only one of two individuals and, then, in the third stage they decide how much they are willing to pay to "repair" the created inequality. Our experimental data indicate that standard measures of network theory, such as betweenness, out-degree and reciprocal degree, have a positive effect on inequity concerns. These results suggest that (1) pro-sociality and social networks coevolve and (2) information on the social network structure, in which subjects are embedded is important to account for their behavior.