Physics of Socio-Economic Systems Division
Fachverband Physik sozio-ökonomischer Systeme (SOE)

Dirk Helbing
ETH, Chair of Sociology,
in particular Modeling and
Simulation
Clausiusstraße 50
CH-8052 Zürich
dhelbing@ethz.ch

Jens Christian Claussen
Jacobs University Bremen
Systems Biology Lab, Research 2
Campus Ring 1
28759 Bremen
j.claussen@jacobs-university.de

Tobias Preis
Warwick Business School
The University of Warwick
Coventry
CV4 7AL, UK
Tobias.Preis@wbs.ac.uk

Overview of Invited Talks and Sessions

(Lecture rooms: HSZ 03, GÖR 226, and ZEU 118; Posters: P2)

Award Session: Young Scientist Award for Socio- and Econophysics

SOE 5.1	Mon	16:15–17:00	HSZ 03	**The Mesh of Civilizations in the Global Network of Digital Communications** — Bogdan State, Ingmar Weber, Yelena Mejova, •Michael Macy
SOE 5.2	Mon	17:15–18:00	HSZ 03	**Complex (social) networks: from description to prediction** — •Roger Guimera

Invited and Topical Talks

SOE 1.1	Mon	9:30–10:15	GÖR 226	**The robustness of complex networks** — •Hans Herrmann
SOE 2.2	Mon	10:30–11:00	GÖR 226	**Statistical Mechanics of a Firm Growth Process** — •Cornelia Metzig
SOE 5.1	Mon	16:15–17:00	HSZ 03	**The Mesh of Civilizations in the Global Network of Digital Communications** — Bogdan State, Ingmar Weber, Yelena Mejova, •Michael Macy
SOE 7.1	Tue	9:30–10:15	GÖR 226	**Measuring the scientific impact of research using bibliometric analysis** — •Luis Amaral
SOE 12.1	Wed	9:30–10:15	GÖR 226	**Crystallized Imagination: Economic Development through the eyes of information** — •Cesar Hidalgo

Focus Session: Complex Systems Approaches to Language and Communication (chaired by E.G. Altmann)

SOE 8.1	Tue	10:15–10:45	GÖR 226	**A Comparative Study of Language Complexity in Wikipedia** — •János Kertész, Taha Yasseri, András Kornai
SOE 8.2	Tue	10:45–11:00	GÖR 226	**Statistical Mechanics of Human Language** — •Kosmas Kosmidis
SOE 8.3	Tue	11:00–11:15	GÖR 226	**Topic models and scaling laws** — •Martin Gerlach, Eduardo G. Altmann
SOE 8.4	Tue	11:15–11:30	GÖR 226	**Reading Stockholm Riots 2013 in social media by text-mining** — •Andrzej Jarynowski, Amir Rostami
SOE 8.5	Tue	11:45–12:15	GÖR 226	**Agent-based models of consensus in language dynamics** — •Martina Pugliese, Christine Cuskley, Claudio Castellano, Francesca Colaiori, Vittorio Loreto, Francesca Tria
SOE 8.6	Tue	12:15–12:30	GÖR 226	**Spatial language dynamics in Northern Italy before standardization** — •Gero Vogl, Michael Leitner, Paul Videsott
SOE 8.7	Tue	12:30–12:45	GÖR 226	**Endogenous and exogenous effects on the adoption curves of linguistic innovations** — •Fakhteh Ghanbarnejad, Martin Gerlach, Jose M. Miotto, Eduardo G. Altmann

SOE 8.8	Tue	12:45–13:00	GÖR 226	**A Coarse Grained Approach for Distinguishing Whale "Dialects"** — •Sarah Hallerberg, Heike Vester, Kurt Hammerschmidt, Marc Timme

Invited talks of the joint symposium SYEE (SOE/DY/jDPG): Energy Meets Economy: Dynamics and Statistics of Future Energy Systems (chaired by M. Timme and J.C. Claussen)

See SYEE for the full program of the symposium and SOE 14 for the accompanying session.

SYEE 1.1	Wed	15:00–15:30	HSZ 02	**Smart Grids - From incentives to coupled markets** — •Rudolf Sollacher
SYEE 1.2	Wed	15:30–16:00	HSZ 02	**Energy and the economy** — •Reiner Kümmel
SYEE 1.3	Wed	16:00–16:30	HSZ 02	**Planetary constraints to energy supply and the economy** — •Oliver Richters
SYEE 1.4	Wed	16:45–17:15	HSZ 02	**Identifying critical infrastructures in complex supply networks** — •Dirk Witthaut
SYEE 1.5	Wed	17:15–17:45	HSZ 02	**Short time fluctuations of renewable energies** — •Joachim Peinke, M. Reza Rahimi Tabar, Patrick Milan, Matthias Wächter

Invited talks of the joint symposium SYGP (DY/BP/SOE): Stochastic Dynamics of Growth Processes in Biological and Social Systems (chaired by T. Galla and A. Traulsen)

See SYGP for the full program of the symposium and SOE 23 for the accompanying session.

SYGP 1.1	Thu	15:00–15:30	HSZ 02	**Noisy invasions: large fluctuations in stochastic invasion models** — •Baruch Meerson
SYGP 1.2	Thu	15:30–16:00	HSZ 02	**Fractal clustering of inertial particles in random velocity fields** — •Bernhard Mehlig, Kristian Gustavsson
SYGP 1.3	Thu	16:00–16:30	HSZ 02	**Stochastic population dynamics on rugged fitness landscapes** — •Joachim Krug
SYGP 1.4	Thu	16:45–17:15	HSZ 02	**Modeling cancer as a stochastic process** — •Tibor Antal
SYGP 1.5	Thu	17:15–17:45	HSZ 02	**Von Neumann's growth model: from statistical mechanics to cell metabolism** — •Andrea De Martino

Sessions

SOE 1.1–1.1	Mon	9:30–10:15	GÖR 226	**Robustness in Socio-Economic Systems (Invited Talk Hans Herrmann)**
SOE 2.1–2.6	Mon	10:15–12:00	GÖR 226	**Dynamics of Social and Financial Networks**
SOE 3.1–3.5	Mon	12:00–13:15	GÖR 226	**Financial Markets and Risk Management**
SOE 4.1–4.3	Mon	15:00–16:15	HSZ 03	**Social Systems, Opinion and Group Dynamics I**
SOE 5.1–5.2	Mon	16:15–18:15	HSZ 03	**Award Session - Young Scientist Award for Socio- and Econophysics (YSA)**
SOE 6.1–6.18	Mon	18:00–20:00	P2	**Poster Session**
SOE 7.1–7.1	Tue	9:30–10:15	GÖR 226	**Networks and Social Systems (Invited Talk Luis Amaral)**
SOE 8.1–8.8	Tue	10:15–13:00	GÖR 226	**Focus Session: Complex Systems Approaches to Language and Communication**
SOE 9.1–9.38	Tue	9:30–12:30	P1	**Poster - Glasses / Stat. Phys. Bio. / Networks (joint session DY/BP/CPP/SOE)**
SOE 10.1–10.4	Tue	15:00–16:00	GÖR 226	**Networks, From Topology to Dynamics I (joint with DY and BP)**
SOE 11	Tue	18:30–19:30	GÖR 226	**Annual SOE Member's Assembly**
SOE 12.1–12.1	Wed	9:30–10:15	GÖR 226	**Information Science and Economic Processes (Invited Talk Cesar Hidalgo)**
SOE 13.1–13.6	Wed	10:15–11:45	GÖR 226	**Social Systems, Opinion and Group Dynamics**
SOE 14.1–14.6	Wed	11:45–13:15	GÖR 226	**Energy meets Economy: Dynamics and Statistics of Future Energy Systems (accompanying symposium SYEE joint with DY and jDPG)**
SOE 15.1–15.5	Wed	15:00–17:45	HSZ 02	**Symposium SYEE: Energy Meets Economy: Dynamics and Statistics of Future Energy Systems**

SOE 16.1–16.14	Wed	15:00–18:45	ZEU 118	**Networks - Statistics and Dynamics (joint with BP and DY)**
SOE 17.1–17.6	Thu	9:30–11:00	GÖR 226	**Economic Models**
SOE 18.1–18.5	Thu	11:00–12:15	GÖR 226	**Evolutionary Game Theory and Economic Models (joint with BP and DY)**
SOE 19.1–19.3	Thu	12:15–13:00	GÖR 226	**Networks, From Topology to Dynamics II (joint with DY and BP)**
SOE 20.1–20.5	Thu	15:00–17:45	HSZ 02	**Symposium SYGP: Stochastic Dynamics of Growth Processes in Biological and Social Systems**
SOE 21.1–21.2	Fri	9:30–10:00	GÖR 226	**Traffic Dynamics, Urban and Regional Systems I**
SOE 22.1–22.4	Fri	10:00–11:00	GÖR 229	**Traffic Dynamics, Urban and Regional Systems II**
SOE 23.1–23.11	Fri	10:00–12:45	GÖR 226	**Stochastic Dynamics of Growth Processes in Biological and Social Systems (session accompanying symposium SYGP, joint with DY and BP)**

Annual General Meeting of the Physics of Socio-Economic Systems Division

Tue 18:30–19:30 GÖR 226

- Report on activities
- Dissemination of events
- Discussion of future work of the division
- Collection of suggestions for future symposia and focus sessions
- Election of representatives of SOE
- Miscellaneous

After the assembly, there will be an informal get-together dinner in one of the restaurants in Dresden (details to be announced in the assembly).

SOE 1: Robustness in Socio-Economic Systems (Invited Talk Hans Herrmann)

Time: Monday 9:30–10:15 Location: GÖR 226

Invited Talk SOE 1.1 Mon 9:30 GÖR 226

The robustness of complex networks — •Hans Herrmann — ETH, Zürich, Switzerland

The Internet, protein interactions or social organizations are examples for complex networks. Such networks typically cease to be operational when they fall apart in disconnected pieces. This can be desired as in the case of criminal networks or should be avoided for instance in the case of communication systems. Destruction can happen randomly or due to a malicious attack. I will present various strategies of optimizing the robustness of networks preserving some of their properties as for instance their degree distribution. Artificial networks like the Apollonian network can serve to systematically investigate the optimization process. The optimized networks exhibit a novel "onion-like" topology. Applications to power networks, botnets, road systems and brain models will be discussed. Particularly dramatic failures occur when two networks are coupled, like for example the electric grid and the communication network. The abruptness in the connectivity at collapse can be attenuated through autonomous nodes and I will discuss strategies to optimize the choice of these nodes.

SOE 2: Dynamics of Social and Financial Networks

Time: Monday 10:15–12:00 Location: GÖR 226

SOE 2.1 Mon 10:15 GÖR 226

DebtRank-transparency: Controlling systemic risk in financial networks — •Stefan Thurner[1,2,3] and Sebastian Poledna[1] — [1]Section for Science of Complex Systems; Medical University of Vienna; Spitalgasse 23; A-1090; Austria — [2]Santa Fe Institute; 1399 Hyde Park Road; Santa Fe; NM 87501; USA — [3]IASA, Schlossplatz 1, A-2361 Laxenburg; Austria

Nodes in a financial network, such as banks, cannot assess the true risks associated with lending to other nodes in the network, unless they have full information on the riskiness of all other nodes. These risks can be estimated by using network metrics (as DebtRank) of the interbank liability network. With a simple agent based model we show that systemic risk in financial networks can be drastically reduced by increasing transparency, i.e. making the DebtRank of individual banks visible to others, and by imposing a rule, that reduces interbank borrowing from systemically risky nodes. This scheme does not reduce the efficiency of the financial network, but fosters a more homogeneous risk-distribution within the system in a self-organized critical way. The reduction of systemic risk is due to a massive reduction of cascading failures in the transparent system. A regulation-policy implementation of the proposed scheme is discussed.

Topical Talk SOE 2.2 Mon 10:30 GÖR 226

Statistical Mechanics of a Firm Growth Process — •Cornelia Metzig — Université Joseph Fourier, Grenoble, France

A stochastic process for firm growth is analyzed, which arises from competition for a scarce quantity. In its nonequilibrium stationary state, the model exhibits a tent-shaped growth rate distribution, a heavy tailed size distribution, and a growth rate variance which scales as a power of firm size. These results reproduce qualitatively three stylized facts found in firm databases. Market allocations of the quantity – like workforce or purchasing power of customers – happens such that every market realization has the same probability. Firms demand a quantity proportional to their actual size n, and the number of actually received resources is binomially distributed, with n dependent variance. Fluctuations of this process are described by the linear Langevin equation for the size n. A well-known case is a system with additive fluctuations, as in equilibrium systems, leading to a Gaussian stationary distribution, and multiplicative fluctuations, where the stationary distribution exhibits a power law tail. In the latter, superstatistics can be used, which can be seen as a way of mapping multiplicative noise onto n-dependent additive noise. In contrast, in this model, fluctuations are neither simply additive nor multiplicative, since the fluctuations scale as a power $\neq 1$ of n. Despite this difference, the concept of superstatistics can be applied to explain the aggregate growth rate distribution. Here, it consists of expressing the fluctuations as n-dependent multiplicative noise, and then integrate over all sizes. Theoretical an numerical results for firms' size and firms' growth rate distribution are given.

SOE 2.3 Mon 11:00 GÖR 226

A dynamical model of knowledge generation in scientific space — •Moritz Joseph[1] and Jens Christian Claussen[2,1] — [1]INB, Universität zu Lübeck, Germany — [2]Computational Systems Biology Lab, Research II, Jacobs University Bremen, Germany

How does the topological space of science emerge? Inspired by the concept of mapping scientific topics to a scientific space [1], we question which topological structure a dynamical process of authors collaborating and publishing papers can generate. We propose a dynamical process where papers as well as new groups receive topical positions embedded in a, e.g., two-dimensional euclidean space. The precise position of new papers depends on previous topics of the respective authors and is chosen randomly in a surrounding neighborhood including novelty and interdisciplinarity. Depending on parameters, the spatial structure resembles a simple Gaussian distribution, or spatial clusters of side-topics are observed. We quantify the time-evolution of the spatial structure and discuss the influence of inhomogenities.

[1] K.W. Boyack, R. Klavans and K. Börner, Mapping the backbone of Science, Scientometrics 64, 351 (2005)

SOE 2.4 Mon 11:15 GÖR 226

The rise and the fall of musical genres and the evolution of music publishing networks — •Gamaliel Percino[1], Peter Klimek[1], and Stefan Thurner[1,2,3] — [1]Section for Science of Complex Systems, Medical University of Vienna, Spitalgasse 23, A-1090, Austria — [2]Santa Fe Institute, 1399 Hyde Park Road, Santa Fe, NM 87501, USA — [3]International Institute for Applied Systems Analysis, Schlossplatz 1, A-2361 Laxenburg, Austria

A music style is defined by a community of musicians with different skills to play different musical instruments. We present an analysis of a collection of bipartite networks attaching music styles to musical instruments, artists to musical instruments, and artists to music styles. We study the evolution of these networks from 1969 to 2010. We investigate the dynamics of bipartite network measures for music styles such as their instrumental diversity and ubiquity, i.e. how many other styles use similar musical instruments. Based on these measures one can obtain a similarity network for music styles which undergoes complex dynamical transitions. We compare the average change of diversity and ubiquity with the commercial success of the style as measured by Amazon sales rank per number of records by style. We find that in the last seven years music styles with decreasing diversity had more commercial success. These results suggest that popular music becomes more simplistic as it gains mainstream success.

SOE 2.5 Mon 11:30 GÖR 226

Trade-off between virality and mass media influence in the evolution of online social networks — •Kaj Kolja Kleineberg and Marián Boguñá — Departament de Física Fonamental, Universitat de Barcelona, Martí i Franquès 1, 08028 Barcelona, Spain

We investigate the topological evolution of online social networks. To this end, we analyze empirical data from a large online social network. We observe a dynamical phase transition between a disconnected and a connected phase. We present a two-layer multiplex model which incorporates viral and mass media dynamics and is based on the real underlying social structure. We identify viral spreading and mass media influence as the underlying mechanisms for the evolution of online social networks. We show that the trade-off between these complementary principles governs the topological growth of the network. The comparison of the model results with empirical data allows us to provide new quantitative insights about the relationship between the

importance of virality and mass media for the evolution process of the analyzed online social network. The investigation of the evolution of local topology leads to the conclusion that the formation of the online social network favors weak ties. We discuss this finding within the framework of Granovetters theory.

SOE 2.6 Mon 11:45 GÖR 226

Structure and Dynamics of the Bitcoin Transaction Graph — •Kay Hamacher — Depts. of Physics, Computer Science, and Biology, TU Darmstadt

Bitcoin is a decentralized, digital currency that is built upon a peer-to-peer (P2P) network. Monetary transactions are secured by a proof-of-work concept originating in cryptography. Due to this basis, all transaction need to be known to all participants. Therefore, the bitcoin transaction data set is a rich, complete, and consistent data set of a particularly interesting social network, namely one of economic transactions. In this contribution, I want to discuss recent results obtained in a comprehensive study on the structure and the time evolution of the transaction graph.

SOE 3: Financial Markets and Risk Management

Time: Monday 12:00–13:15 Location: GÖR 226

SOE 3.1 Mon 12:00 GÖR 226

Endogenous bubbles in an equilibrium model of rational and noise traders without strategy switching — •Matthias Leiss[1], Taisei Kaizoji[2], Alexander Saichev[1], and Didier Sornette[1] — [1]ETH Zurich, Switzerland — [2]International Christian University, Tokyo, Japan

We introduce a model of financial bubbles with two assets (risky and risk-free), in which rational investors and noise traders co-exist. Rational investors form expectations on the return and risk of a risky asset and maximize their expected utility with respect to their allocation on the risky asset versus the risk-free asset. Noise traders are subjected to social imitation and follow momentum trading. By contrast to previous models in the field, we do not allow agents to switch between trading strategies. Allowing for random time-varying herding propensity, we are able to reproduce several stylized facts of financial markets such as a fat-tail distribution of returns, volatility clustering and transient faster-than-exponential bubble growth with approx- imate log-periodic behavior. The model accounts well for the behavior of traders and for the price dynamics that developed during the dotcom bubble in 1995-2000. Momentum strategies are shown to be transiently profitable, supporting these strategies as enhancing herding behavior.

SOE 3.2 Mon 12:15 GÖR 226

Universal behavior of the interoccurrence times between losses in finanical markets: Independence of the time resolution — •Josef Ludescher and Armin Bunde — Institut für Theoretische Physik, Universität Gießen, Germany

We consider representative financial records (stocks and indices) on time scales between 1 minute and 1 day and show that the distribution $P_Q(r)$ of the interoccurrence times r between losses below a negative threshold $-Q$, for fixed mean interoccurrence times R_Q in units of the corresponding time resolutions, can be described on all time scales by the same q-exponentials, $P_Q(r) \propto 1/((1+(q-1)\beta\, r)^{1/(q-1)})$. The parameters q and β depend only on R_Q, but not on the specific asset or time resolution. While the q-value increases logarithmically with R_Q, $q = 1 + q_0 \ln(R_Q/2)$, β depends only slightly on R_Q reaching a plateau for $R_Q > 6$. We propose that the analytic form of $P_Q(r)$ can be regarded as an additional 'stylized fact' of the financial markets and represents a nontrivial test for market models. We analyze the distribution $P_Q(r)$ as well as the autocorrelation of the interoccurrence times for five market models: MRC, MRW, ARCH, GARCH, FARIMA. Only the multiplicative random walk (MRW) model reproduces the q-Exponential form of $P_Q(r)$.

SOE 3.3 Mon 12:30 GÖR 226

Free markets and the emergence of leverage thresholds — Joao P. da Cruz[1,2], Frank Raischel[3], and •Pedro G. Lind[4] — [1]Closer Consultoria Lda, Avenida Engenheiro Duarte Pacheco,Torre 2, 14-C, 1070-102 Lisboa, Portugal — [2]Departamento de Física, Faculdade de Ciências da Universidade de Lisboa, 1649-003 Lisboa, Portugal — [3]Instituto Dom Luiz, CGUL, 1749-016 University of Lisbon, Lisbon, Portugal — [4]ForWind and Institute of Physics, Carl-von-Ossietzky University of Oldenburg, DE-26111 Oldenburg, Germany

The emergence of critical behavior in economic systems has been reported in the literature as belonging to the same class of phenomena observed in models of self-organized criticality (SOC). Self-organized criticality lays on local state transitions which are triggered when local properties exceed a specific threshold value. While in many natural systems this threshold is not known, we show that for financial networks composed by financial agents and their trade connections it is possible to directly derive the threshold below which one agent enters insolvency. Focusing in empirical data sets of assets and liabilities from almost hundred thousand companies, we further show that the threshold to insolvency is related to the way asset and liability values are related with each other.

SOE 3.4 Mon 12:45 GÖR 226

Asset Allocation as function of business policy, stressed market environment, risk and structure of liability in Austrian severance pay funds during 2003-2013 — •Uli Spreitzer[1] and Alexander Rabanser[2] — [1]Uli Spreitzer, Bonus Pensionskassen AG, Vienna, Austria — [2]Concisa Vorsorgeberatung und Management AG, Vienna

We analysed the asset allocation structure of austrian severance pay funds with respect to business policy, stressed market environment, risk management/measure and structure of liabilities. Despite the low guaranty (sum of contributions) and the not so short duration of liabilities, we recognised changes in the asset allocation, which we will discuss as driven by influences beside standard asset allocation/risk optimizations processes.

SOE 3.5 Mon 13:00 GÖR 226

Can *Google Trends* search queries contribute to risk diversification? — •Ladislav Kristoufek — Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic

Portfolio diversification and active risk management are essential parts of financial analysis which became even more crucial (and questioned) during and after the years of the Global Financial Crisis. We propose a novel approach to portfolio diversification using the information of searched items on *Google Trends*. The diversification is based on an idea that popularity of a stock measured by search queries is correlated with the stock riskiness. We penalize the popular stocks by assigning them lower portfolio weights and we bring forward the less popular, or peripheral, stocks to decrease the total riskiness of the portfolio. Our results indicate that such strategy dominates both the benchmark index and the uniformly weighted portfolio both in-sample and out-of-sample.

SOE 4: Social Systems, Opinion and Group Dynamics I

Time: Monday 15:00–16:15 Location: HSZ 03

SOE 4.1 Mon 15:00 HSZ 03

What Physics Can Contribute to the Science of Social Systems — •Dirk Helbing — ETH Zurich

Social systems may be viewed as complex multi-component systems. But given the cognitive features and the diversity of social agents, is it possible to develop explanatory theories of social phenomena, and if so, how? What are the potentials and limitations of a quantitative approach? And how to put social theories to the test, or apply them? What can physics contribute to the progress of this field? These questions will be addressed with examples from opinion formation, pedestrian, crowd, and traffic dynamics, as well as the emergence of social coordination, cooperation and norms. It will be shown that models of social phenomena can be used to create socio-inspired technologies, and to mitigate problems such as traffic jams, failures of financial systems, and conflicts. It will also be argued that many fields of physics, from mechanics, over kinetic gas theory and fluid dynamics, up to spin systems and renormalization theory could make fundamental contributions to revealing some of the most exciting (social) scientific puzzles of the 21st century.

SOE 4.2 Mon 15:30 HSZ 03

Origin of traveling waves in an emperor penguin huddle — •Richard Gerum[1], Ben Fabry[1], Claus Metzner[1], Michael Beaulieu[2], André Ancel[3,4], and Daniel P Zitterbart[1,5] — [1]Department of Physics, University of Erlangen-Nuremberg, Germany — [2]Faculty of Biology, University of Freiburg, Germany — [3]IPHC, 67087 Strasbourg, France — [4]CNRS, UMR 7178, 67037 Strasbourg, France — [5]AWI, Bremerhaven, Germany

Emperor penguins breed during the Antarctic winter and have to endure temperatures as low as -50°C and wind speeds of up to 200km/h. To conserve energy, they form densely packed huddles with a triangular lattice structure. Video recordings from previous studies revealed coordinated movements in regular wave-like patterns within these huddles. It is thought that these waves are triggered by individual penguins that locally disturb the huddle structure, and that the traveling wave serves to remove lattice defects and restore order. The mechanisms that govern wave propagation are currently unknown, however. Moreover, it is unknown if the waves are always triggered by the same penguin in a huddle. Here, we present a model in which the observed wave patterns emerge from simple rules involving only the interactions between directly neighboring individuals, similar to interaction rules found in other jammed systems, e.g. between cars in a traffic jam. Our model predicts that a traveling wave can be triggered by a forward step of any individual penguin located within a densely packed huddle. This prediction is confirmed by optical flow velocimetry of video recordings of emperor penguins in their natural habitat.

SOE 4.3 Mon 15:45 HSZ 03

On the time evolution of the Hirsch index: inertia versus predictabiliy — •Michael Schreiber — Institut für Physik, Technische Universität Chemnitz, 09107 Chemnitz, Germany

The h-index can be used as a predictor of itself. However, the evolution of the h-index with time is shown in the present investigation to be dominated for several years by citations to previous publications rather than by new scientific achievements. This inert behaviour of the h-index raises questions, whether the h-index can be used profitably in academic appointment processes or for the allocation of research resources.

- 15 min. break -

SOE 5: Award Session - Young Scientist Award for Socio- and Econophysics (YSA)

Time: Monday 16:15–18:15 Location: HSZ 03

Invited Talk SOE 5.1 Mon 16:15 HSZ 03

The Mesh of Civilizations in the Global Network of Digital Communications — Bogdan State[1], Ingmar Weber[2], Yelena Mejova[3], and •Michael Macy[4] — [1]Stanford University — [2]Qatar Computing Research Institute — [3]Yahoo! Research Barcelona — [4]Cornell University

In The Clash of Civilizations, Samuel Huntington challenged the prevailing consensus that the axes of international geopolitical alignments reflect economic and ideological divisions. Based on a top-down analysis of the alignments of nation states, Huntington famously concluded, "The great divisions among humankind and the dominating source of conflict will be cultural." On the 20th anniversary of the publication of Huntington's thesis, we revisit his analysis, taking instead a bottom-up view using hundreds of millions of anonymized email and Twitter communications among tens of millions of worldwide users to map the global alignment of interpersonal relations. We also extend previous research on spatial and geographic patterns by examining economic, demographic, historical, political, and cultural correlates of international communication densities. Results confirm the existence of the eight culturally differentiated "civilizations" posited by Huntington, with the divisions corresponding to differences in language, religion, economic development, and spatial distance.

Presentation of the YSA to Roger Guimera

Prize Talk SOE 5.2 Mon 17:15 HSZ 03

Complex (social) networks: from description to prediction — •Roger Guimera — ICREA & Universitat Rovira i Virgili, Tarragona, Catalonia

In complex systems, individual components interact with each other giving rise to complex networks, which are neither totally regular nor totally random. Because of the interplay between network topology and dynamics, it is crucial to characterize the structure of complex networks. Although during the last decade significant progress has been made in the study of complex networks, we are still far from the ultimate goals of understanding the precise mechanisms responsible for the observed topology, and evaluating the impact of the structure of the network on the dynamics of the system. The two main impairments to achieve these goals are: (i) most network data are very unreliable, that is, for most systems there is uncertainty as to what is the real structure of the network; and (ii) we lack the tools to extract the relevant information contained in the structure of networks, and to evaluate the impact of network structure on a system's dynamics. In my talk, I will discuss how we can use very general properties of complex networks to address these two very prominent problems, and even to go one step further and uncover previously unknown interactions. This opens the door to radically new applications of network theory, including, for example, the prediction of human decisions and preferences, and of novel drug interactions.

After the awardees talk, there will be a social gathering with beer and pretzels (on third floor of the HSZ, close to HSZ03 and the posters)

SOE 6: Poster Session

Please note: Posters can and should be on display all day. The poster boards for this session will be on 3rd floor of the HSZ in close location to HSZ03 (where sessions SOE 4 and SOE 5 are held).

Time: Monday 18:00–20:00 Location: P2

SOE 6.1 Mon 18:00 P2

Context sensitive and time resolved relevance of Wikipedia articles — •Eric Tessenow[1], Mirko Kämpf[2], and Jan W. Kantelhardt[2] — [1]Institute for Communications Studies, University of Leeds, UK — [2]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg

Since the numbers of hypertext pages and hyperlinks in the WWW have been continuously growing for more than 20 years, the problem of finding relevant content has become increasingly important. We have developed and evaluated techniques for a time-dependent characterization of the global and local relevance of WWW pages based on document length, number of links, and cross-correlations in user-access time series. We focus on content and user activity in selected groups of Wikipedia articles as a first application mainly because of data availability. Our goal is the assignment of a ranking value to a hypertext page (node), which covers static properties of the given node and its neighborhood (context) as well as dynamic properties derived from their page-view rates. We show in several examples how this goal can be achieved.

SOE 6.2 Mon 18:00 P2

Energetics of Money — •Stephen I. Ternyik — POB.201, D82043Munich

The legally requested quantity in the reserve requirement (on demand deposits)of big private banks is the single most effective wave signal of (stock) market price behavior; the whole economic business direction of the private and public banking machinery is moved by the expansion/contraction of liquidity creation/destruction, because banks are not operating in an economic vacuum, but for private and public clients to earn money. The economic wavelength (l)is quantitatively proportional to the liquidity frequency (f); the greater the monetary volume (x)in a wave, the higher its economic frequency. As in this economic system, money (m) is temporal(t) access to energy (e), the cybernetic circuit reads: money/quantizes/energy=energy/quantizes/time=time/quantizes/production (p), i.e. the increasing energy conversion (of nature into needs) quantizes physically the temporal acceleration of economic wave frequency and length. Thus the monetary research goal of sustainable global economics science is to keep x˜e as constant as possible, so f and l will behave accordingly (reciprocal transduction). Consequently, only a dynamic kind of an efficient narrow banking system can resolve the decisive economic problem between infinite mathematical alchemy and finite biophysical resources.

SOE 6.3 Mon 18:00 P2

Comparison of risk optimized portfolios to the underlying market — •Alexander Eckrot, Jan Jurczyk, and Ingo Morgenstern — Universität Regensburg, Regensburg, DE

Optimized portfolios of stocks regarding the mean return and risk were created by means of simulated annealing. The portfolios consist of a few assets out of 111 stocks of the german market. We compare the performance of these portfolios for different optimization parameters. Furthermore the risk of the german stock index DAX will be compared to the risk of the portfolios for different market phases (stable market and crisis). For this comparison, we use two different measurements of risk: the standard deviation and the value at risk.

SOE 6.4 Mon 18:00 P2

Bringing advanced analytics to the business world — •Niklas Teichmann and Holger Hürtgen — McKinsey + Comp. Inc. Düsseldorf

For McKinsey, as a leading strategy consulting company, new challenges arise in an increasingly data-driven world. Topics like 'Big Data" and 'Cloud Computing" are on everyone's lips. McKinsey takes more and more advantage of advanced analytic approaches in recent projects. For a few case examples we present how analytical methods and tools can be applied in the business world, generate new insights and lead to lasting impacts for our clients.

SOE 6.5 Mon 18:00 P2

Time-dependent Optimization of the Markowitz Model with Simulated Annealing — •Jan Jurczyk[1], Johannes Schneider[2], and Ingo Morgenstern[1] — [1]Universität Regensburg — [2]Universität Mainz

We investigate portfolio properties connected to the Markowitz Model. The introduction of observables other than average return and risk allows us to see a more detailed picture of the modern portfolio theory introduced by Markowitz. This gives us a better understanding of the efficient frontier behavior. We utilize a successful optimization algorithm based on Simulated Annealing and use a similar approach as with spin glass optimization methodology. The time-dependent resolution of the critical points within the optimization process leads to one explanation how financial bubbles can occur in the Mean-Variance Model

SOE 6.6 Mon 18:00 P2

Optimizing the combination of technical indicators for generating optimized stock portfolios — •Thorsten Rehberg and Ingo Morgenstern — Universität Regensburg

We are using Threshold-Accepting for optimizing portfolios with many different indicators from the technical analysis. Therefore we create a cost-function containing 120 technical analysis indicators with different weights. To find the optimal values of these weights, we use a self-learning algorithm, which adjusts these values in such a manner that the resulting portfolios have a huge average return and also a limited risk. Applying these technique to create portfolios with stocks from the DAX, MDAX and S&P500 results in a significant better average performance.

SOE 6.7 Mon 18:00 P2

Modeling long-range dependent inverse cubic distributions by nonlinear stochastic differential equations — •Bronislovas Kaulakys, Miglius Alaburda, and Julius Ruseckas — Institute of Theoretical Physics and Astronomy, Vilnius University, A. Gostauto 12, LT-01108 Vilnius, Lithuania

One of stylized facts emerging from statistical analysis of financial markets is the inverse cubic law for the cumulative distribution of number of events of trades, volatility and of the logarithmic price change. Here we model the long-range dependent inverse cubic cumulative distributions by square multiplicative stochastic differential equations [1] and taking into account a transition from Stratonovich to Ito convention in noisy systems [2] according to Wong-Zakai theorem [3], with decrease of the driving noise correlation time when the market proceeds from turbulent to calm behavior.

[1] B. Kaulakys and M. Alaburda, J. Stat. Mech. P02051 (2009); J. Ruseckas and B. Kaulakys, Phys. Rev. E **81**, 031105 (2010).
[2] G. Pesce et al, Nature Commun. **4**, 3733 (2013).
[3] E. Wong and M. Zakai, Ann. Math. Stat. **36**, 1560 (1965).

SOE 6.8 Mon 18:00 P2

Stochastic Evolution of New York Stock Market Distributions — •Paulo Rocha[1], Joao P. da Cruz[2,3], Frank Raischel[4], and Pedro G. Lind[5] — [1]Mathematical Department of Faculdade de Ciências of University of Lisbon, Campo Grande 1749-016 Lisboa — [2]Closer Consultoria Lda, Avenida Engenheiro Duarte Pacheco,Torre 2, 14-C, 1070-102 Lisboa, Portugal — [3]Departamento de Física, Faculdade de Ciências da Universidade de Lisboa, 1649-003 Lisboa, Portugal — [4]Instituto Dom Luiz, CGUL, 1749-016 University of Lisbon, Lisbon, Portugal — [5]ForWind and Institute of Physics, Carl-von-Ossietzky University of Oldenburg, DE-26111 Oldenburg, Germany

Using data from the New York stock market, extracted from the Yahoo platform (`http://finance.yahoo.com`) every 10 minutes since January 2011, we test four different bi-parametric models to fit the correspondent volume-price distributions at each 10-minute lag: the Gamma distribution, the inverse Gamma distribution, the Weibull distribution and the lognormal distribution. In each case, the value of the pair of parameters is recorded, composing a bivariate time-series, which is then analyzed as a stochastic process. Assuming that the evolution of

the two parameters is governed by a two-dimensional coupled Langevin equation, we derive the corresponding drift vector and diffusion matrix, which can then provide physical insight for understanding the mechanisms underlying the evolution of the stock market.

SOE 6.9 Mon 18:00 P2

Dynamics of popstar record sales on phonographic market - stochastic model — •Andrzej Jarynowski[1,2], Andrzej Buda[3], and Jaroslaw Kwapien[3] — [1]Department of Sociology, Stockholm University, Sweden — [2]Smoluchowski Institute of Physics, Jagiellonian University, Cracow, Poland — [3]Institute of Nuclear Physics PAN, Cracow, Poland

We investigate weekly record sales of the world's most popular 30 artists (2003-2013). Time series of sales have non-trivial kind of memory (anticorrelations, strong seasonality and constant autocorrelation decay within 120 weeks). Amount of artists record sales are usually the highest in the first week after premiere of their brand new records and then decrease to fluctuate around zero till next album release. We model such a behavior by discrete mean-reverting geometric jump diffusion (MRGJD) and Markov regime switching mechanism (MRS) between the base and the promotion regimes. We can built up the evidence through such a toy model that quantifies linear and nonlinear dynamical components (with stationary and nonstationary parameters set), and measure local divergence of the system with collective behavior phenomena. We find special kind of disagreement between model and data for Christmas time due to unusual shopping behavior. Analogies to earthquakes, product life-cycles, and energy markets will also be discussed.

SOE 6.10 Mon 18:00 P2

N-individual Hawk-Dove games in finite and infinite populations — Binghui Fan[1], Xinsheng Liu[1,3], •Jens Christian Claussen[2,3], and Wanlin Guo[1] — [1]Nanjing University, China — [2]Computational Systems Biology Lab, Research II, Jacobs University Bremen, Germany — [3]INB, Universität zu Lübeck, Germany

The Hawk-Dove game has been used to analyze conflicts for resources such as food and habitats. But, in the real world, many contests are activities in which many individuals engage. In this paper, we present an N-individual generalization of the well-known Hawk-Dove game by considering the possible existence of a threshold of the frequency of Hawks in the interacting group above which the Doves get nothing and the Hawks fight for the total resource. When the frequency of Hawks is less than the threshold, the Doves can share a portion of the resource and the hawks fight for the remaining portion. Besides, as the frequency of Hawks increases, the portion of the resource that the Doves can gain decreases sharply according to a nonlinear function. Then we discuss evolutionary dynamics of the N-individual Hawk-Dove games with variation of reasonable range of some significant parameters in both infinite and finite populations. Specially, as for infinite populations, the system will always end up either in full Hawk or in a stable equilibrium where Hawks and Doves coexist. In finite populations, which may exhibit different dynamics, we discuss fixation probabilities and fixation times by analytic and numerical methods. We find that the conditional fixation time exhibits a maximum with respect to the group size or the value-to-cost ratio.

SOE 6.11 Mon 18:00 P2

Spatial constraints and auspicious buying in a self-organized cartel formation model — •Philipp C. Böttcher, Tiago P. Peixoto, and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Hochschulring 18, D-28359 Bremen, Germany

The decision of the German cartel office to require gas stations to record and release their gas prices to the public sparked considerable interest in the media. We investigated a simple trust game to qualitatively predict the effects of this decision.

In our model, a population of agents is forced to play against each other: Buyers buy from a fixed number of sellers that are chosen dynamically, and sellers can compare their payoff and adapt accordingly. The results for simulations on a globally mixed population [1] showed the existence of a phase transition, observed at a specific value for the strategy update rate, where the spontaneous formation of an effective cartel occurs. This suggested that a cartel can be formed without collusion and may simply be the result of individual payoff maximization. However, the model lacked important ingredients, such as the fact that both buyers and sellers are often constrained to specific geographical locations. To model this effect, we investigated the dynamics of the model on a 2D-lattice and introduced a distance of interaction. Finally, to model the effect of the global knowledge introduced by a general price list, we added a fraction of buyers who were fully aware of their neighborhood and were therefore able choose the best seller to buy from, instead of comparing with randomly chosen neighbors.

[1] T. Peixoto and S. Bornholdt, Phys. Rev. Lett. 108, 218702 (2012)

SOE 6.12 Mon 18:00 P2

Edge-to-edge relations from failure-induced flowredistribution to identify relations between structure and dynamics in complex networks — Michael T. Schaub[1], •Jörg Lehmann[2], Sophia N. Yaliraki[1], and Mauricio Barahona[1] — [1]Imperial College London, U.K. — [2]ABB Switzerland Ltd, Corporate Research, Baden-Dättwil, Switzerland

The structural analysis of complex networks commonly focuses on nodes and corresponding node communities. However, in many dynamical processes on complex networks, e.g., those related to the flow of energy or information, edges play a more prominent role than nodes. In these situations, an analysis based on edge-to-edge relations is more appropriate. Here, we put forward a corresponding approach, which is based on the flow redistribution induced by edge failures [1]. Our method takes into account not only the local coupling between edges but also potential long-range interactions between them. Furthermore, it leads naturally to the concept of an edge embeddedness, which reflects the importance of an edge in weighted cuts of the network. We exemplify the significance of our approach with analyses of the Iberian power grid, traffic flows in road networks and the C. elegans neuronal network.

[1] M. T. Schaub et al., arXiv:1303.6241

SOE 6.13 Mon 18:00 P2

Co-authorship patterns on the scale of network motifs — •David Fabian Klosik[1], Marc-Thorsten Hütt[2], and Stefan Bornholdt[1] — [1]Institut für Theoretische Physik, Universität Bremen, Hochschulring 18, 28359 Bremen, Germany — [2]School of Engineering and Science, Jacobs University Bremen, Campusring 1, 28759 Bremen, Germany

Ever since the seminal philosophical work of Thomas S. Kuhn it is widely accepted that the institutional process of knowledge production, i.e. science, cannot be fully described in purely logical, content-related terms, but has a significant social aspect to it. The recently growing accessibility to aggregated citation information in form of electronic datasets might allow for a quantitative assessment of the social influences. Following the work of Krumov et al. [1] we evaluate network motifs in a co-authorship network constructed from a dataset provided by the American Physical Society, in order to investigate whether there is a correlation between collaboration patterns on the motif scale and the impact of the corresponding papers. We find that care has to be taken when applying motif-based measures to co-authorship networks.

[1] L. Krumov, C. Fretter, M. Müller-Hannemann, K. Weihe, and M.-T. Hütt, Motifs in co-authorship networks and their relation to the impact of scientific publications, EPJ B (84), 535 (2011)

SOE 6.14 Mon 18:00 P2

Boolean networks with veto functions — •Haleh Ebadi[1] and Konstantin Klemm[2] — [1]Bioinformatics, Institute for Computer Science, Leipzig University, Haertelstrasse 16-18, 04107 Leipzig, Germany — [2]Department of Theoretical Chemistry, University of Vienna, Waehringerstrasse 17, 1090 Wien, Austria

Boolean networks are discrete dynamical systems for modeling regulation and signaling in living cells. We investigate a particular class of Boolean functions with inhibiting inputs exerting a veto (forced zero) on the output. We give analytical expressions for the sensitivity of these functions and provide evidence for their role in natural systems. In an intracellular signal transduction network [Helikar et al., PNAS (2008)], the functions with veto are over-represented by a factor exceeding the over-representation of threshold functions and canalyzing functions in the same system. In Boolean networks for control of the yeast cell cycle [Fangting Li et al., PNAS (2004), Davidich et al., PLoS One (2009)], none or minimal changes to the wiring diagrams are necessary to formulate their dynamics in terms of the veto functions introduced here.

SOE 6.15 Mon 18:00 P2

Controlling the collective behavior in the agent-based herding model — •Aleksejus Kononovicius and Vygintas Gontis — Institute of Theoretical Physics and Astronomy, Vilnius University,

Vilnius, Lithuania

The characteristic feature of the complex socio-economic systems is a tight coupling of the constituent parts. We can see them as generalized agents, which are tightly coupled with other agents via the herding interactions. Previous empirical research, from a point of view of the behavioral biology and sociology (see recent papers by Jens Krauze), has shown that one can use the tight coupling to control the collective behavior of large groups of individuals. In this contribution we approach the same problem from an agent-based modelling point of view. Namely, we study the dynamics of the agent-based herding model in which certain agents are controlled externally.

SOE 6.16 Mon 18:00 P2

Agent Based Model to describe Socio-Technical Regime Changes — •Florian Senger — Fraunhofer Institut für System- und Innovationsforschung, Breslauer Str. 48, 76139 Karlsruhe

In the work presented here we combined methods from physics of social systems with methods from evolutionary economics to develop an agent-based model that is supposed to mimic the dynamics of regime changes in socio-technical systems.

We therefore modeled the demand side as consumer agents according to a distribution of endowments and needs, connected to each other in a social network, influencing each other in a voter-model-like manner and choosing the technology and company they think suite their needs best. For the supply side we modeled explicit company agents consisting of genes in an evolutionary sense, producing a technology in a quality depending on their particular fitness, taking influence on particular areas of the consumer network via marketing and changing the alleles of their genes by a process of imitating and stochastic innovating, getting feedback on their fitness by the degree of success with the consumers.

We show here the results so far with different realisations of the model, especially different network topologies and give an outlook on how the model will be applied to real case studies.

SOE 6.17 Mon 18:00 P2

Measuring the predictability in social media — •José M. Miotto and Eduardo G. Altmann — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

We derive a formula to quantify the predictablity of binary events in different systems. We apply it to the problem of predicting whether the attention devoted to social-media items will pass a given threshold (e.g., whether a scientific paper will become more than 1,000 views within 2 months). Results obtained using different prediction factors in four different databases show that increasing the threshold increases the predictability, a surprising results which is interepreted using simple statistical and stochastic models.

SOE 6.18 Mon 18:00 P2

Multi-level multi-channel modeling of human relationship — •János Török[1], Kimmo Kaski[2], and János Kertész[1,3] — [1]Department of Theoretical Physics, Budapest University of Technology and Economics, H-1111 Budapest, Hungary — [2]Department of Biomedical Engineering and Computational Science, FI-00076 Aalto, Finland — [3]Center for Network Science, Central European University, H-1051 Budapest, Hungary

We present a model of society. Human relations are strengthened by communication and eroded by time. Communication is, in general, related to some social activity (work, friendship, hobby) or social context. Therefore we postulate that individuals having different social needs participate in a number of social contexts (family, workplace etc.) - which may also evolve in time - and communicate with other members of the contexts using different communication channels (face to face, phone, email, etc.) for different purposes and with different impact on their relationship. We show that using realistic input data from surveys and statistical data one can reproduce important features of real society like Dunbar's numbers and their meaning.

SOE 7: Networks and Social Systems (Invited Talk Luis Amaral)

Time: Tuesday 9:30–10:15 Location: GÖR 226

Invited Talk SOE 7.1 Tue 9:30 GÖR 226

Measuring the scientific impact of research using bibliometric analysis — •Luis Amaral — Northwestern University/ HHMI, Evanston USA

In spite of its importance, how or even whether to quantify scientific impact remains a source of controversy within the scientific community. For example, the *San Francisco Declaration on Research Assessment* has called for "the need to eliminate the use of journal-based metrics, such as Journal Impact Factors, in funding, appointment, and promotion considerations." It is ironic that, in spite of the fact that measurement is a core component of science itself, many scientists are recommending a move away from measurement and quantification. However, the scientific method is about improving imperfect theories and measurement techniques, rather than discarding them. In my view, the scientific community, must strongly support the development of better bibliometric evaluation tools instead of opposing their use. In this talk, I will review the state-of-the-art on using bibliometric analysis to measure scientific impact of individuals, departments and journals.

SOE 8: Focus Session: Complex Systems Approaches to Language and Communication

In this session language and communication are investigated using ideas from statistical physics, time series analysis, and complex systems. New opportunities for quantitative studies in this field come both from the availability of large databases of human communication and from the richness of theoretical models developed in Physics. (Focus Session organized by Eduardo Altmann, Dresden)

Time: Tuesday 10:15–13:00 Location: GÖR 226

SOE 8.1 Tue 10:15 GÖR 226

A Comparative Study of Language Complexity in Wikipedia — •János Kertész[1,2], Taha Yasseri[2,3], and András Kornai[2,4] — [1]Central European University — [2]Budapest University of Technology and Economics — [3]University of Oxford — [4]Computer and Automation Research Institute of the Hungarian Academy of Sciences.

We present statistical analysis of English texts from Wikipedia [1]. We try to address the issue of language complexity empirically by comparing the Simple English Wikipedia (Simple) to comparable samples of the main English Wikipedia (Main). Simple is supposed to use a more simplified language with a limited vocabulary, and editors are explicitly requested to follow this guideline, yet in practice the vocabulary richness of both samples are at the same level. Detailed analysis of longer units (n-grams of words and part of speech tags) shows that the language of Simple is less complex than that of Main primarily due to the use of shorter sentences, as opposed to drastically simplified syntax or vocabulary. Comparing the two language varieties by the Gunning readability index supports this conclusion. We also report on the topical dependence of language complexity, that is, that the language is more advanced in conceptual articles compared to person-based (biographical) and object-based articles. Finally, we investigate the relation between conflict and language complexity by analyzing the content of the talk pages associated to controversial and peacefully developing articles, concluding that controversy has the effect of reducing language complexity.

[1] Yasseri T, Kornai A, Kertész J (2012) PLoS ONE 7(11): e48386.

SOE 8.2 Tue 10:45 GÖR 226

Statistical Mechanics of Human Language — •Kosmas Kosmidis — Computational Systems Biology Group, Jacobs University,Bremen — Computational Physics Group, Aristotle University of Thessaloniki,Thessaloniki,Greece

We use the formulation of equilibrium statistical mechanics in order to study some important characteristics of language. Using a simple expression for the Hamiltonian of a language system, which is directly implied by the Zipf law, we are able to explain several characteristic features of human language that seem completely unrelated, such as the universality of the Zipf exponent, the vocabulary size of children, the reduced communication abilities of people suffering from schizophrenia, etc. While several explanations are necessarily only qualitative at this stage, we have, nevertheless, been able to derive a formula for the vocabulary size of children as a function of age, which agrees rather well with experimental data.

SOE 8.3 Tue 11:00 GÖR 226

Topic models and scaling laws — •Martin Gerlach and Eduardo G. Altmann — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

In this talk we combine statistical analysis of large text databases and simple stochastic models to explain the appearance of scaling laws in the statistics of word frequencies. We focus on the well studied case of the vocabulary growth with database size (Heaps' law) and on a novel scaling law we observe using fluctuation scaling analysis. In order to simultaneously explain both scaling laws we show that it is essential to account for the heterogeneity in the vocabulary of texts by considering topic models (e.g. Latent Dirichlet Allocation). Our models are tested against three different databases: Google n-gram database, Wikipedia, and all articles published by PLoS.

SOE 8.4 Tue 11:15 GÖR 226

Reading Stockholm Riots 2013 in social media by text-mining — •Andrzej Jarynowski[1,2] and Amir Rostami[1] — [1]Department of Sociology, Stockholm University, Sweden — [2]Smoluchowski Institute of Physics, Jagiellonian University, Cracow, Poland

The riots in Stockholm in May 2013 were an event that reverberated in the world media for its dimension of violence that had spread through the Swedish capital. In this study we have investigated the role of social media in creating media phenomena via text mining and natural language processing. We have focused on two channels of communication for our analysis: Twitter and Poloniainfo.se (Forum of Polish community in Sweden). Our preliminary results show some hot topics driving discussion related mostly to Swedish Police and Swedish Politics by counting word usage. Typical features for media intervention are presented. We have built networks of most popular phrases, clustered by categories (geography, media institution, etc.). Sentiment analysis shows negative connotation with Police. The aim of this preliminary exploratory quantitative study was to generate questions and hypotheses, which we could carefully follow by deeper more qualitative methods.

15 min. break

SOE 8.5 Tue 11:45 GÖR 226

Agent-based models of consensus in language dynamics — •Martina Pugliese[1], Christine Cuskley[2], Claudio Castellano[2], Francesca Colaiori[2], Vittorio Loreto[1,3], and Francesca Tria[3] — [1]Physics Department, Sapienza University, Rome, Italy — [2]Institute for Complex Systems (ISC-CNR), Rome, Italy — [3]Institute for Scientific Interchange (ISI), Turin, Italy

The emergence of consensus in language dynamics can be studied in the framework known as the Naming Game (NG), where agents engage in pairwise interactions about naming an object and achieve a stable vocabulary, with a convergence-time depending on the network used and on the population replacement rate.

We have implemented a NG-like model investigating morphology where the focus is given on a fixed set of topic words chosen with an *a priori* frequency distribution. We examine processes of regularisation from two different perspectives: memory and development. Memory limitations are dictated by an expanding time window within which a word must be encountered to be recalled by an agent, otherwise the agent "forgets" the inflection for that word and falls back on the regular rule. The second strategy examines population turnover as a probabilistic replacement: if chosen as a speaker, a new agent defaults to the regular form.

Both strategies result in a frequency-based transition of regularity: high frequency words stabilise indefinitely in the irregular state, while those at low frequency regularise. With a mean-field approach we show that the transition is discontinuous.

SOE 8.6 Tue 12:15 GÖR 226

Spatial language dynamics in Northern Italy before standardization — •Gero Vogl[1], Michael Leitner[2], and Paul Videsott[3] — [1]Fakultät für Physik, Universität Wien, Austria — [2]Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München, Germany — [3]Freie Universität Bozen, Italy

In the year 1200 every city in Northern Italy wrote its derivative from Latin in its own way. We have followed the change from the local to standard language over time (1200 to 1525) and space. Documents from 36 cities with more than 500.000 words have been scanned for 300 specific traits. We constructed similarity matrices and found: (a) there is certain continuity in one and the same city, i.e. similarity of written language over the time is greater than similarity to neighbour cities and even more so than similarity with the average North Italian city. (b) in the period around 1500, in cities along the Via Emilia the trend to standard Italian is strong, whereas in the North of the region towards the Alps local traits persist.

SOE 8.7 Tue 12:30 GÖR 226

Endogenous and exogenous effects on the adoption curves of linguistic innovations — •Fakhteh Ghanbarnejad, Martin Gerlach, Jose M. Miotto, and Eduardo G. Altmann — Max Planck Institute for the Physics of Complex Systems, Dresden,Germany

It is well accepted that adoption of innovations are described by S-curves (slow start, accelerating period, and slow end). In this talk we search for a quantitative description of the curve of total number of adopters as a function of time and we analyze how much information on the dynamics of innovation spreading can be obtained from them. We are particularly interested in the case of linguistic innovations because detailed databases of written texts from the last 200 years allow for an unprecedent statistical precision. Combining data analysis with simulations of simple models (e.g., the Bass dynamics on networks) we identify signatures of endogenous and exogenous factors in the adoption curves and we propose a method to quantify the strength of these factors from data. We obtain that in cases in which the exogenous factors are dominant (e.g., in the 1901 and 1996 orthographic reforms of German) the adoption curve is better described by an exponential than by an S-curve.

SOE 8.8 Tue 12:45 GÖR 226

A Coarse Grained Approach for Distinguishing Whale "Dialects" — •Sarah Hallerberg[1], Heike Vester[2], Kurt Hammerschmidt[3], and Marc Timme[1,4,5] — [1]Network Dynamics, Max Planck Institute for Dynamics and Self-Organization (MPIDS) — [2]Ocean Sounds, Henningsvaer, Norway — [3]Research Group Cognitive Ethology Lab, German Primate Center, Göttingen — [4]2Faculty of Physics, University of Göttingen, Göttingen, Germany — [5]Bernstein Center for Computational Neuroscience, Göttingen, Germany

Complex vocal communication simultaneously requires high cognitive abilities, a large flexibility in sound production, and advanced social interactions. Social whales, such as killer whales and pilot whales, fulfill all of these requirements. How their acoustic signals are used and how the acoustic patterns are organized, however, is largely unknown. Up to date, mostly human observers classify acoustic patterns through hearing and visual comparison of spectrograms. We decided to use a data analysis approach and study distributions of acoustic features (in particular, cepstral coefficients) generated from ensembles of pilot whale vocalizations. Comparing these distributions by computing Kullback-Leibler-divergences we find substantially different distributions for sounds produced by different groups of pilot whales.

SOE 9: Poster - Glasses / Stat. Phys. Bio. / Networks (joint session DY/BP/CPP/SOE)

In this poster session there are contribution from
- Focus Session: Slow Dynamics in Glasses and Granular Matter
- Focus Session: Feedback Control - Soft and Hard Matter
- Glasses
- Statistical Physics in Biological Systems
- Networks - Statistics and Dynamics

Time: Tuesday 9:30–12:30 Location: P1

SOE 9.1 Tue 9:30 P1

Investigation of the behavior of binary mixtures upon variation of the dynamic asymmetry — •Marie-Luise Braatz[1], Sebastian Schramm[1], Thomas Blochowicz[1], Bernd Stühn[1], and Bernhard Frick[2] — [1]Experimental Condensed Matter Physics, TU Darmstadt, Germany — [2]Institut Laue Langevin, Grenoble, France

We study dynamically asymmetric binary mixtures comprised of polystyrene and the small molecule methyl tetrahydrofuran (MTHF). The blends are fully miscible on supercooling but still exhibit two glass transition temperatures. Between these two temperatures MTHF relaxes in a matrix of polystyrene, showing the signature of geometrical confinement on the nanoscale in its dynamic properties. Among the interesting characteristics observed, is a transition from fragile to strong behavior of the time constants and in some cases features of a type-A glass transition are found.

We study the behavior of these characteristics upon varying the molecular weight and thereby the dynamic asymmetry of the mixture as well as the concentration of the small molecules. Dielectric spectroscopy, depolarized dynamic light scattering and quasielastic neutron scattering are combined to cover a dynamic range of 1ps to 1000s.

Our results are compared to theoretical predictions that expect fragile-strong transitions and type-A glass transitions to be most pronounced at low concentrations of the small molecules and large dynamic asymmetries.

SOE 9.2 Tue 9:30 P1

Mesoscale modeling of aeolian sand transport — •Anne Meiwald, Marc Lämmel, and Klaus Kroy — Institut für Theoretische Physik, Leipzig, Germany

Aeolian transport of sand is one of the most important geological processes on Earth and other rocky planets, creating a wide range of self-organised dynamic structures, like ripples or sand dunes. To make the complex grain physics more amenable to analytical studies, it was proposed to coarse-grain the ensemble of grain trajectories by two types representing low-energetic reptating grains and high-energetic saltating grains [1]. We recently showed that our analytically tractable and numerically efficient continuum model reliably reproduces sand flux measurements obtained in various wind tunnel experiments [2].

Here, we scrutiny the potential of our approach to predict important grain-scale properties and find remarkable agreement with various experimental data. We also speculate about the reason for the success of the coarse-grained description, even in comparison to more detailed numerical models, despite its allegedly unfaithful representation of some of the grain-scale details [3]. Finally we conclude that the two-species continuum approach provides an appropriate starting point for analytical and efficient numerical modelling of seemingly complex aeolian saltation process and the structures it creates.

[1] Bagnold, *The physics of blown sand and desert dunes.* Dover Publ. (2005).
[2] Lämmel, Rings, and Kroy, New J. Phys. 14, 093037 (2012).
[3] Kok, and Renno, J. Geophys. Res. 114, D17204 (2009).

SOE 9.3 Tue 9:30 P1

Railway buckling safety: From Theory to application — •János Török[1], László Halma[2], and István Fejér[2] — [1]Department of Theoretical Physics,Budapest University of Technology and Economics, H-1111 Budapest, Hungary — [2]Vasútépítök Kft, H-9023 Györ, Csaba utca 9

Using numerical simulation and mesoscopic theory we show that in granular materials the effective friction coefficient at walls depends heavily on the wall roughness. We show that it can be used in real application. In continuous welded rails the standard railbed in small radius curves are not able to resist the radial load arising from temperature and train movement. Today many different and expensive methods are used to tackle this problem. We show that by making the bottom of the sleepers rough we can increase the buckling safety of the track.

SOE 9.4 Tue 9:30 P1

Continuum Mechanics Simulations of Nonlinear Deformation of Viscoplastic Solids — •Heliana Cardenas[1] and Thomas Voigtmann[1,2] — [1]Institut für Materialphysik im Weltraum, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Köln, Germany — [2]Zukunftskolleg und Fachbereich Physik, Universität Konstanz, Konstanz, Germany

When amorphous solids are formed by solidification of dense liquids slow intrinsic relaxation plays a determining role on describing their behavior. Systems like this can be perturbed by external mechanical fields driving it to a non-equilibrium regime following then non-linear deformation laws. The mode-coupling theory of the glass transition (MCT) has been extended to describe the interplay between strong external forces and slow relaxation.

A non-linear extension of the Maxwell model of viscoelastic fluids is proposed. This model takes into account the relaxation time dependence on the shear rate and thereby mimics microscopic processes identified by MCT. Combining this constitutive equation with the Navier-Stokes equations we can describe the evolution of macroscopic flows. Attention will be focused on shear-thinning fluids where the fluid's viscosity decreases with an increasing rate of shear stress.

To solve non-linear integro-differential equations finite element modeling (FEM) is used through a computational fluid dynamics tool. The effect of different relaxation times for a pressure driven flow is studied by analyzing velocity profiles, among other measurable quantities.

SOE 9.5 Tue 9:30 P1

Mechanical Properties of Sheared Wet Granular Piles — •Somnath Karmakar[1], Marc Schaber[1], Anna-Lena Hippler[1], Martin Brinkmann[2], Mario Scheel[3], Marco Di Michiel[3], and Ralf Seemann[1,2] — [1]Experimental Physics, Saarland University, Saarbrücken, Germany — [2]MPI for Dynamics and Self-Organization, Göttingen, Germany — [3]European Synchrotron Radiation Facility, Grenoble, France

Adding small amount of wetting fluid to dry granulates typically leads to the granular stiffness which arises due the formation of minute liquid contacts between individual granules by the virtue of capillary forces. We experimentally study the mechanical properties of wet granulates, composed of monodisperse spherical glass or basalt beads. The glass microspheres are almost perfectly wetted by water whereas the basalt microspheres have a rather large contact angles with water. The different wettability causes a difference in the shape and volume distribution of the appeared liquid morphologies. We have investigated the shear strength, measured under cyclic shear deformation for various system parameters like liquid content, shear rate and absolute pressure. At large absolute pressures, the associated energy dissipation of a sheared wet granulate is considerably smaller than that of a completely dry bead assembly; where the wetting fluid might act as a 'liquid lubricant' by lowering the wet bead pile's shear stiffness. With time resolved X-ray microtomography, we could shed some light on the underlying microscopic mechanisms of the sheared wet granulates.

SOE 9.6 Tue 9:30 P1

Stability of Barchan Dune Fields — •Sven Auschra, Marc Lämmel, and Klaus Kroy — Institut für theoretische Physik, Leipzig, Germany

Crescent-shaped barchan dunes are among the most impressive structures observed in arid regions on Earth and Mars. Although they are isolated from nearby dunes by bedrock, models suggests that truly isolated barchans would be unstable with respect to their mass balance

[1]. This suggests that some sort of interactions between the dunes in a dune field give rise to some size stabilization resulting in the empirically observed uniform size distribution along the dune field [2, 3].

To uncover the underlying mechanism, we perform a mass stability analysis for a pair of consecutive dunes in a barchan field. Sand supplied from the horn of the windward dune to its downwind neighbor initiates a complex response of its shape and mass. Based on a dimensionally reduced description justified by a closeby shape attractor, a one-dimensional fixed-point equation for the mass balance of the downwind dune is derived and analyzed for stable solutions.

[1] Fischer, Cates and Kroy, Phys. Rev. E 77, 031302, 2008.
[2] Hersen, Andersen, Elbelrhiti, Andreotti, Claudin and Douady, Phys. Rev. E 69, 011304, 2004.
[3] Duran, Schwämmle, Lind and Herrmann, Nonlin. Processes Geophys. 69, 455-467, 2001.

SOE 9.7 Tue 9:30 P1

Ab-inito MD parameter estimation for Na diffusion in glasses — •Lars Winterfeld and Erich Runge — Institut für Physik, TU Ilmenau, 98693 Ilmenau

Molecular dynamics (MD) simulation provide a scalable method for the investigation of disordered systems like glasses. However, there is no generally accepted method for the determination of the MD model parameters. We present a new first-principle approach that allow us to self-consistently obtain such parameters by sampling an ensemble of representative configurations. We use MD to create these configurations and run ab-initio DFT calculations as basis for the subsequent fitting procedure. Results of this approach are compared for $(Na_2O)_x - SiO_2$ glass systems with those from the literature.

SOE 9.8 Tue 9:30 P1

Non-universal dielectric properties of glasses at very low temperatures — •Annina Luck, Andreas Fleischmann, and Christian Enss — Kirchhoff-Institut für Physik, INF227, D-69120 Heidelberg

The universal behaviour of amorphous solids at low temperatures, governed by two level tunneling systems, has long been a generally accepted fact. In the last years, however, measurements of dielectric two-pulse polarization echoes have revealed that nuclear electric quadrupole moments involved in atomic tunneling sytems can cause specific material-dependent effects in magnetic fields.

To study the possible influence of nuclear electric quadrupoles connected with atomic tunneling systems on the low frequency dielectric properties of glasses down to a temperature of 10 mK, we measured the multicomponent glass N-KZFS11, which contains 25 mass percent of tantalum oxide and a glass containing a similar amount of holmium oxide. As ^{181}Ta and ^{165}Ho carry very large nuclear electric quadrupole moments,these glasses seem to be ideal candidates to determine the influence of nuclear electric quadrupole moments on the physical properties of glasses at low temperatures.

Our measurements not only show a non-universal dieletric behaviour in the two glasses, but also differ significantly from various predictions of the standard tunneling model. We discuss these new findings in the framework of the tunneling model.

SOE 9.9 Tue 9:30 P1

Understanding the properties of two dimensional silica systems — •ProjeshKumar Roy[1] and Andreas Heuer[2] — [1]Graduate school of chemistry, University of Muenster — [2]Institute of physical chemistry, University of Muenster

Recently, STEM and SPM studies were performed by Lichtenstein et al, [1] in a virtually two dimensional silica bilayer; which was grown by depositing vaporised Si atoms on a [Ru(0001)] metal surface in an oxygen atmosphere. Silica bilayers were generated, which could be either amorphous or crystalline, depending on the preparation conditions. Under specific conditions even both states could be generated in the same layer, including a short-range transition between them. Remarkably, even in the amorphous case both layers were virtually identical. Due to the atomic resolution the ring statistics in the amorphous structure could be characterized in detail.

We report about computer simulations which have the aim to reproduce the properties of two-dimensional silica layers and, consequently, obtain an improved microscopic understanding of this system. In particular we want to learn, under which conditions crystalline and amorphous structures can be generated, respectively. For this purpose, an appropriate silica potential has to be developed which can be used in the two-dimensional case and is able to generate the observed structural features.

[1] Lichtenstein L; Heyde M; Freund H.J.; J. Phys. Chem. C 2012, 116, 20426.

SOE 9.10 Tue 9:30 P1

Understanding the energy landscape of a simple water model — •Katharina Ferling and Andreas Heuer — Institut für Physikalische Chemie, WWU Münster

Liquid water plays an important role not only in our everyday life but also in simulations and experiments where it serves as a solute with many applications. The understanding of the water behaviour, including its anomalies, can play an important role in improving the description of water. Here the emphasis lies on the property of building H-bonds which is believed to be one major factor for many anomalies such as the density change or the liquid-liquid phase transition at low temperatures. For the present investigation a simple model has been chosen which focuses on the distinction between a close-packed and an open structure. The one dimensional model - which was first introduced by Ben-Naim [1,2] - has now been extended with additional long range interactions in the underlying potential to get rid of the mean-field character of that model. First, simulations are performed in the NPT-ensemble with the aim to show water-like behaviour such as a high-density liquid and low-density liquid (HDL-LDL) transition. Second, from simulations in the NVT-ensemble for different volumes (lengths, resp.) a closer understanding of the possible anomalies can be reached, related to properties of the underlying potential energy landscape.

[1] Arieh Ben-Naim, J. Chem. Phys. 128, 024505 (2008)
[2] Lotta Heckmann and Barbara Drossel, J. Chem. Phys. 137, 064503 (2012)

SOE 9.11 Tue 9:30 P1

Compressed exponential decays in correlation experiments: The influence of temperature gradients and convection — •Jan Gabriel, Thomas Blochowicz, and Bernd Stühn — Institut für Festkörperphysik, Darmstadt

In a wide range of correlation experiments using laser light or partially coherent X-rays so called compressed exponential correlation functions were reported [1] i.e. decays $c(\tau) \propto \exp(-(t/\tau)^\beta)$ with $\beta > 1$. The source of this phenomenon is still a point of discussion. For example for colloidal particles in supercooled liquid [2] it is claimed that near T_g hyperdiffusive behavior appears, which leads to compressed correlation functions.

We performed multispeckle-dynamic light scattering experiments in a temperature range from 230 K to 300 K with a sCMOS camera in a system of Polystyrene spheres in supercooled propanediol. At low temperatures compressed exponential decays are observed. At the same time, however, the speckle pattern shows indication for convection in the sample due to a slight temperature gradient, across the sample cuvette mounted on a cold finger cryostat. These effects increase with decreasing temperature and after a temperature jump and can be corrected for by assuming convective flow at constant velocity. Such corrections reduce or remove compressed exponential behavior.

[1] A Madsen, R. L. Leheny, H. Guo, M Sprun and Orsolyal, New J. Phys., **12**, 055001 (2010)
[2] C. Caronna, Y. Chushkin, A. Madasen and A. Cupane, Phys. Rev. Lett., **100**, 055702 (2008)

SOE 9.12 Tue 9:30 P1

Temperature and pressure dependence of the supramolecular structure of 2-ehyl-1-hexanol and 4-methyl-3-heptanol — •Thomas Büning[1], Christian Sternemann[1], Catalin Gainaru[2], Michael Paulus[1], Kolja Mende[1], Florian Wirkert[1], Irena Kiesel[1], Johannes Möller[1], Julia Nase[1], Stefan Bauer[2], Roland Böhmer[2], and Metin Tolan[1] — [1]Fakultät Physik/DELTA, Technische Universität Dortmund, D-44221 Dortmund — [2]Fakultät Physik/E3, Technische Universität Dortmund, D-44221 Dortmund

Hydrogen bonds are essential for structure and dynamics of e.g. alcohols, aqueous solutions and water. Due to their low tendency to crystallization and large variability in molecular configuration, monohydroxy alcohols are a typical system that is studied to learn about the impact of hydrogen-bonding on molecular liquids. Because of the hydrogen bonds alcohols form supramolecular structures in the liquid phase. Here, the molecular arrangements of monohydroxy alcohols such as 2-ethyl-1-hexanol (2E1H) and 4-methyl-3-heptanol (4M3H) strongly depend on the position of the OH group within the molecule.

Based on dielectric spectroscopy molecular arrangements in chain-like (2E1H) and, ring-like (4M3H) structures have been proposed. We present an x-ray diffraction study of 2E1H and 4M3H, providing new information regarding the supramolecular structure in pressure up to 4 kbar and temperature down to -110 °C.

SOE 9.13 Tue 9:30 P1

Molecular Order and Dynamics of Nanometric Thin Layers of Poly(styrene-b-1,4-isoprene) Diblock Copolymers — •Wycliffe K. Kipnusu[1], Mahdy M. Elmahdy[1], Martin Tress[1], Emmanuel U. Mapesa[1], Detlef-M. Smilgies[2], Jianqi Zhang[3], Christine M. Papadakis[3], and Friedrich Kremer[1] — [1]Institute of Experimental physics I, Linnstr.5, 04103, Leipzig — [2]CHESS, Wilson Laboratory, Cornell University, Ithaca, NY 14853, USA — [3]Technische Universität München, Physik-Department, James-Franck-Straße 1, 85748 Garching, Germany

Order and dynamics of poly(styrene-block-1,4-isoprene), P(S-b-I) diblock copolymers in nanometer thin layers with different isoprene volume fraction (fPI) and identical molecular weight of the styrene blocks are studied by a combination of Grazing-Incidence Small-Angle X-ray Scattering (GISAXS), Atomic Force Microscopy (AFM) and Broadband Dielectric Spectroscopy (BDS). GISAXS and AFM reveal randomly oriented lamellar structures in the films and a parallel orientation at the top surface, respectively. Using BDS, three well separated relaxation processes are detected, (i) and (ii) the dynamic glass transitions (segmental mode) in the styrene and isoprene blocks respectively and (iii) the normal mode relaxation representing fluctuations of the isoprene chain as a whole or parts of it. While the two former do not show any thickness dependence in their spectral positions, the latter becomes faster with decreasing sample thickness. This reflects the difference in the length-scale on which the molecular fluctuations take place.

SOE 9.14 Tue 9:30 P1

Intra- and inter-molecular dynamics in the course of vitrification in organic glasses — Ludwig Popp, Benjamin Suttner, •Wilhelm Kossak, and Friedrich Kremer — Universität Leipzig, Fakultät für Physik und Geowissenschaften, Institut für Experimentelle Physik I, Linnestr. 5, 04103 Leipzig

FTIR and BDS are utilized to study the vitrification of various well known glass formers in a wide temperature range around the calorimetric glass transition temperature, Tg. Measurements on Propylene glycol, Glycerol, Salol, Benzophenone, Sorbitol, Xylitol, etc. are compared and the sub-molecluar specificity of the different moieties in their contribution to thermally activated processes including the dynamic glass transition are discussed. By that the necessity of atomistic models of the glass transition beyond coarse grained models is revealed.

SOE 9.15 Tue 9:30 P1

The potential energy landscape of sheared glass-forming systems — •Markus Blank-Burian and Andreas Heuer — Institut für Physikalische Chemie, WWU Münster, Deutschland

We performed molecular dynamics simulations of small supercooled binary Lennard-Jones mixtures ($65 <= N <= 1040$) under a constant shear rate. The shearing is achieved by applying Lees-Edwards periodic boundary conditions to the system. The potential energy landscape (PEL) is most informative for small systems. However, we also study the influence of finite size effects on our results.

In previous work, it was shown, that the finite size effects in unsheared systems is quite small for thermodynamic observables and for the diffusivity. The dynamics of these systems can be described by a continous time random walk (CTRW) between minima in the potential energy landscape. Our focus now lies on comparing these results with the constantly sheared system.

In the sheared system, we test for finite size effects in general properties like the velocity profile or the shear viscosity. Since the potential energy landscape is now time-dependent, we use affine transformations to understand the temporal evolution of its minima. With this insight, we can use the same continuous time random walk analysis as with the unsheared system.

SOE 9.16 Tue 9:30 P1

Self-stabilizing Learning Rules in Neural Models driven by Objective Functions — •Rodrigo Echeveste and Claudius Gros — Institut für Theoretische Physik, Johann Wolfgang Goethe Universität, Max-von-Laue-Str. 1, Frankfurt am Main, Germany

In the present work, learning rules for a neuronal model are derived from two objective functions. On the one hand, the neuron's firing bias is adjusted by minimizing the Kullback-Leibler divergence with respect to an exponential output distribution. On the other hand, learning rules for the synaptic weights are obtained by minimizing a Fisher information that measures the sensitivity of the input distribution with respect to the growth of the synaptic weights. In this way, we obtain rules that both account for Hebbian/anti-Hebbian learning and stabilize the system to avoid unbounded weight growth. As a by-product of the derivation, a sliding threshold, similar to the one found in BCM models, is obtained for the learning rules.

As a first application of these rules, the single neuron case is studied in the context of principal component analysis and linear discrimination. We observe that the weight vector aligns to the principal component when the input distribution has a single direction of maximal variance but, when presented with two directions of equal variance, the neuron tends to pick the one with larger negative Kurtosis. In particular, this fact allows the neuron to linearly separate bimodal inputs. Robustness to large input sizes (1000 inputs) is also studied, observing that the neuron is still able to find the principal component in a distribution under these conditions.

SOE 9.17 Tue 9:30 P1

Fluctuations of Probe Particles Coupled to Molecular Motors — •Patrick Pietzonka, Eva Zimmermann, and Udo Seifert — II. Institut für Theoretische Physik, Universität Stuttgart

In recent years, many experiments have been carried out in which the motion of molecular motors is probed by the observation of attached colloidal particles. For the experimental determination of the torque exerted by the rotational motor F_1-ATPase onto such a particle, the application of a fluctuation theorem (FT) for the motion of the colloid has been proposed [1].

However, we show that this approach is generally valid only in the limit of fluctuations on short timescales. The statistics of fluctuations during larger time-intervals depends significantly on the intrinsic behavior of the motor and the linker, which is not observable in experiments. In particular, we investigate a simple model characterized by discrete motor jumps and harmonic coupling between the motor and the colloid [2]. Using the framework of the theory of large deviations, we calculate the distribution of fluctuations of the colloid in the long-time limit. This result implies a refined formulation of the FT-like relation observed in experiments. Moreover, we gain general insight into the properties of stochastic processes with hidden degrees of freedom.

[1] K. Hayashi *et al.*, Phys. Rev. Lett. **104**, 218103 (2010)
[2] E. Zimmermann and U. Seifert, New J. Phys. **14**, 103023 (2012)

SOE 9.18 Tue 9:30 P1

Detention time of a model microswimmer at a plane surface: importance of hydrodynamic interactions — •Konstantin Schaar, Andreas Zöttl, and Holger Stark — TU Berlin, Institut für Theoretische Physik

We discuss the detention time of a microswimmer at a plane no-slip surface taking into account hydrodynamic interactions of the swimmer with the surface and rotational diffusion. To evaluate the detention time, we use the formalism of the mean first-passage time (MFPT) based on an appropriate Smoluchowski equation. The microswimmer operates in 'squirmer' mode and can easily be tuned between a 'pusher' and a 'puller'. The hydrodynamic interactions with the surface are described by lubrication theory.

We examine the MFPT and also the distribution of first passage times at the surface and achieve good agreement of our results with direct simulations of the squirmer motion close to the no-slip surface using the method of multi-particle collision dynamics. The detention time of the squirmer is clearly determined by hydrodynamic interactions with the surface. They rotate the squirmer away from the surface and therefore reduce the detention time considerably compared to pure rotational diffusion. We find that pushers have a larger detention time than pullers.

SOE 9.19 Tue 9:30 P1

Thermodynamically consistent coarse graining of molecular motor models — •Eva Zimmermann and Udo Seifert — II. Institut für Theoretische Physik, Universität Stuttgart

In many single molecule experiments probe particles that are attached to molecular motors are used to infer properties of the motor protein from the analysis of the particle's trajectory and to manipulate the

system by exerting external forces on the motor protein via the probe particle. Theoretical modelling used to describe such assays should comprise at least two coupled degrees of freedom. However, many simple theoretical models applied to molecular motor experiments contain only one degree of freedom representing the motor.

We use a simple illustrative model consisting of two coupled degrees of freedom for the molecular motor and the probe particle to introduce a coarse graining method that allows to eliminate the explicit dynamics of the probe particle in a dynamically and thermodynamically consistent way. We discuss under which conditions the coarse grained model reduces to the widely-used one-particle models.

SOE 9.20 Tue 9:30 P1

Active Turing Systems — •Silke Bergeler, Florian Thüroff, and Erwin Frey — Arnold Sommerfeld Center for Theoretical Physics (ASC) and Center for NanoScience (CeNS), Department of Physics, Ludwig-Maximilians-Universität München

Active Turing systems combine the ideas of active matter and reaction diffusion systems showing Turing patterns. We investigate such systems analytically and numerically starting within the framework of Boltzmann-like equations. Adapting previous analytical approaches for active systems we derive a set of hydrodynamic equations and perform a linear stability analysis of the isotropic uniform steady state. We find that the stability against homogeneous perturbations switches from unstable to stable by crossing a threshold noise from below. From direct simulations of the Boltzmann equation we observe that activity changes the form of the Turing patterns and broadens the parameter range for which patterns emerge. Analytical investigations on the stability of the isotropic homogeneous steady state are confirmed by numerical analysis.

SOE 9.21 Tue 9:30 P1

Application of a random fitness landscape model to a long term evolution experiment — •Mares Barekzai[1], Su-Chan Park[2], and Joachim Krug[3] — [1]Department of Physics, University of Cologne,Germany — [2]Department of Physics, Catholic University of Korea, Bucheon, South Korea — [3]Department of Physics, University of Cologne,Germany

Since 1988, a long term microbial evolution experiment has attracted attention in the scientific community. In the experiment 12 populations of Escherichia coli are propagated in a daily refreshed minimal medium for more than 50000 generations. One of many results are the fitness trajectories of these asexually evolving populations, where fitness is measured as relative growth rate compared to the founding population. Is there a simple model to interpret the observed microbial evolution? We approached this question using the House of Cards Model introduced in 1978 by Kingman, which models the evolution of an asexual population on an uncorrelated random fitness landscape in the limit of infinite genome size. This limit implies that all mutations generate new fitness values drawn from a fixed probability distribution. The model produces fitness trajectories that are in qualitative agreement with the experimental data. Based on an analytical solution for the long term behavior of the model, we estimate the model parameters from the experimental data and provide a biological interpretation of our results.

SOE 9.22 Tue 9:30 P1

Event chain simulations of polymer bundles — •Tobias Alexander Kampmann and Jan Kierfeld — TU Dortmund, Germany, NRW

We study simulation methods for large polymer systems forming locally dense structures such as polymer or filament bundles. In order to simulate such systems effectively using Monte-Carlo methods, we propose a novel event chain algorithm adapted from hard sphere systems [E. P. Bernard, W. Krauth, Phys. Rev. E, 80: 056704 (2009)]. The algorithm works rejection-free and reduces autocorrelation and equilibration times significantly.

We demonstrate the advantages of the algorithm by investigating the diffusive behaviour of bundle structures. Using the event chain algorithm a polymer bundle exhibits the correct scaling of diffusion constants with bundle size, which is not obtained using simple local displacement moves. We apply the algorithm to bundle networks formed by semiflexible filaments with short-range attractive interactions.

SOE 9.23 Tue 9:30 P1

Estimation of sleep stages and sleep depth dynamics by neural clustering — •Stephan Volkland[1] and Jens Christian Claussen[2,1] — [1]INB, Universität zu Lübeck, Germany — [2]Computational Systems Biology Lab, Research II, Jacobs University Bremen, Germany

The quantitative analysis of sleep from polysomnographic date (i.e., simulataneous recording of EEG, EMG and EOG) is practically limited by the final step of sleep scoring, i.e. extensive manual inspection of data according to the Rechtschaffen and Kales rules or the recent AASM counterpart, leading to a manually classified time series of sleep stages on a discrete scale of six values (wake, REM, S1, S2, S3, S4). Starting from the observation that the stages S2, S3, and S4 are merely defined by spectral properties, namely by activity in the delta and sigma band, here we present a neural clustering approach to assess sleep stages automatically by unsupervised neural clustering and a posteriori assignment of sleep stages. One particular goal is to provide a finer resolution in time as well as a finer interpolation in sleep depth than obtainable from manual scoring. We find that EOG and EMG data are still needed to improve classification of wake and REM states, and still an interpolation of states at the borders of wake, REM and S1 is difficult. In the range between the NonREM stages S1–S4 an interpolation with higher resolution is feasible, as expected.

SOE 9.24 Tue 9:30 P1

Extended diffusion model of sleep depth dynamics — •Anna Barkentien[1] and Jens Christian Claussen[2,1] — [1]INB, Universität zu Lübeck, Germany — [2]Computational Systems Biology Lab, Research II, Jacobs University Bremen, Germany

The duration of wake bouts during sleep has puzzled complex systems scientists since a decade since [1], as these distributions eventually resemble a power-law. The theoretical understanding is incomplete, biologically plausible models still are not available. A pure Markov analysis [2] assuming random switching however ignores any deterministic components in the dynamics which are manifest in time correlations. The phenomenological model proposed in [1] describes sleep depth by a one-dimensional diffusion process with a reflecting border for sleep and a restoring force for wake. We extend this model in [3] to account for the REM state and modify the restoring force law to account for deviations to the power law that are observed in data from some (but not all) labs and obtain a better fit to data [3]. We conclude that a refined model as [3] is necessary to account for the different experimental results, but significantly larger cohorts of sleep studies would be needed to distinguish between the two-regime and the one-regime distributions. This concerns only the wake → sleep transition, the sleep → wake transition remains consistant with a random process homogeneous in time.

[1] C.C. Lo et al, EPL 57, 631, 2002. [2] J.W. Kim et al, PRL 102, 2009. [3] A. Barkentien and J.C. Claussen (in preparation).

SOE 9.25 Tue 9:30 P1

Multidimensional epistasis and the transitory advantage of sex — •Johannes Neidhart, Stefan Nowak, Ivan G. Szendro, and Joachim Krug — THP, Universität zu Köln, Deutschland

The benefit of sex and recombination is a long standing problem. We numerically study evolutionary dynamics on high dimensional epistatic fitness landscapes, with focus on the temporal development of the evolutionary advantage of recombination. We show that the adaptive advantage of recombination on static landscapes is strictly transitory. These findings are explained by means of well established results for a setup with two loci. It is further shown that the transitory advantage can be prolonged indefinitely in fluctuating environments.

SOE 9.26 Tue 9:30 P1

Adaptive walks in Kauffman's NK-Landscape — •Stefan Nowak and Joachim Krug — Institut für Theoretische Physik, Universität zu Köln, Deutschland

We study evolutionary dynamics in a high-dimensional genotype space in the limit of rare mutations and strong selection. In this regime the population performs an uphill walk which terminates at local fitness optima. We analyze the length and attained fitness of such walks with our focus on the influence of different genetic interaction patterns.

SOE 9.27 Tue 9:30 P1

Coexisting autocatalysts generate increasing complexity — •Emanuel Gregor Worst[1], Philipp Zimmer[2], Eva Wollrab[1], Karsten Kruse[2], and Albrecht Ott[1] — [1]Biologische Experimentalphysik, Universität des Saarlandes, Deutschland — [2]Theoretische Biologische Physik, Universität des Saarlandes, Deutschland

The evolution towards more complex structures from the earliest building blocks of life remains poorly understood. Here we present an experimental realization that exhibits evolutionary properties in one dimension and generates multiple coexisting species. Molecular chains of a certain length (identified as a species) are autocatalytically reproducing, and new species form randomly by spontaneous concatenation. We use DNA strands and DNA ligase, covalently linking single-stranded DNA, as an experimental model system. Reproduction occurs by template-directed ligation. Spontaneous and random generation of new species is a consequence of thermal fluctuations. We show that the system evolves towards more complex structures in a non-trivial way if the ratio between autocatalytic reproduction and spontaneous generation of new species exceeds a critical value. An outstanding characteristic of this system is the iterated production of more complex species while coexistence is maintained.

SOE 9.28 Tue 9:30 P1

Identifying molecular expression dynamics in practice - how to distinguish between noise regulation and direct deterministic control using experimental data — •Martin Hoffmann[1] and Jörg Galle[2] — [1]Fraunhofer ITEM, Project Group Personalized Tumor Therapy, Biopark I, Josef-Engert-Strasse 9, 93053 Regensburg, Germany — [2]Interdisciplinary Centre for Bioinformatics, University of Leipzig, Haertelstr. 16-18, 04107 Leipzig, Germany

Biological noise plays an important role in generating phenotypic diversity and contributes to unspecific environmental adaptation. However, the classical pathway view of cell biology focusing on deterministic stimulus-response relationships may well accommodate the majority of biological phenomena. It is thus necessary to develop combined theoretical and experimental approaches that can dissect the relative contribution of noise regulation and direct deterministic control. Accordingly, we define molecular level conditions for noise-driven and deterministic dynamics and compare corresponding modeling results to published experimental data. We show that both models can fit the FACS data for the toggle switch system equally well while simulated dynamic mRNA labeling results in distinct observations for both models. Using synthetic time course data we demonstrate that complete system identification can be achieved based on single cell tracking. As demonstrated, noise regulation can be an effective second layer of cell regulation that may be associated with active short term search processes.

SOE 9.29 Tue 9:30 P1

Propagation and propagation failure of waves on excitable tree networks — Nikos Kouvaris[1], •Thomas Isele[2], Alexander Mikhailov[3], and Eckehard Schöll[2] — [1]Department of Physics, University of Barcelona, Marti i Franques 1, 08028, Barcelona, Spain — [2]Institut für theoretische Physik, Technische Universität Berlin, Hardenbergstraße 36, 10623 Berlin, Germany — [3]Department of Physical Chemistry, Fritz Haber Institute of the Max Planck Society, Faradayweg 4-6, 14195 Berlin, Germany

We study the properties of pulse solutions on excitable tree networks by means of numerical (simulation and continuation) as well as analytical methods. We focus on the dependence of the propagation velocity and the change of stability properties with respect to the branching ratio (i.e. degree) of the nodes. But we also consider different coupling strengths and the continuous (thermodynamic) limit of our model.

SOE 9.30 Tue 9:30 P1

Dynamics of neural networks with transient synaptic plasticity rules — •Bulcsú Sándor and Claudius Gros — Institut für Theoretische Physik, Goethe Universität, Frankfurt am Main, Deutschland

Working memory makes it possible to hold information temporarily for processing purposes; as such it has an important role in the execution of cognitive tasks. Its operation may possibly be mediated via short-term or transient synaptic plasticity effects. Thus the standard Tsodyks-Markram model for transient synaptic dynamics, built upon short-term synaptic plasticity effects, is a promising candidate to investigate the underlying dynamical behavior of these systems.

In our work we propose a simplified continuous time model for presynaptic plasticity rules, called full depletion model, which may allow a stricter control of the dynamics. The model is implemented for clique encoding recurrent networks with a Mexican-hat connection profile of synaptic weights. These systems show a wide variety of dynamical states as a function of the control parameters. We study the different types of behaviour emerging from transient synaptic plasticity rules from a dynamical system's point of view.

SOE 9.31 Tue 9:30 P1

Optimization of complex network for minimizing traffic congestion: case study for a popular internet based service in Serbia — •Igor Stanković[1], Vladica Tinotor[2], and Jovan Radunović[3] — [1]Scientific Computing Laboratory, Institute of Physics Belgrade, University of Belgrade, Pregrevica 118, 11080 Belgrade, Serbia — [2]Republic Agency for Electronic Communications, Višnjićeva 8, 11000 Belgrade, Serbia — [3]School of Electrical Engineering, University of Belgrade, Bulevar kralja Aleksandra 73, 11120 Belgrade, Serbia

We present a case study of network parameter optimization for a popular internet based service in Serbia. The physical layer of the network consists of two existing nation-wide optical networks, i.e., a commercial telecommunication network and a network of public power grid operator. The second network is build for synchronization and control of the power grid and is not currently used commercially. Information traffic is directed by standard Open Shortest Path First routing protocol and in our case initial link weights are assigned according to the link costs [1]. We apply optimization algorithm aimed at avoiding, if possible, link overload by a judicious link weight tuning. The output characteristics which enter into quality of service function are link utilization and total cost of the service. The input parameters of the optimization algorithm are network topology, relevant protocol, link costs and capacities.

[1] J. Smiljanic, I. Stankovic, "Efficient Routing on Small Complex Networks Without Buffers", Physica A **392**, (2013) 2294.

SOE 9.32 Tue 9:30 P1

Motifs in Triadic Random Graphs Based on Steiner Triple Systems — •Marco Winkler and Jörg Reichardt — Institute for Theoretical Physics, University of Würzburg, Germany

Conventionally, pairwise relationships between nodes are considered to be the fundamental building blocks of complex networks. However, over the last decade so-called motifs have attracted much attention. It has been hypothesized that these motifs, rather than links, serve as the building blocks of network structures. Although the relation between a network's topology and its function, its robustness against perturbations, or its efficiency in spreading information, is the central theme of network science, there is still a lack of sound generative models needed for testing the functional role of subgraph motifs. Our work aims to overcome this limitation. We employ the framework of exponential random graph models (ERGMs) to define models based on triadic substructures. The fact that only a small portion of triads can actually be set independently poses a challenge for the formulation of such models. To overcome this obstacle, we use Steiner triple systems (STSs). These are partitions of sets of nodes into pair-disjoint triads, which thus can be specified independently. Combining the concepts of ERGMs and STSs, we suggest generative models capable of generating ensembles of networks with nontrivial triadic Z-score profiles. Further, we discover inevitable correlations between the abundance of triad patterns, which occur solely for statistical reasons and need to be taken into account when discussing the functional implications of motif statistics.

SOE 9.33 Tue 9:30 P1

Architecture of biologically inspired adaptive transport networks — •Johannes Gräwer[1], Carl Modes[2], Marcelo O. Magnasco[2], and Eleni Katifori[1] — [1]Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany — [2]Laboratory of Mathematical Physics, The Rockefeller University, New York, NY, USA

We study self-organized adaptation mechanisms of biologically inspired transport networks (e.g. plasmodial veins of slime moulds). Therefore, evolving network architectures are simulated using a generic dynamical system and weighted graphs. The graphs' edges represent tubes with Hagen-Poiseuille flow, connected through junctions, represented by their nodes. A local update rule, that changes the conductivity of the tubes (edge weights) according to the flow through them, is used as a self-organizing adaptation principle. We model these interrelated transportation and adaptation processes on paradigmatic complex network topologies (e.g. Watts-Strogatz, Barabási-Albert, Erdös-Rényi) with random initial edge weights. We examine the adaptation dynamics and find, that it exhibits discrete, cascade reorganization events until the network reaches a hierarchically organized state.

SOE 9.34 Tue 9:30 P1

Quantum walks on 1D and 2D quasi-crystals — •Chi-Hung Weng and Oliver Mülken — Institute of Physics, University of Freiburg, Germany

We study the dynamics of quantum walks on a quasi-crystals modelled by the tight-binding Aubry-André-Harper (AAH) equation. We numerically solved both the diagonal/off -diagonal AAH in both 1D and 2D cases. It is known that the 2D diagonal AAH can also be regarded as a model for the Integer Quantum Hall Effect (IQHE), a phenomena when a 2D electron gas is subjected to strong magnetic fields at a low temperature. As a consequence we also observe the edge states which are responsible for carrying the current. Those states can be changed from localized to de-localized, as a topological phase within the aperiodic modulated on-site potential varies. In order to identify how localized the states are, as well as how fast the transport is, the Inverse Participation Ratio (IPR) and Mean Squared Displacement (MSD) are calculated, respectively. Moreover, we also study the impact of disorder and non-Hermitian settings (i.e. system with absorbers or Parity-Time (PT) symmetric modulated aperiodicity) on the dynamics.

SOE 9.35 Tue 9:30 P1

Transport efficiency in complex networks — •Marco Tabarelli and Oliver Mülken — Albert-Ludwigs-Universität, Freiburg, Germany

We examine complex networks of two-level quantum systems regarding their efficiency to transport exitons through the network. Our model uses the so-called Quantum Stochastic Walk (QSW), a version of a quantum master equation in Lindblad form (LME) which allows to parametrize the classical-quantummechanical crossover. To describe a circular probability current an external node is coupled to two "ends" of the network acting as a source to an entrance node and a trap to an exit node. These links are directed and their effect is realized with additional Lindblad operators in the dissipative term of the LME. Comparing stationary solutions of node populations sheds light on the probability current through the network. In addition to the geometry of the network, parameters varied include the internal coupling constant, source- and trap strength and the ratio of coherent and decoherent transitions. Networks studied include modified linear chains and networks with self-similarity properties.

SOE 9.36 Tue 9:30 P1

Feedback control of vorticity in a Newtonian fluid — •Maria Zeitz and Holger Stark — Institut für Theoretische Physik, Technische Universität Berlin, D-10623 Berlin

Our goal is to explore feedback control strategies to stabilize novel dynamic flow patterns in microfluidic model systems. As an example, we investigate a Couette flow geometry without the inner cylinder filled with a Newtonian fluid. Its vorticity satisfies a diffusion equation. To stabilize a mean vortex strength in the flow field, we use feedback control with hysteresis. We either set the angular velocity of the outer cylinder or apply a torque at the boundary and switch velocity or torque value in a hysteretic fashion depending on the actual mean vortex strength. Since the boundary condition changes with time, the system does not reach a stationary state. In this setup, we explore the possibility of time-periodic solutions and spatial flow patters. In a second step, we will also implement time-delayed feedback in our system.

SOE 9.37 Tue 9:30 P1

Fractal distributions in a cyclic information-engine with optimal feedback — •Michael Bauer, Andre C. Barato, and Udo Seifert — II. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart, Germany

It is known that information obtained by measurements can be converted into work, the paradigmatic example being Szilard's engine. For a two level system coupled to a heat bath and a work reservoir we obtain the optimal protocol corresponding to the maximal work extraction. Moreover, we consider a controller performing cyclic measurements and changing the protocol accordingly. Analyzing this optimal cyclic machine we find a recursion relation for the initial occupation probability of the level with higher energy, which depends on the measurement error. Through the numerical analysis of this relation we obtain a fractal histogram, which is a strange attractor (common in chaos theory). This fractal structure can be explained with a simplified model leading to the Cantor set.

SOE 9.38 Tue 9:30 P1

Feedback control of non-equilibrium dynamics of a multilayer system of confined colloidal particles in planar shear flow — •Sascha Gerloff, Tarlan A. Vezirov, and Sabine H. L. Klapp — Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstraße 36, 10623 Berlin, Germany

We perform computer simulations of charged colloidal particles in planar shear flow combined with feedback control. The particles interact via a combined Yukawa- and softsphere-potential. The system is known to form shear-induced multi-layer configurations in confinement and to show different intra-layer structures which depend on the applied shear rate [1]. The parameters are set to suit experimental data for ludox silica particles, which where previously studied [2, 3].
We employ overdamped Brownian dynamics simulations to investigate the structure and the rheological behavior of the considered system. We then supplement our equations of motion by an additional dynamical equation, which corresponds to a feedback control mechanism for the shear rate via the shear stress. This enables the system to select between steady states dependent on the control parameters. Furthermore we present an approximation which estimates the transtion between steady states in the control parameter space analytically.
[1] T. A. Vezirov and S. H. L. Klapp, Phys. Rev. **E 88**, 5 (2013).
[2] S. Grandner and S. H. L. Klapp, J. Chem. Phys. **129**, 244703 (2008).
[3] S. H. L. Klapp, Y. Zeng, D. Qu and R. v. Klitzing, Phys. Rev. Lett. **100**, 118303 (2008).

SOE 10: Networks, From Topology to Dynamics I (joint with DY and BP)

Time: Tuesday 15:00–16:00 Location: GÖR 226

SOE 10.1 Tue 15:00 GÖR 226

The Hidden Geometry of Complex, Network-Driven Contagion Phenomena — •Dirk Brockmann[1,2] and Dirk Helbing[3] — [1]Humboldt University, Berlin — [2]Robert Koch Institute, Berlin — [3]ETH Zurich

The global spread of epidemics, rumors, opinions, and innovations are complex, network-driven dynamic processes. The combined multiscale nature and intrinsic heterogeneity of the underlying networks make it difficult to develop an intuitive understanding of these processes, to distinguish relevant from peripheral factors, to predict their time course, and to locate their origin. We show that complex spatiotemporal patterns can be reduced to surprisingly simple, homogeneous wave propagation patterns, if conventional geographic distance is replaced by a probabilistically motivated effective distance[1]. In the context of global, air-traffic-mediated epidemics, we show that effective distance reliably predicts disease arrival times. Even if epidemiological parameters are unknown, the method can still deliver relative arrival times. The approach can also identify the spatial origin of spreading processes. We validate the approach by application to data on the worldwide 2009 H1N1 influenza pandemic, the 2003 SARS epidemics and the 2011 outbreak of EHEC/HUS in Germany.
D. Brockmann, D. Helbing, Science (2013)

SOE 10.2 Tue 15:15 GÖR 226

Spread of Infectious Diseases with Finite Infectious Period on Temporal Networks — •Andreas Koher, Lucian Willareth, Hartmut Lentz, and Igor M. Sokolov — Institut für Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, 12489 Berlin, Germany

Traversal in temporal networks is only possible, if paths are formed by a causal sequence of edges. Recently, a matrix formalism has been introduced in order to compute the causal path structure of temporal networks [1]. This formalism describes the spread of infectious diseases that can traverse the network even after arbitrary waiting times, i.e. a SI-model (susceptible-infected-model). Many infectious diseases however possess a finite infectious period, i.e. the time period after which

the infection dies out, if it is not passed on. This can be implemented as an SIS or SIR (susceptible-infected-recovered) model, respectively. In this work, we introduce a novel matrix formalism that allows for an explicit consideration of finite infectious periods, which gives a more realistic model of outbreak scenarios. As a central result, we compute the critical infectious period necessary in order to allow for percolation on a given temporal network. The introduced methods can be implemented efficiently and we demonstrate their capability on different datasets.

[1] Lentz et al., Unfolding Accessibility Provides a Macroscopic Approach to Temporal Networks, Phys. Rev. Lett. (2013)

SOE 10.3 Tue 15:30 GÖR 226

Dynamics of Manufacturing Supply Networks — •Thilo Gross — University of Bristol

High-value manufacturing builds on increasingly complex supply networks. In contrast to classical supply chains these networks have a high connectivity and can contain loops and hubs. Failure of the supply network can cause business disruptions associated with high financial losses. Presently, already more than 30% of such losses are caused by cascading effects that propagate through the system. In the face of this threat mathematical tools are needed to assess the robustness and resilience of supply networks and identify vulnerabilities. In this talk I present modelling approaches and results on the stability of dynamical manufacturing supply networks. In particular, I identify potential bifurcations of the network and propose a method to identify the most critical suppliers in large networks.

SOE 10.4 Tue 15:45 GÖR 226

Automatic discovery of plausible network models — Telmo Menezes[1,2] and •Camille Roth[1] — [1]Centre Marc Bloch Berlin, CNRS — [2]Centre d'Analyse et de Mathématique Sociales, CNRS/EHESS

A methodology is proposed to discover plausible network generators for complex networks. Generators are defined as computer programs that define local morphogenetic behaviors. We employ a machine learning technique inspired by biological Darwinism to look for generators that produce synthetic networks which match a number of metrics on target real networks. We use a number of metrics that capture both global and fine-grained structural characteristics of networks. Remarkably, when applied on networks stemming from prototypical models of the Erdös-Rényi or Barabási-Albert sort, our approach generally discovers the exact original generator. Empirical validation of our methodology is then presented in the form of a number of plausible generators for a series of five real networks, including a simple brain and a social network.

SOE 11: Annual SOE Member's Assembly

Annual Member's assembly of SOE: Report on activities, dissemination of events, discussion of future work of the division, collection of suggestions for future symposia and focus sessions, and election of representatives of SOE. The assembly is public to everyone interested, but only SOE members are entitled to vote.

Time: Tuesday 18:30–19:30 Location: GÖR 226

After the assembly, there will be an informal get-together dinner in one of the restaurants in Dresden (details to be announced in the assembly).

SOE 12: Information Science and Economic Processes (Invited Talk Cesar Hidalgo)

Time: Wednesday 9:30–10:15 Location: GÖR 226

Invited Talk SOE 12.1 Wed 9:30 GÖR 226

Crystallized Imagination: Economic Development through the eyes of information — •Cesar Hidalgo — MIT, Cambridge, USA

People are not born with the ability to fly, cure diseases, or communicate at long distances, but they are born in a society that can endow them with those capacities. Crystallized Imagination [1] is exploring how these capacities emerge from our species ability to accumulate knowledge and information, and how the evolution of these capacities is limited by the need for knowledge and information to always be physically embodied. By building on ideas of information theory, network science, economics, anthropology, sociology and political science, Crystallized Imagination explains the process of economic development as our species struggle to accumulate physically embodied knowledge and information.

[1] Cesar Hidalgo: Crystallized Imagination. To appear late 2014 / early 2015 in English, German and Chinese (under contract with Basic Books (US), Penguin (UK), Hoffmann und Campe (Germany), and CITIC (China)).

SOE 13: Social Systems, Opinion and Group Dynamics

Time: Wednesday 10:15–11:45 Location: GÖR 226

SOE 13.1 Wed 10:15 GÖR 226

Ignorance is bliss. An agent-based model of the diffusion of norm violation in networks — •Michael Mäs[1] and Karl-Dieter Opp[2] — [1]ETH Zurich, Switzerland — [2]University of Leipzig, Germany

Classical sociological theories assume that individuals will deviate norms more when they learn that there is more norm violation than they expected. Based on this assumption, it has been predicted that norm-violating behavior such as tax evasion and fare dodging increases when a population is informed about the actual rates of norm violation on these dimensions. We challenge this prediction, arguing that there may also be individuals who violated the behavior before the actual rate of norm violation was disclosed. These individuals might have overestimated the rate of norm violation and will start following the norm when they are informed about a relatively low rate of norm violation. These decisions might neutralize the increase in overall norm violation that has been predicted, resulting in a stable crime rate.

To test the logical validity of our criticism, we developed an agent-based model. Agents are represented as nodes in a network and individually estimate the rate of norm violation based on the behavior of their network contacts. Agents violate norms when this estimate exceeds their individual norm acceptance. We studied model dynamics that obtain when the actual rate of norm violation is disclosed. With simulation experiments, we explored the conditions of increasing and decreasing rates of norm violation, focusing on the distribution of norm acceptance in the population and the structure of the social network. We also studied scenarios where norm acceptance is flexible.

SOE 13.2 Wed 10:30 GÖR 226

Age-dependent voter model — •Toni Pérez[1], Konstantin Klemm[2], and Victor M. Eguíluz[1] — [1]Institute of Cross-Disciplinary Physics and Complex Systems (IFISC), Spain — [2]Institute for Theoretical Chemistry, University of Vienna, Austria

The dynamics of adoption of different features such as innovations, opinions, or ideas is a topic that has attracted the attention of researchers from disciplines as diverse as Economics, Sociology, and Physics. The complex composition of modern societies allows for conservative groups, who hold traditional ideas for a long time, to coexist with groups of people open to fast innovation. This fact, however, has not been translated yet to the diverse variety of innovation models. Here we consider a model that takes into account the time an individual has held its feature (opinion, idea, or innovation). Specifically, we address the question of how the time since adoption of a feature by an individual influences its spreading. As one of our analytical results, we determine the expected time a new created feature takes to fixate, i.e. be adopted by the whole system. With N individuals in a well-mixed population, the scaling of fixation time $S(N)$ ranges from $S(N) \sim \log(N)$ to $S(N) \sim \exp(N)$, depending on the microscopic spreading rule giving preference to recently adopted or long conserved features.

SOE 13.3 Wed 10:45 GÖR 226

Opinion formation on a gradient — Michael Gastner[1,2,3], •Nikolitsa Markou[4], Gunnar Pruessner[2], and Moez Draief[4] — [1]Department of Engineering Mathematics, University of Bristol, Merchant Venturers Building, Woodland Road, Bristol BS8 1UB, UK — [2]Department of Mathematics, Imperial College London, South Kensington Campus, London SW7 2AZ, UK — [3]Institute of Technical Physics and Material Science, Research Centre for Natural Sciences, Hungarian Academy of Sciences, P.O. Box 49, H-1525 Budapest, Hungary — [4]Department of Electrical and Electronic Engineering, Imperial College London, South Kensington Campus, London SW7 2AZ, UK

Statistical physicists have become interested in models of collective social behavior such as opinion formation, where individuals change their inherently preferred opinion if their friends disagree. Real preferences often depend on regional cultural differences, which we model here as a spatial gradient g in the initial opinion. The gradient does not only add reality to the model. It can also reveal that opinion clusters in two dimensions are typically in the standard (i.e., independent) percolation universality class, thus settling a recent controversy about a non-consensus model. However, we also present a model where the width of the transition between opinions scales $\propto g^{-1/4}$, not $\propto g^{-4/7}$ as in independent percolation, and the cluster size distribution is consistent with first-order percolation.

SOE 13.4 Wed 11:00 GÖR 226

Match data in soccer as a new trend: relevant information or unnecessary details? — •Andreas Heuer and Oliver Rubner — WWU Münster, Inst. f. Phys. Chemie, D-48149 Münster

Companies like Opta and Impire record a large amount of data, characterizing many details of soccer matches. Examples are number of passes, ball possession, shots, fouls, just to mention a few. However, the relevance of the different observables is far from evident. For example, does the running distance, covered by the players of a team, reflect the quality of that team?

From a scientific perspective different questions emerge when analyzing the individual observables: (1) How team-specific are these observables? Have different teams different characteristics, e.g. for the number of fouls? (2) How relevant are the individual observables to characterize the strength of a team? For example, is the fraction of ball possessions a good indicator of the team quality? (3) How can one measure the success of a team in a given match beyond the obvious number of scored goals which is often simply subject to good or bad luck. Whereas (1) and (2) deal with the overall behavior during a whole season, (3) analyzes the properties of individual matches.

Using statistical concepts, appropriate for the analysis of the time series of sports data [1,2], all questions can be answered in general terms. It will become clear which part of the match data is of real importance.

[1] A. Heuer, O. Rubner, Eur. Phys. J. B 67, 445-458 (2009).
[2] A. Heuer, "Der perfekte Tipp", Wiley-VCH (2012).

SOE 13.5 Wed 11:15 GÖR 226

Distribution of Attention in YouTube — •José M. Miotto and Eduardo G. Altmann — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

Records of users activity in YouTube allow for a detailed study of the dynamics of attention distribution in social media. In this talk we describe and model the main statistical properties of the number of views of Youtube videos. We focus on the characterization and predictability of extreme events, the small number of videos in the tail of the distribution for views which capture a considerable amount of the total attention.

SOE 13.6 Wed 11:30 GÖR 226

Stochastic growth in social systems — •Juergen Mimkes[1] and Stefan Hutzler[2] — [1]Physics Department, Paderborn University — [2]Physics Department, Trinity College, Dublin

Stochastic growth in social systems is observed in many instances: in opinion formation a new idea is evolving, in elections one party may grow at the costs of others, in the interaction of languages one language may displaces another, in wars one country may grow at the costs of others, in nature we find growth and survival of the fittest. Stochastic growth in social systems may be calculated similar to crystal growth in physical systems. Simulations based on local optimization of the free energy may visualize the process of stochastic opinion growth, but not the outcome of an election.

SOE 14: Energy meets Economy: Dynamics and Statistics of Future Energy Systems (accompanying symposium SYEE joint with DY and jDPG)

Time: Wednesday 11:45–13:15 Location: GÖR 226

SOE 14.1 Wed 11:45 GÖR 226

Fluctuation analysis of high frequency electricity power load in the Czech Republic — •Hynek Lavicka[1,2] and Jiri Kracik[3] — [1]Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering, Department of Physics, Břehová 7, CZ-11519 Praha 1, Czech Republic — [2]Bogolyubov Laboratory of Theoretical Physics, Joint Institute of Nuclear Research, RU-141980 Dubna, Russia — [3]Charles University in Prague, Faculty of Social Sciences, Institute of Economic Studies, Opletalova 26. CZ-110 00 Prague 1, Czech Republic

We focus our analysis on data of electricity power loads in Czech Republic which exhibits seasonality and well as periodic trends typical for other European states. We separate the signal into two parts in Fourier picture where the data undergo power law with significant peaks. Deterministic part governs seasonal and periodic trends. While the latter part holds information on random fluctuations. To deeply analyze stochastic part we employ Multifractal Detrended Fluctuation Analysis (MF-DFA) to determine estimation of Hurst exponent and scaling exponent. Power law exponent of MF-DFA depends on parameter of analysis for stochastic and shuffled stochastic part. This behavior is typical for heavy-tailed distributions. Moreover we also determined properties of autocorrelation function and we found long-range correlation which depends on parameter of analysis.

SOE 14.2 Wed 12:00 GÖR 226

Large-deviation properties of power grids — •Timo Dewenter and Alexander K. Hartmann — Institut für Physik, Carl von Ossietzky Universität Oldenburg, 26111 Oldenburg

We study numerically a Kuramoto-like model [1,2] on different standard and spatial random graphs, which is used to describe the dynamical behavior of coupled mechanical rotators. Such a turbine is represented by a node in the graph, whereas edges stand for transmission lines which can transmit power up to a maximum capacity P^{MAX} between the machines. A machine can either produce (generator) or consume (motor) power. Here, we investigate the robustness of such networks of the random graph ensemble against transmission line failures, i.e. removal of edges. The measured histograms of the robustness certainly provide only information for the smallest probabilities being of order $1/N_{\mathrm{samp}}$, where N_{samp} is the number of samples used to generate the random graph ensemble. Therefore, we apply a

large-deviation approach [3] to obtain the low-probability tails of the distribution, which allows us to gain insight in the topology of extreme robust and extreme vulnerable networks.

[1] G. Filatrella, A.H. Nielsen, N.F. Pedersen, Eur. Phys. J. B **61**, 485 (2008)
[2] M. Rohden, A. Sorge, M. Timme, D. Witthaut, PRL **109**, 064101 (2012)
[3] A.K. Hartmann, Eur. Phys. J. B **84**, 627 (2011)

SOE 14.3 Wed 12:15 GÖR 226

Extending electric grid physics to implement smart grid trading function — •Thomas Walter and Bernd Brunner — Wirsol Integrated PV Solutions

Renewable energy (RE) sources like solar and wind can now compete on generation cost with some fossil sources, but have the property of being volatile. Traditional concepts use storage of electric energy to compensate for this volatility. However, storage cost exceeds generation cost until major breakthroughs will be achieved. Electric grids in which reneable energies provide the larger share (RE dominated grids) therefore utilize the flexibility of decentral loads and generation units. If these are shifted suitably in time, they can utilize too high RE production, and supply energy when RE production is too low. The paper shows how the well known effect that grid freguency varies according to the balance of supply and demand can be utilized to build the basis of a smart grid. This system simplifies overall complexity and reduces cost by appropriate combination of physics and data based technologies.

SOE 14.4 Wed 12:30 GÖR 226

Imaginary Interest Rates and Complex Net Present Value Calculus in Energy Economics — •Gunnar Kaestle — Clausthal University of Technology, 38678 Clausthal-Zellerfeld, DE

A helpful instrument for evaluating the economic feasibility by integrating cash-flows is the Laplace transform [1], as it is an equivalent for net present value calculation. Mathematic rules known from control theory are able to simplify economic assessments. Introducing interest rates from the two-dimensional plane of comlex numbers expands their descriptive power from purely growth or decline to cyclical processes.

Besides discounting cash-flows, discounting energy flows is also a more general but very important assessment of investments in the energy sector. The limiting EROI-factor is gradually degrading in the fossil fuel sector due to the human nature to go for the low hanging fruits first. Severe long term economic implications have to be anticipated, due to the fact that energy is a very powerful production factor.

Therefore, a controlled transition towards non-exhaustive energy resources with a stable EROI has to be started when discretionary spending in learning investments and the deployment of new technology is still possible. The so called net energy cliff shall be avoided by following an exergy efficient transition pathway. Incentive schemes such as the self-adjusting feed-in tariff for German PV systems can be interpreted as supervisory economic control loops.

[1] Robert Grubbström: On the Application of the Laplace Transfrom to Certain Economic Problems; Management Science; Vol. 13; No. 7; 1967; pp. 558-567.

SOE 14.5 Wed 12:45 GÖR 226

Self-Organized Synchronization and Voltage Stability in Power Grids Modeled by Networks of Synchronous Machines — •Katrin Schmietendorf[1], Joachim Peinke[1], Oliver Kamps[2], and Rudolf Friedrich[3] — [1]Carl von Ossietzky Universität Oldenburg, Institut für Physik, ForWind — [2]CeNoS, Münster — [3]WWU Münster, Institut für Theoretische Physik

The energy transition is accompanied by grid decentralization and fluctuating power feed-in characteristics. Hence, with a view to future grids, power system stability and design are actual key issues.

We investigate power system stability in terms of self-organized synchronization aspects on the basis of a network of coupled synchronous machines. In recent years, a relationship between this approach and synchronization phenomena described by the well-known Kuramoto model (KM) has been uncovered. The KM models the dynamical behaviour of coupled oscillators displaying a phase transition from incoherent to partially synchronized states at a critical coupling value. In contrast to other attempts, our network model incorporates both rotor angle and voltage dynamics plus the feature of angle-voltage stability interplay. It can be shown to correspond to a novel version of the KM with time-varying coupling coefficients, which has not been investigated in the context of nonlinear dynamics yet.

We discuss the model's potential applications to modern power systems with a high percentage of renewable energy plants and present results concerning the stability properties of small two-machine units up to large networks.

SOE 14.6 Wed 13:00 GÖR 226

Power transmission in a renewable European future — •Sarah Becker[1], Rolando Rodriguez[2], Martin Greiner[2], and Stefan Schramm[1] — [1]FIAS Uni Frankfurt, Germany — [2]Uni Aarhus, Denmark

We investigate a renewable-based European electricity system, where wind and solar PV produce as much energy as is consumed. Since this generation flucuates with the weather, there will in general be a mismatch between load and generation in individual hours. We assume deficits to be covered by dispatchable power plants, while excesses are curtailed.

In this setting, we study different flow paradigms for inter-country power transmission, i.e. ways to share renewables and match deficits and excesses between the countries. Particular focus is placed on the effects on backup energy usage ("how much fuel is burned?"), backup capacity needs ("how many dispatchable plants need to be available?"), and transmission line investments. Furthermore, we examine different approaches to transmission grid strengthening and compare actual and optimized developments.

SOE 15: Symposium SYEE: Energy Meets Economy: Dynamics and Statistics of Future Energy Systems

Time: Wednesday 15:00–17:45 Location: HSZ 02

Invited Talk SOE 15.1 Wed 15:00 HSZ 02

Smart Grids - From incentives to coupled markets — •Rudolf Sollacher — Siemens AG, Corporate Technology, Munich, Germany

Future energy systems must meet the challenges introduced by an increasing portion of distributed renewable power generation. This talk describes the main challenges and presents current and future solutions. A special focus will be on market based approaches.

Invited Talk SOE 15.2 Wed 15:30 HSZ 02

Energy and the economy — •Reiner Kümmel — Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Am Hubland, D-97074 Würzburg

Energy conversion and entropy production determine the growth of wealth in industrialized economies. Novel econometric analyses have revealed energy as a production factor whose output elasticity, which measures its economic weight, is much larger than its share in total factor cost, while for labor just the opposite is true. Although this result is at variance with neoclassical economic theory, it is compatible with the standard maximization of profit or time-integrated utility, if one takes technological constraints on capital, labor, and energy into account.

Invited Talk SOE 15.3 Wed 16:00 HSZ 02

Planetary constraints to energy supply and the economy — •Oliver Richters — Universität Oldenburg, Institut für Chemie und Biologie des Meeres, Theoretische Physik / Komplexe Systeme — Vereinigung für Ökologische Ökonomie

The "great transformation" towards a future proof economy depends on the provision of a sustainable energy supply. Different planetary boundaries restrict the phase space of possible technical and sociatal solutions. Solar energy or nuclear fusion appear to be the solution for the radical reduction of greenhouse gas emissions, disregarding

that other problem areas persist: First, the excessive installation of photovoltaics enters into competition with other kind of landuse and therefore may lead to land system change and accelerate biodiversity loss. Second, the low entropy of solar radiation is the basis for life on earth and its harvesting for human activity reduces the energy available for biological and meteorological processes. Jointly, though renewables can't run out of stock, the energy throughput is constrained by the speed of regeneration. Third, even nuclear fusion or other sun-independent energy supply cause global warming simply by thermal pollution, as every human activity finally ends up as heat. On the whole, this poses relevant limitations to world energy consumption and possible future energy systems. The realisation of a sustainable energy supply will stop the excessive growth of energy throughput, putting relevant constraints to economic growth, so that it will probably come to an end. An insight is given into the significance this development has for finance, economics, social security and the people on earth.

- 15 minutes break -

Invited Talk SOE 15.4 Wed 16:45 HSZ 02

Identifying critical infrastructures in complex supply networks — •Dirk Witthaut — Institut für Energie- und Klimaforschung, Forschungszentrum Jülich — Institut für theoretische Physik, Universität zu Köln — Max-Planck-Institut für Dynamik und Selbstorganisation

Transmission line failures can induce large-scale outages in power grids and other complex supply networks, causing potentially huge economic losses. Yet, how to determine which lines are particularly sensitive to inducing larger-scale outages is currently not well understood. In this talk I will discuss how the topological redundancy of a transmission line limits dynamical network robustness and allows to reliably identify critical infrastructures. I derive criteria to predict the dynamic stability of power grids based on the networks topology and the static loads prior to line failure. As both criteria are available before any outage from the state of normal operation, they may support network planning and real-time monitoring of grid operation.

Invited Talk SOE 15.5 Wed 17:15 HSZ 02

Short time fluctuations of renewable energies — •Joachim Peinke, M. Reza Rahimi Tabar, Patrick Milan, and Matthias Wächter — Institut für Physik und ForWind, Universität Oldenburg, Germany

Wind and solar energy, the main renewable energies on which the modern sustainable electrical power supply will be based, are characterized by a high volatility. News report frequently on a new challenge for the energy management to handle these new sources. For a better understanding of their impact on the electrical power system it is essential to know in more details the nature of the power fluctuations of wind and solar energy.

In our contribution we present results from an analysis of wind and solar power. We show that the turbulent features of the weather can be seen in the power output of such systems. We will mainly focus on the characterization and modeling of these power systems with advanced stochastic tools. Concerning the extreme event statistics, we show evidence that solar power is more volatile than wind power.

SOE 16: Networks - Statistics and Dynamics (joint with BP and DY)

Time: Wednesday 15:00–18:45 Location: ZEU 118

SOE 16.1 Wed 15:00 ZEU 118

Chimera states: spontaneous symmetry-breaking in dynamical networks — •Eckehard Schöll — Institut für Theoretische Physik, TU Berlin, Hardenbergstr 36, 10623 Berlin, Germany

Systems of nonlocally coupled identical oscillators can exhibit symmetry-breaking in the form of complex spatiotemporal patterns, called chimera states, which consist of coexisting domains of spatially coherent (synchronized) and incoherent (desynchronized) dynamics. We describe the scenario leading from complete coherence to complete incoherence via chimera states [1,2], and present a general analytical calculation of the critical coupling strength at the onset of the chimera states.

[1] I. Omelchenko, Y. Maistrenko, P. Hövel, and E. Schöll: Loss of coherence in dynamical networks: spatial chaos and chimera states, Phys. Rev. Lett. 106, 234102 (2011).

[2] A. Hagerstrom, T.E. Murphy, R. Roy, P. Hövel, I. Omelchenko, and E. Schöll: Experimental observation of chimeras in coupled-map lattices. Nature Physics 8, 658 (2012)

Work in collaboration with A. Hagerstrom, P. Hövel, K. Krischer, Y. Maistrenko, T.E. Murphy, I. Omelchenko, O.E. Omel'chenko, R. Roy, A. Zakharova.

SOE 16.2 Wed 15:15 ZEU 118

Pattern-matching via a network of phase oscillators of different frequency: A novel Architecture — •Daniel Heger and Katharina Krischer — Technische Universität München, Physikdepartment

Oscillatory networks can in principle be used for pattern recognition. Nevertheless, current architectures either lack scalability towards large numbers of oscillators or need the external input of complex time-dependent coupling functions. In our talk, we will present a novel architecture for pattern matching with oscillatory neural networks. A system of oscillators of different frequencies and coupling functions is used whose dynamics average to the dynamics of an all-to-all coupled oscillator network. In contrast to previous approaches, the necessary coupling functions are automatically generated inside the network and the output pattern can easily be read out binary. By additionally choosing a new type of coupling function, the matching mechanism is stable even for high coupling strengths and the degenerate attractive limit set containing the memorized patterns transforms to a system of seperated attractors for each memorized pattern. Although the system's dynamics do not average to the dynamics of simple coupled Kuramoto oscillators, the appealing mathematical structure permits determination of the stability of all fixed points using nonlinear stability analysis and a dynamic equation solely in pattern space can be derived.

SOE 16.3 Wed 15:30 ZEU 118

Data acquistion by vectorization of high resolution images of vascular networks — •Jana Lasser — Max-Planck-Institut für Dynamik und Selbstorganisation

Leaf vein networks form highly complex, reticulate, hierarchically organized webs that are believed to be the result of a process of gradual optimization over the course of evolutionary history. These networks form planar graphs dominated by cycles, but to this day the topological properties of such reticulate networks have not been adequately described. We analyze the hierarchical organization of the loops in transport networks from roughly 100 cleared leaf images that are converted into a weighted graph representation using custom tailor-made image analysis tools. We employ tools from statistics and topology, in particular an algorithmic way of assigning a topological tree graph to the leaf's loop graph which represents its hierarchical organization, thus allowing us to make use of specialized tree metrics to unravel the distinguishing characteristics between different network realisations. Our algorithmic tools allow us to quantitatively describe subtle differences between venation phenotypes, and compare reticulate network data with the predictions of optimisation models.

SOE 16.4 Wed 15:45 ZEU 118

Structure and Topology of Optimal Transport Networks in Plant Leaves — •Henrik Ronellenfitsch and Eleni Katifori — Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany

Efficient photosynthesis in plants crucially depends on the ability to transport water from the soil into the leaves, where it can evaporate. To this effect, plants are equipped with a network of pipe-like cells, the xylem, facilitating efficient delivery of water to all parts of the organism. In the leaf, these networks form highly complex, highly reticulate, hierarchically organized webs that are believed to be the result of a process of gradual optimization over the course of evolutionary history. Based on the assumption of functional optimization over the course of evolution, we construct models for optimal transport networks adapted

to different kinds of damage (modelling herbivory, diseases, etc...) and fluctuating load (modelling the fact that the stomata, small orifices responsible for the exchange of gasses, open in patches at a time). We numerically solve the resulting optimization problem and analyze the solutions with special regard to structure and hierarchical organization of loops which arise in response to damage and fluctuations.

SOE 16.5 Wed 16:00 ZEU 118

The topology of adaptively controlled networks — •Judith Lehnert[1], Philipp Hövel[1,2], Alexander Fradkov[3,4], and Eckehard Schöll[1] — [1]Institut für Theoretische Physik, TU Berlin, Hardenbergstr. 36, 10623 Berlin, Germany — [2]Bernstein Center for Computational Neuroscience, HU Berlin, Philippstr. 13, 10115 Berlin, Germany — [3]SPb State University, Universitetskii pr.28, St. Petersburg, 198504 Russia — [4]Institute for Problems of Mechanical Engineering, Russian Academy of Sciences, Bolshoy Ave, 61, V. O., St. Petersburg, 199178 Russia

Adaptive networks are characterized by a complicated interplay between the dynamics of the nodes and a changing topology: The topology evolves according to the state of the system, while at the same time the dynamics on the network and thus its state is influenced by that topology. Here, we present an algorithm for a changing topology that allows us to control the dynamics on the network. In particular, we control zero-lag and cluster synchronization in delay-coupled networks of Stuart-Landau oscillators.

The emerging topology of the network is modulated by the delay. If the delay time is a multiple of the system's eigenperiod, the coupling within a cluster and to neighboring clusters is on average positive (excitatory), while the coupling to clusters with a phase lag close to π is negative (inhibitory). For delay times equal to odd multiples of half of the eigenperiod, we find the opposite: Nodes within one cluster and of neighboring clusters are coupled by inhibitory links, while the coupling to clusters distant in phase state is excitatory.

SOE 16.6 Wed 16:15 ZEU 118

Hierarchical block structures and high-resolution model selection in large networks — •Tiago P. Peixoto — Universität Bremen, Germany

Many social, technological, and biological networks are composed of modules, which represent groups of nodes which have a similar role in the functioning of the network. The problem of detecting and characterizing these modules is a central one in the broad field of complex systems. However most existing methods used to obtain the modular structure of networks suffer from serious problems, such as the resolution limit on the size of communities. This phenomenon occurs for the very popular approach of modularity optimization, but also for more principled ones based on statistical inference and model selection. Here I construct a nested generative model which, through a complete description of the entire network hierarchy at multiple scales, is capable of avoiding this limitation, and enables the detection of modular structure at levels far beyond those possible by current approaches. Even with this increased resolution, the method is based on the principle of parsimony, and is capable of separating signal from noise. Furthermore, it fully generalizes other approaches in that it is not restricted to purely assortative mixing patterns, directed or undirected graphs, and ad hoc hierarchical structures such as binary trees..

References: [1] Tiago P. Peixoto, Phys. Rev. Lett. 110 14 148701 (2013); [2] Tiago P. Peixoto, arXiv: 1310.4377; [3] Tiago P. Peixoto, arXiv: 1310.4378

SOE 16.7 Wed 16:30 ZEU 118

Temporal networks: Laplacian spectra and synchronization — •Konstantin Klemm[1,2], Naoki Masuda[3], and Victor M. Eguiluz[4] — [1]Bioinformatics, Institute of Computer Science, Leipzig University, Germany — [2]Bioinformatics and Computational Biology, University of Vienna, Austria — [3]Department of Mathematical Informatics, The University of Tokyo, Japan — [4]Instituto de Fisica Interdisciplinar y Sistemas Complejos, Palma de Mallorca, Spain

Interactions among units in complex systems occur in a specific sequential order thus affecting the flow of information, the propagation of diseases, and general dynamical processes. We investigate the Laplacian spectrum of temporal networks and compare it with that of the corresponding aggregate network. First, we show that the spectrum of the ensemble average of a temporal network has identical eigenmodes but smaller eigenvalues than the aggregate networks. In large networks without edge condensation, the expected temporal dynamics is a time-rescaled version of the aggregate dynamics. Even for single sequential realizations, diffusive dynamics is slower in temporal networks [1]. These discrepancies are due to the noncommutability of interactions. The final part of the presentation uses the calculated spectra to predict the stability of non linear-systems with diffusive temporal couplings.

[1] N. Masuda, K. Klemm, V. M. Eguiluz, Phys. Rev. Lett. 111, 188701 (2013).

15 min break

SOE 16.8 Wed 17:00 ZEU 118

Phase Transitions in Cooperative Coinfections: Simulation Results for Networks and Lattices — •Weiran Cai[1], Li Chen[2,3], Fakhteh Ghanbarnejad[2], and Peter Grassberger[4] — [1]Faculty of Electrical and Computer Engineering, Technische Universität Dresden, Germany — [2]Max Planck Institute for Physics of Complex Systems, Dresden, Germany — [3]Robert Koch-Institut P4 - Epidemiologische Modellierung von Infektionskrankheiten, Berlin, Germany — [4]JSC, FZ Jülich, D-52425 Jülich, Germany

In this talk, we study the spreading of a cooperative coinfection on different networks topologies. Previous work has shown that in a mean field approximation, the cooperativity of two diseases in the SIR framework can lead to first-order transitions, where the relative size of the infected cluster changes discontinuously with respect to control parameters. However, due to the mean field approximation, such discontinuous transitions could occur only when the initial density of infected sites is finite. Here we show that the same is true on trees, but not on other networks. On Erdős-Renyi(ER) networks, on networks with long range contacts, and lattices with dimension = 3 we find first order transitions initiated even by a single sick site, while no first order transitions are observed on 2-dimensional lattices, if the contacts are short range. The importance of loops for the presence/absence of discontinuous transitions is discussed.

SOE 16.9 Wed 17:15 ZEU 118

Stability of Boolean and continuous dynamics — •Fakhteh Ghanbarnejad[1] and Konsatntin Klemm[2,3] — [1]Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany — [2]Bioinformatics, Institute for Computer Science, University of Leipzig, Germany — [3]Institute for Theoretical Chemistry, University of Vienna, Austria

Regulatory dynamics in biology is often described by continuous rate equations for continuously varying chemical concentrations. Binary discretization of state space and time leads to Boolean dynamics. In the latter, the dynamics has been called unstable if flip perturbations lead to damage spreading. Here, we find that this stability classification strongly differs from the stability properties of the original continuous dynamics under small perturbations of the state vector. In particular, random networks of nodes with large sensitivity yield stable dynamics under small perturbations. (Phys. Rev. Lett. 107, 188701 (2011))

SOE 16.10 Wed 17:30 ZEU 118

Physiological networks studied with time-delay stability analysis — •Jan W. Kantelhardt[1], Amir Bashan[2], Ronny P. Bartsch[3], Shlomo Havlin[2], and Plamen C. Ivanov[3] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg — [2]Department of Physics, Bar-Ilan University, Israel — [3]Harvard Medical School, Boston, USA

The human organism is an integrated network where complex physiological systems, each with its own regulatory mechanisms, continuously interact, and where failure of one system can trigger a breakdown of the entire network. Identifying and quantifying dynamical networks of diverse systems with different types of interactions is a challenge. We have developed time-delay stability analysis as a framework to probe interactions among diverse systems and identified a physiological network from recorded time series data. Each physiological state is characterized by a specific network structure, demonstrating a robust interplay between network topology and function. Across physiological states, the network undergoes topological transitions associated with fast reorganization of physiological interactions on time scales of a few minutes, indicating high network flexibility in response to perturbations.

SOE 16.11 Wed 17:45 ZEU 118

Large networks have small Problems — •Helge Aufderheide[1] and Thilo Gross[2] — [1]Max-Planck Institut für Physik komlpexer Sys-

teme — [2]University of Bristol, MV School of Engineering Mathematics

On several levels, humans depend on the functioning of complex networks, such as food webs and technical infrastructure networks. However, recent work shows that trying to stabilize a network can lead to large-scale failures. This suggests that it is important to assess not only the risk of a failure, but also its scale. Here we show that instabilities which naturally occur in large networks are typically localized, such that they affect only a relatively small part of the network directly, whereas attempts to stabilize the network can lead to a delocalization, such that instabilities are less likely but will affect a larger number of nodes when they occur. These results may explain how many natural networks can stabilize themselves by sacrificing the parts in which instabilities occur, whereas cases of delocalized systemic failure are known to occur in artificial technical or organizational networks.

SOE 16.12 Wed 18:00 ZEU 118

Outbreaks of coinfections: the critical role of cooperativity — •Fakhteh Ghanbarnejad[1], Li Chen[1], Weiran Cai[2], and Peter Grassberger[1,3] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]Faculty of Electrical and Computer Engineering, TU Dresden, Germany — [3]JSC, FZ Jülich, D-52425 Jülich, Germany

Modeling epidemic dynamics plays an important role in studying how diseases spread, predicting their future course, and designing strategies to control them. In this talk, we introduce a model of SIR (susceptible-infected-removed) type which explicitly incorporates the effect of *cooperative coinfection*. More precisely, each individual can get infected by two different diseases, and an individual already infected with one disease has an increased probability to get infected by the other. Depending on the amount of this increase, we prove different threshold scenarios. Apart from the standard continuous phase transition for single disease outbreaks, we observe continuous transitions where both diseases must coexist, but also discontinuous transitions are observed, where a finite fraction of the population is already affected by both diseases at the threshold. All our results are obtained in a mean field model using rate equations, but we argue that they should hold also in more general frameworks. (arXiv:1307.2404)

SOE 16.13 Wed 18:15 ZEU 118

Onset of self-sustained activity in a simple model of excitable dynamics on graphs — •Christoph Fretter[1,2], Annick Lesne[3], Claus C. Hilgetag[1,4], and Marc-Thorsten Hütt[2] — [1]Department of Computational Neuroscience, Universitätsklinikum Hamburg-Eppendorf, Hamburg, Germany — [2]School of Engineering and Science, Jacobs University Bremen, Germany — [3]LPTMC UMR 7600, Université Pierre et Marie Curie-Paris 6, 4 place Jussieu, F-75252 Paris, France — [4]Department of Health Sciences, Boston Uniersity, Boston, USA

Models of simple excitable dynamics on graphs are an efficient framework for studying the interplay between network topology and dynamics. This subject is a topic of practical relevance to diverse fields, ranging from neuroscience to engineering. Using a discrete excitable node model, we analyse how a single excitation propagates through a random network as a function of the excitation threshold,that is, the percentage of excitations in the neighborhood required for an excitation of a node. Using numerical simulations and analytical considerations, we can understand the onset of sustained activity as an interplay between topological cycle statistics and path statistics. Our findings are interpreted in the context of the theory of network reverberations in neural systems, which is a question of long-standing interest in computational neuroscience.

SOE 16.14 Wed 18:30 ZEU 118

Laplacian Spectrum of 2d Lattice Triangulations — •Ella Schmidt, Benedikt Krüger, and Klaus Mecke — Institut für Theoretische Physik, FAU Erlangen-Nürnberg, Staudtstr. 7, 91058 Erlangen

Triangulations are an important tool in physics for describing curved geometries. Unimodular triangulations on 2d lattices can also be considered as connected, simple, plane graphs, which allows the appliance of methods from spectral graph theory on triangulations.

We calculate the distribution and averages of eigenvalues of the Laplacian matrix for random and highly ordered unimodular triangulations. Introducing a curvature energy of triangulations we measure microcanonical and canonical averages of the eigenvalues using Monte-Carlo-Simulations. We examine the probability distributions of the spectra of the ensembles of triangulations, the dependence of the eigenvalues on energy and temperature as well as the scaling with the lattice size and compare with random graph models.

In the microcanonical ensemble we find in agreement with our analytical predicitions a linear dependence of the algebraic connectivity and the spectral radius on the energy, in the canonical ensemble we encounter quasi-critical behaviour.

SOE 17: Economic Models

Time: Thursday 9:30–11:00 Location: GÖR 226

SOE 17.1 Thu 9:30 GÖR 226

Duality and stationary distributions of wealth distribution models — •Pasquale Cirillo, Wioletta Ruszel, and Frank Redig — Delft Institute of Applied Mathematics, TU Delft, Delft, The Netherlands

We analyze a class of energy and wealth redistribution models, discussing their economic implications. We characterize their stationary measures and show that they have a discrete dual process. In particular we show that the wealth distribution model with a non-zero propensity to save can never have invariant product measures. We also introduce diffusion processes associated to the wealth distribution models by "instantaneous thermalization". The emergence of Paretian tails in the distribution of wealth is also analyzed.

SOE 17.2 Thu 9:45 GÖR 226

Behavioral and network origins of wealth inequality: insights from a virtual world — •Benedikt Fuchs[1] and Stefan Thurner[1,2,3] — [1]Section for Science of Complex Systems, Medical University of Vienna, Spitalgasse 23, A-1090, Austria — [2]Santa Fe Institute, 1399 Hyde Park Road, Santa Fe, NM 87501, USA — [3]International Institute for Applied Systems Analysis, Schlossplatz 1, A-2361 Laxenburg, Austria

Almost universally, wealth is not distributed evenly within societies or economies. Most studies of wealth distributions suffer from low resolution of the data, and connections to the behavioral origins of wealth inequalities could so far not be established. Here we present wealth data of an entire economy of the players in a massive multiplayer online game. This unique dataset contains every player's wealth at any instant, as well as all of her actions. When comparing the wealth distribution with data from real world economies, we find striking similarities. Comparing measures of inequality such as the Gini index and the exponent of the power law tail of the wealth distribution, we find that wealth is distributed slightly more equally in the game than in western countries. Considering individual behavioral factors, we observe that the wealthiest players are monopolists of certain goods. We find that wealthy players generally are active members in social groups and entertain many mutual friendships; they have few personal enemies, but show pronounced animosity towards public enemies.

SOE 17.3 Thu 10:00 GÖR 226

Econophysics in modeling of regional development — •Efim Ya. Frisman and Mikhail Yu. Khavinson — Russia, 679016 Jewish Autonomous Oblast,Birobidzhan, Sholom-Aleikhem St., 4

The presentation will reflect experiences in regional development modeling in the context of econophysics. We explore regional development in the near equilibrium state by simulating the dynamics of main production factors (labor and capital). Regional economy can be considered a set of independently developing economic branches. The regional dynamics near the equilibrium point is in accordance with the heat irradiation law. The growth points (i.e., large investment projects) are capable of pulling the economy out of stagnation (thermodynamic equilibrium). This model is applied to the economic development of the Jewish Autonomous Region in the Russian Far East. Currently, a large project on the construction of Kimkano-Sutarsky mining complex is being realized in the autonomy. We have calcu-

lated the model parameters on the basis of the data gathered from the Jewish Autonomous Region. We have also evaluated the displacement of equilibrium points and determined a general trajectory of economy branches in the region. This research was supported by the Russian Foundation for Humanities (Project no. 13-12-79001).

SOE 17.4 Thu 10:15 GÖR 226

When forecasting of youth employment becomes as complex as weather forecasting — •Mikhail Yu. Khavinson and Matvey P. Kulakov — Russia, 679016 Jewish Autonomous Oblast,Birobidzhan, Sholom-Aleikhem St., 4

Having used the econophysical approach, we propose to study a complex interaction of different age-group workers in the aspect of nonlinear dynamics. These interactions can be described by a system of nonlinear ordinary differential equations. By analogy with biophysical models, the interaction of different age-group workers can be categorized into the following: neutralism, partnership, competition, discrimination (ageism, in particular), and oppression. The model contains complex stochastic dynamics or chaos, such as 'the butterfly effect' in the Lorenz system, referred to weather forecasting. The model allows the evaluation of possibilities of controlling the level of employment among different age-group workers by affecting the bifurcation parameters. We present the results of model verification on the data of the Jewish Autonomous Region (Russian Far East). We observe damped oscillations of employment in the region. According to simulation results, these fluctuations can be periodic in case of recession in the socio-economic situation.

This research was supported by the Russian Foundation for Humanities (Project no. 13-12-79001).

SOE 17.5 Thu 10:30 GÖR 226

Merging agent-based models with stock-flow consistent modeling in economics — •Oliver Richters — Universität Oldenburg, Institut für Chemie und Biologie des Meeres, Theoretische Physik / Komplexe Systeme — Wissenschaftliche Arbeitsgruppe nachhaltiges Geld

Agent-based modeling (ABM) provides microfoundations for economic models where macroeconomic relations emerge from interacting agents. Micro behaviour can generate complex macro trends. Unfortunately, they are generally not in agreement with basic accounting identities. In contrast, stock-flow consistent models (SFC) are macro models that integrate all stocks and flows of an economy and explain their mechanics. They rely on double-accounting bookkeeping for capital stocks and transactions and behavioral equations for the transactions not determined by the accounting structure. SFC mainly deal with aggregates of the institutional sectors and are therefore not based on a micro perspective.

Combining both approaches as suggested by Dirk Bezemer and others may lead to a consistent micro-foundation of macro behaviour and allows for a wide variety of models. After an insight in this emerging field, an application is given, studying the existence of an economic growth imperative in today's monetary system.

SOE 17.6 Thu 10:45 GÖR 226

G7 growth is bypassing the people — •Hans Danielmeyer and Thomas Martinetz — Institut für Neuro- und Bioinformatik, Uni Lübeck

The title identifies one of Paul Krugman's famous articles on socioeconomic mysteries. It was published in The NY Times years before the banking crash. We present its first theoretical proof and get perfect agreement with G7 data.

The absolute problem of macroeconomics is that it can only quantify supply since demand cannot be divided into added value chains. We solved it with symmetrical completion of variables and parameters for obtaining an equilibrium condition between supply and demand. The main costs are maintaining the technical infrastructure TI and law and order LO. Both increased since World War II from 8 to 20 % of the GDP, LO not least because the distribution of wealth (=TI) is nationally and internationally diverging. This doubles the cost of TI which is the driver of economic growth. The equilibrium condition shows that the rising cost of LO resulted in a flat maximum benefit for G7 people around 1985. This explains also why the weekly working time is increasing again after it had decreased from 96 hours per week in 1800 to a minimum of 35 hours around 1985.

Further consequences are just mentioned.

SOE 18: Evolutionary Game Theory and Economic Models (joint with BP and DY)

Time: Thursday 11:00–12:15 Location: GÖR 226

SOE 18.1 Thu 11:00 GÖR 226

Learning dynamics explains human behavior in Prisoner's Dilemma on networks — •Giulio Cimini[1] and Angel Sanchez[1,2] — [1]Grupo Interdisciplinar de Sistemas Complejos (GISC), Universidad Carlos III de Madrid, 28911 Leganés, Madrid, Spain — [2]Instituto de Biocomputación y Física de Sistemas Complejos (BIFI), Universidad de Zaragoza, 50018 Zaragoza, Spain

Cooperative behavior lies at the very basis of human societies, yet its evolutionary origin remains a key unsolved puzzle. Whereas reciprocity or conditional cooperation is one of the most prominent mechanisms proposed to explain the emergence of cooperation in social dilemmas, recent experimental findings on networked Prisoner's Dilemma games suggest that conditional cooperation also depends on the previous action of the player—namely on the 'mood' in which the player currently is. Roughly, a majority of people behave as conditional cooperators if they cooperated in the past, while they ignore the context and free-ride with high probability if they did not. However, the ultimate origin of this behavior represents a conundrum itself. Here we aim specifically at providing an evolutionary explanation of moody conditional cooperation. To this end, we perform an extensive analysis of different evolutionary dynamics for players' behavioral traits—ranging from standard processes used in game theory based on payoff comparison to others that include non-economic or social factors. Our results show that only a dynamic built upon reinforcement learning is able to give rise to evolutionarily stable moody conditional cooperation, and at the end to reproduce the human behaviors observed in the experiments.

SOE 18.2 Thu 11:15 GÖR 226

Human coordination in the presence of local and global information: A laboratory experiment — •Alberto Antonioni[1,2], Marco Tomassini[1], and Angel Sánchez[2] — [1]University of Lausanne, Switzerland — [2]Universidad Carlos III de Madrid, Spain

Pure coordination games arise in many situations that affect the functioning of society. In fact, many frequent social and economic activities require individuals to coordinate their actions on a common goal since in many cases the best course of action is to conform to the standard behavior. In particular, social coordination can be studied through coordination games between individuals located in space. Here we study the behavior of humans in the laboratory when they play a pure coordination game in a setting in which subjects are situated in a virtual two-dimensional grid space and can move around. We compare a local information setting situation to one in which global information is available. In the local information treatment subjects can see only the eight cells that are their spatial neighbors in the grid and they can decide if they want to move and/or pay a cost to switch to the other strategy type. In the global treatment subjects are in the same condition as before but they possess also the global information about the current fraction of strategies in the population. We observe that in the local information treatment people tend to converge to two separated monomorphic clusters each playing a different strategy. In contrast, in the global setting this can lead to full predominance of one strategy when strategy fluctuations reach a threshold such that imitation of the majority sets in.

SOE 18.3 Thu 11:30 GÖR 226

Differential value of information in non-cooperative games — Nils Bertschinger[1], David H. Wolpert[2], •Eckehard Olbrich[1], and Jürgen Jost[1,2] — [1]Max Planck Institut für Mathematik in den Naturwissenschaften, Leipzig — [2]Santa Fe Institute, NM, USA

We study how players value changes in the information structure of non-cooperative games with imperfect information.

We use the functionals central to Shannon's information theory to quantify amounts of information study how changes in the values of those functionals are related to changes in the expected utility of the

players. Our approach is based on the Multi-Agent Influence Diagram representation of games, and is based on a generalization of the concept of marginal utility in decision scenarios to apply to infinitesimal changes of the channel parameters in non-cooperative games. Using that framework we derive general conditions for the possibility of a negative value of information, and show that generically, these conditions hold in all games unless one imposes a priori constraints on the allowed changes to information channels. In other words, in any game in which a player values some aspect of the game's specification beyond the information provided in that game, there will be an infinitesimal change to the parameter vector specifying the game that increases the information but hurts the player.

We demonstrate these results numerically for a leader-follower game and discuss their general implications.

SOE 18.4 Thu 11:45 GÖR 226

Stability of Zero-Sum Games in Evolutionary Game Theory — •Johannes Knebel, Torben Krüger, Markus F. Weber, and Erwin Frey — Ludwigs-Maximilians-Universität, München, Deutschland

Evolutionary game theory has evolved into a successful theoretical concept to study mechanisms that govern the evolution of ecological communities. On a mathematical level, this theory was formalized in the framework of the celebrated replicator equations (REs) and its stochastic generalizations.

In our work, we analyze the long-time behavior of the REs for zero-sum games with arbitrarily many strategies, which are generalized versions of the children's game Rock-Paper-Scissors (1). We demonstrate how to determine the strategies that survive and those that become extinct in the long run. Our results show that extinction of strategies is exponentially fast in generic setups, and that conditions for the survival can be formulated in terms of the Pfaffian of the REs' antisymmetric payoff matrix. Consequences for the stochastic dynamics, which arise in finite populations, are reflected by a generalized scaling law for the extinction time in the vicinity of critical reaction rates.

Our findings underline the relevance of zero-sum games as a reference for the analysis of other models in evolutionary game theory.

(1) J. Knebel, T. Krüger, M.F. Weber, E. Frey, Phys. Rev. Lett. 110, 168106 (2013)

SOE 18.5 Thu 12:00 GÖR 226

Opportunistic strategies and the emergence of responsible punishment — •Arne Traulsen — Max-Planck-Institute for Evolutionary Biology, Evolutionary Theory Group, Plön, Germany

One way to promote cooperation among selfish actors is to allow for the opportunity to punish those peers who do not cooperate. However, the vast majority of models and behavioral experiments considers situations in which actors cannot assess whether it is likely that they will be punished. If this information is available, opportunistic strategies that act according to this information become possible and lead to the emergence of responsible punishment targeted at non-cooperators only, without the problems of antisocial punishment, second order free-riding or spite. Also for institutional, so called pool punishment, such opportunistic strategies are successful, which implies that the presence of punishment institutions should be made public.

SOE 19: Networks, From Topology to Dynamics II (joint with DY and BP)

Time: Thursday 12:15–13:00 Location: GÖR 226

SOE 19.1 Thu 12:15 GÖR 226

Synchronization in two-layer multiplex networks of conformist and contrarian interactions — •Maximilian Sadilek[1] and Stefan Thurner[1,2,3] — [1]Section for Science of Complex Systems, Medical University of Vienna, Spitalgasse 23, A-1090, Austria — [2]Santa Fe Institute, 1399 Hyde Park Road, Santa Fe, NM 87501, USA — [3]International Institute for Applied Systems Analysis, Schlossplatz 1, A-2361 Laxenburg, Austria

Several mathematical models have been proposed to describe synchronization in social, biological and physical systems, the most known being the Kuramoto model (KM).

We present a Kuramoto-type model on two layers which is designed to capture the interplay of synchronization-enhancing (conformist) and -reducing (contrarian) links in a multiplex network. The model is a combination of a KM on the first layer and a phase shifted KM on the second layer. The topology of the layers varies from random networks to small world networks.

We find indications of a phase transition from the synchronized to the unsynchronized phase in terms of the phase shift parameter of the model. Further, we observe an upward shift of the dominant frequencies in the power spectra with increasing values of the phase shift parameter.

These results may elucidate the understanding of synchronization modes in the human brain and their consequences.

SOE 19.2 Thu 12:30 GÖR 226

Controllability of Temporal Networks — •Márton Pósfai[1,2] and Philipp Hövel[2,3] — [1]Department of Physics of Complex Systems, Eötvös University, Budapest, Hungary — [2]Institut für Theoretische Physik, TU Berlin, Berlin, Germany — [3]Bernstein Center for Computational Neuroscience, HU Berlin, Berlin, Germany

The control of complex systems is an ongoing challenge of complexity research. Resent advances making use of structural control made it possible to deduce a wide range of control related properties from the network representation of complex systems. Here we examine the controllability of complex systems for which the timescale of the dynamics we control and the timescale of changes in the network topology are comparable. We provide analytical and computational tools to study the controllability of such systems based on temporal network characteristics of the system. We apply these results to investigate the controllable subnetwork using a single input. We present analytical results for a simple class of temporal network models, and we preform measurements using data collected from real systems. Depending on the density of the interactions compared to the timescale of the dynamics, we witness a phase transition describing the sudden emergence of a giant controllable subspace spanning a finite fraction of the network. We also study the role of temporal patterns in real data making use of various randomization processes, with special focus on the role of the hubs.

SOE 19.3 Thu 12:45 GÖR 226

Analysis of local network structure by node-specific triadic Z-score profiles — •Marco Winkler and Jörg Reichardt — Institute for Theoretical Physics, University of Würzburg, Germany

Over the last decade so called network motifs have attracted high attention. A motif is a subgraph pattern that appears significantly more often than in a random network with the same degree distribution as the original one. Triadic Z-score profiles, $\vec{Z}$, assign every possible triadic subgraph pattern i a score Z_i, corresponding to the magnitude of over-/underrepresentation of the pattern compared to the random null model. These Z-score profiles are a common tool to analyze complex networks.

However, triad patterns are not necessarily homogeneously distributed over the network. Therefore, we introduce the concept of *node-specific Z-scores*. For the node-specific Z-score profile, $\vec{Z}^{\alpha}$, of a node α, only the triads it participates in are taken into account. The node-specific Z-score profiles can then be used for classification of a network's vertices into different structural groups. We present results for various real-world data sets including neural networks and transcription networks.

SOE 20: Symposium SYGP: Stochastic Dynamics of Growth Processes in Biological and Social Systems

Time: Thursday 15:00–17:45 Location: HSZ 02

Invited Talk SOE 20.1 Thu 15:00 HSZ 02

Noisy invasions: large fluctuations in stochastic invasion models — •Baruch Meerson — Racah Institute of Physics, Hebrew University of Jerusalem, Jerusalem 91904 Israel

Invasion fronts have been recognized as important, and often fateful, phenomena in ecology, epidemiology and biological evolution. The position of an invasion front fluctuates because of the shot noise of individual reactions. What is the probability to observe, at a given time, a front displacement that is considerably smaller or larger than that predicted from deterministic theory? The answer strongly depends on whether the front propagates into a metastable or unstable state, and I will review recent theoretical progress in both cases. The progress is mostly based on a dissipative version of WKB theory which assumes many individuals in the front region. In this theory the most likely history of the system, for a given front displacement, is encoded in a special trajectory of the underlying effective Hamilton mechanics, a classical field theory. This special trajectory is described by a traveling front solution. For fronts, propagating into unstable states, very large front displacements are much more likely than very small ones. The leading contribution to the probability density of a large displacement comes from a few fastest particles running ahead of the front. For such fronts the WKB theory breaks down, and new methods are needed.

Invited Talk SOE 20.2 Thu 15:30 HSZ 02

Fractal clustering of inertial particles in random velocity fields — •Bernhard Mehlig and Kristian Gustavsson — Department of Physics, University of Gothenburg, 41296 Gothenburg, Sweden

Independent particles suspended in incompressible turbulent or randomly mixing flows may cluster together even though incompressible flows exhibit no sinks. This is an inertial effect: inertia allows the particles to detach from the flow. Distinct mechanisms have been invoked to explain clustering in incompressible flows. The two most common ones are "preferential concentration" and "multiplicative amplification". Preferential concentration refers to the tendency of heavy particles to avoid vortical regions of the flow. Multiplicative amplification, by contrast, explains clustering in terms of the logarithmic amplification of the sequence of many small kicks that the suspended particles experience.

In order to quantify the relative importance of the two mechanisms it is necessary to compute the fluctuations of the flow-velocity gradients that the particles experience as they move through the flow. We show how this can be achieved systematically by means of perturbation expansions that recursively take into account how the flow affects the actual particle trajectory. We analyse the statistics of particle- and flow-velocity gradients as seen by the particles. Based on these results we show that in random velocity fields multiplicative amplification has a much stronger effect than preferential concentration, except at very small Stokes numbers. We discuss the implications of these findings for particles suspended in turbulent flows.

Invited Talk SOE 20.3 Thu 16:00 HSZ 02

Stochastic population dynamics on rugged fitness landscapes — •Joachim Krug — Institut für Theoretische Physik, Universität zu Köln

Biological evolution is inherently noisy because of random mutations and stochasticity induced by sampling in finite populations. Since the sampling noise is inversely proportional to population size, one expects deterministic dynamics to emerge in large populations, but in practice this regime is hardly every attainable and fluctuations dominate the behavior even in the largest microbial populations. In this talk I will show how the interplay of the stochastic population dynamics with the structure of the underlying fitness landscape can lead to counter-intuitive phenomena such as an adaptive advantage of small populations and a non-monotonic dependence of evolutionary predictability on population size. If time permits, the adaptive benefits of recombination in rugged fitness landscapes will be briefly addressed as well. The talk is based on joint work with Kavita Jain, Johannes Neidhart, Stefan Nowak, Su-Chan Park, Ivan Szendro and Arjan de Visser.

15 min break

Invited Talk SOE 20.4 Thu 16:45 HSZ 02

Modeling cancer as a stochastic process — •Tibor Antal — School of Mathematics at Edinburgh University, Edinburgh, UK

Stochasticity is essential when modeling initiation of tumors, progression of tumors from benign to malignant states, or metastasis formation. Many aspects of these phenomena can be modeled by simple multi-type branching processes, and the results compare fairly well with experimental and clinical data. These models then can be used to optimize drug treatments. Spatial heterogeneity of tumors are also important for treatment, and their exploration has recently begun by modeling the interplay between tumor shapes and genetic mutations.

Invited Talk SOE 20.5 Thu 17:15 HSZ 02

Von Neumann's growth model: from statistical mechanics to cell metabolism — •Andrea De Martino — Sapienza Universita' di Roma & CNR, Roma, Italy

This talk reviews the basic properties of Von Neumann's model of growth in production economies, mainly from a statistical mechanics perspective. In addition, I will discuss its recent applications in quantitative biology, for the profiling of a cell's metabolic activity and of its thermodynamics. Finally, a class of Boolean constraint-satisfaction problems based on Von Neumann's idea will be presented, whose solutions allow to shed new light on the modular organization of metabolic networks.

SOE 21: Traffic Dynamics, Urban and Regional Systems I

Time: Friday 9:30–10:00 Location: GÖR 226

SOE 21.1 Fri 9:30 GÖR 226

Phases of scaling and cross-correlation behavior in traffic — •Jan W. Kantelhardt[1], Matthew Fullerton[2], Mirko Kämpf[1], Cristina Beltran-Ruiz[3], and Fritz Busch[2] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg — [2]Department of Traffic Engineering, Technische Universität München — [3]Sociedad Iberica de Construcciones Electricas, Madrid, Spain

While many microscopic models of traffic flow describe transitions between different traffic phases, such transitions are difficult to quantify in measured traffic data. Here we study long-term traffic recordings consisting of $\approx$ 2900 days of flow, density, and velocity time series with minute resolution from a Spanish motorway. We calculate fluctuations, cross-correlations, and long-term persistence properties of these quantities. This leads to a data-driven definition of three (local) traffic states based on the dynamical properties of the data. The states can be identified with free flow, viscous traffic, and traffic jam. The dynamic classification is related with a static classification into three regions in the flow-density diagram.

SOE 21.2 Fri 9:45 GÖR 226

Air Traffic, Boarding and Scaling Exponents — •Reinhard Mahnke — Rostock University, Institute of Physics, D-18051 Rostock, Germany

The air traffic is a very important part of the global transportation network. In distinction from vehicular traffic, the boarding of an airplane is a significant part of the whole transportation process.

Here we study an airplane boarding model, introduced in 2012 by Frette and Hemmer, with the aim to determine precisely the asymptotic power–law scaling behavior of the mean boarding time $\langle t_b \rangle$ and other related quantities for large number of passengers N. Our analysis is based on an exact enumeration for small system sizes $N \leq 14$ and Monte Carlo simulation data for very large system sizes up to

$N = 2^{16} = 65\,536$. It shows that the asymptotic power–law scaling $\langle t_b \rangle \propto N^{\alpha}$ holds with the exponent $\alpha = 1/2$ ($\alpha = 0.5001 \pm 0.0001$). We have estimated also other exponents: $\nu = 1/2$ for the mean number of passengers taking seats simultaneously in one time step, $\beta = 1$ for the second moment of $\langle t_b \rangle$ and $\gamma \approx 1/3$ for its variance. We have found also the correction–to–scaling exponent $\theta \approx 1/3$ and have verified that a scaling relation $\gamma = 1 - 2\theta$, following from some analytical arguments, holds with a high numerical accuracy.

SOE 22: Traffic Dynamics, Urban and Regional Systems II

Time: Friday 10:00–11:00 Location: GÖR 229

SOE 22.1 Fri 10:00 GÖR 229

Prediction of lane changes with a mathematical model using steering wheel angle — •Kim Schmidt, Matthias Beggiato, Karl Heinz Hoffmann, and Josef F. Krems — Technische Universität Chemnitz, Chemnitz, Deutschland

Advanced driver assistance systems aim at increasing driving safety. However, positive safety impact can only take effect if drivers accept and use these systems. If too many false alarms occur, the systems are switched off and the potential gain in safety gets lost. Early detection of driver's intention would allow a selective activation of these assistance systems. A present driving simulator study aims at exploring early predictors of lane changes. In total, 3,111 lane changes of fifty-one participants, which drove the same highway track in a fixed-base driving simulator, were analyzed. Results show that drivers stopped their engagement in the secondary task about 7 seconds before crossing the lane, which indicates a first planning phase of the maneuver. Subsequently, drivers start moving towards the lane marking with a mean steering wheel angle of 2.5 degrees. Steering wheel angle as a directly measurable vehicle parameter appears as promising early predictor of a lane change. A mathematical model of the steering wheel angle is presented for lane change. This model is supposed to contribute for predicting lane change maneuvers.

SOE 22.2 Fri 10:15 GÖR 229

Autonomous Vehicle Control through Dynamic Traffic Scenarios Based on Artificial Potential Fields — •Thomas Streubel[1] and Karl Heinz Hoffmann[2] — [1]Adam Opel AG, Rüsselsheim, Deutschland — [2]TU Chemnitz, Deutschland

Mobility is a basic need in modern societies. However, the increasing traffic volume is challenging and asks for efficient solutions. Drivers are not capable of synchronizing traffic streams due to inherent limits of our cognitive abilities. Autonomous driving can overcome this restraint with sensor systems providing environmental information more accurate and faster than any driver would be able to. Here, this information is utilized to create an environmental representation in the form of an artificial potential field. In the field of robotics, it is already used for autonomous motion control. However, the vehicle environment differs greatly especially on highways due to the high speed and vehicle dynamics. We introduce road and object models to generate the artificial potential field, so the objects as well as the road edge is assigned a high potential while the potential on the lanes is rather low. This can be interpreted as a risk map. So, the driving task is reduced to seek for a lower potential. Thus, the adverse gradient is retrieved from the potential field and is used directly for the vehicle control. Consequently, the modeling of objects and roads determines the driving behavior. The vehicle control is realized in a simulation. In particular, the lateral and longitudinal control was combined and tested in the scenario "approaching a slower vehicle in a highway environment".

SOE 22.3 Fri 10:30 GÖR 229

SPINWIRE(R): the smart solution for cities in motion — •I. Fina[1], X. Marti[1], J. Garces[1], and T. Jungwirth[2,3] — [1]IGSresearch, Barcelona, Spain — [2]Institute of Physics ASCR, v.v.i., Cukrovarnick 10, 162 53 Praha 6, Czech Republic — [3]School of Physics and Astronomy, University of Nottingham, Nottingham NG7 2RD, United Kingdom

SPINWIRE(R) is the revolutionary method for deploying millions of sensors to monitor everything from street parking and traffic flow, to vehicle permits. By removing the expensive batteries, maintenance costs became negligible and nonstop high frequency readings possible, owing to magnetoresistive nanometric sensors help. Check it: www.igsresearch.com

SOE 22.4 Fri 10:45 GÖR 229

Large scale embedded networks: The UK bus grid — •Masayuki Hase[1] and Christian von Ferber[2] — [1]Universidade de Sao Paulo, Sao Paulo, Brasil — [2]AMRC, Coventry University, Coventry, UK

Using large scale data on a large part of the UK public bus networks we investigate the embedding of these interconnected networks in the given underlying road network. In particular we investigate the statistics of spatial route distance as function of the number of stations traveled testing earlier observations of fractal and Levy type behaviour in smaller systems. We identify different regimes for these particular behaviours. Further, we investigate the shapes of the local embedded networks applying notions developed for polymer shape characterisation.

SOE 23: Stochastic Dynamics of Growth Processes in Biological and Social Systems (session accompanying symposium SYGP, joint with DY and BP)

Time: Friday 10:00–12:45 Location: GÖR 226

SOE 23.1 Fri 10:00 GÖR 226

Evolution of increasingly complex linear molecules — •Philipp Zimmer[1], Emanuel Gregor Worst[2], Eva Wollrab[2], Albrecht Ott[2], and Karsten Kruse[1] — [1]Universität des Saarlandes, Theoretische Biologische Physik, Postfach 151150, 66041 Saarbrücken — [2]Universität des Saarlandes, Biologische Experimentalphysik, Postfach 151150, 66041 Saarbrücken

Darwinian evolution is based on variation and selection acting on mutations, reproduction, or the metabolism of a species. These processes can only take place when the underlying system is out of thermodynamical equilibrium. For natural evolution the species as well as their relation network has continuously been gaining complexity. The conditions necessary for a steady increase in complexity are not well understood. Performing stochastic simulations as well as experiments with DNA, we analyze a chemical system consisting of autocatalytically concatenating chains. We find that, despite its inherent stochastical nature, the system evolves along a reproducible path towards states of increasing complexity if the autocatalytic activity exceeds a critical value.

SOE 23.2 Fri 10:15 GÖR 226

Autocatalysis in a primordial broth — •Sabrina Scherer, Eva Wollrab, and Albrecht Ott — Biologische Experimentalphysik, Universität des Saarlandes

In many energetically driven systems non-linearities lead to pattern formation. Here we study the dynamics of a driven primordial broth, synthesized from a gas mixture of methane, ammonia and steam that is triggered by eletric discharge and heat. Using real-time mass spectrometry, we observe the generation of many hundreds of different molecules in a mass range from 50 to 1000 Dalton. The temporal course of the primordial broth reveals the spontaneous emergence and disappearance of several oligomeric groups that consist primarily of polyethylene glycol (PEG) surfactants. These oligomers appear in aperiodic oscillations. This requires stronger non-linearities than a simple autocatalytic reaction. PEG and -surfactants are well known phase-transfer catalysts, able to favour biochemical reactions by inhibiting

hydrolysis. We suggest that autocatalytic phase-transfer leads to self-organizing processes in a primordial broth and enables the production of relevant biomolecules.

SOE 23.3 Fri 10:30 GÖR 226

Cooperation in suddenly changing environments — •Karl Wienand[1], Jonas Cremer[2], Anna Melbinger[2], and Erwin Frey[1] — [1]Arnold Sommerfeld Center for Theoretical Physics, Ludwig-Maximilians-Universität München, Theresienstrasse 37, 80333 München, Germany — [2]UC San Diego, 9500 Gilman Dr., La Jolla, CA 92093, U.S.A.

The interdependence of evolutionary and growth dynamics shapes the evolutionary fate of populations. This is especially the case in microbial populations, where volatile population sizes and capricious environments are the rule rather than the exception. A suddenly changing carrying capacity, which periodically oscillates between abundance and scarcity of resources, represents such changing environment and causes the population size to grow and shrink. The variation in size, in turn, affects the evolutionary dynamics. Studying this complex interplay, we find most oscillating environments enhance demographic fluctuations and cooperative behavior.

SOE 23.4 Fri 10:45 GÖR 226

Selection and drift in expanding bacterial colonies — •Fred Farrell[1], Bartlomiej Waclaw[1], Davide Marenduzzo[1], and Oskar Hallatschek[2] — [1]School of Physics, University of Edinburgh, Edinburgh, UK — [2]Department of Physics, University of California, Berkeley, California, USA

In an expanding population, such as a bacterial colony growing on a surface in the laboratory or in nature, evolution proceeds very differently to in a well-mixed population with a static population size. This is mostly due to the so-called founder effect, where individuals close to the expanding front of the population have a much better chance of passing their genes on to future generations than those deep within the population. Since there are relatively few of these founders, rates of genetic drift are much higher, and the probability that a beneficial mutation will fixate in the population much lower. This is important as it will impact the speed with which such a population adapts to its environment, for example developing antibiotic resistance.

I will present my work using a fairly detailed agent-based biophysical simulation model of an expanding microbial colony to estimate probabilities of fixation of beneficial mutations, and how these depend on the fitness advantage and the properties of the cells, and compare these results to analytical theories of selection in expanding populations.

SOE 23.5 Fri 11:00 GÖR 226

Bacterial population genetics in antibiotic concentration gradients: Accelerated evolution of antibiotic resistance — •Philip Greulich[1,2], Bartlomiej Waclaw[2], and Rosalind Allen[2] — [1]Cavendish Laboratory, University of Cambridge, Cambridge, UK — [2]School of Physics and Astronomy, University of Edinburgh, Edinburgh, UK

The increased emergence of antibiotic resistance poses a major threat to human health nowadays. Evolution of antibiotic resistance occurs by a sequence of mutations (mutational pathway) when bacteria are exposed to the selection pressure of an applied antibiotic. Recent experiments indicate that the spatial distribution of an antibiotic plays an important role for the evolution of antibiotic-resistant bacterial strains. I will present a stochastic model for the population genetics of bacteria growing in different spatial distributions of an antibiotic. This model reveals an intriguing interplay between the mutational pathway and the spatial structure of the drug distribution. It shows that spatial gradients in antibiotic concentrations can strongly accelerate the emergence of resistance when the mutational pathway involves a long sequence of mutants. However, gradients may slow down evolution if the pathway is short or crosses a fitness valley.

SOE 23.6 Fri 11:15 GÖR 226

Evolution of the size distribution of colloidal particles: focussing, breakdown of scaling, and asymptotic distributions — •Martin Rohloff[1,2] and Jürgen Vollmer[1,2] — [1]Max Planck Institute for Dynamics and Self-Organisation (MPIDS), 37077 Göttingen, Germany — [2]Faculty of Physics, University of Göttingen, 37077 Göttingen, Germany

Mechanisms underlying the synthesis of mono-disperse colloids and nanocrystals are under vivid discussion. A common feature of the recipies is the growth of an assembly of particles subjected to a flux of material, provided e.g. by a chemical reaction like the decomposition of precurser.

We present analytical and numerical studies on diffusion dominated growth of particles with a constant overall volumetric growth rate. The resulting particle growth is qualitatively different from Ostwald ripening, and it leads to narrow and non-universal asymptotic size distributions.

SOE 23.7 Fri 11:30 GÖR 226

Multi-Species Range Expansions: Frequency-Dependent Selection at Rough Fronts — •Jan-Timm Kuhr and Holger Stark — Institut für Theoretische Physik, Technische Universtität Berlin

Growing microbial colonies have recently been used as model systems for macroscopic colonization events, known as range expansions, since growth in the Petri dish is comparably fast and controllable.

Employing the statistical Eden model, already single-strain colonies feature remarkable properties like self-affine fronts, which have also been found in experiments. Multi-species settings promise a plethora of possible phenomena, e.g. irreversible mutations resulting in a non-equilibrium phase transition to an absorbing state [1].

Whereas a simple selective advantage entails quasi-deterministic fixation of the faster growing strain, local frequency-dependent selection gives rise to non-trivial outcomes. We focus on representations of social dilemmas, where local group selection brings about extremely rough fronts, the effects of which are neglected in other approaches.

[1] J.-T. Kuhr, M. Leisner, and E. Frey, *Range expansion with mutation and selection: dynamical phase transition in a two-species Eden model*, New J. Phys. **13**, 113013 (2011).

SOE 23.8 Fri 11:45 GÖR 226

Clonal interference and Muller's ratchet in spatial habitats — Jakub Otwinowski[1] and •Joachim Krug[2] — [1]Biology Department, University of Pennsylvania, Philadelphia, USA — [2]Institute for Theoretical Physics, University of Cologne, Cologne, Germany

Competition between independently arising beneficial mutations is enhanced in spatial populations due to the linear rather than exponential growth of the clones. The resulting fitness dynamics is analogous to a surface growth process, where new layers nucleate and spread stochastically, leading to the build up of scale-invariant roughness. This scenario differs qualitatively from the standard view of adaptation in that the speed of adaptation becomes independent of population size while the fitness variance does not, in apparent violation of Fisher's fundamental theorem. Here we exploit recent progress in the understanding of surface growth processes to obtain precise results for the universal, non-Gaussian shape of the fitness distribution for one-dimensional habitats. We then consider a version of the model where all mutations are deleterious, that is, a spatial version of Muller's ratchet. Based on an analogy to models of nonequilibrium wetting, we show that the system displays a phase transition related to directed percolation. The transition is governed by the ratio U/s^2, where U denotes the deleterious mutation rate and s the selection coefficient of mutations. For $U/s^2 > 1$ the speed of the ratchet remains finite in the limit of infinite habitat size.

SOE 23.9 Fri 12:00 GÖR 226

A Non-Equilibrium Phase Transition in a Biofilm Growth Model in a Fluctuating Environment — •Florentine Mayer and Erwin Frey — Arnold Sommerfeld Center for Theoretical Physics (ASC) and Center for NanoScience (CeNs), Department of Physics, Ludwig-Maximilians-Universität München, Germany

Bacterial communities represent complex and dynamic ecological systems. They appear in the form of free-floating bacteria and biofilms in nearly all parts of our environment. They are highly relevant for human health and disease. Spatial patterns arise from heterogeneities of the underlying landscape or are self-organized by the bacterial interactions, and play an important role in maintaining species diversity. Bacteria must rapidly adapt to fluctuating environments in order to survive. In biofilms this is often achieved by phenotypic diversity, where bacteria can switch between different phenotypic states. Survival of the population can increase if each of these phenotypes is adapted to different environmental conditions.To analyze biofilm growth we set up a two-species automaton model in which growth, death and switching rates depend on the environmental conditions. These fluctuate, resulting in periodically interchanged reaction rates. Depending on the rates we find either fast extinction or thriving biofilms with intriguing spatio-temporal patterns. Close to the region of extinction patterns become

self-affine, which is typical for a phase transition to an absorbing state. Employing extensive stochastic simulations we measure critical exponents of our non-equilibrium phase transition and find universal scaling behaviour characterising the universality class of our model.

SOE 23.10 Fri 12:15 GÖR 226

Discrete scale invariance in growing networks — Wei Chen[1,2,3], •Malte Schröder[4], Raissa M. D'Souza[3], Didier Sornette[5], and Jan Nagler[5,4] — [1]Chinese Academy of Sciences, Beijing — [2]Peking University, Beijing — [3]University of California, Davis — [4]MPI DS Göttingen — [5]ETH Zürich

Discrete scale invariance (DSI) arises in systems where the usual (continuous) scale invariance (for example at phase transitions) is partially broken, leading to a remarkable discrete hierarchy of resonances in the system order parameter. DSI has broad technical, physical and biological relevance, penetrating statistical physics (Potts model, Singularities), hydrodynamics, turbulence, astronomy, evolution, fracture and economics. (D. Sornette, Phys. Rep. 297, 239 (1998)).

A hierarchy of discrete micro-transitions leading up to the transition to global connectivity in models of continuous and discontinuous percolation is observed. These transitions can in some cases be observed in the relative variance of the size of the largest cluster even in the thermodynamic limit.

Depending on the model these cascades exhibit either genuine discrete scale-invariance or a generalized (novel) form. In contrast to average values, the size of the largest cluster before the phase transition is limited to integer values. This leads to a family of scaling relations that describe the behavior of the micro-transition cascade (Chen, Schröder, D'Souza, Sornette, Nagler (under review)). Our findings open up the possibility for the prediction of tipping in complex systems that are dominated by large-scale disorder.

SOE 23.11 Fri 12:30 GÖR 226

Firm growth and inter-organizational flows in the Stockholm region, 1990-2003 — •Hernan Mondani[1], Petter Holme[2,3,1,4], and Fredrik Liljeros[1,4] — [1]Department of Sociology, Stockholm University, Sweden — [2]Department of Energy Science, Sungkyunkwan University, Korea — [3]IceLab, Department of Physics, Umeå University, Sweden — [4]Institute for Futures Studies, Stockholm, Sweden

Explaining the emergence of fat-tailed growth-rate distributions in terms of the action of individual agents remains an important open question in the study of socio-economic systems. Studies of organizational growth statistics are limited by the quantity and level of detail of the available information. Large databases have little or no information about the composition of each workplace, and the time-dependent variables are often reported at the level of the organization.

In this empiric study, we use Swedish register data, a quite unique individual-level longitudinal database that provides data on organizational membership of all workers in the Stockholm region, for a period of 14 years (1990-2003). With this dataset, we can analyze how individual attributes are aggregated at the organizational level, and track individual movements on a yearly basis.

We compute statistics for organizational size and growth, and look at their time evolution in the period of analysis. We further study the distribution of individual-level properties across organizations, especially the in- and out-flow of people moving between organizations.