DY 20: Networks III

Time: Wednesday 15:00–16:45 Location: MA 004

DY 20.1 Wed 15:00 MA 004

Efficient transport and symmetries in models of Light Harvesting Systems — Tobias Zech[1], •Roberto Mulet[1,2], Torsten Scholak[1], Thomas Wellens[1], and Andreas Buchleitner[1] — [1]Quantum optics and statistics, Institute of Physics Albert Ludwigs University of Freiburg Hermann-Herder-Str. 3 D-79104 Freiburg — [2]Group of Complex Systems, Department of Theoretical Physics. Physics Faculty, University of Havana. La Habana, Cuba

Recent experimental results suggest the existence of quantum coherence and efficient transport in Light Harvesting Systems. Particularly motivated by results on the FMO complex we study exciton transport in random tri-dimensional lattices of seven sites with long range dipolar interactions. We show that some of these networks are consistent with efficient transport.

Moreover, we present evidence that the statistically relevant Hamiltonians associated with the efficient transport are centro-symmetric. We compare our results with numerical tests on realistic Hamiltonians for Light Harvesting systems and present a finite size scaling analysis of the model. Some implications of our results for the comprehension of the role of symmetry in Biology and for Quantum Communications are outlined.

DY 20.2 Wed 15:15 MA 004

Traveling fronts and stationary patterns in bistable reaction-diffusion systems on networks — •Nikos Kouvaris[1], Hiroshi Kori[2], and Alexander Mikhailov[1] — [1]Department of Physical Chemistry, Fritz Haber Institute of the Max Planck Society, Faradayweg 4-6, D-14195 Berlin, Germany — [2]Division of Advanced Sciences, Ochadai Academic Production, Ochanomizu University, Tokyo 112-8610, Japan

We focus on activation fronts in bistable one-component systems on large complex networks. Fronts can trigger a transition from the one stable state to the other which spreads in the entire network. However, depending on the connectivity pattern of the network and the strength of diffusive coupling, the fronts can be pinned forming stationary localized patterns or can be retracted into their sources. Particularly, a front can be spread through nodes with low degrees, can be pinned at nodes with higher degrees, or can be retracted from nodes with even higher degrees. Similar behavior is observed for various values of coupling. This reach dynamical behavior can be described in terms of a mean field theory, while for the specific class of complete k-ary tree networks, saddle-node bifurcations have been found that distinguish the different dynamical regimes of traveling fronts and stationary patterns. Theoretical predictions have been verified by numerical simulations in large k-ary trees, Erdös-Rényi and scale-free networks, showing a very good agreement.

DY 20.3 Wed 15:30 MA 004

Network evolution towards optimal dynamical performance — •Steffen Karalus and Markus Porto — Institut für Theoretische Physik, Universität zu Köln, Germany

The functionality of a large number of real world networks is associated with dynamical processes based on the network in the sense that the network structure defines the local interaction pattern between the individual elements of the system. A deeper understanding of the interplay between the network topology and the behavior of the dynamical process in such cases is, however, still missing. As the 'fitness' of these networks is primarily determined by their functionality, we presume that they are driven into 'fitter' structures by an evolutionary process with mutation acting on topology and selection acting on dynamical properties. We propose a simple optimization scheme in which the latter are determined by the eigenvalue spectrum of the associated time evolution operator. Exemplifying this approach with the graph Laplacian, the relevant operator for fundamental processes such as random walks on a network, we show that our algorithm is able to successfully evolve networks into states with a given eigenvalue spectrum and corresponding dynamical behavior.

DY 20.4 Wed 15:45 MA 004

High performance simulation and visualization of epidemics on complex networks — •Peter A Kolski[1], Martin Clauss[2], Thomas Selhorst[3], and Arkadi Pikovsky[1] — [1]University of Potsdam, Germany — [2]University of Leipzig, Germany — [3]Friedrich-Loeffler-Institut, Germany

Dynamical processes on complex networks are a growing field of interest. Performing simulations on large system of this kind demand a high computational power. To handle dynamics on networks the NetEvo C++ library can assign dynamical systems to edges and nodes. Furthermore it solves these ODEs via the ODEint library and can perform heuristic optimization. We introduce an extension to NetEvo using OpenCL on GPUs. With this approach we achieve an increase of computational performance up to a factor of 87, compared to an optimized C++ code on a modern CPU. Additionally we developed a framework to visualize intermediate results and to perform instantaneous visual analytics. The software will be applied in epidemiology, simulating disease spread on trade networks by solving the SIR model*s ODEs. The modification of parameter in real-time and the immediate access to simulation results leads to intuitive insights into the behavior of epidemics on large complex networks.

DY 20.5 Wed 16:00 MA 004

Information spread via on-line networks: from time series to co-evolving functional networks — •Jan W. Kantelhardt[1], Mirko Kämpf[1], Shlomo Havlin[2], and Lev Muchnik[3] — [1]Institut für Physik, Martin-Luther Universität Halle-Wittenberg, Halle/Saale, Germany — [2]Physics Department, Bar-Ilan University, Ramat Gan, Israel — [3]Leonard N. Stern School of Business, New York University, USA

Human interaction and information spread via on-line networks is becoming increasingly important for our contemporary technological society. Here, we characterize and compare three organizational and dynamical network structures associated with the online encyclopedia Wikipedia. We study (i) the network of the direct links between Wikipedia articles of various languages, (ii) the usage network as determined from cross-correlations between click-count time series of many pairs of articles, and (iii) the edit network as determined from coincident edit events. The major goal is to find correlations between components of these three networks that characterize the dynamics of information spread in the complex system. We find that even though the dynamics of article click and edit time series are characteristically different - download activity is characterised by strongly persistent fluctuations (scaling exponent $\alpha \approx 0.9$), while edit activity is only short-term correlated - there are indications of a co-evolution of the corresponding dynamic networks. The results help in understanding the complex process of collecting, processing, validating, and distributing information in self-organised social networks.

DY 20.6 Wed 16:15 MA 004

Complete Reconstruction of Correlation Networks — •Jan Nagler, Magdalena Kersting, Annette Witt, and Theo Geisel — MPI DS, Göttingen

Consider a network of N vertices, each associated with a wide-sense stationary stochastic process. To what extent is it possible to reconstruct the interrelationships of the whole network knowing only a limited number of correlation functions? Under what circumstances is the system over- or underdetermined? Compared with the usual time series analysis we present a different approach to these questions by means of the Wiener-Khintchine Theorem and unfold the basic structure underlying correlation networks. Except for networks with certain loop structures, we show that either N crosscorrelation functions, or $N-1$ crosscorrelation functions together with a single autocorrelation function determine the full network dynamics. We analytically derive explicit expressions for the missing correlation functions and study exemplarily the ubiquitous case of exponentially decaying correlation functions.

DY 20.7 Wed 16:30 MA 004

Formation of the frozen core in critical Boolean Networks — •Marco Möller and Barbara Drossel — Festkörperphysik, TU Darmstadt, Germany

We investigate numerically and analytically the formation of the frozen core in critical random Boolean networks with biased functions. We demonstrate that a previously used efficient algorithm for obtaining the frozen core, which starts from the nodes with constant functions,

fails when the number of inputs per node exceeds 4. We present computer simulation data for the process of formation of the frozen core and its robustness, and we show that several important features of the data can be derived by using a mean-field calculation.