DY 26: Nonlinear Dynamics II

Time: Wednesday 16:30–18:15 Location: ZEU 255

DY 26.1 Wed 16:30 ZEU 255

Nonlinear dynamics of the internal degrees of freedom and transport of benzene on graphite — •Astrid S. de Wijn — IMM, Radboud University Nijmegen, the Netherlands

The presence of internal degrees of freedom has been connected to the diffusion and friction of molecules on surfaces. In this work, the chaotic internal degrees of freedom of a benzene molecule adsorbed on a graphite substrate [1], their interplay with thermal noise, and their effects on the diffusion and friction are investigated analytically and numerically by making use of the presence of two different time scales. It is found that that the substrate temperature affects the dynamics of the internal degrees of freedom only weakly, yet still influences the friction and diffusion.

The contributions from different degrees of freedom to diffusion and friction are identified analytically and numerically and found to be sufficiently large to account for the high friction found in experiments [2]. In atomistic molecular dynamics simulations of the system, various internal degrees of freedom can be investigated separately. Torsion of the benzene molecule dominates the chaotic dynamics and the effects of the internal degrees of freedom on the diffusion and friction. Based on the analytical and numerical results, suggestions are made for experimental conditions under which the effects of internal degrees of freedom might be more directly observable.

[1] A. S. de Wijn and A. Fasolino, Journal of Physics: Condensed Matter, 21, 264002 (2009).

[2] H. Hedgeland, er al., Nature Physics, 5, 561 (2009).

DY 26.2 Wed 16:45 ZEU 255

Asymmetries in delay coupled systems: mismatches and their impact on dynamics and synchronization of two coupled lasers — •Konstantin Hicke[1,2], Otti D'Huys[3], Valentin Flunkert[2], Eckehard Schöll[2], Jan Danckaert[3,4], and Ingo Fischer[1] — [1]Instituto de Fisica Interdisciplinar y Sistemas Complejos, IFISC (UIB-CSIC), Campus Universitat de les Illes Balears, E-07122 Palma de Mallorca, Spain — [2]Institut für Theoretische Physik, TU Berlin, Hardenbergstraße 36, 10623 Berlin, Germany — [3]Department of Physics (DNTK), Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussel, Belgium — [4]Department of Applied Physics and Photonics (TONA), Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussel, Belgium

We study the dynamics and synchronization properties of two mutually delay-coupled semiconductor lasers. We concentrate on a configuration in which the lasers are coherently coupled via a partially transparent mirror. We investigate the influence of mismatches of the delay times and of the coupling strengths for self-feedback and coupling. We show that the former mismatch alters the lasers' dynamics significantly but does not affect the synchronization quality. The latter mismatch has a considerable effect on the stability of the zero-lag synchronized state of the system, but does not change the dynamics within the synchronization manifold. Finally, we discuss the implications of our analytical and numerical results.

DY 26.3 Wed 17:00 ZEU 255

Leaking chaotic systems — •Jefferson S. E. Portela[1], Eduardo G. Altmann[1], and Tamás Tél[2] — [1]Max Planck Institute for the Physics of Complex Systems, 01187 Dresden, Germany — [2]Institute for Theoretical Physics, Eötvös University, Pázmány P. s. 1/A, Budapest, H–1117, Hungary

A large class of problems have been addressed by relating the properties of a closed dynamical system, where the main dynamical properties are well defined asymptotically in time, to the relevant properties of its open, leaked counterpart, where typically all trajectories eventually escape and the relevant quantities are dependent on the escape procedure, as described by transient chaos theory.

Using a billiard – a system of point particles moving freely inside a bounded area and colliding specularly with its boundary – we illustrate the effects of a leak, emphasizing the dependence of the orbits decay on the leak characteristics.

Billiards model a number of relevant physical systems, such as optical microcavities and wave/quantum-chaos systems, and also are, due to their symmetries, particularly convenient for numerical simulation and visualization purposes. We consider the family of Robnik billiards, defined by limaçon curves ($\rho(\phi) = 1 + \varepsilon\cos(\phi)$, in polar coordinates), which has already been extensively studied in both its classical and quantum versions.

DY 26.4 Wed 17:15 ZEU 255

The Geometry of Chaotic Dynamics - A Complex Network Perspective — •Reik V. Donner[1], Jobst Heitzig[1], Jonathan F. Donges[1,2], Yong Zou[1], Norbert Marwan[1], and Jürgen Kurths[1,2] — [1]Potsdam Institute for Climate Impact Research, Potsdam, Germany — [2]Department of Physics, Humboldt University of Berlin, Germany

Among the different existing complex network approaches to time series analysis, ε-recurrence networks most faithfully represent the geometrical fine structure of the underlying chaotic attractors. We demonstrate that the well known graph theoretical properties local clustering coefficient and global network transitivity can meaningfully be exploited to define new local and global measures of dimension in phase space. Rigorous analytical as well as numerical results for self-similar sets and simple chaotic model systems suggest that these measures are well-behaved in most non-pathological situations and that they can be estimated reasonably well using ε-recurrence networks constructed from relatively short time series. These findings theoretically explain why the networks' transitivity properties are particularly well suited for identifying dynamically invariant objects as well as regime shifts in non-stationary time series. Our results demonstrate that ε-recurrence networks exhibit an important link between dynamical systems and graph theory.

DY 26.5 Wed 17:30 ZEU 255

Algorithms for the integration of variational equations of multidimensional Hamiltonian systems — Enrico Gerlach[1], Siegfried Eggl[2], and •Charalampos Skokos[3] — [1]Lohrmann Observatory, Technical University Dresden, D-01062 Dresden, Germany — [2]Institute for Astronomy, University of Vienna, Türkenschanzstrasse 17,A-1180 Vienna, Austria — [3]Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, D-01187 Dresden, Germany

We investigate the efficiency of different algorithms for the integration of the variational equations of multidimensional Hamiltonian systems. In particular we consider the tangent map (TM) method (Skokos Ch. and Gerlach E., 2010, PRE, 82, 036704 - Gerlach E. and Skokos Ch., 2010, arXiv:nlin.CD/1008.1890), a scheme based on symplectic integration techniques, as well as non-symplectic schemes, like the DOP853 general-purpose integrator and methods based on Taylor and Lie expansions. The numerical verification of well-known properties of chaos indicators like the Lyapunov Characteristic Exponents (LCEs) and the Generalized Alignment Indices (GALIs) is used for characterizing the efficiency of the various integration schemes. Besides discussing the methods theoretically, we will apply them exemplarily to the Fermi-Pasta-Ulam (FPU) β lattice model and to an astronomical N body problem to demonstrate the differences between them regarding parameters of practical importance, as e.g. CPU time requirements and reliability of the results.

DY 26.6 Wed 17:45 ZEU 255

Conditional Mutual Sorting Information for Coupling Analysis of Time Series — •Jakob Runge[1] and Bernd Pompe[2] — [1]Potsdam-Institut für Klimafolgenforschung — [2]Universität Greifswald

We propose a method to detect couplings between two simultaneously measured time series. It is based on conditional mutual sorting information. By setting suitable conditions, we are able to diminish misleading effects of auto dependencies within each series. This enables the detection of the right coupling delays also in the case of bidirectional couplings. Our approach is based on ordinal properties of time series. This makes the analysis invariant with respect to monotonous distortions which is very useful, e.g., in the analysis of proxy data in climatology. Moreover, ordinal analysis is robust to some trend, and easy and fast to compute. We consider also the problem of reliable estimation from finite time series. Finally, we apply the proposed method to nonlinear models as well as to some climate data.

DY 26.7 Wed 18:00 ZEU 255

Effects of Janus particles in a phase-separating binary mixture — Alexei Krekhov, •Vanessa Weith, and Walter Zimmermann — Theoretische Physik I, Universität Bayreuth, 95440 Bayreuth, Germany

A new class of colloidal particles, so-called Janus particles, have been synthesized in large quantities [1], recently. Janus particles represent colloids with a different chemical composition of the surface of the two hemispheres of a particle. Each half of a particle may be wetted preferentially by one component of a binary mixture.

We suggest a mean field approach for the dynamics of phase separation in binary mixtures in the presence of Janus particles. The numerical results on the dynamics of Janus particles are presented. The different wetting properties of the two hemispheres of a Janus particle cause a spatial variation of the concentration in their neighborhood. Accordingly, the Janus particles are trapped to interfaces in the two-phase region, leading to a complex particle and interface dynamics. The Janus particles also induce an interesting interface ordering in one and two dimensions, leading to layered structures with small tunable length scale.

[1] A. Walther and A. H. E. Müller, Soft Matter 4, 663 (2008)