DY 51 Non-Linear Stochastic Systems

Time: Friday 11:30–13:30 Room: HÜL 186

DY 51.1 Fri 11:30 HÜL 186

The power spectrum of a driven nonlinear stochastic system — •Benjamin Lindner — MPI fuer Physik komplexer Systeme, Noethnitzer Str.38, 01187 Dresden

We study the effect of an external broad band driving on the power spectrum of a nonlinear stochastic system. A heuristic formula used frequently in the literature is shown to be valid at large internal noise of the system, i.e. when the system is effectively close to a linear dynamics. In the opposite limit of small internal noise, however, this formula may fail. We show that an external broadband perturbation can have effects not described by a purely linear theory: (1) power is reduced or added at frequencies which are outside the frequency band of the driving; (2) sharp peaks of the unperturbed system become much broader under the influence of random noise; (3) side bands appear in certain cases. We present two simple systems for which the power spectrum can be analytically calculated or at least approximated and discuss the implications of our findings for more general situations.

Ref. Lindner, Chacron, Longtin Phys. Rev. E 72, 021911 (2005)

DY 51.2 Fri 11:45 HÜL 186

A stochastic model for noise-free stochastic resonance near a merging crisis — •Thomas Stemler[1], Wolfram Just[2], and Hartmut Benner[1] — [1]Institut für Festkörperphysik, TU Darmstadt — [2]Department of Mathematics, Queen Mary/University of London, UK

We provide a stochastic model for stochastic multiresonance which is found in dynamical systems exhibiting crisis induced intermittency. The role played by the external noise in conventional stochastic resonance (SR) is replaced by the fast chaotic dynamics of the system. The latter causes a slow jump dynamics between the two intermittent states. The stochastic model is derived following the spirit of the Kramers-Moyal expansion. It can be used to map the deterministic chaotic dynamics to the standard model of SR, i.e. the overdamped motion of a particle in a double-well potential subjected to noise. We applied the method successfully to an electronic Chua-type circuit. The deterministic and stochastic terms of the corresponding Langevin equation were obtained by analysing the time series of the circuit. The dependence of both terms on the control parameter of the intermittent system explains the complexity of the observed resonance phenomenon and introduces a new mechanism for stochastic multiresonance.

DY 51.3 Fri 12:00 HÜL 186

Precursors of Extreme Increments — •Sarah Hallerberg, Eduardo G. Altmann, Detlef Holstein, and Holger Kantz — Max Planck Institute for the Physics of Complex Systems
Noethnitzer Str. 38,

We investigate precursors and predictability of extreme events in time series, which consist in large increments within successive time steps. We determine analytically the marginal and the joint probability density function (PDF) for large increments in uncorrelated random numbers and AR(1)- correlated data. These PDFs provide us with different possibilities to choose convenient precursors for the events we are looking for. The performance of these precursors is then tested via creating receiver operator characteristics (ROC). Surprisingly we obtain better predictions for completely uncorrelated Gaussian random numbers than for AR(1)-correlated data. This apparent paradox can be qualitatively explained by clustering of the AR(1)- correlated data, which inhibits large increments. Additionally we present a quantitative discussion of this effect by using a not common summary index for smooth ROC- curves. Furthermore this index can be used to estimate the quality of smooth ROC- curves for any given event size and correlation strength.

DY 51.4 Fri 12:15 HÜL 186

Statistics of a noise-driven Manakov soliton — •Stanislav Derevyanko[1], Jaroslaw Prilepskiy[2], and Dennis Yakushev[3] — [1]Photonics Research Group, Aston Iniversity, Birmingham, UK — [2]B.I. Verkin Institute for Low Temperature Physics and Technology, Kharkov, Ukraine — [3]Institute for Radiophysics and Electronics, Kharkov, Ukraine

We investigate the statistics of a vector Manakov soliton in the presence of additive Gaussian white noise. The adiabatic perturbation theory for Manakov soliton yields a stochastic Langevin system which we analyze via the corresponding Fokker-Planck equation for the probability density function (PDF) for the soliton parameters. We obtain marginal PDFs for the soliton frequency and amplitude as well as soliton amplitude and polarization angle. We provide the expressions for the Stokes parameters of soliton polarization and determine the depolarization length. We also derive formulae for the variances of all soliton parameters and analyze their dependence on the initial values of polarization angle and phase.

DY 51.5 Fri 12:30 HÜL 186

Controlling noise-induced oscillations by time-delayed feedback — •Clemens v. Loewenich and Hartmut Benner — Institut für Festkörperphysik, Technische Universität Darmstadt

Noise-induced oscillations may be observed in a van der Pol oscillator in the regime just below the Hopf bifurcation, where the noisefree system still has a stable fixed point. It was shown analytically and numerically that these oscillations can be controlled by time-delayed feedback, which allows to maximize their correlation time on variation of delay time and feedback strength [1,2].

In order to check the validity of these theoretical findings we made experimental investigations on a van der Pol type electronic circuit. In fact, we observed the occurrence of noise-induced oscillations and studied the dependence between correlation time, noise and feedback strength. Discrepancies between experimental and theoretical data could be attributed to the limited bandwidth of our experimental noise source in contrast to the white noise assumption of the model.

[1] N. B. Janson et al., Phys. Rev. Lett. **93**, 010601 (2004)
[2] J. Pomplun et al., Europhys. Lett. **71**, 366 (2005)

DY 51.6 Fri 12:45 HÜL 186

Formation of shocks in forced Burgers Equation — •Stephan Eule and Rudolf Friedrich — Instute of Theoretical Physics Wilhelm-Klemm-Straße 9 48149 Münster

We analyze the formation of shocks in the Burgers-equation with linear forcing on a bounded interval. We numerically determine the probability distribution for velocity increments. We show that shock formation can be considered in close analogy to the behaviour of an excitable system under external perturbations.

DY 51.7 Fri 13:00 HÜL 186

Phase transitions and "negative heat capacity" of active Brownian particles — •Hendrik U. Bödeker[1], Andreas W. Liehr[2], and Hans-Georg Purwins[1] — [1]Westfälische Wilhelms-Universität Münster, Institut für Angewandte Physik, Corrensstr. 2/4, 48149 Münster — [2]Freiburger Materialforschungszentrum, Stefan-Meier-Str. 21, 79104 Freiburg i. Br.

Active Brownian particles as a generalization of classical Newtonian particles exhibit a large variety of dynamical properties that have no classical counterpart. In this talk, we focus on the interaction of many active Brownian particles by investigating the clustering behavior under short-ranged interaction. Numerical simulations show that a number of phenomena like phase transitions from a solid to a liquid phase can be found that qualitatively resemble the behavior of classical many-body systems. In addition, new phenomena like "negative heat capacity", i.e. the decrease of the mean-squared velocity of the particles with increasing fluctuation strength, can be found. We show that these findings essentially depend on the nature of the interaction and that "negative heat capacity" can be looked upon as a stochastic resonance effect.

DY 51.8 Fri 13:15 HÜL 186

Foraging Active Brownian Agents - Do they diffuse normal or not? — •Udo Erdmann and Sebastian Göller — Institut für Physik, Humboldt-Universität zu berlin

First results on the (anomalous) diffusive behavior of foraging active agents are presented. As could have been observed in nature the individuals are able to take up energy and convert it into free degrees of freedom. The uptaken energy is located in randomly distributed food depots. A whole population of Active Brownian agents is investigated.

Hereby our main interest is to distiguish between regimes of normal and anomalous diffusion depending on the system parameters.