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Participant	Title	Abstract
Jon Aaronson	rational weak mixing of infinite measure preserving transformations (provisional title)	
Yoji Aizawa	Nonstationary chaos revisited from infinite measure ergodicity	Nonstationary slow dynamics with $f^{-\nu} \, (\nu \ge 1)$ spectra are often generated in nearly integrable Hamiltonian systems due to the stagnant layer near the invariant sets in phase space, e.g., KAM tori and Poincar\'e-Birkhoff's island-tori. Strong nonstationarity is surmised to come from the hierarchical (fractal) distribution of those invariant sets in infinitesimal scales, and also from the topological diffusion (Arnold diffusion) if we treat high dimensional chaos. Similar slow motions can appear in the strong intermittent dynamics which belongs to a typical class of infinite ergodicity, where the indifferent fixed points (or the singular reinjection sets) induce the same kind of nonstationarity. In the present talk, we will see several nonstationary aspects common to both in Hamiltonian chaos and in infinite ergodicity, and discuss the possible paths to link between them. First, the statistical features of generic Hamiltonian chaos are demonstrated, and it is especially emphasized that the stagnant time distribution obeys the log-Weibull law consistent with the Nekhoroshev's theorem. Next, various nonstationary aspects in infinite ergodicity are shown systematically by carrying out with the modified Bernoulli map. Our early results were obtained by use of the renewal theory and the large deviation theory, but more significant aspects of nonstationarity can be derived from the Darling-Kac theory and the Aaronson theorem; the distribution and fluctuation spectra of the correlation function are determined. Finally, discussions will be focused on the linkage between infinite ergodicity and Hamiltonian chaos. The mixmaster Hamiltonian model (Bianchi type IX) is a good example that manifests an infinite ergodic subdynamics. It is still open in generic Hamiltonian case whether the infinite ergodic subdynamics exists, but we will discuss the embedding of infinite ergodic dynamics into higher dimensional space.
Takuma Akimoto	Relationship between dynamical instability and transport coefficient in anomalous diffusion	We show the relationship between dynamical instabilities and transport coefficients in deterministic subdiffusion using infinite ergodic theory. First, we review distributional limit theorems in infinite ergodic theory. We characterize dynamical instability in dynamical systems with infinite invariant measures by the generalized Lyapunov exponent. A weak chaotic dynamical system, i.e., a conservative, ergodic, infinite measure-preserving transformation, shows subexponential instability. Second, we apply a distributional limit theorem to a deterministic subdiffusive dynamical system with an asymmetric parameter describing bias in random walks. In an unbiased case, a distributional limit theorem for the diffusion coefficient of the time-averaged mean square displacement (TAMSD) is derived. In a biased case, the relationship between the generalized Lyapunov exponent and the time-averaged drift is obtained by Hopf's ergodic theorem, which leads to a distributional limit theorem for the time-averaged drift. Moreover, the Einstein relation for the time-averaged drift and the diffusion coefficient of the TAMSD is derived. Finally, the role of an infinite invariant measure and the Lyapunov exponent in deterministic subdiffusion is discussed.
Eduardo Altmann	Interplay between randomness and chaos in scattering systems	Interplay between randomness and chaos in scattering systems In this talk I will discuss different effects of randomness on the classical problem of chaotic scattering in Hamiltonian systems. In particular, I am interested in the cases in which the deterministic trapping is enhanced due to the randomness. Randomness can be introduced as a perturbation of trajectories (noise) or of parameters of the system (random maps). Both cases will be discussed and compared. In fully chaotic systems the enhancement of the trapping is seen as a reduction of the escape rate with increasing random perturbation. In the generic case of Hamiltonian systems with mixed phase space small random perturbations lead to a slower decay of the survival probability for a large interval of times, an effect absent in one dimensional intermittent maps. If anomalous transport is observed in the deterministic system, this enhancement of the trapping is shown to lead to a non-monotonous dependence of the asymptotic diffusion coefficient on the intensity of the random perturbation.
Roberto Artuso	Dynamical features of weak chaos (2 lectures)	I will review peculiar dynamical features of low dimensional weakly chaotic systems, and illustrate some techniques that are appropriate to deal with such a situation.
Armin Bunde	tba	
Leonid Bunimovich	Some finite time properties of dynamics.	Some new counterintuitive results on dynamics and transport in ergodic systems will be discussed. Although we are used to approximate chaotic dynamics by Markov chains, even for Markov chains these results are new. The last reveal why these simple and natural results/questions were not obtained/asked before.
Stanislav Burov	Single particle to Ensemble of particles transition and Weak Ergodicty Breaking	
Shai Carmi	Fractional Feynman-Kac equation for anomalous diffusion functionals	Functionals of the path of a Brownian particle are known to obey the celebrated Feynman Kac equation. We developed a fractional Feynman Kac equation for functionals of the sub-diffusive continuous-time random walk process. Several simple examples of functionals were explicitly treated such as the occupation time, the first passage time, and the maximum of the walk. In the presence of a binding field, the fractional Feynman Kac equation describes the route to weak ergodicity breaking.
Francesco Cellarosi	Homogeneous Dynamics for Theta Sums	I will discuss a number of limit theorems for theta sums (quadratic exponential sums) that can be proven using equidistribution properties of the geodesic flow on a hyperbolic manifold. For example, I will explain a non-standard weak invariance principle for certain strongly dependent random variables.
Aleksei Chechkin	Natural and Modified Forms of Distributed Order Fractional Diffusion Equations	We consider diffusion-like equations with time and space fractional derivatives of distributed order for the kinetic description of anomalous diffusion and relaxation phenomena, whose mean squared displacement does not change as a power law in time. Correspondingly, the underlying processes cannot be viewed as self-affine random processes possessing a unique Hurst exponent. We show that different forms of distributed-order equations, which we call “natural” and “modified” ones, serve as a useful tool to describe the processes which become more anomalous with time (retarding subdiffusion and accelerated superdiffusion) or less anomalous demonstrating the transition from anomalous to normal diffusion (accelerated subdiffusion and truncated Lévy flights). Fractional diffusion equation with the distributed-order time derivative also accounts for the logarithmic diffusion (strong anomaly).
Alain Comtet	continuous fractions and diffusion processes	Excursions of one-dimensional diffusion processes can be studied by studying a certain Riccati equation associated with the process.We show that in many cases of physical interest the Riccati equation can be solved in terms of an infinite continued fraction. We illustrate on some examples of diffusion in a deterministic or random environments. The link with occupation time problems will be discussed.
Giampaolo Cristadoro	tba	
Itzhack Dana	Weak-Chaos Ratchet Accelerator	Classical Hamiltonian systems with a mixed phase space and some asymmetry may exhibit chaotic ratchet effects. The most significant such effect is a directed momentum current or acceleration. In known model systems, this effect may arise only for sufficiently strong chaos. We introduce a Hamiltonian ratchet accelerator featuring a momentum current for {\em arbitrarily weak chaos}. The system is a realistic generalized kicked rotor and is exactly solvable to some extent, leading to analytical expressions for the momentum current. While this current arises also for relatively strong chaos, the {\em maximal} current is shown to occur, at least in one case, precisely in a limit of arbitrarily weak chaos.

Diego del-Castillo-Negrete	to be announced	
Carl Dettmann	New horizons in multidimensional diffusion: The Lorentz gas and the Riemann Hypothesis	The Lorentz gas is a model of deterministic diffusion consisting of many fixed scatterers and a point particle making elastic collisions. In a two dimensional periodic array of spherical scatterers it is known that displacements are normally distributed, but with a nonstandard, superdiffusive scaling of the form sqrt(t ln t). I will describe attempts to extend this result to higher dimensions. In the case of small scatterers, the superdiffusion coefficient is related to the Riemann hypothesis. There is also theoretical and numerical evidence for a qualitative change of behaviour in six dimensions and beyond.
Peter Dieterich	Dynamics of directed cell migration	later
Bartlomiej Dybiec	Anomalous diffusion: non-Markovianity and weak ergodicity breaking	Abstract. Traditionally, the discrimination between a Markovian and a nonMarkovian process is based on the denition. If the process is Markovian, its transition probability does not depend on the history of the process and it fullls the Smoluchowski–Chapman–Kolmogorov equation. A practical verication of these two criteria is not always possible or fully conclusive. Therefore, we present an additional method which can be used to conrm the simplest version of Markovianity. This method is based on the properties of sums of independent random variables. We apply the presented method to prove the increment dependent character of an anomalous process combining long waiting times with long jumps. Such a process, despite being non-Markovian in nature, due to a competition between long waiting times and long jumps, can reveal 'normal' behavior. We also demonstrate that this anomalous process breaks the ergodicity in the weak sense. Finally, we apply the suggested method to some experimental time series proving their Markovian nature for small timescales. References: [1] B. Dybiec, Anomalous diffusion: non-Markovianity and weak ergodicity breaking J. Stat. Mech. P08025 (2009).
Mark Edelman	Chaos in fractional dynamical systems	On the examples of fractional generalizations (Caputo and Riemann-Liouville) of standard map and dissipative standard map (Zaslavsky map) we show that fractional dynamical systems demonstrate new properties, not found in a regular dynamical systems: intersection of trajectories, overlapping of attractors, and cascade of bifurcation type trajectories which possess properties of the weakly chaotic systems.
Andrew Ferguson	tba	
Vladimir Filimonov	Robust Effective Multifractality and the Self-Excited Multifractal Model	Generalizing the cascade models that started with Richardson and Kolmogorov, multifractal cascades have been introduced in turbulence to model the anomalous scaling exhibited by the moments of the velocity increments in hydrodynamic turbulence. They have been since applied to many other complex fields including fractal growth processes, geophysical fields, high energy particle physics, astronomy, biology, and finance. The constructions involved in multifractal cascades are based on hierarchical geometries coupled with multiplicative noise and form discrete hierarchical cascades. Classical continuous-time multifractal models, such as Multifractal Random Walks, were developed to reproduce the exact multifractal properties of the cascade models. For this, Multifractal Random Walk is delicately tuned to a critical point associated with logarithmic decay of the correlation function of the log-increment up to an integral scale. As a consequence, the moments of the increments of the MRW process become infinite above some finite order, which depends on the intermittency parameter of the model. This issue contradicts the properties of real processes, which at the same time don't require strictly multifractal models for their description, exhibiting effective multifractal properties only within a finite range of scales. For instance, in turbulence this "inertial interval" is bounded from below by the viscous scale and from above by the integral scale. We have found that multifractal scaling is a robust property of a large class of continuous stochastic processes, constructed as exponentials of long-memory processes, which we called the class of Quasi-Multifractal models. Not insisting on asymptotically exact multifractal properties, it has effective multifractal properties for a broad range of parameters, removing the rather artificial tuning to criticality needed in the previous models. The Self-Excited Multifractal model is an elaboration of the Quasi-Multifractal model aimed to describe the explicit dependence of future values on the past history of the process. The principal novel feature of the model lies in the self-excitation mechanism combined with exponential nonlinearity and long memory, i.e. the explicit dependence of future values of the process on past ones. The self-excitation captures the microscopic origin of the emergent endogenous self-organization properties, such as the energy cascade in turbulent flows, the triggering of aftershocks by previous earthquakes and the "reflexive" interactions of financial markets. Being relatively simple, the defined Self-Excited Multifractal process has very rich statistical properties, namely: multifractality, heavy tails of the distribution of increments with intermediate asymptotics, zero correlation of the signed increments with long memory in the squared increments and statistical asymmetry under time reversal.
Rudolf Friedrich	Anomalous Diffusion: From Fractional Master Equations to Path Integrals	Anomalous diffusion usually is described by a master equation determining the single time probability distributions of continous time random walks. Since these processes are non-Markovian multiple time distributions have to be determined. A complete information about the process is contained in a path-integral representation. We shall present such a path-integral representation for a class of stochastic processes containing continuous time random walks.
Theo Geisel	Mixing Normal and Anomalous Kinetics	The time evolution of the probability density P(n, t) to find a system in a specific state n at time t is commonly described by a master equation. In this context it is usually assumed that all processes leading to a change of the system's state have a welldefined rate and time-scale respectively. However, if the waiting-times between consecutive transitions lack a specific scale and their distributions have broad tails, the system exhibits anomalous dynamics and has to be described by a generalized master equation. The Continuous Time Random Walk and the Lévy Walk are prominent examples for such stochastic processes. It is well-known that systems whose dynamics is governed by a generalized master equation can be described by the concept of subordination. In this contribution stochastic processes are discussed, which can be viewed as a mixture of both types of dynamics. That is to say, we consider a process whose transitions are governed by broad tailed waiting time statistics which is additionally subjected to an internal random process with a welldefined time-scale. It will be shown that the resulting master equation exhibits a nontrivial structure. Approximation schemes of this type of equation will be presented and applications will be pointed out, ranging from the bursty production of mRNA molecules in gene transcription to the transmission dynamics of infectious diseases. * in collaboration with Rudolf Friedrich, Institute for Theoretical Physics, WWU Münster
Katrin Gelfert	Phase transitions in non-contracting Iterated Function Systems	Iterated function systems (IFS) enable a convenient description of certain dynamical systems. I will in particular focus on dynamical systems on the interval. The need for a detailed understanding of such systems is apparent, as they appear in many building blocks for higher-dimensional dynamics. Very well understood are IFS's that are composed of contracting maps over a finite symbolic space. However, there exist various examples that lack uniform contraction properties and mix contracting and expanding behavior. In some interesting examples that are, in fact, derived from systems with unstable dimension variability (with heterodimensional cycles) we can observe some interesting phenomena such as the coexistence of invariant distributions maximizing free energy. I will present examples of transitive maps defined as skew products over a horseshoe that exhibit rich phase transitions. This phase transition follows from a gap in the spectrum of Lyapunov exponents and is associated to the coexistence of two equilibrium states with positive entropy. The map mixes hyperbolic behavior of different types. However, in some sense the expanding behavior is not dominating which is indicated by the existence of a measure of maximal entropy with nonpositive central exponent.
Sebastien Gouezel	tba	
Igor Goychuk	Subdiffusive dynamics in washboard potentials	I will discuss and compare two different approaches to fractional subdiffusion and transport in washboard potentials. One is based on the concept of random fractal time and is associated with the fractional Fokker-Planck equation. Another approach is based on the fractional generalized Langevin dynamics and is associated with

anti-persistent fractional Brownian motion and its generalizations.
Profound differences between these two different approaches sharing the common adjective "fractional" are explained in spite of some similarities they share in the absence of a nonlinear force. In particular, we show that the asymptotic dynamics in tilted washboard potentials obey two different universality classes independently of the form of potential.

Phil Howard — Entropy and stretching rates for intermittent maps

The piecewise-linear approximation of the Pommeau-Manneville map is a well-known toy model of a 1-parameter family of zero-entropy systems, with non-trivial dynamics. We derive the asymptotic behaviour of the push-forward of Lebesgue measure for these maps, leading to an explicit expression for the infinite invariant measure.

We review the definition of the entropy of such a measure and relate it to the ensemble-averaged long-time stretching rate of the system, generalizing Pesin's identity for the entropy of hyperbolic dynamical systems. We discuss aspects of the thermodynamic formalism for such systems, including the case where holes are present.

Thomas Kempton — Gurevich Pressure for Suspension Flows

We introduce a new definition of topological pressure for suspension flows over countable Markov shifts and show that it satisfies a variational principle and is the supremum of topological pressure for compact subsets. We shall also discuss a conjecture regarding the existence of Gibbs measures and the distribution of periodic orbits for suspension flows.

David Kessler — Infinite covariant densities for diffusion in logarithmic potentials

We solve the Fokker-Planck equation for Brownian motion in a logarithmic potential. When the diffusion constant is below a critical value the solution approaches an infinite invariant density.
With this non-normalizable solution we obtain the phase diagram of anomalous diffusion for this important process. We briefly discuss the consequences for atoms in optical lattices. Our work explains in what sense the infinite invariant density
and not Boltzmann's equilibrium describes the long time limit of these systems.

Rainer Klages — Weak Chaos, Anomalous Diffusion, and Fluctuation Relations

Concluding this conference with my lectures, I do not aim at giving a basic introduction to its main themes. I assume that this has been done in previous presentations already. Rather, I will try to talk about topics that might not have been covered so far. Accordingly, please note that I may adjust this abstract based on what has been discussed at the conference in the previous weeks.

The first lecture is about deterministic random walks on the line generated by simple chaotic maps [1]. For the case of normal deterministic diffusion two different methods to exactly calculate the diffusion coefficient of such maps are outlined: One employs the Taylor-Green-Kubo formula for diffusion by evaluating it in terms of fractal generalized Takagi functions. The other one is based on solving eigenvalue problems of Frobenius-Perron operators and leads to the escape rate formula for diffusion, which expresses transport coefficients in terms of chaos quantities [2]. I then generalize these models towards an intermittent map exhibiting anomalous (sub)diffusion. Lacking similar methods for exactly calculating the generalized diffusion coefficient for this model, I use stochastic continuus time random walk theory and computer simulations to obtain results [1,2].

The second lecture introduces to fluctuation relations (FRs), which generalize the Second Law of thermodynamics to small systems. I first illustrate this concept for the ordinary Langevin equation. I then remind of three generic types of stochastic dynamics generating anomalous diffusion: L´evy flights, long-correlated Gaussian processes and time-fractional kinetics [3]. For these different models, which exhibit both sub- and superdiffusion, FRs will be checked in the simple nonequilibrium situation of a particle subject to a constant force [4]. It turns out that there is an interesting interplay between validity of fluctuation-dissipation relations and FRs. I finally show that these findings are important for understanding fluctuations in experimentally accessible systems, such as migrating biological cells and a paradigmatic lattice gas modeling glassy dynamics.

The first lecture is based on joint work with G.Knight, P.Gaspard, J.R.Dorfman, N.Korabel, and A.V.Chechkin [1,2], the second one elaborates on research performed with A.V.Chechkin [4]. Their collaboration with me on these themes is gratefully acknowledged.

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Nickolay Korabel — Pesin-Type Identity for Intermittent Dynamics with a Zero Lyaponov Exponent

Pesin's identity provides a profound connection between the Kolmogorov-Sinai entropy and the Lyapunov exponent. It is well known that many systems exhibit sub exponential separation of nearby trajectories and then the Lyapunov exponent is zero. In many cases such systems are nonergodic and do not obey usual statistical mechanics. We investigate the nonergodic phase of the Pomeau-Manneville map where separation of nearby trajectories is stretched exponential $dx_t=dx_0 exp^{\lambda_{\alpha} t^{\alpha}}$, $0<\alpha<1$. $\lamda_{\alpha}$ does not converge to a constant but remains a random variable. The limit distribution of λ_{α} is the inverse Le´vy function. The average is related to the infinite invariant density, and most importantly to entropy. Our work gives a generalized Pesin's identity valid for systems with an infinite invariant density.

Carlangelo Liverani — Toward a rigorous derivation of the Fourier Law

I will present some results in collaboration with S.Olla and D.Dolgopyat on lattices of very weakly interacting Hamiltonians system. In the limit of vanishing interactions we show that the properly rescaled energy evolution satisfies an autonomous equation. This evolution, in turns, seems to be amenable to yield the Heat equation in the appropriate diffusive limit.

John Lowenstein — Weakly chaotic kicked oscillators: renormalization, symbolic dynamics, and transport

In this series of three talks, we consider a one-dimensional harmonic oscillator which receives delta-function kicks in 4:1 resonance with its natural frequency, where the kick amplitude is a periodic function of position. A piecewise linear (sawtooth) kick amplitude leads to a tenuous, weakly chaotic web, whose orbits generate geometric complexity in phase space without the exponential separation of nearby orbits that is the hallmark of genuine chaos. The Poincare map of the kicked oscillator decomposes naturally into a local part, a piecewise isometry on a square, and a global part, a lattice isometry. Underlying both maps is a powerful symbolic dynamics which incorporates the most important renormalization properties of the models. Asymptotic behavior of orbits in the weakly chaotic web is found to depend crucially on the arithmetical properties of the parameter characterizing the strength of the kick amplitude. For irrational parameters satisfying quadratic and cubic polynomial equations, one finds various types of asymptotic long-time behavior: trapping within a finite region, logarithmic expansivity, and power-laws with diffusive, sub-diffusive, and super-diffusive exponents.

Eric Lutz — to be communicated

Marcin Magdziarz — Ergodic properties of anomalous diffusion processes

We study ergodic properties of some classes of anomalous diffusion processes. Using the recently developed measure of dependence called
Correlation Cascade, we derive a generalized Khinchin theorem for the general class of Levy-driven processes. Moreover, we analyze the asymptotic behavior of two different fractional
Ornstein-Uhlenbeck processes, both originating from subdiffusive dynamics. We show that only one of them is ergodic.

Satya Majumdar — Brownian functionals and their applications

I'll give a set of elementary lectures on Brownian functionals and their applications. In particular, I'll discuss Feynamn-Kac formula and its applications. I'll also discuss properties of first-passage Brownian functionals.

Ian Melbourne — Suppression of anomalous diffusion in even dimensions

It is known that weakly chaotic dynamics, such as the type generated by Pomeau-Manneville intermittency maps,
may lead to anomalous diffusion (Levy processes). I will describe work in progress with Georg Gottwald indicating that when analysed in the context of systems with Euclidean E(n) symmetry, typically the anomalous diffusion persists if and only if n is odd.
In even dimensions, the anomalous diffusion is typically suppressed and replaced by Brownian motion.

Ralf Metzler — RANDOM MOTION IN COMPLEX SYRANDOM MOTION IN COMPLEX SYSTEMS, ERGODICITY BREAKING, AND SINGLE PARTICLE TRAJECTORIES

RANDOM MOTION IN COMPLEX SYSTEMS, ERGODICITY BREAKING, AND SINGLE PARTICLE TRAJECTORIES

In a wide variety of systems ranging from geophysical scales down to biological cells, deviations from the standard laws of diffusion are observed. In particular on small scales single particle tracking has become a standard tool to probe the passive motion of test particles.
While in an ergodic system the long time average from individual tra-

jectories produces information equivalent to the ensemble average of quantities such as the mean squared displacement, this is no longer true in systems exhibiting anomalous diffusion and ageing effects. After an introduction to stochastic models for anomalous diffusion a framework for single trajectory averages in complex systems will be presented. In particular it will be shown that in non-ergodic subdiffusive systems the time averaged mean squared displacement in the presence of a confining potential shows a turnover from a linear dependence on the lag time to a power-law increase, an a priori quite unexpected behaviour. The scatter between individual trajectories due to both small sample size and dynamic effects will be discussed. The theoretical results will be compared to data from living biological cells, and further tools to analyse single particle tracking data will be presented.

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Tomoshige Miyaguchi — Ultraslow Convergence to Ergodicity in Transient Subdiffusion

We investigate continuous time random walks (CTRWs) with exponentially truncated α-stable trapping times. It is analytically shown that the time-averaged observables exhibit an weak ergodicity breaking for short measurement times; namely, the time-averaged observables follow the probability density function called Mittag--Leffler distribution. This weak ergodicity breaking behavior persists for a long time, and therefore the convergence to the ordinary ergodicity is considerably slower than the case in which the trapping-time distribution is given by common distributions such as the exponential distribution. We also find a clear crossover from the weak ergodicity breaking to the ergodic behavior. Finally, we discuss the truncated CTRWs in a confined geometry. Some analytical results obtained by using generalized fractional Fokker-Plank equation are presented.

Peter Nandori — Limit Theorems for Time-Dependent Dynamical Systems

Functional central limit theorems for several autonomous chaotic deterministic systems - and for almost all versions of random dynamical systems as well - are well known (see [1] or [2] for instance). As a first step, in [3], memory loss is established in the time-dependent case of uniformly expanding maps of the interval. Here, under stronger conditions, we prove convergence to the normal distribution of the appropriately scaled Birkhoff-like partial sums. Our approach is based on the martingale approximation of [4]. This is a joint work with Domokos Szasz and Tamas Varju.

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András Némedy Varga — Statistical properties of the system of two falling balls

The system of two falling balls is considered, a physical model first introduced by Wojtkowski, who also identified the cases when the dynamics are hyperbolic and ergodic. For an open set of the external parameter (the ratio of the two masses), we prove finer statistical properties, in particular the central limit theorem for a natural class of observables. The proof uses the tower method of Young (in its Chernov-Zhang version) and relies on a detailed geometric analysis of the dynamics, including the expansion and regularity properties of unstable curves, as well as the description of the singularity structure. Joint work with Gábor Borbély and Péter Bálint.

Markus Niemann — Parameters of a Continuous Time Random Walk from Deterministic Dynamics

Continuous Time Random Walks (CTRWs) are commonly used to describe anomalous diffusion. Starting with an anomalous deterministic diffusion the question arises how to obtain a corresponding CTRW. We present a method how to determine a CTRW as asymptotic description of a deterministic diffusion process.

We have introduced a diagrammatic method to determine the joint probability distributions of CTRWs. This method is extended to allow couplings between steps. These couplings may arise from deterministic maps, thereby allowing a unified treatment of stochastic and deterministic systems. Often, these processes converge in the scaling limit to a CTRW without coupling between steps. We apply the theory to a diffusion process driven by a deterministic map of Manneville-Pomeau type. Depending on the parameter, one gets a transition from an uncoupled to a coupled CTRW and a transition from sub- to superdiffusion. These findings are well supported by numerical simulations.

Gleb Oshanin — tba

Kathrin Padberg-Gehle — Transfer operator based numerical analysis of mixed phase space

A transfer operator (Perron-Frobenius operator) describes the evolution of measures or densities in a dynamical system and can be approximated in terms of a transition matrix of a finite-state Markov chain. The numerical transfer operator is the basis for different computational approaches for analysing the mixed phase space of Hamiltonian systems. In this talk we will give a brief introduction to the underlying mathematical concepts and show numerical results.

Thomas Prellberg — Multiple Intermittency and q-State Spin Chains

Encoding the dynamics of iterated maps of the interval with multiple intermittent fixed points via the thermodynamic formalism, we establish a connection between the dynamics of these maps and the thermodynamics of q-state spin chains with long-range cluster interactions. This approach generalises previous work on Farey fraction spin chains.

Ferruccio Renzoni

Power-law tail distributions and anomalous diffusion in cold atom systems

Statistical physics deals with systems composed of a large number of particles. The state of such systems is usually described by a distribution function, which allows us to determine the relevance of a certain configuration and to calculate macroscopic quantities, as the mean of physical observables. Gaussian distributions often occur whenever dealing with systems consisting of a large number of particles. These distributions well describe dynamics dominated by a large number of small random events, as for example the erratic motion of a small particle in water (Brownian motion). Not every system can however be described by Gaussian distributions, and there are situations in which the dynamics is dominated by rare and large fluctuations, in striking contrast with the Brownian motion corresponding to a Gaussian distribution. These large fluctuations result in long, power-law tail distributions, commonly termed Levy distributions. Associated to the long tail is the divergence of the first and/or second moment of these distributions.

Due to their tunability, cold atom systems, and more specifically cold atoms in optical lattices, have proven to be an ideal system to study the transition from Gaussian distributions and normal diffusion to power-law tail distributions and anomalous diffusion. In this talk I will review the workd done with cold atoms and ions in this context, and discuss possible future development of the field.

Alberto Robledo

Manifestations of the intermittency route to chaos in the physics of condensed matter and of complex systems

We describe the remarkable appearance of the dynamics associated to the tangent bifurcation in low dimensional nonlinear maps in central problems in condensed matter and in complex systems. We first recall the basic features of the intermittency route to chaos via this kind of bifurcation and then turn into the description of two precise equivalences between apparently different physical problems. The first one concerns the electronic transport properties obtained via the scattering matrix of a solid defined on a double Cayley tree. This strict analogy reveals in detail the nature of the mobility edge normally studied near (not at) the metal-insulator transition in electronic systems. We provide an analytical expression for the conductance as a function of the system size. This manifests as power-law decay (with universal exponent) or few and far between large spike oscillations. The second relates to the laws of Zipf and Benford, obeyed by scores of numerical data generated by many and diverse kinds of natural phenomena and human activity. The analogy effortlessly, and quantitatively, reproduces the bends or tails observed in real data for small and large rank. It explains the generic form of the degree distribution of scale-free networks and also suggests a possible thermodynamic structure underlying these empirical laws.

Lamberto Rondoni

We discuss the problem of anomalous transport without any form of disorder and with vanishing Lyapunov exponents. We also discuss the emergence of chaos, contrary to intuition, when dissipation is added to these dynamical systems.

Hans-Peter Scheffler

tba

Renat Sibatov

Fractional infinitely divisible processes as a basis for modeling nanodynamics

A fractional generalization of infinitely divisible processes is introduced via fractional generalization of differential equation for the characteristic function. The obtained family includes as subfamilies fractional generalizations of Brownian motion, Lévy motion, Poisson process, negative binomial motion, etc. Three aspects of the new statistics based on this generalization are described: generalization of the limit theorem, self-similarity, and fractional asymptotics of CTRW dynamics. The memory concept is discussed in connection with fractional Poisson process. Conception of intermidiate asymptotics is introduced on the base of truncated Lévy flights. This leads to the correspondence principle connecting macro- and nano-statistics. Applications of these ideas to some nanophysical problems such as blinking quantum dot fluorescence, conductance through multi-channel mesoscopic conductors, electronic transport in disordered semiconductors and nanocrystal arrays, subrecoil laser cooling and diffusion of atoms in optical lattices are demonstrated. Some numerical results are presented and future perspectives are discussed.

Igor Sokolov

tba

Domokos Szasz

Mixing in a stochastic model of heat conduction

Consider a linear chain of N particles each carrying an energy. The evolution of the energies is governed by a continuous time, pure jump Markov process. The interactions are nearest neighbor ones preserving the energy. A lower bound (in terms of N) is presented for the spectral gap of the Markov generator under the assumption that the stationary distributions are reversible and, moreover, reversible states are also characterized. Joint work with A. Grigo and K. Khanin.

Alessandro Taloni

N-body interacting systems: Fractional dynamics representation and beyond

The Generalized Elastic Model accounts for the dynamics of several physical systems, such as polymers, fluctuating interfaces, growing surfaces, membranes, proteins and file systems among others. We derive the fractional stochastic equation governing the motion of a probe particle (tracer) in such kind of linear systems. This Langevin equation involves the use of fractional derivative in time and satisfies the Fluctuation-Dissipation relation, it goes under the name of Fractional Langevin Equation. Within this framework the spatial correlations appearing in the Generalized Elastic Model are translated into time correlations described by the fractional derivative together with the space-time correlations of the fractional Gaussian noise. We derive the exact scaling analytical form of several physical observables such as structure factors, roughness and mean square displacement. Special attention will be devoted to the dependence on initial conditions, linear-response relations in the case of an applied potential and non-linear interactions.

Dalia Terhesiu

Mixing rates and higher order dual ergodic theorems for dynamical systems with infinite measure

We will report on recently developed methods that provide sharp mixing rates and higher order dual ergodic theorems for a large class of dynamical systems with infinite measure. Examples of interest include the Pomeau-Mannevile family of intermittency maps. This is joint work with Ian Melbourne.

Maximilian Thaler

will be announced later

Henk van Beijeren

Anomalous transport properties of one-d Hamiltonian systems

The dynamics of generic one-dimensional Hamiltonian systems with translation invariant interaction potentials are shown to be in the Kardar-Parisi-Zhang universality class. Scaling functions obtained by Prähofer and Spohn by solving the polynuclear growth model [2] can be used to obtain exact expressions for the long time behavior of the Green-Kubo integrands for heat diffusion and sound attenuation, as well as for system size dependent coefficients of heat conduction and sound damping. The Green-Kubo integrands decay with time as t2/3; the linear sound mode damping constant diverges with system size as L1/2 and the linear heat conduction coefficient as L1/3. The coefficients can be obtained exactly from the Prähofer-Spohn scaling functions combined with mode-coupling amplitudes as obtained by Ernst, Hauge and Van Leeuwen [3]. They only depend on thermodynamic properties. Due to the presence of three conserved densities (mass, momentum and energy), giving rise to three hydrodynamic modes with different propagation velocities (+ or - the adiabatic sound velocity c for the sound modes and zero for the heat mode), there are important and still superdiffusive corrections to the asymptotic long time respectively large size behaviors. By using mode coupling techniques one can calculate the exponents as well as perturbative approximations for the coefficients of these corrections.

Previous results by Delfini et al. [4] provide a correct one-loop mode coupling approximation to these exact results for weakly anharmonic chains. For strongly anharmonic systems corrections are needed.
For heat diffusion a Levy flight representation obtains with an exact expression for the long time behavior of the jump distribution.
Exceptional systems, for which the results above do not hold include systems for which n/c(\partial c/\partial n)s = 1, with n the number density and s the entropy per particle, and exactly solvable models such as harmonic chains and Toda lattices.
Finally, in one and two dimensions the possibility emerges of anomalous transport in systems described by nonlinear fluctuating hydrodynamic equations with finite transport coefficients. In other words: diverging Green-Kubo integrals do not necessarily imply non-existent transport coefficients.

1. H. van Beijeren, arXiv:1106.3298v2 [cond-mat.stat-mech]
2. M. Prähofer and H. Spohn, Exact scaling functions for one-dimensional stationary KPZ growth, J. Stat. Phys. 115 (2004) 255
3. M. H. Ernst, E. H. Hauge and J. M. J. van Leeuwen, Asymptotic time behavior of correlation functions. II. Kinetic and potential terms J. Stat.

		Phys. 15 (1976) 7
Franco Vivaldi	Anomalous transport in a piecewise isometric system	We study transport in a one-parameter family of piecewise rotations of the torus, for rotation number approaching $1/4$. This is a zero-entropy system which in this limit exhibits a divided phase space, with island chains immersed in a `pseudo-chaotic' region. We identify a novel mechanism for long-range transport, namely the adiabatic destruction of accelerator-mode islands. This process originates from the quasi translational invariance of the phase space, and leads to long flights of linear motion, for a significant measure of initial conditions.
Angelo Vulpiani	Transport properties of chaotic and non-chaotic many particle systems	Two deterministic models for Brownian motion are investigated by means of numerical simulations and kinetic theory arguments. The first model consists of a heavy hard disk immersed in a rarefied gas of smaller and lighter hard disks acting as a thermal bath. The second is the same except for the shape of the particles, which is now square. The basic difference of these two systems lies in the interaction: hard core elastic collisions make the dynamics of the disks chaotic whereas that of squares is not. Remarkably, this difference is not reflected in the transport properties of the two systems: simulations show that the diffusion coefficients, velocity correlations and response functions of the heavy impurity are in agreement with kinetic theory for both the chaotic and the non-chaotic model. The relaxation to equilibrium, however, is very sensitive to the kind of interaction. These observations are used to reconsider and discuss some issues connected to chaos, statistical mechanics and diffusion.
Aleksander Weron	Khinchin Theorem for Levy Flights	One of the most fundamental theorems in statistical mechanics is the Khinchin ergodic theorem, which links the ergodicity of a physical system with the irreversibility of the corresponding autocorrelation function. However, the Khinchin theorem cannot be successfully applied to processes with infinite second moment, in particular, to the relevant class of Levy flights. Here, we show how to solve this challenging problem. Namely, using the recently developed measure of dependence called Levy correlation cascade, we derive a version of the Khinchin theorem for Levy flights. This result allows us to verify the Boltzmann hypothesis for systems displaying Levy-flight-type dynamics. Refs: S, Burov, R.Metzler, and E.Barkai. "Aging and nonergodicity beyond the Khinchin theorem", PNAS 107, 13228 (2010). A. Weron, Magdziarz M. "Generalization of the Khinchin theorem to Levy flights", Phys. Rev. Lett. 105, 260603 (2010). M. Magdziarz, Weron A. "Ergodic properties of anomalus diffusion processes", Ann. Phys. (2011).
Vasily Zaburdaev	Perturbation spreading in many-particle systems: a random walk approach	The propagation of an initially localized perturbation via an interacting many-particle Hamiltonian dynamics is investigated. We argue that the propagation of the perturbation can be captured by the use of a continuous-time random walk where a single particle is traveling through an active, uctuating medium. Employing two archetype ergodic many-particle systems, namely (i) a hard-point gas composed of two unequal masses and (ii) a Fermi-Pasta-Ulam chain we demonstrate that the corresponding perturbation proles coincide with the diusion proles of the single-particle L´evy walk approach. The parameters of the random walk can be related through elementary algebraic expressions to the physical parameters of the corresponding test many-body systems.