DY 12: Nonlinear dynamics, synchronization and chaos II

Time: Tuesday 10:00–11:15 Location: MA 004

DY 12.1 Tue 10:00 MA 004

Decelerating microdynamics accelerates macrodynamics in the voter model — Hans-Ulrich Stark, Claudio Juan Tessone, and •Frank Schweitzer — Chair of Systems Design,ETH Zurich, Switzerland

We study an extension to the standard voter model, in which voters have an individual inertia to change their state. We assume that this inertia increases with the time a voter has been in its current state. Increasing the level of inertia in the system decelerates the microscopic dynamics. Counter-intuitively, we find that the time to reach a macroscopic ordered state can be accelerated for intermediate levels of inertia. This is true for different network topologies, including fully-connected ones. We derive a mean-field approach that shows that the origin of this phenomenon is the break of the magnetization conservation because of the evolving inertia. We find that the dynamics near the ordered state is governed by two competing processes, which stabilize either the majority or the minority of voters. If the first one dominates, it accelerates the ordering of the system.

DY 12.2 Tue 10:15 MA 004

Tunable Fermi acceleration in the driven elliptical billiard — •Florian Lenz[1], Fotis K. Diakonos[2], and Peter Schmelcher[1,3] — [1]Physikalisches Institut, University of Heidelberg, Philosophenweg 12, 69120 Heidelberg, Germany — [2]Department of Physics, University of Athens, GR-15771 Athens, Greece — [3]Theoretische Chemie, Physikalisch-Chemisches Institut, University of Heidelberg, Im Neuenheimer Feld 229, 69120 Heidelberg, Germany

We explore the dynamical evolution of an ensemble of non-interacting particles propagating freely in an elliptical billiard with harmonically driven boundaries. The existence of Fermi acceleration is shown thereby refuting the established assumption that smoothly driven billiards whose static counterparts are integrable do not exhibit acceleration dynamics. The underlying mechanism based on intermittent phases of laminar and stochastic behavior of the strongly correlated angular momentum and velocity motion is identified and studied with varying parameters. The diffusion process in velocity space is shown to be anomalous and we find that the corresponding characteristic exponent depends monotonically on the breathing amplitude of the billiard boundaries. Thus it is possible to tune the acceleration law in a straightforwardly controllable manner.

DY 12.3 Tue 10:30 MA 004

Deterministic escape of a dimer over an anharmonic potential barrier — •Simon Fugmann, Dirk Hennig, and Lutz Schimansky-Geier — Institut für Physik, Humboldt-Universität Berlin, Newtonstrasse 15, 12489 Berlin, Germany

We consider the deterministic escape dynamics of a dimer from a metastable state over an anharmonic potential barrier. The underlying dynamics is conservative and noiseless. The dimer consists of two particles coupled through a spring. Its motion takes place in a two-dimensional plane. Each of the constituents for itself is unable to escape, but as the outcome of the coupled dynamics the system is eventually enabled to exit the domain of attraction, it is initially put in. Related to escape, we present the critical dimer configurations and the corresponding activation energies. It is found that, there exists a range of optimal coupling for escape to take place. Interestingly, out of this range the system shows Fermi resonance, which completely inhibits the process of overcoming the barrier.

DY 12.4 Tue 10:45 MA 004

Simulating Classical Particles in Random Potentials — •Kai Bröking[1], Stephan Kramer[2], Ragnar Fleischmann[1], and Theo Geisel[1] — [1]Max-Planck-Institut für Dynamik und Selbstorganisation, 37073 Göttingen — [2]Institut für Theoretische Physik, 37077 Göttingen

The propagation of classical trajectories in systems with chaotic dynamics or in the presence of weak correlated disorder often makes high demands in accuracy and speed on the ODE solver employed; in either case the conservation of integrals of motion is a valuable indicator whether the correct physics is being reproduced by the simulation.

This becomes even more important when the analysis of the physics of the problem requires extensive post-processing of the numerical results, e.g. aiming at finding small effects which depend on the correct simulation of an ensemble of particles. In the latter case, the solver must treat the problem accurately and with greatest possible efficiency to allow the simulation of a large number of trajectories. This is crucial when simulating ballistic transport effects in the presence of weak disorder which leads to a branching of the electron flow [1][2].

We study the abidance of conservation laws by solvers of the DOPRI family [3] with regard to motion on unstable periodic orbits, and to the simulation of an ensemble of electrons in weak disordered potentials.

[1] Topinka et al., Coherent branched flow in a two-dimensional electron gas, Nature 410 (2002)

[2] Jura et al., Unexpected features of branched flow through a high-mobility 2DEG, Nature Physics, doi:10.1038/nphys756

[3] Hairer et al., Solving ODEs Vol. I, Springer 2000

DY 12.5 Tue 11:00 MA 004

How does God play dice? — •Jan Nagler — Institute for Nonlinear Dynamics, University of Bremen — Max Planck Institute for Dynamics und Self-Organization, Göttingen

A dice throw is commonly considered a paradigm for chance. However tossing the dice has little to do with fortuitousness. We show how deterministic classical dynamics make a dice throw to a fairly good random number generator, and under which conditions the outcome is rather predictable. In order to keep things simple, we focus on the simplest possible dice throw model: a barbell with two marked masses at each end that is thrown with initial rotation and eventually comes to rest when the bounces have consumed all energy. The two possible final configuration types of the masses define then the outcome of the throw. We analyze the pseudorandom nature of a dice roll studying the dependence of the outcomes on initial energy, position, momenta and friction strength.