DY 24: Complex Systems

Time: Tuesday 10:00–11:00 Location: BH-N 128

DY 24.1 Tue 10:00 BH-N 128

Using quantum physics to simulate discrete-time, highly non-Markovian complex processes — •Felix Binder[1], Jayne Thompson[2], Chengran Yang[1], Varun Narasimhachar[1], and Mile Gu[1,2,3] — [1]School of Physical and Mathematical Sciences, Nanyang Technological University, 637371 Singapore, Singapore — [2]Centre for Quantum Technologies, National University of Singapore, 3 Science Drive 2, 117543 Singapore, Singapore — [3]Complexity Institute, Nanyang Technological University, 639673, Singapore

Stochastic processes are as ubiquitous throughout the quantitative sciences as they are notorious for being difficult to simulate and predict. In this talk I present a unitary quantum simulator for discrete-time stochastic processes which requires less internal memory than any classical analogue throughout the simulation. The simulator's internal memory requirements equal those of the best previous quantum models. However, in contrast to previous models it only requires a (small) finite-dimensional Hilbert space. Moreover, since the simulator operates unitarily throughout, it avoids any unnecessary information loss. Interestingly, the formalism of matrix product states may be used to systematically derive the memory states and the unitary operator which define the simulator. This renders the results useful for direct experimental implementation with current platforms for quantum computation and I will present results obtained from simulation on IBM's Quantum Experience for a representative example process.

DY 24.2 Tue 10:15 BH-N 128

Analyzing the bifurcation behavior of complex systems via stochastic continuation - application to the Ising model — •Clemens Willers[1], Uwe Thiele[1], David Lloyd[2], Andrew Archer[3], and Oliver Kamps[1] — [1]Institut für Theoretische Physik, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 9, 48149 Münster, Germany — [2]Department of Mathematics, University of Surrey, Guildford, GU2 7XH, UK — [3]Department of Mathematical Sciences, Loughborough University, Loughborough LE11 3TU, UK

For many complex systems an analytical description of the macroscopic dynamics is not available, for instance, for systems that are described on the microscopic level by lattice- or agent-based models. These are frequently used in all natural sciences, social science, and economics. To analyse in this case the solution and bifurcation structure of the model on the level of macroscopic observables, one has to rely on equation free methods like stochastic continuation [1,2]. The question arising in this context is which kind of bifurcation diagrams can be extracted and how they relate to such diagrams of related mean-field models if available. Our contribution briefly introduces the method of stochastic continuation. As an example, we then investigate the bifurcation diagram of the two-dimensional Ising model without and with external field both, with stochastic continuation and in the corresponding mean field model. This includes a discussion of the scaling of the extracted solutions and its relation to the known critical exponents.

[1] S.A. Thomas et. al., Physica A, 464 (2016) 27-53 [2] D. Barkley et. al., SIAM J. Appl. Dyn. Syst. 5 (2006) 403-434

DY 24.3 Tue 10:30 BH-N 128

Universal law for waiting internal time in seismicity and its implication to complex network of earthquakes — •Norikazu Suzuki — College of Science and Technology, Nihon University, Chiba, Japan

In the studies of seismicity, one can consider two different kinds of time: one is the conventional time, and the other is the internal time. Let {t_1, t_2, ..., t_N} be the conventional occurrence times of N earthquakes contained in the dataset to be analyzed. In this case, the internal time is simply the label "n" of t_n (n=1, 2, ..., N), which is henceforth referred to as the "event time". Carbone et al. (Europhys. Lett., 71 (2005) 1036) show that "unified scaling law" for conventional waiting times of earthquakes claimed by Bak et al. (Phys. Rev. Lett., 88 (2002) 178501) is actually not universal. We show that, in contrast to the conventional waiting time, the waiting "event time" obeys a power law. This implies the existence of temporal long-range correlations in terms of the event time with no sharp decay of the crossover type. The discovered power-law waiting event-time distribution turns out to be universal in the sense that it takes the same form for seismicities in California, Japan and Iran. In particular, the parameters contained in the distribution take the common values in all these geographical regions. An implication of this result to the procedure of constructing earthquake networks is discussed (S.Abe and N.Suzuki, Europhys. Lett.,65 (2004) 581; 97 (2012) 49002; 99 (2012) 39001; 110 (2015) 59001).

DY 24.4 Tue 10:45 BH-N 128

Stochastic Analysis of Snow Layers — •Pyei Phyo Lin[1], Joachim Peinke[1], Matthias Wächter[1], Isabel Peinke[2], and Pascal Hagenmuller[2] — [1]Inst Physik & ForWind Uni Oldenburg 26111 Oldenburg — [2]Météo-France - CNRS, CNRM UMR 3589, CEN, Grenoble, France

Data of high-resolution penetration tests are analyzed with stochastic methods. The measurements were performed with the snow micro penetrometer, measuring the snow resistance at micro-scale on small snow depths. We analyse this noisy data by stochastic methods. Therefore we determine drift an diffusion coefficients showing that the mean force increases with the depth. The solidity increases overall with the depth. Layer with different solidity can be detected. The noise analysis indicates that jump rise is involved, most likely due to breaking of ice bonds.