SM&FT 2015 - The XVI Workshop on Statistical Mechanics and nonpertubative Field Theory

Report of Contributions

https://agenda.infn.it/e/SM&FT2015

Contribution ID: **3** Type: **not specified**

Thermal fluctuations in a kinetic model for multicomponent fluids

Friday, 11 December 2015 10:40 (20 minutes)

Thermal fluctuations and non-ideal multicomponent effects are important ingredients for a proper mesoscale description of a wide variety of flows in soft matter and biological physics [1, 2, 3]. Theoretically, thermally fluctuating mesoscopic flows are most conveniently dealt within the framework of fluctuating hydrodynamics [4]. An important ingredient in this formulation is the fluctuation-dissipation theorem (FDT) relating the noises covariances to the Onsager coefficients of the fluid. Even without the presence of thermal fluctuations, modeling and simulation of multicomponent and multiphase fluid flows is extremely difficult, especially because of the problems in simulating complex diffusion processes, phase separation, and interface dynamics. This has triggered the development of a whole range of innovative numerical methods to solve the Navier-Stokes equations, of which the lattice Boltzmann equations (LBE) [5, 6] stands out due to the capability of handling boundary conditions associated with highly irregular geometries, its nearly ideal amenability to parallel computing, and the possibility to describe non-ideal fluids with phase transitions/phase separation.
The original contribution of the work will result in formulating a kinetic model able to reproduce the desired equilibrium correlation functions for the density and velocity fields invoking FDT directly at the kinetic level. These results will serve as a basis for the development of LBE, embedding both the effects of fluctuations and non-ideality with a limited set of kinetic velocities.

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[2] J. Lyklema, Fundamentals of Interface and Colloid Science (Academic Press, London, 1991)
[3] W. B. Russel, D. A. Saville & W. R. Schowalter, Colloidal Dispersions (Cambridge University Press,
Cambridge, 1995)
[4] L. D. Landau & E. M. Lifshitz, Fluid Mechanics (Pergamon, New York, 1959)
[5] R. Benzi, S. Succi & M. Vergassola, Physics Reports 222, 145-197 (1992)
[6] S. Chen & G. D. Doolen, Annu. Rev. Fluid Mech. 30, 329-364 (1998)

Summary

A model based on the continuum Boltzmann equation for describing multicomponent fluids is extended to incorporate the effects of thermal fluctuations. The resulting equation is then linearized around the equilibrium and noise correlations for all the modes are determined by invoking the fluctuation-dissipation theorem directly at the kinetic level. By suitable discretizations of time, space and velocity, the results are then transferred on the lattice and numerical simulations are performed. From numerical results, it can be appreciate the importance of using our noise correlations, instead of using uncorrelated noise, to get a proper thermalization of the system in a homogeneous case, while capillary fluctuations of a fluid-fluid interface in a non-homogeneous case are well reproduced.

Primary author: Dr BELARDINELLI, Daniele (Università di Roma, Tor Vergata)

Co-authors: Dr VARNIK, Fathollah (ICAMS Ruhr-Universität Bochum); BIFERALE, Luca (ROMA2); Dr

GROSS, Markus (Max Planck Institute for Intelligent Systems); Dr SBRAGAGLIA, Mauro (Università di Roma, Tor Vergata)

Presenter: Dr BELARDINELLI, Daniele (Università di Roma, Tor Vergata)

Session Classification: Session 7

Contribution ID: **4** Type: **not specified**

Superfluids of charged mesons

Thursday, 10 December 2015 10:40 (20 minutes)

We present various results regarding the chemical potential driven meson condensation. A system of mesons at vanishing temperature can undergo a phase transition to various superfluid phases by varying the isospin chemical potential and/or the strange quark chemical potential. In the condensed phase one of the charged mesons becomes the superfluid mode, the mesons are mixed and their masses depend in a nontrivial way on the isospin and strange quark chemical potential. The leptonic decay channels are also affected by the meson condensation, indeed some of these channels have a peculiar nonmonotonic behavior as a function of the isospin chemical potential.

Primary author: MANNARELLI, Massimo (LNGS)

Co-author: MAMMARELLA, Andrea (INFN)

Presenter: MANNARELLI, Massimo (LNGS)

Session Classification: Session 3

Contribution ID: **5** Type: **not specified**

Network geometry

Thursday, 10 December 2015 09:00 (40 minutes)

Networks are mathematical structures that are universally used to describe a large variety of complex systems such as the brain or the Internet. Characterizing the geometrical properties of these networks has become increasingly relevant for routing problems, inference and data mining. In real growing networks, topological, structural and geometrical properties emerge spontaneously from their dynamical rules. Here we show that a single two parameter model of emergent network geometry,constructed by gluing triangles, can generate complex network geometries with non-trivial distribution of curvatures, combining exponential growth and small-world properties with finite spectral dimensionality. In one limit, the non-equilibrium dynamical rules of these networks can generate scale-free networks with clustering and communities, in another limit 2 dimensional manifolds with non-trivial modularity. These properties of the geometrical growing networks are present in a large set of real networks describing biological, social and technological systems. When manifold of arbitrary dimension are constructed, and energies are assigned to their nodes these networks can be mapped to quantum network states and they follows quantum statistics despite they do not obey equilibrium statistical mechanics.

Primary author: Dr BIANCONI, Ginestra (Queen Mary University of London)

Presenter: Dr BIANCONI, Ginestra (Queen Mary University of London)

Session Classification: Session 3

Contribution ID: **6** Type: **not specified**

Kuramoto model of synchronization: equilibrium and nonequilibrium aspects

Thursday, 10 December 2015 16:00 (30 minutes)

Recently, there has been considerable interest in the study of spontaneous synchronization, particularly within the framework of the Kuramoto model. The model comprises oscillators with distributed natural frequencies interacting through a mean-field coupling, and serves as a paradigm to study synchronization. In this talk, I will describe the model from a different point of view, emphasizing the equilibrium and nonequilibrium aspects of its dynamics from a statistical physics perspective. I will discuss in a unified way known results with more recent developments obtained for a generalized Kuramoto model that includes inertial effects and noise.

Primary author: RUFFO, Stefano (FI)

Co-authors: CAMPA, Alessandro (ISS); Dr GUPTA, Shamik (MPIPKS Dresden Germany)

Presenter: RUFFO, Stefano (FI)

Session Classification: Session 5

Contribution ID: **7** Type: **not specified**

CONDENSATION OF FLUCTUATIONS

Friday, 11 December 2015 13:00 (30 minutes)

Observing fluctuations of an extensive quantity is alike to put a constraint on the system. Though it may sound odd, the statement is of general validity, with far reaching consequences both in equilibrium and out of equilibrium. Its meaning becomes precise in the framework of large deviation theory. As an example of the connection, in the talk it will be shown that the so called grand-canonical-catastrophe of the Ideal Bose Gas is an instance of condensation of fluctuations. The relation to the recently experimentally observed condensation of photons will be hinted to.

Primary author: Prof. ZANNETTI, Marco (Università di Salerno)

Presenter: Prof. ZANNETTI, Marco (Università di Salerno)

Session Classification: Session 8

Contribution ID: **8** Type: **not specified**

Plastic events in soft glasses

Wednesday, 9 December 2015 15:40 (30 minutes)

Many materials around us respond elastically to small applied stresses, but flow once a threshold stress (the yield stress) is exceeded. This is the case for food products, powders, cosmetics, foams, etc···It turns out that understanding the yield stress transition in these materials, often called soft glasses, is a challenging question. Similar to structural glasses, soft glasses exhibit aging and complex dynamics. Also, the size of the elementary building block of a soft glass is usually ranging from 1 micron to 1mm, ruling out the possibility to investigate the problem by molecular dynamics.

Recently, a new approach has been proposed: using a mesoscopic formulation of the system, the dynamics of relative simple soft glasses, like foams or micro emulsions, has been investigated. Numerical simulations allow the computation of several important properties of the systems, such as the yield stress transition. In this talk, I will review the new approach and explain how the complexity of soft glass dynamics may be disentangled in a systematic way.

Primary author: Prof. BENZI, Roberto (Dipartimento di Fisica, Univ. di Roma "Tor Vergata")

Presenter: Prof. BENZI, Roberto (Dipartimento di Fisica, Univ. di Roma "Tor Vergata")

Session Classification: Session 1

Contribution ID: **9** Type: **not specified**

Spontaneous knotting of DNA and other biomolecules: dynamical and functional aspects.

Wednesday, 9 December 2015 18:30 (30 minutes)

By using both coarse-grained models and bioinformatics approaches, we shall address a few prototypical examples of the intriguing implications of entanglement and knotting on the functional, mechanical and folding properties of various types of biomolecules. In particular, we shall discuss the kinetics of spontaneous knotting of long ssDNA chains and examine the "topological friction" accompanying their translocation through nanopores equivalent to those used in nanopore sequencing techniques. The broader implications for the ejection of knotted DNA out of viral capsids will also be discussed.

Primary author: Prof. MICHELETTI, Cristian (SISSA)

Presenter: Prof. MICHELETTI, Cristian (SISSA)

Session Classification: Session 2

Contribution ID: **10** Type: **not specified**

The electric dance of cholesteric colloids

Friday, 11 December 2015 12:10 (30 minutes)

Dispersions of colloidal particles in liquid crystals are nowadays a subject of
intensive studies due to their potential as novel and versatile metamaterials with
important applicative avenues such as digital-ink technologies,
biosensors and optical devices.
In this talk I will report theoretical results, based on lattice Boltzmann simulations,
on a novel method to manipulate the spatial arrangements of colloids in cholesteric liquid crystals
.
By controlling the amplitude and shape of a time-dependent electric field, I will show that the system can be
reproducibly driven out of equilibrium through different kinetic pathways and
navigated through a glassy-like free energy landscape encompassing many competing metastable equilibria. Such states range from simple Saturn rings to complex structures
featuring amorphous defect networks, or stacks of disclination loops.
In particular, by using suitable non-equilibrium electric pulses, one can drive colloids from planar to
linear, rope-like configurations and vice-versa.
These results can stimulate the development of new (e.g. non equilibrium) experimental procedures to control
the three-dimensional patterning and self-assembly of colloidal particles suspended in complex fluids
as well as prompt the design of new types of switching devices with tunable elastic and electro-optic properties.

Primary author: ORLANDINI, Enzo (P)

Co-authors: Prof. MICHELETTI, Cristian (SISSA); Prof. MARENDUZZO, Davide (The University of Edinburgh); Dr D'ADAMO, Giuseppe (SISSA, Trieste)

Presenter: ORLANDINI, Enzo (P)

Session Classification: Session 8

Contribution ID: **11** Type: **not specified**

Heterogenous mean field approach to neural networks dynamics

Wednesday, 9 December 2015 16:10 (20 minutes)

We apply to neural networks dynamics on on random massive networks the hetherogeneous mean field approach which has been originally developed for epidemic and social systems. In particular we focus on leaky integrate-and-fire neurons with short-term plasticity evidencing that for large enough connectivity the method provides a good descriptoin of the full network dynamics. Then we analyze in details the dynamical phase characterized by the presence of quasisynchronous events. Finally, we prove that the hetherogeneous mean field formulation allows to solve the inverse problem of reconstructing the in-degree distribution for different network topologies from the knowledge of the global activity field.

Primary author: Dr VEZZANI, Alessandro (CNR NANO)

Presenter: Dr VEZZANI, Alessandro (CNR NANO)

Session Classification: Session 1

Contribution ID: **12** Type: **not specified**

Long Range Force and Y-Bosonic strings in Baryons

Thursday, 10 December 2015 18:00 (20 minutes)

The potential due to system of a three static quark (3Q) is studied using SU(3) lattice QCD at finite T. The (3Q) potential is calculated in pure SU(3) Yang-Mills latice gauge theory at finite temperature with Polyakov loops operators. In this work, we focus on the relation between the parameterization ansatz of the (3Q) potential and the observed form of the strings in the baryon. The interesting result is that, although the gluonic pattern is a Δ-shaped, the lattice data for the potential fits well to a Y-shaped string pattern. Moreover, we found that in order to reproduce the quark anti-quark string tension, the fit ansatz of the Y-law must include a Dedekind eta function accounting for the Y-string fluctuation with modular corresponding to the minimal length of the Y-string.
Our results may promote the picture of the baryonic strings as always exhibiting a Δ field profile, however, the baryonic potential is consistent with a Y-law describing a system of fluctuating strings.

Primary author: Dr BAKRY, Ahmed (Institute of Modern Physics,CAS)

Co-authors: Prof. ZHANG, Pengming (Institute of Modern Physics); Prof. CHEN, Xurong (Institute of Modern Physics)

Presenter: Dr BAKRY, Ahmed (Institute of Modern Physics,CAS)

Session Classification: Session 6

Contribution ID: **13** Type: **not specified**

The meson spectrum in large N QCD

Thursday, 10 December 2015 09:40 (40 minutes)

We compute the continuum limit of meson masses, the pion decay constant and the chiral condensate in lattice similations with different numbers of colours N and extrapolate these to the limit of large N.

Primary author: Prof. BALI, Gunnar (University of Regensburg)

Presenter: Prof. BALI, Gunnar (University of Regensburg)

Session Classification: Session 3

Contribution ID: **14** Type: **not specified**

Active dumbbells: from diffusion properties to aggregation phenomena

Friday, 11 December 2015 09:20 (20 minutes)

In the last two decades active matter has been the object of a surge of theoretical and experimental interest. Apart from the obvious biological relevance, theorists are also specially attracted by the inherently non-equilibrium nature of self-propulsion phenomena. After a quick overview of the theoretical models and experimental systems that are currently under the spotlight, this talk will be focused on one simple model of active dumbbells. Two kinds of results will be presented in some detail, that belong to the opposite ends of the density range: the diffusion behaviour of a single active dumbbell and its interpretation in terms of an effective temperature on one hand, and aggregation processes on the other.

Primary author: Dr MOSSA, Alessandro (FI)

Presenter: Dr MOSSA, Alessandro (FI)

Session Classification: Session 7

Contribution ID: **16** Type: **not specified**

New Metrics for Economic Complexity: Measuring the Intangible Growth Potential of Countries

Thursday, 10 December 2015 15:00 (40 minutes)

Economic Complexity refers to a new line of research which portrays economic growth as a process of evolution of ecosystems of technologies and industrial capabilities. Complex systems analysis, simulation, systems science methods, and big data capabilities offer new opportunities to empirically map technology and capability ecosystems of countries, industrial sectors and companies, analyse their structure, understand their dynamics and measure economic complexity. This approach provides a new vision of a data driven fundamental economics in a strongly connected, globalised world.

In particular here we discuss the COMTRADE dataset which provides the matrix of countries and their exported products. According to the standard economic theory the specialization of countries towards certain specific products should be optimal. The observed data show that this is not the case and that diversification is actually more important. The situation is different for companies or sectors which seem instead to specialize only on few products.

The crucial challenge is then how to turn these qualitative observations into quantitative variables. We have introduced a new metrics for the Fitness of countries and the Complexity of products which is a sort of economic version of the Google Page rank approach. The direct comparison of the Fitness with the country GDP gives an assessment of the non-expressed potential of the country. This can be used as a predictor of GDP evolution or stock index and sectors performances. These results are also useful for risk analysis, planning of industrial development and strategies to exit from the "poverty trap". Analogously the Complexity of products can be compared with its added value leading also to new information.

The dynamics in the GDP-Fitness plane reveals a heterogeneous structure and certain areas behave in a laminar way (high predictability) while others appear turbulent (low predictability). This situation requires an analysis inspired to the theory of Dynamical Systems and it is not appropriate to study with the usual regressions.

Recently we are considering the extension of these ideas also to the Fitness of Companies which are instead mostly specialized in terms of products. This requires different datasets and a new algorithm. The implication of the present study for the general problem of Big Data Science will be discussed.

References

[1] A. Tacchella, M. Cristelli, G. Caldarelli, A. Gabrielli and L. Pietronero:
A New Metrics for Countries'Fitness and Products'Complexity, Nature: Scientific Reports, 2-723 (2012)

[2] M. Cristelli, A. Gabrielli, A. Tacchella, G. Caldarelli and L. Pietronero:
Measuring the Intangibles: A Metrics for the Economic Complexity of Countries and Products, PLOS One Vol. 8, e70726 (2013)

(3) M. Cristelli, A. Tacchella, L. Pietronero: The Heterogeneous Dynamics of Economic Complexity, PLOS One 10(2): e0117174 (2015) and Nature editorial 2015: http://www.nature.com/news/physicists-make-weather-forecasts-for-economies-1.16963

Primary author: Prof. PIETRONERO, Luciano (University of Rome Sapienza and Institute of Com-

plex Systems, ISC-CNR)

Presenter: Prof. PIETRONERO, Luciano (University of Rome Sapienza and Institute of Complex Systems, ISC-CNR)

Session Classification: Session 5

Contribution ID: **18** Type: **not specified**

The pseudocritical line in QCD at nonvanishing chemical potential

Thursday, 10 December 2015 12:40 (20 minutes)

We present a determination of the curvature of the pseudo-critical line in Nf=2+1 QCD at the physical point, performed using the analytic continuation approach. We extrapolate the results towards the continuum limit by considering four different lattice spacings and studying the possible systematics involved.

Primary authors: BONATI, Claudio (PI); NEGRO, Francesco (PI); Mr SANFILIPPO, Francesco (Southampton University); MARITI, Marco (PI); D'ELIA, Massimo (PI); MESITI, Michele (PI)

Presenter: MESITI, Michele (PI)

Session Classification: Session 4

Contribution ID: **19** Type: **not specified**

Real-time simulation of large open quantum spin systems driven by dissipation

Friday, 11 December 2015 11:30 (40 minutes)

The real-time evolution of large open quantum spin systems, whose dynamics are entirely driven by dissipative couplings to an environment, is studied in two and three spatial dimensions. Dissipative processes with Hermitean quantum jump operators lead from the ordered phase of the Heisenberg or XY-model into a disordered phase at late times. The corresponding Lindblad equation is solved using an efficient cluster algorithm. The symmetries of the dissipative process determine the time scales that govern the approach towards equilibrium. One encounters slow equilibration if the dissipative process conserves any of the magnetization Fourier modes. The non-equilibrium transport of magnetization between a Heisenberg ferromagnet and an antiferromagnet, initially isolated
from each other in two separate parts of the volume, is also investigated. Finally, a cooling process with non-Hermitean quantum jump operators, which leads into a Bose-Einstein condensate of hard-core bosons as a dark state, is simulated with a worm algorithm, and the different time-scales that arise during equilibration are again investigated.

Primary author: Prof. WIESE, Uwe-Jens (Bern University)

Presenter: Prof. WIESE, Uwe-Jens (Bern University)

Session Classification: Session 8

Contribution ID: **28** Type: **not specified**

Quench Dynamics in Two-Dimensional Integrable SUSY Models

Friday, 11 December 2015 09:40 (20 minutes)

We analyse quench processes in two dimensional quantum field theories with infinite number of conservation laws which also include fermionic
charges that close a $N = 1$ supersymmetric algebra. While in general the quench protocol induces a breaking of supersymmetry, we show that there are particular initial states which ensure the persistence of supersymmetry also for the dynamics out of equilibrium following a quantum quench. We discuss the conditions that identify such states and, as application, we present the significant cases of the Tricritical Ising Model and the Sine-Gordon model at its supersymmetric point. We also address the issue of the Generalized Gibbs Ensemble in the presence of fermionic conserved charges.

Primary authors: CORTES CUBERO, Axel (T); Prof. MUSSARDO, GIUSEPPE (SISSA-TRIESTE); PANFIL, Milosz

Presenter: CORTES CUBERO, Axel (T)

Session Classification: Session 7

Contribution ID: **29** Type: **not specified**

On the width of the confining flux tube in the 3D U(1) lattice gauge theory

Thursday, 10 December 2015 18:20 (20 minutes)

A great deal of information about the confining regime of gauge theories can be obtained from the dynamics of the flux tube connecting two opposite chromoelectric charges. Specifically, from the behaviour of its squared width at increasing intercharge distance, which, in an effective string theory approach, is predicted to be logarithmic. This prediction has been confirmed numerically in several models on the lattice, both at zero and at finite temperature, where a linear growth should set in.

The features of the 3D U(1) lattice gauge theory at finite lattice spacing allow us to study the behaviour of the squared width at a very high precision for several values of the coupling and to test the predictions of effective string theory. We discuss our results and relate them to the properties of the static intercharge potential in the same model.

Primary authors: VADACCHINO, Davide (TO); PANERO, Marco (University of Helsinki); CASELLE, Michele (TO)

Presenter: VADACCHINO, Davide (TO)

Session Classification: Session 6

Contribution ID: **30** Type: **not specified**

Hagedorn spectrum in pure Yang-Mills theories on the lattice

Friday, 11 December 2015 10:20 (20 minutes)

We present a novel set of high-precision lattice results for the equation of state of the SU(2) pure Yang-Mills theory in the confining phase.
The prediction of a gas of non-interacting, massive glueballs yields a remarkable description of lattice data, provided that a bosonic closed string model is used to derive an exponentially growing Hagedorn spectrum for heavy glueball states.
This effective model can be applied also to the SU(3) Yang-Mills theory and describes with great accuracy lattice results reported by Borsányi et al. in JHEP 07 (2012) 056.

Primary author: NADA, Alessandro (TO)

Presenter: NADA, Alessandro (TO)

Session Classification: Session 7

Contribution ID: **31** Type: **not specified**

Curvature of the pseudocritical line in (2+1)-flavor QCD

Thursday, 10 December 2015 12:10 (30 minutes)

We study QCD with (2 + 1) HISQ fermions at nonzero temperature and nonzero imaginary baryon chemical potential. Monte Carlo simulations are performed using the MILC code along the line of constant physics with a light to strange mass ratio of ml/ms=1/20 on lattices up to 48^3x12 to check for finite cutoff effects. We determine the curvature of the pseudocritical line extrapolated to the continuum limit.

Primary authors: PAPA, Alessandro (CS); COSMAI, Leonardo (BA); CEA, Paolo (BA)

Presenter: PAPA, Alessandro (CS)

Session Classification: Session 4

Contribution ID: **32** Type: **not specified**

The role of metals in the Alzheimer disease. Experiments and ab initio simulations

Wednesday, 9 December 2015 17:00 (30 minutes)

The simultaneous development of new algorithms and powerful computers together with more and more advanced experimental techniques, is opening a new era where numerical and experimental approaches will be synergistically employed to make us understanding phenomena until recently unattainable.
I will highlight the importance of the complementary use of experiments and numerical approaches in an especially relevant scientific problem that has to do with the role played by metals in the development of Amyloid diseases (also called Protein Conformational Diseases (PCD's)) to which the Alzheimer disease (AD) in particular also belong.
The hallmark of PCD's is the misfolding and subsequent aggregation of a certain protein, that in AD is actually a short amino acidic sequence (a peptide) called the A-beta peptide, that is known to be able to bind metal ions, in particular Cu(II) and Zn(II). The role played by metal ions in the development of the pathology is a necessary piece of information to find successful strategies against AD.
Among the many experimental techniques that are at our disposal to attack the problem of clarifing the biochemical basis of protein misfolding and aggregation, X-ray Absorption Spectroscopy, appropriately complemented by numerical (classical and ab initio) simulations, represents a very promising approach.
I will present a few examples where synergistically experiments and simulations have been successfully employed.

Primary author: Prof. MORANTE, silvia (department of physics University of Rome Tor Vergata)

Co-authors: Prof. ROSSI, Giancarlo (departmente of physics University of Rome Tor Vergata); Dr STELLATO, francesco (INFN Sez Tor Vergata Roma); Dr MINICOZZI, velia (deprtment of physics university of rome tor vergata)

Presenter: Prof. MORANTE, silvia (department of physics University of Rome Tor Vergata)

Session Classification: Session 2

Contribution ID: **33** Type: **not specified**

Duals of lattice QCD in the presence of dynamical fermions

Thursday, 10 December 2015 17:30 (30 minutes)

A various approaches to construction of dual formulations
of non-abelian lattice gauge theories are reviewed. The conventional approach based on the character expansion is elaborated for SU(2) LGT with the staggered fermions. In the case of U(N) LGT we use the theory of the Weingarten functions to construct a dual formulation. Possible applications related to the finite-density QCD are discussed.

Primary author: BORISENKO, Oleg (Bogolyubov Institute for Theoretical Physics, Academy of Sciences of Ukraine)

Co-author: CHELNOKOV, Volodymyr (Bogolyubov Institute for Theoretical Physics of the National Academy of Sciences of Ukraine)

Presenter: BORISENKO, Oleg (Bogolyubov Institute for Theoretical Physics, Academy of Sciences of Ukraine)

Session Classification: Session 6

Contribution ID: **34** Type: **not specified**

Infinite order phase transitions in two-dimensional U(N) and SU(N) spin models.

Friday, 11 December 2015 10:00 (20 minutes)

Two dimensional U(N) and SU(N) spin models are studied both analytically and numerically to establish the existence of BKT-like phase transitions. In U(N) case a BKT phase transition is found for any value of N. In SU(N) case two BKT-like transitions appear in the model with an adjoint interaction term, if it is large enough, though in the model without the adjoint term only a first order phase transition is found.

Primary authors: PAPA, Alessandro (CS); CUTERI, Francesca (CS); BORISENKO, Oleg (Bogolyubov Institute for Theoretical Physics, Academy of Sciences of Ukraine); CHELNOKOV, Volodymyr (Bogolyubov Institute for Theoretical Physics of the National Academy of Sciences of Ukraine)

Presenter: CHELNOKOV, Volodymyr (Bogolyubov Institute for Theoretical Physics of the National Academy of Sciences of Ukraine)

Session Classification: Session 7

Contribution ID: **35** Type: **not specified**

Time-energy correlations as a hallmark of different branching processes

Wednesday, 9 December 2015 15:10 (30 minutes)

Several biological and natural systems appear to operate close to a critical point, as evidenced by the absence of a characteristic size in the phenomenon. Indeed, the existence of power law distributions has been detected in several contexts, as different as earthquakes, solar flares or spontaneous brain activity, and, surprisingly, with similar scaling behaviour. We propose that the specific features of each phenomenon are imbedded in the temporal organization of events in time. A detailed analysis of time-energy correlations detrending statistical noise is able to enlighten the difference between the physical mechanisms controlling different phenomena, as earthquakes, solar flares or neuronal avalanches.

Primary author: DE ARCANGELIS, Lucilla (S)

Presenter: DE ARCANGELIS, Lucilla (S)

Session Classification: Session 1

Contribution ID: **36** Type: **not specified**

Fully automated clustering by accurate non-parametric density estimation

Thursday, 10 December 2015 15:40 (20 minutes)

The use of the right density estimates in the framework of density-based cluster analysis is one of the keys to reveal the properties of a given dataset. We developed a new unsupervised and adaptive density estimator [1], that is able to reconstruct the point local density in an accurate way, even in highly inhomogeneous datasets. By combining the new density estimator with a generalized version of a recently developed clustering approach [2], we can automatically recognize sets of data points organized in clusters, regardless of the dataset characteristics (i.e. space dimensionality, shape of the clusters, distance metrics). We demonstrate the power of the algorithm performing cluster analyses on biological systems to disentangle complexity patterns. In particular, interesting results have been obtained by analysing rRNA sequences from human GUT microbiota.

[1] M. d'Errico, A. Laio, E. Facco and A. Rodriguez, "An accurate and unsupervised density estimator for highly inhomogeneous datasets" (In preparation).
[2] A. Rodriguez, A. Laio, "Clustering by fast search and find density peaks", Science, 2014, 344, 1492-1496

Primary author: Dr D'ERRICO, Maria (SISSA)

Co-authors: Prof. LAIO, Alessandro (SISSA); Dr RODRIGUEZ, Alex (SISSA); Ms FACCO, Elena (SISSA)

Presenter: Dr D'ERRICO, Maria (SISSA)

Session Classification: Session 5

Contribution ID: **37** Type: **not specified**

Large deviations and condensation

Friday, 11 December 2015 12:40 (20 minutes)

Condensation is the phenomenon whereby a finite fraction of some quantity, e.g. a particle density, concentrates into a small region of phase-space, as in the paradigmatic example of a vapor transforming into a liquid when crossing a phase-transition. It is observed in a number of different models, related to magnetic properties, gravity, mass transport and other issues. A different manifestation of condensation is observed when probability distributions of a fluctuating collective variable, such as the number of particles in a thermodynamic system, are considered. In this case, a fluctuation well above the typical value can be associated to a condensed configuration of the system. This effect, referred to as condensation of fluctuations, is not restricted to the particle number but is observed for quantities as diverse as energy, exchanged heats, particles currents etc···In this talk I will review some examples of this phenomenon and elucidate its origin.

Primary author: CORBERI, Federico (SA)

Presenter: CORBERI, Federico (SA)

Session Classification: Session 8

Contribution ID: **38** Type: **not specified**

Progress toward QCD at non-zero matter density

Thursday, 10 December 2015 11:30 (40 minutes)

Determining the phase diagram of QCD, as a function of the density of matter and the temperature, could be accomplished by lattice Monte Carlo simulations, if it were not for a severe “sign problem”. I present one promising approach to circumvent this obstacle, based on reversing the usual order of integration and integrating the gauge fields first.

Primary author: Mr DE FORCRAND, Philippe (ETH Zurich & CERN)

Co-author: Mr VAIRINHOS, Helvio (ETH Zurich)

Presenter: Mr DE FORCRAND, Philippe (ETH Zurich & CERN)

Session Classification: Session 4

Contribution ID: **39** Type: **not specified**

Flux tubes at finite temperature

Thursday, 10 December 2015 10:20 (20 minutes)

An attempt to adapt the study of color flux tubes to the case of finite temperature has been made. The field is measured both through the correlator of two Polyakov loops, one of which connected to a plaquette, and through a connected correlator of Wilson loop and plaquette in the spatial sublattice. Still the profile of the flux tube resembles the transverse field distribution around an isolated vortex in an ordinary superconductor. The temperature dependence of all the parameters characterizing the flux tube is investigated.

Primary authors: PAPA, Alessandro (CS); CUTERI, Francesca (CS); COSMAI, Leonardo (BA); CEA, Paolo (BA)

Presenter: CUTERI, Francesca (CS)

Session Classification: Session 3

Contribution ID: **40** Type: **not specified**

The INFN SUMA Project

Wednesday, 9 December 2015 17:30 (30 minutes)

The INFN-SUMA project started in early 2013 and is expected to reach its end of life later this year. The main goal of this project is to support those theoretical studies at INFN that need state-of-the-art computing systems and advanced computing techniques.
In this talk I plan to review the main areas of the project, quickly providing pointers to the main physics results made possible by the support offered by the project, and then discussing with just a few more details the impact that the current and foreseen evolution of computers and computing techniques has had (and is going to have in the future) on how large scale simulation are designed and performed.

Primary author: TRIPICCIONE, Raffaele (FE)

Presenter: TRIPICCIONE, Raffaele (FE)

Session Classification: Session 2

Contribution ID: **43** Type: **not specified**

Implications of Poincare' symmetry for thermal field theories

Thursday, 10 December 2015 17:00 (30 minutes)

The canonical partition function of a thermal system expressed in a moving frame has a natural implementation in the Euclidean path-integral formulation in terms of shifted boundary conditions. The Poincare' invariance underlying a relativistic theory implies a set of Ward identities among the correlators of the energy-momentum tensor which have also interesting applications in lattice field theory. In particular, they offer identities to define non-perturbatively the energy-momentum tensor and novel ways to compute the equation of state of the theory. Numerical results in the SU(3) Yang-Mills theory for the renormalization constants of the energy-momentum tensor and for the entropy density will also be presented.

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Session Classification: Session 6

Contribution ID: **44** Type: **not specified**

Early indicators of abrupt desertification transitions

Wednesday, 9 December 2015 18:00 (30 minutes)

Regime shifts in ecosystems can imply relevant economic and social effects. This is especially true when they involve abrupt transitions occurring on a relatively short timescale [1-2]. A special case of regime shift is given by desertification transitions of semi-arid ecosystems which can be strongly affected by climatic or anthropogenic factors [1-3]. A crucial issue in this field concerns the identification of early and reliable transition indicators, providing not only an estimate of the desertification risk, but also a tool to monitor the effectiveness of actions devoted to contrast it [1]. To this purpose, several new transition indicators have been proposed [2,3]. In particular, at increasing values of the mortality rate (control parameter of the transition) very early indicators have been recently identified in the case of continuous or nearly continuous
transitions (where the order parameter of the transition is the fraction of vegetation covered surface). These new early indicators are associated with a change in the skewness sign of the fluctuation distribution of the size of both the biggest clusters: the vegetation covered and the non-vegetated one [3]. On the other hand, numerical simulations based on a stochastic cellular automaton model [2,3] showed that several physical and ecological parameters, like in particular the colonization rate and the aridity parameter, can affect the character of the transition: from continuous to abrupt or vice versa [3,4]. Here we discuss the possibility of extending the new indicators to the case of abrupt transitions.

[1] S. Kéfi, V. Guttal, W. A. Brock, S. R. Carpenter, A. M. Ellison, V. N. Livina, D. A. Seekell, M. Scheffer, E. H. van Nes, V. Dakos, PLoS One, 9, e92097 (2014).
[2] S. Kéfi, M. Rietkerk, C. L. Alados, Y. Pueyo, V. P. Papanastasis, A. ElAich, P. C. de Ruiter, Nature, 449, 213 (2007).
[3] R. Corrado, A. M. Cherubini, C. Pennetta, Phys. Rev. E, 90, 062705 (2014).
[4] R. Corrado, A. M. Cherubini, C. Pennetta, Commun. Nonlinear Sci. and Numer. Simulat. 22, 3 (2015).

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Presenter: Prof. PENNETTA, Cecilia (Università del Salento)

Session Classification: Session 2

Contribution ID: **45** Type: **not specified**

Pathway-based personalized analysis of cancer

Wednesday, 9 December 2015 14:30 (40 minutes)

I will present a "systems approach"to analysis of high throughput large cancer datasets. The basic idea is to make use of existing knowledge, taking the golden path between "ignorance-based" machine learning approaches and the "all details are essential"view of many biologists. This philosophy [1] has been implemented in Pathifier –an algorithm that infers pathway deregulation scores for each individual tumor sample, on the basis of expression data [2]. This score is determined in a context-specific manner for every particular data set and type of cancer that is being investigated. The algorithm transforms gene level information into pathway level information, generating a compact and biologically relevant representation of each sample. We demonstrated [2] the algorithm's performance on three colorectal cancer datasets, two glioblastoma multiforme datasets, and on a very extensive dataset on breast cancer [3]. We showed that our multi-pathway-based representation is robust, preserves much of the original information, and allows inference of complex biologically significant knowledge. In particular, we demonstrate that one can glean clinically useful information, such as prediction of response to particular chemotherapy for a carefully selected subclass of patients. These results indicate that the prevalent search for "silver bullet" prognostic and predictive gene lists, that are supposed to work for all breast cancer subtypes, are to be replaced by much more specific (and restricted) biomarkers.

[1] Using High-Throughput Transcriptomic Data for Prognosis: A Critical Overview and Perspectives. Eytan Domany, Cancer Research 74, 4612 (2014).
[2] Pathway-based personalized analysis of cancer. Yotam Drier, Michal Sheffer, and Eytan Domany, PNAS 110, 6388 (2013)
[3] Pathway-based personalized analysis of breast cancer data. Anna Livshits et al, Molecular Oncology 9, 1471 (2015).

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Session Classification: Session 1

Contribution ID: **47** Type: **not specified**

Turbulence on a Fractal Fourier set

Friday, 11 December 2015 09:00 (20 minutes)

The dynamical effects of mode reduction in Fourier space for three dimensional turbulent flows is studied. We present fully resolved numerical simulations of the Navier-Stokes equations with Fourier modes constrained to live on a fractal set of dimension D. The robustness of the energy cascade and
vortex stretching mechanisms are tested at changing D, from the standard three dimensional case to a strongly decimated case for D = 2:5, where only about 3% of the Fourier modes interact. While the direct energy cascade persist, deviations from the classical Kolmogorov scaling are observed in the kinetic
energy spectra. A model in terms of a correction with a linear dependency on the co-dimension of the fractal set explains the results. At small scales, the intermittent behaviour
due to the vorticity production is strongly modified by the fractal decimation, leading to an almost Gaussian statistics already at D ~ 2.98. These effects are connected to a genuine modification in the triad-to-triad nonlinear energy transfer mechanism.

Primary author: LANOTTE, Alessandra S. (LE)

Co-authors: Prof. TOSCHI, Federico (TUE Eindhoven); BIFERALE, Luca (ROMA2); BENZI, Roberto (ROMA2); Dr MALAPAKA, Shiva Kumar (IIIT India)

Presenter: LANOTTE, Alessandra S. (LE)

Session Classification: Session 7

Contribution ID: **48** Type: **not specified**

Tetraquarks, pentaquarks and the like: old and new views

Thursday, 10 December 2015 14:30 (30 minutes)

In this talk, after a short introduction on the history of the discovery of unusually narrow, massive resonances, I will present a QCD interpretation of this new set of mesonic and baryonic hadrons as tetraquark and pentaquark states, respectively.

Primary authors: Prof. VENEZIANO, Gabriele (Collège de France and CERN); ROSSI, Giancarlo (ROMA2)

Presenter: ROSSI, Giancarlo (ROMA2)

Session Classification: Session 5