Dynamical systems: classical, quantum, stochastic

Talks

Monday, September 13

09:00 - 09:55	**F. Guerra**	Phase separation in mean field spin glasses
10:30 - 11:25	**V. Mastropietro**	Chiral anomaly and vanishing of Beta function in interacting fermion systems
11:30 - 12:25	**G. Fusco**	An extended LSW theory of Coarsening: Correlations and self-similar solutions
16:00 - 16:55	**D. Mauro**	Geometric Dequantization
17:30 - 18:25	**A. Giuliani**	Anomalous Universality in the Ashkin-Teller model
18:30 - 19:25	**U. Locatelli**	On the stability of the Trojan asteroids: a few new results based on KAM theory

Tuesday, September 14

09:00 - 09:55	**R. Onofrio**	Physics of Fermi degenerate dilute gases: results and prospectives
10:30 - 11:25	**G. Gentile**	Elliptic lower-dimensional tori in a degenerate case
11:30 - 12:25	**S. Graffi**	A local quantum version of the Kolmogorov theorem
16:00 - 16:55	**S. Kuksin**	On the inviscid limit for randomly forced nonlinear PDE
17:30 - 18:25	**S. Olla**	Transport and Fluctuations in stationary non-equilibrium states
18:30 - 19:25	**C. Toninelli**	Stochastic lattice gases with degenerate rates and glassy dynamics

Wednesday, September 15

09:00 - 10:30	**W. Werner**	SLE, conformal restriction and loop-soups
11:00 - 11:55	**F. Martinelli**	Glauber dynamics and reconstruction problems on trees

Thursday, September 16

09:00 - 09:55	**R. Zecchina**	From statistical physics methods to algorithms for combinatorial optimization and coding
10:30 - 11:25	**B. Scoppola**	Modelling the friction between the tectonic plates and the mantle
11:30 - 12:25	**M. Zworski**	Quantum resonances of chaotic systems
16:00 - 16:55	**M. Ostilli**	Ground state of many-body lattice systems: an analytical probabilistic approach
17:30 - 18:25	**C. Giardina'**	Factorization properties for the Edward-Anderson model
18:30 - 19:25	**M. Degli Esposti**	A semi-classical study of weakly chaotic maps

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Friday, September 17

09:00 - 09:55	**L. Triolo**	"Coexistence of different scales and spatial structures in some biomathematical models
10:30 - 11:25	**C. Falcolini**	Analyticity Domains of Periodic Orbits and Invariant Curves in Area Preserving Maps
11:30 - 12:25	**F. Benatti**	Quantum Entanglement and Dynamical Semigroups
16:00 - 16:55	**M. Procesi**	Quasi-periodic solutions for the completely resonant non-linear wave equation in 1D and 2D
17:30 - 18:25	**J.J.P. Veerman**	Flight in Formation: Patterns and Stability.
18:30 - 19:25	**R. Adami**	The NLS in dimension one as the limit of a quantum many-body problem

- **Roberto Onofrio:** *Physics of Fermi degenerate dilute gases: results and prospectives*

  Abstract
  I will discuss recent progress in cooling and manipulation of dilute Fermi gases of alkali atoms. The study of atomic Fermi gases in their low density regime is a promising avenue to understand Fermi many-body systems from first principles, in particular with regard to the phenomenon of superfluidity and collective phenomena in optical lattices. After reviewing some of the recent results I will focus on a proposal for trapping and cooling two-species Fermi-Bose mixtures in bichromatic optical dipole traps. I will illustrate the advantages of the proposal and give some insights on the possible explorable physics. References: R. Onofrio and C. Presilla, Phys. Rev. Lett. 89, 100401 (2002) C. Presilla and R. Onofrio, Phys. Rev. Lett. 90, 030404 (2003) R. Onofrio and C. Presilla, Journ. Stat. Phys. 115, 57 (2004)

- **Massimo Ostilli:** *Ground state of many-body lattice systems: an analytical probabilistic approach*

  Abstract
  On the grounds of a Feynman-Kac--type formula for Hamiltonian lattice systems we derive analytical expressions for the matrix elements of the evolution operator. These expressions are obtained in terms of few characteristic functions of the Markov chain corresponding to the evolution of the system configurations. At long times, a central limit theorem applies and as a result we find that the ground-state energy as well as all the correlation functions in the ground state are the solutions of a simple scalar equation involving the cumulants of the above characteristic functions.

- **Riccardo Adami:** *The NLS in dimension one as the limit of a quantum many-body problem*

  Abstract
  We consider the problem of rigorously deriving the cubic nonlinearity arising in the one-body NLS from a N-body, linear quantum dynamics. Such a problem is relevant in the study of Bose-Einstein condensates in the Gross-Pitaevskii (GP) regime, in which an effective equation with the same nonlinearity is prescribed. Lieb, Seiringer and Yngvason

the study of Bose-Einstein condensates in the Gross-Pitaevskii (GP) regime, in which an effective equation with the same nonlinearity is prescribed. Lieb, Seiringer and Yngvason recently proved that, if the condensate lies in a very elongated trap, then the behaviour of the particles becomes genuinely one-dimensional, and the system is well described by the Lieb-Liniger gas: a one-dimensional gas of particles interacting by a two-body Dirac's delta potential. We show that in a suitable weak coupling limit such a system reproduces the GP regime at the level of BBGKY hierarchies, whereas the problem of deriving the one-particle GP equation is still unsolved.

- **Cristina Toninelli:** *Stochastic lattice gases with degenerate rates and glassy dynamics*

  Abstract
  We analyze some stochastic lattice gases with hard core exclusion and degenerate rates, i.e. conservative particle systems where the exchange rates vanish for some configurations. Such models, known as {\sl kinetically constrained lattice gases}, have been introduced as simplified models for glassy dynamics. Focusing on Kob-Andersen model, we prove that in the thermodynamic limit an ergodic/non-ergodic transition cannot occur and the self diffusion coefficient for a tagged particle, D_S, is strictly positive at any finite density. Such results disprove the conjectures from previous numerical works and allow the identification of the finite size effects responsible for such discrepancy. Furthermore, we analyze the density dependence of D_S: in the limit $\rho\to 1$ we predict it to vanish faster than any power law of $1-\rho$. Such rapid slowing down of dynamics, which is reminiscent of the behaviour for glass forming liquids, is due to the fact that diffusion occurs only through the cooperative motion of special regions whose typical size and distance diverges very rapidly for $\rho\to 1$.

- **Livio Triolo:** *Coexistence of different scales and spatial structures in some biomathematical models*

  Abstract
  Many different systems of biological interest are composed of several elementary units (cells, individuals et sim.) which move and/or interact, creating evolving structures at a coarser level. Sometimes the separation of levels is not sharp, "microscopically" localized events play a role in the global evolution of the system and the macroscopic description may give results considerably different with respect to the microscopic one. A biomedical model (tumor growth and spreading) is presented.

- **Ugo Locatelli:** *On the stability of the Trojan asteroids: a few new results based on KAM theory*

  Abstract
  The Trojans constitute a family of asteroids orbiting close the vertexes of the two equilateral triangles having the segment-line connecting Sun and Jupiter as basis. The problem of the apparent stability of their motion is debated since the discovery of the first Trojan asteroids (i.e. almost one century ago). We will study the problem of the stability of the Trojan asteroids in the very simple framework of the planar restricted (circular) three-body problem. We first numerically investigate the size of the stability region by using the frequency analisys. We will see how this region is very much larger than those where the previously known (semi)analytical results apply. Most of the talk will be dedicated to explain how the KAM theory can be adapted to the general problem of constructing invariant tori close to an equilibrium point (i.e., in our system, a vertex of the equilateral triangles in the non-inertial frame corotating with Sun and Jupiter). We will see that the particular problem of the Trojan asteroids needs a few further refinements of the general approach. Finally, we will compare the orbits obtained by the tori constructed

that the particular problem of the Trojan asteroids needs a few further refinements of the general approach. Finally, we will compare the orbits obtained by the tori constructed using our approach with those starting from some initial conditions given by the "projections on the model" of the positions and velocities of some real asteroids. This will give us the possibility of appreciating the improvements given by our approach.

- **Vieri Mastropietro:** *Chiral anomaly and vanishing of Beta function in interacting fermion systems*

  Abstract
  I will present the rigorous construction of an interacting Fermi system in d=1 showing anomalous Luttinger liquid behaviour by the implementation of Ward identities in an RG approach; despite cut-offs breaks gauge invariance and produce chiral anomaly, WI can be used to reduce the number of running coupling constants and to prove the vanishing of Beta function.

- **Benedetto Scoppola:** *Modelling the friction between the tectonic plates and the mantle*

  Abstract
  The observed westward drift of the litosphere with respect to the mantle has an origin that is still unknown. In the seminar we discuss the existing models, and we show how the effective friction between litosphere and mantle can be much smaller than the value argued in the current models, due to the inhomogeneity of the astenosphere.

- **Fabio Martinelli:** *Glauber dynamics and reconstruction problems on trees*

  Abstract
  We give the first comprehensive analysis of the effect of boundary conditions on the mixing time of the Glauber dynamics for various spin models on a tree, including those with hard--core constraints like the antiferromagnetic Potts model at zero temperature (proper colorings) and the hard--core lattice gas (independent sets). Specifically for the Ising model, we show that the mixing time on an n-vertex regular tree with plus boundary remains $O(n\log n)$ at all temperatures (in contrast to the free boundary case, where the mixing time is not bounded by any fixed polynomial at low temperatures). Our results apply also to reconstruction problems on a tree in a noisy channel. Finally we will dexcribe some recent results on the basin of attraction under the Glauber dynamics of the pure phases of the system.

- **Guido Gentile:** *Elliptic lower-dimensional tori in a degenerate case*

  Abstract
  Quasi-periodic motions on invariant tori of an integrable system of dimension smaller than half the phase space dimension may continue to exists after small perturbations. The parametric equations of the invariant tori can often be computed as formal power series in the perturbation parameter and can be given a meaning via resummations. Here we prove that, for a class of elliptic tori, a resummation algorithm can be devised and proved to be convergent, thus extending to such lower-dimensional invariant tori the methods employed to prove convergence of the Lindstedt series either for the maximal (i.e. KAM) tori or for the hyperbolic lower-dimensional invariant tori.

- **Corrado Falcolini:** *Analyticity Domains of Periodic Orbits and Invariant Curves in Area Preserving Maps*

  Abstract
  A review of recent results on the shape of analyticity domains of the function wich conjugates a standard-like map to a rotation of rational or irrational period and some new results on coupled maps.

- **Giorgio Fusco:** *An extended LSW theory of Coarsening: Correlations and self-similar solutions*

  Abstract
  The classical Lifschitz-Slyozov-Wagner (LSW) theory of coarsening is valid in the limit of zero volume fraction of the minority phase. We discuss a theory which includes as a special case the LSW theory and is valid for nonzero small volume fraction. The extended theory accounts for the effect of correlations generated by the coarsening dynamics and, as the classical theory, is compatible with self-similar behavior.

- **Sandro Graffi:** *A local quantum version of the Kolmogorov theorem*

  Abstract
  Consider in $L2(\bbR^\ell)$ the operator family $H(\epsilon):=P_0(\hbar,\omega)+\epsilon Q_0$. P_0 is the quantum harmonic oscillator with diophantine frequency vector $\om$, Q_0 a bounded pseudodifferential operator with symbol holomorphic and decreasing to zero at infinity, and $\epsilon\in\bbR$. Then there exists $\epsilon^\ast >0$ with the property that if $|\epsilon|<\ep^\ast$ there is a diophantine frequency $\om(\epsilon)$ such that all eigenvalues $E_n(\hbar,\epsilon)$ of $H(\epsilon)$ near 0 are given by the quantization formula $E_\alpha(\hbar,\epsilon)={\cE}(\hbar,\epsilon)+\la\om(\epsilon),\alpha\ra\hbar +|\om(\epsilon)|\hbar/2 + \ep O(\alpha\hbar)2$, where α is an l-multi-index.

- **Mirko Degli Esposti:** *A semi-classical study of weakly chaotic maps*

  Abstract
  A semi-classical study of weakly chaotic maps''.}\\ Abstract: {\small \sl In this talk we intend to present recent rigorous and numerical results concerning classical and quantum properties of a class of neutrally stable but mixing dynamics. These dynamical systems possess the essential features of bounce maps of polygonal billiards and 1d hardpoint gasses, namely the parabolic stability type in combination with some form of decay of correlations, and they represents a paradigmatic model for a larger class of systems. Despite their semplicity, little is know rigorously concerning their ergodic and statistical features. In this talk, particular emphasis will be also devoted to the semiclassical features of the models, with particular attention to the eigenvalues statistics (as such as the spacing level distribution and the form factor) and to local/non-local properties of quantum eigenstates. We intende to explore and discuss the observed transition from Random Matrix Theory predictions to a regime with intermediate statistics.

- **Cristian Giardina':** *Factorization properties for the Edward-Anderson model*

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  Abstract
  We present a rigorous approach to derive sum rules for spin-glass models in finite dimensions (joint work with P. Contucci). For the Edwards-Anderson model we show that the bond-overlap correlation functions fulfills, in the thermodynamic limit and almost everywhere in the temperature, factorization rules previously found for the Sherrington-Kirkpatrick model in terms of the standard overlap. We present also a numerical study of the sum rules on system of finite size in order to discern between different physical pictures (Droplet/RSB) wich have been proposed to describe the quenched equilibrium state.

- **Fabio Benatti:** *Quantum Entanglement and Dynamical Semigroups*

  Abstract
  The role of entanglement is central in quantum information and communication theory and its connections with positive and completely positive maps become more and more evident. After an introduction to some aspects of the physics of entanglement, we will review the role of dissipative quantum evolutions, both as possible creators of entanglement between separated parties and as mathematical detectors of entangled states.

- **Danilo Mauro:** *Geometric Dequantization*

  Abstract
  Dequantization is a set of rules which turn quantum mechanics (QM) into classical mechanics (CM). It is not the WKB limit of QM. In this talk we shall show that, by extending time to a 3-dimensional "supertime", we can dequantize the system in the sense of turning the Feynman path-integral version of QM into the functional counterpart of the Koopman-von Neumann operatorial approach to CM. Somehow the procedure is the inverse of "geometric quantization" and we present it in three different polarizations: the Schroedinger, the momentum and the coherent states ones.

- **Francesco Guerra:** *Phase separation in mean field spin glasses*

  Abstract
  We exploit generalized variational principles, of the type introduced by Aizenman-Sims-Starr, in order to provide a general scheme for phase separation in mean field spin glass models. Some applications are given. In particular we will investigate the connection between Parisi representation, and its ultrametric decomposition.`

- **Sergei Kuksin:** *On the inviscid limit for randomly forced nonlinear PDE*

  Abstract
  I shall discuss recent results on behaviour of solutions of 2D Navier-Stokes Equation (and some other related equations), perturbed by a random force, proportional to the square root of the viscocity, when the viscosity goes to zero.

- **Wendelin Werner:** *SLE, conformal restriction and loop-soups*

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  Abstract
  This talk will be a survey of the ideas leading to the definition of SLE processes (Schramm-Loewner Evolutions), the notion of conformal restriction and to some of the recent related results, such as the relation with Brownian loop-soups and Conformal Field Theory.

- **Michela Procesi:** *Quasi-periodic solutions for the completely resonant non-linear wave equation in 1D and 2D*

  Abstract
  We provide quasi-periodic solutions with two frequencies $\omega\in \bbR^2$, for a class of completely resonant non-linear wave equations in one and two spatial dimensions and with periodic boundary conditions. The chosen frequencies are close to that of the linear system in an uncountable zero measure Cantor set. The main idea is to work in an appropriate invariant subspace so that no small divisor problem arises.

- **Alessandro Giuliani:** *Anomalous Universality in the Ashkin-Teller model*

  Abstract
  The Ashkin-Teller model is a two dimensional spin system, in which two Ising layers interact via a four-spin interaction. We consider the case of weak anisotropy (slight a-symmetry between the two Ising layers) and weak coupling. We show that the system admits two critical temperatures whose difference varies continuously with the strength of the coupling, scaling with an anomalous exponent. The specific heat diverges logarithmically at the critical points (as for Ising) but the constant in front of the logarithm is renormalized by an anomalous critical exponent. The talk is based on a joint work with V. Mastropietro.

- **Stefano Olla:** *Transport and Fluctuations in stationary non-equilibrium states*

  Abstract
  For some systems of interacting particles with stochastic dynamics in contact with reservoirs with different densities or temperatures, we study the transport properties (Fourier or Fick law) and the fluctuation of the conserved quantities in the corresponding stationary state.

- **Maciej Zworski:** *Quantum resonances of chaotic systems*

  Abstract
  Quantum resonances describe states which have positive rates of decay. For instance most of chemical reactions proceed via metastable states corresponding to (often many) quantum resonances. In pure maths, the zeros of the Riemann zeta functions are the quantum resonances for the Laplacian on the modular surface. The talk will describe the general motivation and mathematical modeling of quantum resonances. It will then focus on be the recent theoretical and numerical advances in the understanding of fractal Weyl laws for resonances of classically chaotic system.

- **J.J.P. Veerman:** *Flight in Formation: Patterns and Stability.*

  Abstract
  Given N geese and a preferred in flight configuration. We investigate a physically reasonable mechanism to influence the orbits of each goose so that flight in formation with the given configuration is a global attractor for the dynamics. We also discuss how the orbit of the flock as a whole can be altered by central controls, or by assigning a leader.

- **Riccardo Zecchina:** *From statistical physics methods to algorithms for combinatorial optimization and coding*

  Abstract