PERSPECTIVE SPEAKERS with TITLES and ABSTRACTS

METHODS AND PROBLEMS IN MATHEMATICAL PHYSICS

Dip. Fisica, Via Irnerio 46 Bologna, Friday 22 February 2013

9:15-13:00 ; 14:00-18:45 Aula Teorici, 2 piano

- Rudolf **Gorenflo** (Free University of Berlin)

OPENING LECTURE (40 minutes) [**morning]**

"Subordination in stochastic processes: a survey"

- Sergei **Rogosin** (Belarusian State University, Minsk)

CLOSING LECTURE (30 minutes) [**afternoon]**

"Mittag-Lefler functions: related topics and applications"

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12 COMMUNICATIONS 20 Minutes + discussions

(Alphabetic order; Order of presentation to be appointed)

1) Davide **Barbieri** (CAMS/EHSS, Paris) [**afternoon]**
CAMS = Centre d'analyse et de mathématique sociales
EHESS = École des hautes études en sciences sociales
"Geometric and Harmonic models of the functional architecture of the Visual Cortex"
Cortical cells of striate area in primate brain provide an image analysis which can be modeled with tools of generalized coherent states analysis on Lie groups, and their intra-cortical connections can be modeled as well in terms of degenerate stochastic processes on such Lie groups. An overview of recent results and open problems concerning the compression and representation of data and the information integration performed by the visual cortex will be given.

2) Armando **Bazzani** et al. (Dept. Physics, Universita di Bologna) **[afternoon]**

Urban traffic and dynamical systems on networks

Modeling urban traffic has a great relevance for understanding the congestion problems in modern cities. The relation between the road network structure, the traffic rules at crossing points and the vehicle dynamics is still an open problem, that has attracted the attention of complex systems physics community. The models commonly used to simulate traffic are based on the existence of a fundamental diagram relation between vehicle density and travel time on each road and of an origin-destination assignment matrix. We consider a different point of view by proposing simple Markov dynamical models on networks to study the traffic properties from a statistical physics point of view. In the next future the Information Communication Technologies (like GPS) will allow a real time recording of a the traffic state on a whole urban network giving the possibility of a validation procedure for traffic models and of developing e-governance instruments based on macroscopic control parameters.

3) José M. **Carcione** (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS),Trieste) [**afternoon]**

“A generalization of the Fourier pseudo-spectral method”

The Fourier pseudo-spectral (PS) method is generalized to the case of derivatives of non-natural order (fractional derivatives) and irrational powers of the differential operators. The generalization is straightforward because the calculation of the spatial derivatives with the fast Fourier transform is performed in the wave-number domain, where the operator is an irrational power of the wave-number. Modeling constant-Q propagation with this approach is highly efficient because it\does not require memory variables or additional spatial derivatives.\The classical acoustic wave equation is modified by including those with a space fractional Laplacian, which describes wave propagation with attenuation and velocity dispersion.
In particular, the example considers three versions of\the uniform-density wave equation, based on fractional powers of the Laplacian and fractional spatial derivatives

4) Gianni **Pagnini** (BCAM/IKERBASQUE, Bilbao, Spain) [**morning]**

"Gaussian subordination for symmetric space-time fractional diffusion and the corresponding class of self-similar stochastic processes with stationary increments"

A formula of Gaussian subordination for the Green function of the symmetric space-time fractional diffusion equation is obtained. By using the identity between the probability density functions resulting from a subordination process and from the product of two independent random variables, the corresponding self-similar stochastic process with stationary increments is derived.

5) Paolo **Paradis**i (ISAC, CNR, Pisa) **[afternoon]**

"Scaling analysis of brain intermittent events: towards a index of consciousness"

We discuss the critical brain hypothesis and its relationship with intermittent renewal processes displaying power-law decay in the distribution of waiting times between two consecutive renewal events. This condition, which is denoted as "fractal intermittency", was found in the electroencephalograms of subjects observed during a resting state wake condition. It remained unsolved whether fractal intermittency correlates with the stream of consciousness or with a non-task-driven default mode activity, also present in non-conscious states, like deep sleep. We show that during deep sleep fractal intermittency breaks down, and re-establishes during REM (Rapid Eye Movement) sleep, with essentially the same anomalous scaling of the pre-sleep wake condition. From the comparison of the pre-sleep wake, deep sleep and REM conditions we argue that the scaling features of intermittent brain events are related to the level of consciousness and, consequently, could be exploited as a possible indicator of consciousness in clinical applications.

6) Flavio **Pons,** Francesco **Tampieri** (ISAC-CNR, Bologna) [**morning]**

"Stochastic modelling of heavy particles in turbulent flows"

Heavy particles dispersion and deposition in turbulent flows can be described "exactly" only if a complete specification of the Eulerian velocity field is available. For most applicative purposes, direct numerical simulation cannot be performed, so we need stochastic modelling, which essentially corresponds to a stochastic description of the flow along the heavy particle trajectories. In this work, a general stochastic model formulation is presented and some literature is reviewed. In order to define the structure of the stochastic equation describing the flow, direct numerical simulations are used as a set of experimental data for particles with different inertia.

7) Enrico **Scalas** (Universita del Piemonte Orientale, Alessandria) **[morning]**

"The fractional Poisson process and its application to finance"

The fractional Poisson process is a counting renewal process that generalizes the well-known Poisson process. Inter-event waiting times are distributed according to the Mittag-Leffler distribution. The finite dimensional distributions of the fractional Poisson process are derived using the concept of conditional event introduced by B. de Finetti [1]. An application of the compound fractional Poisson process to intra-day option pricing is presented [2].

References

[1] POLITI M, KAIZOJI T, SCALAS E (2011). Full characterization of the fractional Poisson process. EUROPHYSICS LETTERS, vol. 96.

[2] SCALAS E, POLITI M (2013). A note on intraday option pricing. INTERNATIONAL JOURNAL OF APPLIED NON-LINEAR SCIENCE, vol. 1, in press.

8) Aldo **Spizzichino** (Computer Art, Bologna) **[afternoon]**
"Grafica e arte al computer: esperienze personali"

Attraverso una carrellata di immagini, viene presentato il percorso compiuto dall'autore con le sue esperienze di grafica vettoriale (su piattaforma Linux), dando rilievo alla ricaduta autodidattica e allo strumento matematico come parte integrante del processo creativo.

9) Giuseppe B. **Suffritt**i **(**Dipartimento di Chimica e Farmacia, Sassari) [**morning]**
"Problems in modelling single-file diffusion of water in zeolites: simulations and recent theory"

When simulating the behaviour of water in the straight nano-channels of two natural zeolites, where the water molecules are subject to a sinudoisal potential, we found that, the diffusive process was of *single-file type*, and that the propagator at low concentration is approximately Gaussian but is multimodal at higher concentration. The former situation can be interpreted by current single-file diffusion theories, but the latter is still waiting for a complete theoretical treatment.

10) Giorgio **Turchetti** . (Dept Physics, Universita di Bologna) **[afternoon]**
"Models for laser acceleration of charged particles"

The interaction of an intense electromagnetic pulse with a plasma generates high fields capable of accelerating charged particles to high energies in very short distances. The phenomenology is complex and its the interpretation is based on the use of PIC codes to solve the Maxwell-Vlasov equations. However in some regimes simple one dimensional models based on fluid equations and/or electrostatic approximation allow to capture some features. A short review of these models will be presented.

11) Giuliano **Vitali** (Dept Agricolture, Universita di Bologna) **[morning]**

"Applications and Challenges of Mathematics and Physics in Applied Ecology"

The seminar is a trip inside the ultimate researches inside the world of agriculture and forestry, oriented to understand the soil-plant-atmosphere system. The aim is to show which are the competencies required to mathematicians and physicists as well as the tools used in major issues of ecology, precision agriculture and sustainability analysis.

12) Antonio **Volta** (ARPA, Bologna) **[afternoon]**

"Scaling features in rings"

Dynamical properties of diffusion on discrete one dimensional space are well known. Remarkably, by monitoring certain quantities, such as the return probability to the initial site we notice scaling due to the trivial fractal architecture. In discrete spaces the Laplacian operator of diffusion equation becomes a real symmetric matrix. In this contribution we determine in two different ways the Laplacian operator, its diagonalization, and then we analyze the (numerical) differences occurred in the dynamical properties of the same phenomenon. This aspect can result crucial for very precise applications.