SCIENTIFIC REPORT

1) SUMMARY

TITLE: Disorder in Probability and Statistical Mechanics.

TIME: 25-29 June 2012.
PLACE: Modena, Italy.

SCIENTIFIC COMMITTEE: P. Contucci, C. Giardinà, C. Newman, V. Sidoravicious.
ORGANIZING COMMITTEE: P. Contucci, C. Giardinà, C.Giberti, C. Vernia.

ABSTRACT:
The meeting brought together scholars working at the intersection between statistical
mechanics and probability theory with an emphasis on applications. The topics involved
have been:
- Statistical Mechanics (equilibrium, non equilibrium, interacting particle systems)
- Disordered systems (spin glasses, random graphs, polymers),
- Applications (socio-economic and biological)

2) DESCRIPTION OF THE SCIENTIFIC CONTENT:

The meeting brought together scholars working in the areas of mathematics and
theoretical physics with common research interests in disordered complex systems. More
specifically the scientific community involved belongs to the area of statistical physics
and probability. Leading experts in fields where ideas, methods and techniques coming
from those areas are applied, like socio-economical sciences, took part in the activity.

The program has been anchored around three main topics: i) Disordered systems (spin
glasses, diluted systems, directed polymers); ii) Random Spatial Processes (percolation,
growth models, coalescence, non-equilibrium phase transitions); iii) Application to
Socio-Economic sciences (agent based models of economy).

Disordered systems are considered a general framework to describe phenomena with
multiple equilibrium states. They include systems with random interactions and random
dilution, like spin glasses and interacting models on random graphs. Natural hierarchical
structures emerge in such framework like Ruelle probability cascades and its dual
Bolthausen-Snitzman coalescence. Among the great challenges in those topics there is the
rigorous achievement of ultrametricity in spin glasses.

Spatial probability is concerned with the investigation of various probabilistic structures
in extended space/time systems. Examples includes: coalescence, first/last passage

percolation, random graphs, growth models. Non equilibrium models like: conservative driven-dissipative systems that naturally evolves to a critical state, solid growth away from equilibrium, absorbing-state phase transitions, etc. Non-locality of correlations and dynamic long-range effects cause the failure in most cases of interest of classical analytic and probabilistic techniques, making the rigorous analysis of such systems a major mathematical challenge. The conceptual and rigorous description of such systems would constitute a scientific major achievement.

The main theme in the application has been agent based models of the economy, showing a multitude of "equilibrium states", with possibly interesting intermittent dynamics between those, as models of crashes, collective loss of trust, regime shift, etc. Probabilistic models of microstructure and order book dynamics, with particular emphasis on feedback loops and instabilities that lead to spontaneous liquidity crises. Models of non-linear correlations, extreme tail correlations, with applications to default risks and cascades; hierarchical models of correlations and applications to stock markets. Extension to the interacting case of the McFadden discrete choice theory.
Moreover applications to biology have also been considered, like: hierarchical genealogy for the evolution of large population of genes with selection (beyond the neutral Kingman coalescence) such as in the recent Brunet-Derrida model directly inspired by spin glasses.

3) ASSESMENT OF THE RESULTS

All the mentioned topics, having the common binding element of the presence of a large number of microscopic interacting random components, share a deep connection from both the conceptual and methodological point of view. The meeting provided a fruitful cultural background for physicists and mathematicians as well as scientist involved in applications.

In particular the following session gave opportunity of extended discussions:
- disordered systems & spin glasses on Monday/Thursday
- mathematical population genetics: Thursday
- socio-economic systems: Wednesday (including a public lecture): Wednesday
- random polymers and KPZ equation: Thursday
- scaling limits and probabilistic models: Thursday
- non-equilibrium statistical mechanics: Friday.

The abstracts of all talks can be seen at the conference web-site:
http://www.stochastics.unimore.it/

The topics above are all at the frontier of modern mathematical statistical physics and will certainly continue to inspire both rigorous mathematical works and applications.

4) PROGRAM OF THE MEETING

	Monday June, 25	Tuesday June, 26	Wednesday June, 27	Thursday June, 28	Friday June, 29
09.30-10.00	Opening Authorities	Parisi		Den Hollander	Kurchan
10.00-10.30	Lebowitz	Panchencko	Barra	Khanin	Rondoni
10.30-11.00	Chatterjee	Break	LaGatta	Break	Redig
11.00-11.30	Break	Rolla	Break	Seppalainen	Break
11.30-12.00	Sakai	Tournier	Pisati	Sasamoto	Shlosman
12.00-12.30	Camia			Corwin	Kupiainen
14.30-15.00	Aizenman			Sun	
15.00-15.30	Bolthausen	Brunet		van der Hofstad	
15.30-16.00	Break	Bovier		Holmes	
16.00-16.30	Starr	Break		Break	
16.30-17.00	Damron	Derrida	Public Lecture	Dommers	
17.00-17.30	Break	Beresticky	(Aula Magna di Santa Cristina, Bologna)	Hainzl	
17.30-18.00	Arguin	Baake		HR session chair J.Lebowitz	
18.00-18.30	Guerra		Bouchaud Jones		