Curriculum vitae

PERSONAL INFORMATION

Andrea Gabrielli

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Gender Male | Date of birth 18 February 1970 in Rome, Italy | Nationality(-ies) Italian

Fiscal Code: GBRNDR70B18H501O

WORK EXPERIENCE

October 2019 – Present

Associate Professor in Physics

Engineering Department, University Roma 3
Via Vito Volterra 62, 00146 - Rome, Italy

Research in statistical physics of complex systems and stochastic processes.

February 2009 – September 2019

Tenured Researcher (Ricercatore III livello, “Protocollo” CNR n. 0013466, 10/02/2009, CNR identification number “matricola" n. 27819)

Istituto dei Sistemi Complessi (ISC) - Italian National Research Council (CNR)
Via dei Taurini 19, 00185 - Rome, Italy

Research in complex systems, stochastic processes and network theory with applications to physical, social and biological systems and human brain.
Main publications: Physical systems **[64-66, 77, 80, 86, 89, 100]**, Social systems **[54, 67, 74, 75, 79, 82, 85, 88, 90 - 94, 96, 97, 99, 102 - 104]**, Biological Systems and Human Brain **[68, 69, 70, 76, 83, 84, 95, 98]**

July 2004 – February 2009

Tenure Track

INFM and Istituto dei Sistemi Complessi (ISC) - Italian National Research Council (CNR) - (INFM “Protocollo" n. 682/2004, 21/06/2004)
Via dei Taurini 19, 00185 - Rome, Italy

Research in statistical physics of complex systems and stochastic processes.
Main publications: **[L1], [47 - 61]**

November 2002 – June 2004

Post doctoral position in Physics

“E. Fermi” Center for Research and Studies (Rome, Italy) (“Protocollo" E. Fermi Center n. 348/02, 26/09/2002 and n. 907/03, 21/10/2003)
c/o Physics Department of the University “Sapienza" of Rome, Italy.

Research activity on the physics of Complex Systems, fractal growth models, statistical physics of long range interacting systems.
Main publications: **[38, 39, 40, 42, 44, 45]**

December 2000 – October 2002

Post doctoral position in Physics

Istituto Nazionale di Fisica della Materia (INFM) (“Protocollo" INFM n.160, 08/11/2001)
c/o Physics Department of the University “Sapienza" of Rome, Italy.

Research activity on the physics of Complex Systems, fractal growth models, statistical physics of long range interacting systems.
Main publications: **[25 - 27, 30, 33 - 35]**

October 1999 – November 2000

Post doctoral position in Physics

Lab. PMC – Ecole Polytechnique (Palaiseau, France), Group of Prof. Bernard Sapoval
European Project “Fractal Structures and Self-organization" (TMR program of the EEC, contract number: FMRXCT980183, CNRS identification number 905125)

Research activity on the physics of self-organized fractal systems, etching of random solid, rocky coast formation and percolation.
Main publications: **[36, 43]**

November 1998 – September 1999

Post doctoral position in Physics

Lab. PMC – Ecole Polytechnique (Palaiseau, France), Group of Prof. Bernard Sapoval
CIES scholarship (CNRS identification number 905125)

Research activity on the physics of self-organized fractal systems, etching of random solid, rocky coast formation and percolation.
Main publications: **[24, 28]**

EDUCATION AND TRAINING

1996 – 1998

PhD in Physics - Thesis Title: “Memory Effects in Growth Dynamics with Quenched Disorder”

Physics Department, University “Tor Vergata” of Rome, Italy
Supervisor: Prof. Roberto Petronzio
Main publications: **[5-7, 9,10, 12,13, 18 - 20]**

External supervisor: Prof. Luciano Pietronero

1989 – 1995

“Laurea” in Physics - Thesis Title: “Quenched and Stochastic Dynamics: the Case of Invasion Percolation”

Physics Department, University “Sapienza” of Rome, Italy
Supervisor: Prof. Luciano Pietronero
Main publications: **[1 - 3]**

Final note: 110/110 *cum laude*

PERSONAL SKILLS

Mother tongue(s): Italian

	UNDERSTANDING		SPEAKING		WRITING
	Listening	Reading	Spoken interaction	Spoken production	
English	C1	C2	C1	C2	C2
French	C1	C2	C2	C2	C1

: A1/A2: Basic user - B1/B2: Independent user - C1/C2: Proficient user
Common European Framework of Reference (CEF) level

Computer skills: FORTRAN, Mathlab and Mathematica programming, Linux, MS-DOS and Mac Operating Systems, Latex, Microsoft-Office.

Teaching Experience

2017-2018 – 6 hrs lessons at the Course of “Complex Systems" for the 4th year undergraduate students at the Physics Department of the University “La Sapienza” of Rome (Italy).

2016-2017 – Support lessons for the Course on “Introduction to the Theory of Stochastic Processes” for 5th year undergraduate students at the Physics Department of the University “La Sapienza” of Rome (Italy).

2015-2016 – Course on “Introduction to the Theory of Stochastic Processes” for 5th year undergraduate students at the Physics Department of the University “La Sapienza” of Rome (Italy).

2015 – Course on “Introduction to the Theory of Stochastic Processes” for Ph.D students, IMT, Lucca (Italy)

2014-2015 – Course on “Introduction to the Theory of Stochastic Processes” for 5th year undergraduate students at the Physics Department of the University “La Sapienza” of Rome (Italy).

2014 – Course on “Introduction to the Theory of Stochastic Processes” for Ph.D students, IMT, Lucca (Italy);

2013 – Course on “Introduction to the Theory of Stochastic Processes” for Ph.D students, IMT, Lucca (Italy);

2012-2013 – Course on “Introduction to the Theory of Stochastic Processes” for 5th year undergraduate students at the Physics Department of the University “La Sapienza” of Rome (Italy);

2012 – Course on “Introduction to the Theory of Stochastic Processes” for Ph.D students, IMT, Lucca (Italy);

2011-2012 – Course on “Introduction to the Theory of Stochastic Processes” for 5th year undergraduate students at the Physics Department of the University “Sapienza” of Rome (Italy);

2011 – Course on “Introduction to the Theory of Stochastic Processes” for Ph.D students, IMT, Lucca (Italy);

2006-2011 – Course on “Theory of fluctuations and correlations in scale-invariant systems and networks” for Ph.D. students at the Physics Department of the University “La Sapienza" of Rome (Italy);

2005 – Course on “Fractal, networks and scale-invariance” for Ph.D. students at the Dep. of Physics of the University “La Sapienza” of Rome (Italy).

Visiting Positions

(i) Visiting Scholar / Research Fellow at the International Doctoral School IMT - Institute of Advance Studies of Lucca, Italy from 2013 to present, ("Protocollo" IMT n. 00714.VII.15.11.02.13, n. 01998.VII.16.27.05.13, n. 02102.VII.16.11.06.14, n. 02996.VII.16.21.09.15, n. 00085.VII.16.12.01.17).

(ii) Visiting Researcher position at the Lab. LPTMC Université "Pierre et Marie Curie" - Paris VI (France) in December 2015 (CNRS identification number 141943, appointment by letter).

(iii) Visiting Researcher at the Center of Polymer Studies of the Physics Department of Boston University (MA - USA) from 01/02/2012 to 30/05/2015. Appointment by letter.

(iv) Visiting Researcher / Professor Positions at Lab. LPNHE Université "Pierre et Marie Curie" - Paris VI (France) from March to April 2008, and from November to December 2012. Appointments by letters.

(v) Bourse de la Mairie de Paris for Visiting Researcher / Professor from November 2011 to January 2012. Appointment by letter.

(vi) Visiting Staff Member from March to May 2004 and Visiting Professor in May 2006 at the Chemistry and Applied Mathematics Departments of Princeton University (c/o Prof. S. Torquato research group), NJ-USA. Appointments by letter.

Stable and long lasting scientific collaborations

- **Team work**: I have worked in different scientific teams and institutions developing a large number of productive and fruitful national and international scientific collaborations often developed through official visiting positions in national and international institutions. Below a list of the most important collaborations:
(i) Prof. L. Pietronero's research group at the Physics Department of the University "Sapienza" of Rome: Master (Laurea) Thesis in 1994 - 1995, Ph.D. theses from 1995 to 1998, post-doctoral positions from 2000 to 2004, present collaboration. This collaboration has been focused on different aspect of modern statistical physics ranging from fractal growth phenomena and self-organized criticality (e.g. see publications [3, 6, 14, 20, 23]), to application of statistical physics in cosmology (e.g. [L1, 4, 52]) and socio-economic systems (e.g. [79, 80, 87, 98]);
(ii) Prof. G. Caldarelli's research group at the International Doctoral School IMT - Institute of Advance Studies of Lucca, Italy. The collaboration activity focused on applications of complex network theory to both socio-economic systems (e.g. [71, 83, 84]) and human brain functional dynamics through Functional Magnetic Resonance measures (e.g. [101, 104]);
(iii) Prof. B. Sapoval's research group at the Lab. PMC of the Ecole Polytechnique of Palaiseau, France: two years post-doctoral positions from 1998 to 2000. The research activity in this collaboration, which lasted beyond the post-doc period, focused on the application of percolation theory and extreme value statistics to models of corrosion of random solids and of rocky coasts formation through erosion (e.g. [24, 28, 37, 47]);
(iv) Prof. H.E. Stanley's research group at the Center of Polymer Studies of the Physics Department of Boston University, MA-USA. The collaboration focused on the application of statistical physics of disordered media to the study of the brain aging (e.g. [89]);
(v) Prof. S. Torquato's research group at the Chemistry and Applied Mathematics Departments of Princeton University, NJ-USA. This collaboration focused on mathematical studies of super-homogeneous point processes and Voronoi tessellation (e.g. [48, 61]);
(vi) Prof. M. Joyce's research group at Lab. LPNHE Université "Pierre et Marie Curie" - Paris VI, France. The focus of this collaboration has been the development of a out of equilibrium statistical physics of systems with long range interactions and the study of self-gravitating systems (e.g. [L1, 35, 40, 51, 56, 60, 68, 69, 70, 91]);
(viii) Prof. P. Viot's research group at Lab. LPTMC Université "Pierre et Marie Curie" - Paris VI, France. In this collaboration I have worked to mathematical stochastic queueing models for the transport of particles through narrow channels (e.g. [44, 85, 92, 95]);
(ix) Prof. R. Durrer's research group at the Physics Department of the University of Geneva, Switzerland. In this collaboration we have developed a statistical physics interpretation of the power spectrum of cosmological matter density fluctuations (e.g. [22] and [41]).
(x) Prof. J. L. Lebowitz at the Physics Department of Rutgers University (NJ, USA). We have collaborated to the elaboration of interacting particle models of equilibrium statistical physics able to reconstruct the power spectrum of cosmological matter density fluctuations (e.g. [40]).

Mediating and mentoring skills

I have worked as **direct supervisor** of many undergraduate and graduate students:

– Gabriele Camilli (2017-2018, *Laurea Magistrale* in Physics at University “Sapienza" of Rome);
– Martina Formichini (2016-2017, *Laurea Magistrale* in Physics at University “Sapienza" of Rome);
– Matteo Serafino (2016-2017, *Laurea Magistrale* in Physics at University “Sapienza" of Rome);
– Gabriele Incorvaia (2016-2017, *Laurea Magistrale* in Physics at University “Sapienza" of Rome);
– Giulia Poce (2016-2017, *Laurea Magistrale* in Physics at University “Sapienza” of Rome);
– Giampiero Bardella (2014-2015, *Laurea Magistrale* in Physics at University “Sapienza” of Rome);
– Giacomo Vaccario (2013-2014, *Laurea Magistrale* in Physics at University “Sapienza” of Rome)
– Nicolò Musmeci (2011-2012, *Laurea Magistrale* in Physics at University “Sapienza” of Rome);

– Federico Maggiore (2015-2016, *Laurea Triennale* in Physics at University “Sapienza” of Rome);
– Andrea Plati (2014-2015, *Laurea Triennale* in Physics at University “Sapienza” of Rome);
– Nicandro Bovenzi (2010-2011, *Laurea Triennale* in Physics at University “Sapienza” of Rome);

Ongoing **direct supervisor** of undergraduate and graduate students:

- Virginia Gurioli (*Laurea Magistrale* in Physics at University “Sapienza” of Rome)
- Francesco De Luca (*Laurea Magistrale* in Physics at University “Sapienza” of Rome)
- Francesca Santucci (*Laurea Magistrale* in Physics at University “Sapienza” of Rome)
- Giacomo Bray (*Laurea Magistrale* in Physics at University “Sapienza” of Rome)

I collaborated to the **supervision** of the following students:

– Jules Morand (2012-2014, Ph. D. Thesis in Physics at the Lab. LPNHE of the Université “Pierre et Marie Curie" - Paris VI, France; Supervisor: Prof. Michael Joyce);
– Francois Sicard (2010-2012, Ph. D. Thesis in Physics at the Lab. LPNHE of the Université “Pierre et Marie Curie" - Paris VI, France; Supervisor: Prof. Michael Joyce);
– Indaco Biazzo (2005-2006, Tesi di Laurea in Physics at University “Sapienza” of Rome; Supervisor: Prof. L. Pietronero);
– Adolfo Paolo Masucci (2001-2002, Tesi di Laurea in Physics at University “Sapienza” of Rome; Supervisor: Prof. L. Pietronero)

Organisational / managerial skills: **Participation to Scientific Projects**

– Official representative of CNR, coordinator node, and Senior Researcher in the European Project GROWTHCOM: “Growth and innovation policy modelling - Applying next generation tools, data and Economic Complexity ideas” (2013 - 2017; FP7-ICT-2013-10 call, Grant Agreement 611272; see attached pdf document).

– Senior Researcher in the Project CrisisLab: (2012 - present; “Progetti di Interesse" CNR financed by Italian Government)

– Senior Researcher in the European Project MULTIPLEX: “Foundational Research on MULTIlevel comPLEX networks and systems” (2012 - present; FP7 FET-ICT IP project, Grant Agreement 317532).

– Senior Researcher in the European Project FOC II: “Forecasting Financial Crises’ II’ (2012 - 2013; FP7 FET-Open Project, Grant Agreement: 255987).

– Post-Doc position in the European Project “Fractal Structures and Self-organization" (1997 - 2002; TMR program of the EEC, contract number: FMRXCT980183).

Organisational / managerial skills: **Organization of Conferences and Scientific Schools**

Organizing Committee of the Satellite Conference "Network Neuroscience" of “Netsci 2018", June 11, 2018, Paris (France)

Program Committee of the International Conference “Netsci 2018", June 11-15, 2018, Paris (France)

Organizing Committee of the International Workshop “Complex networks: from socio-economic systems to biology and brain", September 8 - 14, 2017, Lipari (Italy)

Organizing Committee of the Satellite Meeting on “Network Neuroscience” of NetSci 2017, June 20, 2017, Indianapolis (Indiana, USA).

Organizing Committee of the International Workshop “Complex networks: from socio-economic systems to biology and brain", August 29 - September 2, 2016, Lipari (Italy)

Organizing Committee of the Satellite Meeting on “Brain Networks” of NetSci 2016, May 31, 2016, Seoul (S. Korea).

Chairman of the Session “Interdisciplinary Statistical Physics” of the International Conference FisMat 2015, September 28 - October 2, 2015, University of Palermo (Italy).

Director of the International School on “Socio-Economic Complex Systems” of the European Project GROWTHCOM, September 6-12, 2015, Lipari (Italy)

Chairman of the Satellite Meeting “Brain Networks” of NetSci 2015, June 1-5, 2015, Zaragoza (Spain).

Chairman of the Satellite Meeting “The Complex Brain” of ECCS’14, September 22-26, 2014, IMT - Lucca (Italy).

Scientific Committee of the European Conference on Complex Systems - ECCS’14, September 22-26, 2014, IMT - Lucca (Italy).

National Advisory Committee of Statphys23, XXIII IUPAP International Conference of Statistical Physics, July 9-13, 2007, Genoa (Italy).

Organisational / managerial skills: **Participation to grant committees**

– Post-graduate grant committee, CNR, call n. 2018/1564, Prot. 699 of 03/07/2018

– Post-graduate grant committee, CNR, call n. 2018/1590, Prot. 672 of 27/06/2018

– Post-graduate grant committee, Physics Department, University Sapienza of Rome, call DD n 55/2018 Cat. 1, SSD: FIS/03, 24/04/2018

– Post-graduate grant committee, Physics Department, University Sapienza of Rome, call DD n 56/2018 Cat. 1, SSD: FIS/03, 24/04/2018

– Post-graduate grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/006/2017, Prot. 1562 of 10/10/2017

– Post-doc grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/003/2017, Prot. 567 of 28/03/2017

– Post-graduate grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/003/2016, Prot. 413 of 01/03/2016

– Post-doc grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/02/2016, Prot. 0000315 of 16/2/2016

– Post-graduate grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/07/2015, Prot. 000002 of 08/01/2016

– Technologist grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/003/2014, Prot. 0000493 of 03/03/2015

– Post-doc grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/001/2015, Prot. 272 of 04/02/2015

– Post-graduate grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/007/2014, Prot. 2394 of 12/11/2014

– Post-graduate grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/004/2014, Prot. 0000866 of 14/04/2014

– Post-graduate grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/002/2014, Prot. 0000352 of 17/02/2014

– Post-doc grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/010/2013, Prot. 3123 of 19/12/2013

– Post-doc grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/009/2013, Prot. 2747 of 19/11/2013

– Post-doc grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/006/2012, Prot. 1253 of 03/05/2012

– Post-doc grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/012/2011, Prot. 2924 of 09/11/2011

– Post-doc grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/004/2011, Prot. 1315 of 19/05/2011

– Post-doc grant committee, Istituto dei Sistemi Complessi (ISC) - CNR, call n. ISC/RMSAP/006/2010, Prot. 1971 of 17/09/2010

Scientific skills and research activity

Below a list of my research activities during my career. Point **[a]** below refers to my main present research activity, while point **[b]** represents the other scientific topic in which I am now involved and that shares with point **[a]** the implementation of mathematical methods of network and graph theory.

[a] Multidisciplinary applications of complex systems and network theory to socio-economic topics. It can be divided into the two following strictly related activities:

- In the last years I actively participated, from its first stages, to the development of the **Economic Fitness and Complexity (EFC)** method for the **data-driven** evaluation of the industrial competitiveness of countries and the complexity of industrial sectors by the analysis of the international flow of exports in the so-called World Trade Web (from the COMTRADE database by UN). In particular I cooperated with the other authors to the formulation of the central non-linear **Fitness and Complexity algorithm** that permitted, through its application to the bipartite network countries-products built from export data, an important advancement in the classification of economical development of countries and of the industrial complexity of products. This method consists in a statistical physics and complex networks approach to the international trade environment seen as an *ecosystem of interactions* between countries on different industrial sectors **[74, 75, 82]** (see publication list below). The development of this new framework constitutes the core of two scientific projects in which I worked as Senior Investigator: GROWTHCOM (2013 - 2017; FP7-ICT-2013-10 call, Grant Agreement 611272) and CrisisLab (2012 - present; “Progetti di Interesse" CNR financed by Italian Government). The success of this initial studies [e.g., in ecology the application of the method to mutualistic ecosystems, whose bipartite network shares with our countries-products network the general nested structure, showed that the EFC is the best classification algorithm of centrality of species available in literature, see Sci. Rep. **5**, 8182 (2015)] stimulated the extension of the same scientific method to other aspects of the international competition and development of countries as for instance: (i) a dynamical system approach to their development dynamics, (ii) the introduction of simple dynamical models of large scale competition and innovation **[92]**, (iii) the extension of the approach for the analysis of a subnational scale **[102]**, and (iv) the study of the dynamics of large scale technological innovations. In particular, in this context I recently coordinated the work of a team that, as a first step, extended the EFC approach to the scientific competition of countries in the different scientific sectors **[85, 93]** by applying the method to the bipartite network countries-scientific sectors built from the Scopus database. As a second step, with my team, I studied competition of countries with respect to the flow of information from scientific articles to technological patents **[99]**. Finally, once the EFC method has been separately and successfully applied to the industrial, the technological and the scientific sector by sector competition of countries, we have worked to the development of a multilayer network approach to the innovation dynamics. We have first built **the innovation space** as a network composed of three interacting layers, constituted respectively by scientific, technological, and industrial sectors. It is obtained by counting the co-occurrences in the three original bipartite networks: (i) countries-scientific domains, (ii) countries-technologies, and (iii) countries-products. We have therefore studied the diffusion of bits of information in this multi-layer network to investigate the impact of an innovation in a given sector on the others (intra and inter-layer). In this way we were able to determine, and statistically validate (see point below) the influence of advancement on a given sector on the others at different time-delays (e.g. the impact of an innovation in the technology of optical instruments in different medical domains science or in computers industrial sector) , determining a global picture of the innovation dynamics **[105]**.
  All this new EFC framework had a major impact on the scientific community and policy makers up to recently lead the World Bank Group to adopt Economic Fitness and Complexity in the set of its official economic metrics. Moreover it has already used Economic Fitness and Complexity method for the evaluation of developing perspectives for more than 50 countries (see `https://www.economic-fitness.com/en` ; `https://www.uniroma1.it/it/node/37933`; `https://datacatalog.worldbank.org/dataset/economic-fitness`). Another important institutions that decided to adopt our approach as a fundamental method for data driven analysis of economic scenarios is Italian CNEL, whose President recently signed an official agreement with University Sapienza in order to start a scientific collaboration on the subject (see `https://www.uniroma1.it/it/notizia/un-accordo-tra-sapienza-e-cnel-i-fenomeni-emergenti-economia` and `https://www.cnel.it/Comunicazione/Primo-Piano/ArtMID/694/ArticleID/151/Accordo-Quadro-tra-Sapienza-Universit224-di-Roma-ed-il-CNEL`).

- Statistical physics and maximal entropy methods for the reconstruction of networks from partial information and for the construction of constrained null models to validate statistical properties of real networks. Very often real networks of interactions between elements in ecology, biology, finance, social systems can be measured only with a certain degree of approximation and suffer from a small to a high degree of incompleteness which often prevent further studies and analysis of the system. In the last years I coordinated a first study for the formulation of a statistical mechanics approach, based on the concept of maximum entropy, statistical ensembles, and maximum likelihood for the reconstruction of the statistical properties of the topology of real binary undirected networks about which only partial information on connectivity is available **[78, 79]**. Then I played a central role, coordinating a team of young scientists and cooperating with other colleagues, in the extension of these first results to a much wider class of networks: weighted, directed and bipartite networks **[88, 90, 91, 97, 103, 104, 105]**. This network reconstruction method have been recently recognized as the best one available in literature for reconstructing ensemble properties of networks of financial institutions by a consortium of many Central Banks including European Central Bank, Bank of England, Deutsche Bank and Banca d'Italia [see J. of Financial Stability **35**, 107 (2018)].
  I actively worked in the extension of the same theoretical method, based on maximum entropy and statistical ensembles, for the construction of advanced null models of networks which are maximally random apart from a chosen set of local conserved quantities (e.g. the degree of connectivity of each single node of the network). This models have been successfully applied to the statistical validation of the static and dynamical properties of the many socio-economical bipartite and multi-layer real networks studied in the context of the EFC method explained above **[94, 96]** . In particular the construction of these advanced null models permitted a precise validation of the interactions between different innovation sectors in the previously explained multi-layer network study of innovation dynamics **[104]**

[b] Applications of stochastic processes, statistical physics and Network theory to Nuclear Magnetic Resonance (NMR) data of organic and inhorganic heterogeneous materials with particular reference to structural and functional properties of the human brain. In particular my work in this context developed along two directions:

1. Diffusion Magnetic Resonance Imaging (DMRI) of brain or other organs is a technique in which MRI is used to get 3D images by the measure of the diffusion properties of extracellular water molecules in the different millimetric regions in which the organ, in particular the brain, is parceled (voxels). In standard literature the imaging is performed by fitting of data in the framework of ordinary anisotropic Gaussian diffusion, the so-called Diffusion Tensor Imaging (DTI). However, in the case of brain, since axons of neurons are almost completely impermeable and form multi-scale cages for the motion of water molecules, large deviation on many spatio-temporal scales from standard anisotropic diffusion are observed. In recent years I was directly involved, in a team including colleagues experimentalists of MRI, in the development of a new theoretical approach based on anomalous diffusion theory to improve resolution of images resulting from DMRI of brain. In particular my contribution was the formulation of a new theoretical framework, grounding on anomalous diffusion theory in the mathematical context of Continuous Time Random Walks (CTRW), for the interpretation of DMRI data in the spatio-temporal regime where large deviation from standard diffusion are observed. This permitted a notable progress in the resolution of different brain tissues with respect to standard methods. Main publications: **[68, 69, 70, 71, 83]**,

2. In the last few year I have been also directly involved in the elaboration of a new statistical physics approach, based on statistical physics of networks, percolation and spanning trees and forests, to the mathematical analysis of functional MRI (fMRI) data of the activity and the dynamical coordination of different functional brain regions. Through fMRI analysis of brain one can indeed have a parallel measure of the dynamical activity of different regions of the brain cortex by the parallel local measure of the density of oxygenated hemoglobin every one-two seconds for a certain time interval (typically 5 to 10 minutes in humans). This permits to study the dynamical coordination in the activity of different cortex regions. I actively worked in the development of a network representation of the coordination/interactions between all anatomical regions in which the brain cortex is standardly parceled. In particular I worked to the elaboration of two algorithms, based on the statistical physics of network percolation and maximum spanning tree and spanning forest, in order to subdivide the whole set of these regions into highly coordinated sub-groups and to uncover the nested hierarchical coordination structure of the brain cortex. At present I am directly involved in a project, involving other physicists, mathematicians and medical doctors, to extend this theoretical approach to fMRI data in order to discriminate brain functional activity of healthy individuals from schizophrenic ones. Main publications: **[95, 99]**

Scientific skills and research activity

[c] Applications of statistical physics to cosmology and systems with long range interactions. During all my career I have been involved in many scientific collaborations on the statistical physics of systems with long range interactions, and worked to the development of a statistical physics approach to cosmological problems concerning both the static matter distribution in space and the dynamical formation of structures. In this respect my activity focused on (i) out of equilibrium statistical physics of large particle systems with long range interactions and the dynamical formation and mechanical stability of Quasi Stationary States, (ii) structure formation in cosmological N-body simulations, (iii) mathematical and probabilistic approach to the problem of initial conditions in cosmological N-body simulations, (iv) study of the density correlation function and of the fractal properties of galaxy distribution. In all these aspects I was mainly involved in the mathematical modeling and in the construction of a statistical physics framework for these problems. One of the results with high impact on the scientific community is the full understanding of the real space statistical properties of the large scale power spectrum of matter density fluctuations hypothesized in cosmological theories, that before our work were underestimated **[L1, 33, 38]**. Moreover, we developed a new statistical dynamics framework for the problem of structure formation on middle and large scales in self-gravitating systems. Main publications: **[L1, 4, 27, 33, 38, 39, 47, 48, 50, 52, 53, 66, 77, 86]**

[d] In strict relation with the previous subject, and in particular with the set up and analysis of N-body cosmological simulations, I have performed during the years a study of the statistical physics of mathematical point processes and related stochastic models. In this field my work focused in formulation of a rigorous mathematical study of point-processes (i.e. point-particle spatial distributions) with prescribed two-point correlation properties. In particular I studied in detail the effects of correlated displacement fields on particle distributions in terms of the two-point density correlations. As aforementioned, this has a great importance in the construction of initial conditions in cosmological N-body simulations with density correlations prescribed by cosmological theories. Main publications: **[L1, 33, 45, 49, 51, 55 - 58, 60, 63-65, 80, 89]**

[e] Dynamical fractal growths in media with quenched disorder and percolation theory. In the first years of my career I was involved in the collective effort to understand "Why nature makes fractals", i.e. why fractal structures with long range spatial density correlations are so common in Nature (e.g trees, clouds, rough surfaces, deicer breakdown, pattern formation by diffusing bacteria etc.). My main activity in this field has been the study of Invasion Percolation and related models for which we have introduced a mathematical approach, based on iterative conditional probability, the so-called Run Time Statistics, to map dynamics in quenched disorder into stochastic dynamics in homogeneous media with memory for which a lattice path integral approach is feasible, e.g. the Fixed Scale Transformation for the analysis of the fractal properties of the growing structure. Main publications: **[3, 6, 9, 18, 23, 24, 28, 30, 35, 43, 54]**

[f] Models of Self-Organized Criticality (SOC) and dynamics of irregular interfaces. My activity in this context dealt with the formulation and study of theoretical percolation models for the formation of experimentally observed fractal surfaces by chemical etching of disordered solids and for the formation of fractal rocky coasts. In both cases our models, which have been study from both the analytical and computational point of view, led to a successful reproduction of the observed fractal dimension and to the reproduction of the scaling behavior of the correlation length with the other system parameters. Main publications: **[13, 14, 19, 20, 23, 26, 59]**

ADDITIONAL INFORMATION AND METRICS

Scientific Journals collaborations	**Editor** of Scientific Reports (Nature); **Reviewer** of many journals among which Phys. Rev. Lett., Phys. Rev. E, Nature Comm., J. of Stat. Mech., J. of Stat. Phys., Eur. Phys. J. B, Europhys. Lett., Plos One, Scientific Reports, Physica A, Neuroimage.
Scientific books	1 monography in Statistical Physics + 2 chapters in Books of Cosmology and Network Theory
Publications on ISI WoS journals	103
Other scientific papers	9
Total number of citations	1955 (Scopus); 3103 (Google-scholar)
H-index	26 (Scopus); 32 (Google-scholar)
i10-index	75 (Google-scholar)
Invited/Keynote Talks/Seminars	41 (see the list below)
Habilitation for Italian Associated Professorship	Theoretical Physics of Fundamental Interactions (Discipline code 02/A2) and of Condensed Matter (Discipline code 02/B2)

PUBLICATIONS

Editorial activity

[E1] Guest editor of the Special Issue *Complexity in Neural and Financial Systems: From Time-Series to Networks* of the journal Complexity (2018). https://www.hindawi.com/journals/complexity/si/215629/

Books

[L1] A. Gabrielli, F. Sylos Labini, M. Joyce, and L. Pietronero, *STATISTICAL PHYSICS FOR COSMIC STRUCTURES*, Springer Verlag Inc. (New York - Berlin, 2005).

[L2] Chapter in *NETWORKS IN CELL BIOLOGY*, Cambridge (Cambridge, UK, 2010).

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Brain Network Topology Maps the Dysfunctional Substrate of Cognitive Processes in Schizophrenia, **Invited Talk** at the FISMAT 2019 Conference, September 30, 2019, Catania (Italy).

Brain Network Topology Maps the Dysfunctional Substrate of Cognitive Processes in Schizophrenia, **Invited Talk** at the 15th Granada Seminar, September 17-20, 2019, Granada (Spain).

Brain Network Topology Maps the Dysfunctional Substrate of Cognitive Processes in Schizophrenia, **Invited Talk** at "Advanced methods for neuroimaging data analysis" conference, September 2-3, 2019, Lille (France).

Statistical mechanics of weighted heterogeneous random (financial) networks, **Invited Talk** at the CSS/Italy 2019 conference, June 30 - July 2, 2019, Trento (Italy).

Statistical physics of heterogeneous random networks, **Invited Talk** at EPS - SPCS Conference, May 8-11, 2019, Stockholm (Sweden).

Functional Brain Networks in Schizophrenia: when Abundance Hinders Functioning,**Invited Talk** at City College New York (CCNY), January 28, 2019, New York (USA).

Unfolding the innovation system for the development of countries: co-evolution of Science, Technology and Production, **Invited Talk**, Workshop “Complex networks from socio-economic systems to biology and brain, July 10-16, 2018, Lipari (Italy).

Unfolding the innovation system for the development of countries: co-evolution of Science, Technology and Production, Contributed Talk, International Conference Netsci 2018, June 13-15, 2018, Paris (France).

Maximum entropy reconstruction of financial networks, **Invited Talk**, 3^{rd} Workshop on Statistical Physics for Financial & Economic Networks, Satellite meeting of the international conference Netsci 2018, June 11-12, 2018, Paris (France).

Unfolding innovation: modeling the interplay of science, technology, and economic growth, **Invited Seminar**, March 9, 2018, Bank of England, London (UK).

Organization and hierarchy of the human functional brain network lead to a chain-like core, **Invited Talk**, January 22-26, 2018, Conference “Regulation and Inference in Biological Networks", organized by Politecnico di Torino, Bardonecchia (IT).

Unfolding innovation: modeling the interplay of science, technology, and economic growth, **Invited Seminar**, January 15, 2018, KT Seminar, CERN, Geneva (CH).

Organization and hierarchy of the human functional brain network lead to a chain-like core, **Invited Talk**, EURANDOM Workshop on “Community Detection and Network Reconstruction", September 18-22, 2017, Workshop Centre in the Area of Stochastic, Eindhoven (Netherlands).

Organization and hierarchy of the human functional brain network lead to a chain-like core, **Invited Talk**, Workshop “Complex networks: from socio-economic problems to biology and brain", September 8-14, 2017, Lipari (Italy).

The scientific and technological competitiveness of nations: a network analysis, **Invited talk**, International Conference “SigmaPhi 2017", July 6-8, 2017, Corfu (Greece).

Detecting early signs of the 2007-2008 crisis in the world trade, **Invited Talk**, International Conference “SigmaPhi 2017", July 6-8, 2017, Corfu (Greece).

Statistical Physics of Brain, **Invited Lecture**, School of Statistical Physics, International Conference “SigmaPhi 2017", July 6-8, 2017, Corfu (Greece).

Organization and hierarchy of the human functional brain network lead to a chain-like core, **Invited Talk**, Summer Solstice Catania 2017 – 9^{th} International Conference on Discrete Models of Complex Systems, June 21-23, 2017, Catania (Italy).

Communications in Workshops, Conferences and Scientific Institutions

The Scientific and technological Competitiveness of Nations: a network analysis, **Invited Talk**, April 20 2017, Department of Informatics, University of Turin (Italy).

A complex network approach to the functional brain from fMRI data, **Invited Talk**, Honours Class LUMC 2017 “Complexity and Networks", April 10 2017, Leiden University, (The Netherland).

Un fisico teorico a spasso nel cervello, **Invited Talk**, March 18 2017, International Brain Awarness Week 2017, IMT - Lucca (Italy).

The Scientific and technological Competitiveness of Nations: a network analysis, **Invited talk**, February 14, 2017, Lorentz Instituut, Leiden University (The Netherlands).

The Scientific Competitiveness of Nations: a network analysis, **Invited Lecture**, International Workshop “Complex networks: from socio-economic systems to biology and brain, August 28 - September 2, 2016, Lipari (Italy).

Estimating topological properties of weighted networks from limited information: applications to socio-economic field, Contributed Talk, Statphys26, July 18-22, 2016, Lyon (France).

The scientific competitiveness of nations: a network analysis, **Invited Talk**, Satellite meeting of Statphys26 on “Statistical Physics of Financial and Economic Networks”, July 15-16,2016, Paris (France).

Estimating topological properties of weighted networks from limited information: applications to socio-economic field, **Invited Talk**, July 8, 2016, University College of London (UK).

The Scientific Competitiveness of Nations: a network analysis, **Invited Talk**, July 5, 2016, London Institute for Mathematical Science (LIMS), London (UK).

The Scientific Competitiveness of Nations: a network analysis, **Invited Talk**, XXI National Conference of Statistical Physics and Complex Systems, June 27-29, 2016, Parma (Italy).

Hierarchical organization of functional connectivity in the mouse brain: a complex network approach, **Invited Talk**, Satellite Meeting of NETSCI 2016 on “Brain Networks”, May 31, 2016, Seoul (S. Korea).

The Scientific Competitiveness of Nations: a network analysis, Contributed Talk, NETSCI 2016, May 30 - June 3, 2016, Seoul (S. Korea).

Systemic risk analysis on reconstructed economic and financial networks, Contributed Talk, NETSCI 2016, May 30 - June 3, 2016, Seoul (S. Korea).

Detecing cluster structure of resting state fMRI brain networks, **Invited Talk**, XXIII Conference of the Italian Society of Psycophysiology - SIPF, November 18 - 21, 2015, IMT - Lucca (Italy).

Estimating topological properties of weighted networks from limited information: applications to socio-economic field, **Invited Talk**, 101^{st} International Conference FisMat 2015, September 28 - October 2, 2015, University of Palermo (Italy).

Detecting cluster structure of resting state fMRI brain networks of mice, **Invited Talk**, International Workshop on “Complex Collective Dynamics: Brains and beyond”, August 31 - September 4, 2015, Villa Orlandi - Anacapri (Italy).

Finite N corrections to Vlasov dynamics and the range of pair interactions, Contributed Talk, XX National Conference of Statistical Physics and Complex Systems, June 29 - July 1, 2015, University of Parma (Italy).

Systemic risk analysis in reconstructed economic and Financial networks, Contributed Talk, IC2S2 - International Conference on Computational Social Science, June 8-11, 2015, Helsinki (Finland).

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The Scientific Competitiveness of Nations, **Invited Talk**, IWcee15 - International Workshop on Computational Economics and Econometrics, May 28-29, 2015, CNR, Rome (Italy).

Finite N corrections to Vlasov dynamics and the range of pair interactions, Contributed Talk, APS March Meeting 2015, March 2-6 2015, San Antonio (Texas, USA).

NMR anomalous diffusion measurements to investigate complex systems, **Invited Talk**, European Conference on Complex Systems - ECCS'14, September 22-26, 2014, IMT - Lucca (Italy).

Structural disorder and anomalous diffusion in random packing of spheres, Contributed Talk, SigmaPhi2014, International Conference on Statistical Physics, July 7-11, 2014, Rhodes (Greece).

Reconstruction real economic and financial networks from partial information: WTW and e-Mid cases, Contributed Talk, SigmaPhi2014, International Conference on Statistical Physics, July 7-11, 2014, Rhodes (Greece).

Statistical physics approach to quantifying differences in myelinated nerve fibers: application to aging detection, SigmaPhi2014, International Conference on Statistical Physics, July 7-11, 2014, Rhodes (Greece).

Reconstruction methods for economic and financial networks from partial information, Contributed Talk, International Conference of Econophysics ICE 2014, May 31 - June 2, 2014, University of Shanghai (China).

Structural disorder and anomalous water diffusion in random packing of spheres, Contributed Talk, APS March Meeting 2014, March 3-7, 2014, Denver (Colorado, USA).

A network analysis and new metrics for countries competitiveness and products complexity from the world trade web, **Invited Talk**, FiSiCo, Workshop on Physics of Complex Systems, September 11, 2013, Università degli Studi di Milano, Milan (Italy).

Non-Markovian Models of Blocking in Concurrent and Countercurrent Flows, Contributed Talk, FisMat 2013 - Italian National Conference on Condensed Matter Physics, September 9-13, 2013, Politecnico di Milano, Milan (Italy).

A network analysis and new metrics for countries competitiveness and products complexity from the world trade web, **Invited Talk** at STATPHYS 25 - 25th IUPAP International Conference on Statistical Physics, July 21-26, 2013, Seoul National University, Seoul (S. Korea).

Bootstrapping topological properties and systemic risk of complex networks using the fitness model, Contributed Talk, FNet 2013 - Financial Networks and Systemic Risk, July 17-19, 2013, Kyoto University, Kyoto (Japan).

Non-Markovian Models of Blocking in Concurrent and Countercurrent Flows, Contributed Talk, XVII National Conference of Statistical Physics and Complex Systems, June 24-26, 2013, University of Parma (Italy).

Bootstrapping Topological Properties and Systemic Risk of Complex Networks Using the Fitness Model, **Keynote Speaker**, NATO Advanced Research Workshop "New Challenges in Complex System Physics: Disaster forecasting, crisis modeling and sustainable development", May 20 - 24, 2013, Samarkand (Uzbekistan).

Clustering and ranking countries and their products: a network analysis, **Invited Talk**, ECT*, Trento Workshop on "Spectral properties of complex networks", July 23-27, 2012 Trento (Italy).

Ranking and clustering countries and their products: a network analysis, Contributed Talk, NetSci 2012, June 20-23, 2012 Evanston (IL, USA).

Ranking and clustering countries and their products: a network analysis, Contributed Talk, International Conference on Statistical Physics SigmaPhi 2011, July 11-15, 2011 Larnaca (Cyprus).

Communications in Workshops, Conferences and Scientific Institutions

Spatio-temporal ordinary and anomalous diffusion in heterogeneous and organic media by NMR, **Invited Talk**, Physics Department, University of Pavia, March 31, 2011, Pavia (Italy).

Topologically biased random walks on graphs and the structure of complex networks, Contributed Talk, International Conference on Network Science - NetSci 2010, May 10-14, 2010. MIT - Boston (MA, USA).

Invasion percolation on a tree and queueing models, Contributed Talk, International Conference on Network Science - NetSci 2009, July 1-3, 2009, Venice (Italy).

Two-point correlation properties of stochastic cloud processes, Contributed Talk, 100th Statistical Mechanics Conference, December 13-18, 2008, Rutgers University, New Jersey (USA).

Priority driven human dynamics: percolation and random walk arguments for social communications, Conference on "Social Networks: *Invasion percolation vs. Barabasi model pf human dynamics*, Invited Talk, Physics Department, University of Cagliari, September 23, 2008, Cagliari (Italy).

Invasion percolation and the time scaling behavior of a queueing model of human dynamics, International Conference in Statistical Physics SigmaPhi2008, July 14-18, 2008, Kolympari - Chania (Crete, Greece).

Clustering and coalescence from multiplicative noise: the Kraichnan ensemble, XIII National Conference of Statistical Physics and Complex Systems, June 23-25, 2008, University of Parma, Parma (Italy).

Application of percolation and random walk theory to priority driven models of queueing theory International Workshop on "Sociophysics: Status and Perspectives", ISI Foundation, May 26-29, 2008, Turin (Italy).

A brief introduction to uniform stochastic point processes, International Workshop on "Uniform point processes: from glasses to cosmology", March 19, 2008, LPTHE, Université "Pierre et Marie Curie" - Paris VI (France).

Critical transient ine the Barabasi model of human dynamics, Satellite Meeting of StatPhys23 on "Complex Networks: from Biology to Information Technology", July 02-06, 2007 Pula (Cagliari, Italy).

Condensed matter methods for the gravitational evolution of a perturbed lattice and its fluid limit, **Invited Talk**, February 08, 2007, Laboratoire de Physique Theorique de la Matière Condensée, Univiversité "Pierre et Marie Curie" - Paris VI (France).

Self-stabilised fractality of sea-coasts through damped erosion, XIII Workshop of Statistical Mechanics and Field Theory - SM&FT, September 20-22, 2006, Università di Bari (Italy).

Linear gravitational evolution of a perturbed lattice and its fluid limit, **Invited Talk**, May 03, 2006, ISI Foundation, Turin (Italy).

Gravitational evolution of a perturbed lattice and its fluid limit, X National Conference of Statistical Physics and Complex Systems, June 29 - July 2, 2005, Università di Parma (Italy).

Point processes and Stochastic Displacement Field, May 19, 2005, Department of Mathematics, 3rd University of Rome (Italy).

Chemical etching of a disordered solid: from experiments to field theory, **Invited Talk**, International Conference on "Physics of Irregular Systems" in honor of Prof. B. Sapoval, August 15-18, 2004, Fortaleza (Brazil).

Stochastic displacement fields and correlated particle distributions, Conference on "N-body Simulation in Cosmology", December 19-20, 2003, Laboratoire de Physique Theorique, Université Paris XI, Orsay (France).

Biasing a Gaussian field revisited: consequences on the correlation function and the power spectrum, **Invited Talk**, Workshop "Facts and fiction in cosmology", March 16-23, 2003, Sils Maria (Switzerland).

Communications in Workshops, Conferences and Scientific Institutions

Real space statistical properties of standard cosmological models, 7th Granada Lectures on "Modelling of complex systems", September 2-7, 2002, Universitad de Granada (Spain).

Chemical corrosion of disorderd solids, Satellite meeting of to STATPHYS 21 on "Fractal Structures and Self-Organization", July 23-28, 2001, Habana (Cuba).

Slow corrosion of disordered solids: self-organized fractality, absorbing states and fractures, **Invited Talk**, June 14, 2001, Physics Department, Università of Naples Federico II (Italy).

Percolation in real wild fires, VI National Conference Statistical Physics, May 29-31, 2001, Parma (Italy).

Etching of Random Solids: Hardening Dynamics and Self Organized Fractality, 6th Granada Seminar on Computational Physics, September 4-9, 2000, Univeristad de Granada (Spain).

Memory effects and quenched disorder in stochastic growth dynamics, **Invited Talk**, March 10, 2000, Institute for the Applications of Calculus (IAC) - CNR, Rome (Italy).

Slow etching of disordered solids and percolation models, IV National Conference of Statistical Physics, June 23-25, 1999, Parma (Italy).

Invasion Percolation with temperature, National Conference of INFM, June 13-18, 1999, Catania (Italy).

Memory effects in growth dynamics with quenched disorder, **Invited Talk**, February 04, 1999, Lab. PMC, Ecole Polytechnique, Palaiseau (France).

Gravitational Force in a fractal distribution of masses, Journ´ee de Physique Statistique, January 28, 1999 ESPCI, Paris (France).

Fractal growths: general properties and theoretical tools, **Invited Talk**, May, 1998, Department for Theoretical Physics of the University of Geneva (Switzerland).

Quenched Dielectric Breakdown Model, International meeting on "Disordered Systems", April 07-09, 1997, ISI Foundation, Turin (Italy).

Signature

Rome, 01/10/2019