

## **AGOSTINO LANZA – INFN Pavia**

### **Personal Information**

- Date of Birth: August 28<sup>th</sup>, 1957
- Citizenship: Italian

### **Employment and Education**

- 2007 – today: Technologist Director (Dirigente tecnologo) at the Istituto Nazionale di Fisica Nucleare (INFN)
- 2001 – 2006: II-Level Technologist (Primo tecnologo) at the INFN
- 1992 – 2000: Permanent position at the INFN as III-Level Technologist (Tecnologo)
- 1991: VIII-Level Technical Graduate (Tecnico laureato) at the Dipartimento di Fisica Nucleare e Teorica of the Pavia University
- 1988 – 1990: VII-level Technical Graduate (Tecnico laureato) at the Dipartimento di Fisica Nucleare e Teorica of the Pavia University
- 1985 – 1988: Teacher in two Technical High Schools (Istituto Tecnico Industriale and Istituto Professionale di Stato per l'Industria e l'Artigianato)
- 1983: Summer Student at CERN, tutor Hans Jurgen Hilke
- 1981 – 1987: Teacher in the Technical Evening School organized by the Regione Lombardia
- 1981: Degree in Physics at the Pavia University
- 1976: High School Diploma at the Liceo Scientifico "Taramelli" in Pavia

### **Management and Institutional Positions**

- 2014 – today: Co-project Manager of the XPR project, the new irradiation facility at Centro Nazionale di Adroterapia Oncologica (CNAO) in Pavia
- 2014 – today: Coordinator of the Comitato Paritetico INFN - CAEN for the application of the framework agreement signed between INFN and the CAEN Company
- 2014 – today: Services Coordinator and Steering Group (SG) member of the New Small Wheel (NSW) upgrade project of the ATLAS experiment
- 2013 – 2015: President of the INFN Pavia Committee for the conferment of the local postdoc grants
- 2012 – today: INFN Pavia Coordinator of the V National Scientific Committee (CSN5)
- 2012 – today: Responsible of the Services and Integration Activities of the Fast Tracker (FTK) upgrade project of the ATLAS experiment
- 2011 – today: Pavia Representative in the INFN Technological Transfer organization
- 2005 – today: Services Manager of the ATLAS Muon Spectrometer
- 2004: Chair of the ATLAS Muon committee in charge of drawing up the specification document of the MDT chamber commissioning at CERN
- 2001 – 2004: Technologist Delegate in the Consiglio di Sezione of INFN Pavia
- 1988 – 2001: Manager of the INFN Pavia Electronics Service

### **Institutional and Educational Activities**

- Member of 7 examination boards for the assignment of permanent or temporary research and technical positions at the INFN and the Cabibbo Lab , 1 as President
- Member or President of 11 national and 8 international tender committees
- Reviewer of the Final Design Review (FDR) and the Production Readiness Review (PRR) of the ATLAS Pixel Services, and of the PRR of the LV Power Supplies of the ATLAS LAr calorimeters
- Organizer of 3 INFN national trainings in the field of electronics
- Tutor of 10 degree theses at the Pavia University

## Research Experience

### ATLAS main activities

- 2013 – today: I joined the ATLAS NSW project, first as member of the Pavia group involved in the construction of the Micromegas detector, and from beginning of 2014 as Services Coordinator and NSW SG member
- 2011 – today: I am involved in the FTK project, from 2011 to 2012 as a designer of the Associative Memory (AM) new mezzanine board, and from 2013 to today as responsible of Services and Integration in USA15
- 2008 – today: I am responsible of the maintenance of the ATLAS MDT, RPC and CSC power supply systems (HV and LV)
- 2005 – 2010: ATLAS Muon Services Manager. From 2008 to 2009 I was responsible of the ATLAS Muon Detector Safety System (DSS)
- 2001 – 2005: I was responsible of the on-chamber services of 116 ATLAS Muon chambers
- 1997 - 2008: I was responsible of the design and production of the MDT HV and LV power systems
- 1997 – 2005: I was responsible of the design, production, test and distribution of the HV hedgehog boards for all the ATLAS MDT chambers

### R&D activities

- 2011 – 2013: I was project leader of the R&D APOLLO, funded by the INFN CSN5
- 2007 – 2010: I participated to an R&D on the next generation LV power supplies for the LHC phase 2, funded by the Italian Ministry of Education and Research (MIUR)
- 1991 -1994: I joined the Tracking & Timing (T&T) collaboration, an R&D on the read-out electronics for the Resistive Plate Counter (RPC) detector
- 1990 – 1992: I was project leader of the R&D NEUNET, funded by the INFN CSN5

### Electronics Service activities

- 2013 – today: I am involved in two tasks of the framework agreement between the INFN and the Centro Nazionale di Adroterapia Oncologica (CNAO), approved by the INFN Consiglio Direttivo in 2013
- 1993 – 2001: I designed the front-end board and the acquisition systems of the GDH (verification of the Gerasimov-Drell-Hearn sum rule) experiment, taking data at the MAMI accelerator of the Mainz University (Germany)
- 1992 – 1994: I designed the front-end and the read-out electronics of the Radiative Pion Decay (RAPID) experiment, installed at the Paul Scherrer Institute (PSI) in Villigen (Switzerland)

### Past activities

- 1992 – 1998: I participated to the Neutrino Oscillation Magnetic Detector (NOMAD) experiment at the CERN SPS, designing the front-end electronics for the lead-glass calorimeter, and the electronics for the calorimeter trigger. I was also responsible for the calorimeter services
- 1988 – 1991: I was involved in the E771 experiment at Fermilab, Batavia (USA), for which I participated to the design of the front-end electronics and to its installation and commissioning
- 1988 – 1993: I worked in the MINI experiment at the INFN Bari, participating to the construction of the RPC-made horizontal telescope to detect backward muons
- 1987 – 1988: I participated to the first phase of the Imaging Cosmic And Rare Underground Signals (ICARUS) experiment
- 1981 – 1987: My first experiment was the Neutron Antineutron Doublet Investigation by Reactor (NADIR), installed at the Laboratorio di Energia Nucleare Applicata (LENA) of the Pavia University by a collaboration among the INFN Pavia, INFN Roma and CESNEF Milano

## Publications

- 243 publications on international peer-review journals, of which: 170 on ATLAS, 1 on ATLAS NSW, 7 on ATLAS FTK, 6 on APOLLO, 35 on NOMAD, 2 on other experiments, 5 on T&T, 6 on E771, 2 on NEUNET, 3 on MINI and 6 on NADIR. The publication list of years 2014 – 2015 follows:

Authors	Title	Journal	Journal n.	Pages	Year	DOI	WOS
Aad, G.; Lanza, A. et al.	Jet energy measurement and its systematic uncertainty in proton-proton collisions at root s=7 TeV with the ATLAS detector	EUROPEAN PHYSICAL JOURNAL C	75:17		2015	10.1140/epj/c/s10052-014-3190-y	WOS:000348991900001
Ameel, J.; Lanza, A. et al.	Radiation-hard power electronics for the ATLAS New Small Wheel	JOURNAL OF INSTRUMENTATION	10 C01009		2015	10.1088/1748-0221/10/01/C01009	WOS:000347715400009
Lazzaroni, M.; Lanza, A. et al.	High B test of a commercial step-down Point of Load for LHC experiments	MEASUREMENT	60	194 - 206	2015	10.1016/j.measurement.2014.10.018	WOS:000345859900023
Andreani, A.; Lanza, A. et al.	The Associative Memory Serial Link Processor for the Fast Tracker (FTK) at ATLAS	JOURNAL OF INSTRUMENTATION	9 C11006		2014	10.1088/1748-0221/9/11/C11006	WOS:000345026000006
Aad, G.; Lanza, A. et al.	Muon reconstruction efficiency and momentum resolution of the ATLAS experiment in proton-proton collisions at root s=7 TeV in 2010	EUROPEAN PHYSICAL JOURNAL C	74:3034		2014	10.1140/epj/c/s10052-014-3034-9	WOS:000350141000001
Aad, G.; Lanza, A. et al.	Measurement of event-plane correlations in root s(N)=2.76 TeV lead-lead collisions with the ATLAS detector	PHYSICAL REVIEW C	90 - 024905		2014	10.1103/PhysRevC.90.024905	WOS:000341240300002
Aad, G.; Lanza, A. et al.	Measurement of chi(c1) and chi(c2) production with root s=7 TeV pp collisions at ATLAS	JOURNAL OF HIGH ENERGY PHYSICS	07 154		2014	10.1007/JHEP07(2014)154	WOS:000340391300001
Aad, G.; Lanza, A. et al.	Search for dark matter in events with a Z boson and missing transverse momentum in pp collisions at root s=8 TeV with the ATLAS detector	PHYSICAL REVIEW D	90 - 012004		2014	10.1103/PhysRevD.90.012004	WOS:000339169600002
Aad, G.; Lanza, A. et al.	Search for direct top-quark pair production in final states with two leptons in pp collisions at root s=8 TeV with the ATLAS detector	JOURNAL OF HIGH ENERGY PHYSICS	06 124		2014	10.1007/JHEP06(2014)124	WOS:000338346400001
Aad, G.; Lanza, A. et al.	Measurement of the low-mass Drell-Yan differential cross section at root s=7 TeV using the ATLAS detector	JOURNAL OF HIGH ENERGY PHYSICS	06 112		2014	10.1007/JHEP06(2014)112	WOS:000338528300001
Aad, G.; Lanza, A. et al.	Measurement of the parity-violating asymmetry parameter ab and the helicity amplitudes for the decay Lambda(0)fb -> J/psi Lambda(0) with the ATLAS detector	PHYSICAL REVIEW D	89 - 092009		2014	10.1103/PhysRevD.89.092009	WOS:000356651300001
Aad, G.; Lanza, A. et al.	Search for invisible Decays of a Higgs Boson Produced in Association with a Z Boson in ATLAS	PHYSICAL REVIEW LETTERS	112, 201802		2014	10.1103/PhysRevLett.112.201802	WOS:000339554800003
Aad, G.; Lanza, A. et al.	Measurement of the production of a W boson in association with a charm quark in pp collisions at root s=7 TeV with the ATLAS detector	JOURNAL OF HIGH ENERGY PHYSICS	05 068		2014	10.1007/JHEP05(2014)068	WOS:000336799600001
Aad, G.; Lanza, A. et al.	Measurement of dijet cross-sections in pp collisions at 7 TeV centre-of-mass energy using the ATLAS detector	JOURNAL OF HIGH ENERGY PHYSICS	05 059		2014	10.1007/JHEP05(2014)059	WOS:000336740400001
Aad, G.; Lanza, A. et al.	Search for Higgs boson decays to a photon and a Z boson in pp collisions at root s=7 and 8 TeV with the ATLAS detector	PHYSICS LETTERS B	732	8 - 27	2014	10.1016/j.physletb.2014.03.015	WOS:000335507900002
Aad, G.; Lanza, A. et al.	Search for direct production of charminos and neutralinos in events with three leptons and missing transverse momentum in root s=8 TeV pp collisions with the ATLAS detector	JOURNAL OF HIGH ENERGY PHYSICS	04 169		2014	10.1007/JHEP04(2014)169	WOS:000335731400001
Aad, G.; Lanza, A. et al.	Measurement of the production cross section of prompt J/psi mesons in association with a W (+/-) boson in pp collisions root s=7 TeV with the ATLAS detector	JOURNAL OF HIGH ENERGY PHYSICS	04 172		2014	10.1007/JHEP04(2014)172	WOS:000335732000001
Aad, G.; Lanza, A. et al.	Study of heavy-flavor quarks produced in association with top-quark pairs at root s=7 TeV using the ATLAS detector	PHYSICAL REVIEW D	89 - 072012		2014	10.1103/PhysRevD.89.072012	WOS:000335235200001
Aad, G.; Lanza, A. et al.	Measurement of the electroweak production of dijets in association with a Z boson and distributions sensitive to vector boson fusion in proton-proton collisions at=8 TeV using the ATLAS detector	JOURNAL OF HIGH ENERGY PHYSICS	04 031		2014	10.1007/JHEP04(2014)031	WOS:000334502400001
Aad, G.; Lanza, A. et al.	Search for Dark Matter in Events with a Hadronically Decaying W or Z Boson and Missing Transverse Momentum in pp Collisions at root s=8 TeV with the ATLAS Detector	PHYSICAL REVIEW LETTERS	112, 41802		2014	10.1103/PhysRevLett.112.041802	WOS:000331947500004
Aad, G.; Lanza, A. et al.	Search for new phenomena in final states with large jet multiplicities and missing transverse momentum at root s = 8 TeV proton-proton collisions using the ATLAS experiment (vol.10, pg.130, 2013)	JOURNAL OF HIGH ENERGY PHYSICS	01 109		2014	10.1007/JHEP01(2014)109	WOS:000346238300003
Aad, G.; Lanza, A. et al.	Measurement of the mass difference between top and anti-top quarks in pp collisions at root s=7 TeV using the ATLAS detector	PHYSICS LETTERS B	728	363 - 379	2014	10.1016/j.physletb.2013.12.010	WOS:000330556000059
Aad, G.; Lanza, A. et al.	Search for new phenomena in photon plus jet events collected in proton-proton collisions at root s=8 TeV with the ATLAS detector	PHYSICS LETTERS B	728	562 - 578	2014	10.1016/j.physletb.2013.12.029	WOS:000330556000086
Annovi, A.; Lanza, A. et al.	Design of a hardware track finder (Fast Tracker) for the ATLAS trigger	JOURNAL OF INSTRUMENTATION	9 C01045		2014	10.1088/1748-0221/9/01/C01045	WOS:000332307000045

# Curriculum Vitae of Irene Giardina - 02/2015

## Current Position:

Since 2013 I am Associate Professor of Theoretical Physics at the Department of Physics, University of Rome La Sapienza, Rome, Italy.

## Contact details:

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## Appointments

- Visiting Professor, Initiative for the Theoretical Sciences, The Graduate Center, CUNY, New York (2013-2014)
- Italian national scientific qualification for full Professor, sectors 02/A2 (Theoretical Physics of Fundamental Interactions) and 02/B2 (Theoretical Condensed Matter Physics)
- Associate Professor in Theoretical Physics, Department of Physics, Sapienza University of Rome (2013-)
- Researcher at the Institute for Complex Systems - CNR, UOS Sapienza, Rome (2009 - 2013)
- Tenure Track Researcher at the Centre for Statistical Mechanics and Complexity, INFN-CNR, Rome (2003 – 2009)
- Assistant Professor with a Fellowship of the Italian Research Ministry MIUR, program “Rientro dei Cervelli” - at the Department of Physics, University of Rome “La Sapienza” (2002-2003)
- Postdoctoral position in the Laboratoire de Physique Théorique, Centre Energie Atomique CEA-SACLAY, France (1999-2001)
- Postdoctoral position in the Theoretical Condensed Matter Physics Group, at the Department of Theoretical Physics, Oxford University (1998 -1999).

## Education

- PhD in Theoretical Physics at the University of Rome “La Sapienza” (May 1998). Supervisor: Prof. G. Parisi.
- Laurea Degree in Physics (MSc.) at the University of Pavia (July 1994). Supervisor: Prof. A. Rimini. Grade: 110/110 *cum laude*
- Undergraduate fellow at Collegio Ghislieri, Pavia (1989-1994)
- High school diploma at Liceo Classico “N. Spedalieri”, Catania (1989)

## Key invited lectures

- Workshop 'Active Liquids', Leiden Lorentz Center, Leiden (2015)
- 113<sup>th</sup> Statistical Mechanics Conference, Rutgers University, Rutgers (2015)
- Workshop 'Flowing matter across the scales', Rome (2015)
- APS March Meeting, Invited talk, Focus Session 'Physics of Behavior', Denver (2014)
- Conference 'Active Processes in living and non living matter', Kavli Institute for Theoretical Physics at the University of California, Santa Barbara (2014)
- Workshop 'Statistical Physics and Information Processing in Biology', Institut H. Poincare, Paris (2012)
- Conference "Collective Dynamics and Pattern Formation in Active Matter Systems", Max Planck Institute, Dresden (2011)
- Extended Workshop "Theoretical physics and the phenomena of life: Optimization and emergent behaviour", Graduate Center, CUNY, New York (2011)
- Workshop Statistical Physics and Biology of Collective Motion, Max Planck Institute, Dresden (2010)
- Workshop on Biophysics, CUNY, New York (2010).
- Princeton Physics Colloquium, invited lecture: "Collective animal behaviour: theoretical speculations and empirical groundings", Princeton University, (2009)
- APS March Meeting 2009, Invited session: 'Active Soft Matter: From Granular Rods to Flocks to Living Cells', (2009)
- Workshop 'Self-organization and dynamics of active matter', Institut Henri Poincare, Paris (2009)
- 22nd General Conference of the Condensed Matter Division of the European Physical Society, Rome (2008)
- 4<sup>th</sup> European Conference on Behavioural Biology ECBB, Dijon (2008)
- Conference "Complexity, Metastability and Nonextensivity", Erice (2007)
- Workshop "Modelling and control of physical networks", Pisa (2007)
- Workshop "Bio inspired design of networks", Cambridge (2007)
- Les Houches Meeting " Statistical Physics of Glasses, Spin Glasses, Information Processing and Combinatorial Optimization", Les Houches (2006)
- 94th Statistical Mechanics Meeting, Rutgers University, Rutgers (2005).
- LAWNP'05, 9th Latin American Workshop on Nonlinear Phenomena, San Carlos de Bariloche (2005).
- Conferenza Nazionale della Societa' Italiana di Fisica, SIF 2005, Catania (2005)
- Advanced Research Workshop ``Application of Physics to Economic Modelling ", Prague (2001)

- CECAM workshop "The Instantaneous Normal Mode Approach to Dynamics in Liquids", ENS Lyon (1999).

### Invited Courses

- 'Collective behavior in animal groups', Beg Rohu Summer school in 'Non equilibrium statistical mechanics and active matter', Beg Rohu (2014)
- 'Metastable States in Glassy systems', Les Houches Summer School - Session 28: Complex Systems (2006)
- 'Econophysics', Les Houches Meeting "Statistical physics of glasses, spin glasses, information processing and combinatorial optimization" (2006)
- 'Phynance Statistique', Ecole Nationale Supérieure des Telecommunications, Paris (2001)
- 'Minority Games', Mini School in Stochastic Finance, Nordita, Copenhagen (1999)

### Funding:

#### Personal grants:

- 2010-2015: **ERC-Starting Grant** (European Research Council)  
 Title: SWARM: *Empirical analysis and theoretical modelling of self-organized collective behaviour in three-dimensions: from insect swarms and bird flocks to new schemes of distributed coordination.*  
 Role: Principal Investigator. Budget: 1124000 euro
- 2010-2013: **SEED Project** (Italian Institute of Technology).  
 Title: ART-SWARM: *From self-organized animal groups to distributed artificial swarms.*  
 Role: Principal Investigator. Budget: 605000 euro
- 2010-2012: **Marie Curie Fellowship** (IEF) for Silvio Manuel Duarte.  
 Title: PASSAROLA: *Statistical and dynamical analysis of collective behaviour in a three-dimensional motion: Empirical studies and modeling*  
 Role: Scientist in Charge Budget: 166239 euro

#### Network grants:

- 2015-2019: **GDRI Network** (GDRI)  
 Title: Evolution, Regulation and Signalling  
 Role: Member of Network Budget: to be defined

- 2014-2018: **COST Action** (EU Framework, cooperation grant)  
Title: *Flowing Matter*  
Role: Network member, Italian Member of the Managing Committee  
Budget: 189000 (for the whole network)
- 2005-2008: **STREP** (EU FP6)  
Title: STARFLAG: Starlings in flight, understanding patterns of animal group motion  
Role: Co-Investigator of the Rome node.  
Budget: 320000 euro (Rome Node only)

### **Professional Awards**

Member of the Young Academy of Europe (12/2012 - )

ERC grantee – European Research Council (2010)

MIUR ‘Rientro dei Cervelli’ - Italian Ministry for Scientific Research (2002)

### **Conference Organization**

Organization (together with W. Bialek, A. Cavagna and P. Nelson) of the Extended Workshop “Theoretical physics and the phenomena of life: Optimization and emergent behaviour”, Graduate Center, CUNY, New York (February-March 2011)

### **Reviewing and Editorial Activity**

- Referee for the following journals: Proceedings of the National Academy of Sciences USA; Physical Review (Letters, B and E); Journal of Physics A; Europhysics Letters; Physica A; Physica D; European Physical Journal B; Journal of Statistical Physics; Quantitative Finance; Journal of Economic Behavior and Organization; Proceedings of the Royal Society B; Neural Computing and Applications; Ethology; Ecology Letters; Animal Behaviour; Plos One; Plos Computational Biology; Robotics and Autonomous Systems; Swarm Intelligence
- Mathematics Consulting Editor for Animal Behaviour (2011-)
- Project Reviewer for the National Science Foundation (2012, 2014)
- Reviewer VQR-ANVUR (National Research Evaluation 2004-2010), panel 02 (2012)

## Teaching and Tutoring

- 2014-15: Undergraduate courses “General Physics” I and II, Department of Earth Sciences, Faculty of Science, University of Rome La Sapienza
- 2010-2011: Postgraduate course “Physical and Mathematical models for Economy”, Laurea Magistrale in Fisica (Master degree), Department of Physics, University of Rome La Sapienza
- 2004-2009: yearly PhD course in Disordered Systems and Anomalous Diffusion, PhD in Physics, University of Rome La Sapienza
- 2003: ‘Agent-based models’ module in the “Physical and Mathematical models for Economy” course, Department of Physics, University of Rome La Sapienza
- Students supervision (see Table below)

Type of Degree	Start /End Date	Name	Title of Project	Co-Advisor
PhD	12/2011-12/2014	Edmondo Silvestri	Self-propelled particle models in 3D	A. Cavagna
MSc	1/2012-8/2012	Duccio Piovani	Maximum Entropy Models for flocks	
BSc	6/2011-12/2011	Flavio Iannelli	Density distribution in flocks	G. Parisi
MSc	10/2009 - 10/2010	Edmondo Silvestri	Numerical Simulations of collective animal behaviour on CUDA	A. Cavagna and G. Parisi
MSc	9/2009-9/2010	Alessio Cimorelli	Structure functions and velocity correlations in starling flocks	
BSc	11/2008-3/2009	Raffaele Tavarone	Interactions in animal collective behaviour	
BSc	11/2008-5/2009	Raffaele Marino	Evolution of Cooperation in the Prisoner’s Dilemma	M.A. Virasoro
PhD	2005-2008	Andrea Procaccini	Starlings Flocks: an experimental study of complex collective phenomena	A. Cavagna and G. Parisi
MSc	1/2005-1/2006	Barbara Capone	Off-equilibrium confined dynamics:	



			analytical solution and entropic interpretation	
MSc	1/2007-10/2007	Mauro Di Tanna	Simplified Minority Games	
DEA stage (CEA - Saclay)	2001	Francois Ghoulmie	Minority Games	

- Postdoctoral mentoring:

There are currently 1 untenured researcher, 2 postdocs, 2 PhD students, 1 master student working in my group under the supervision of Dr Andrea Cavagna (my main senior collaborator) and myself. Previous members who recently left are:

- Dr Asja Jelic (now senior postdoc at ICTP, Trieste)
- Dr Supravat Dey (now postdoc at the University of Montpellier)
- Dr Edward Shen (now working at Bublcam, Toronto)
- Dr Silvio Manuel Duarte Queiros (Marie Curie fellow)

- Member in PhD Dissertation Committee:

- Sebastien Motsch, Universite' de Toulouse III - Applied Mathematics (2009)
- Kartik Anand, King's College London - Applied Mathematics (2009)
- Frank Raynaud, Université Paris Diderot-Paris 7 - Physics (2009)

### Science Popularization

- A. Linke, I. Giardina et al., *Flocking- Cohesion of the aggregation*, art video, from an interdisciplinary collaboration between the Starflag project (CNR-INFM) and HfG – Staatliche Hochschule für Gestaltung Karlsruhe (University of Art and Design Karlsruhe). Venice Biennale (2008); 'Notation' exhibition, ZKM Karlsruhe (2008); Romaeuropafestival (2009);
- A. Cavagna & I. Giardina, *The seventh starling*. Significance 5, 62-66 (2008).
- A. Cavagna & I. Giardina, *Comportamenti collettivi negli animali e nella specie umana*, Enciclopedia Treccani 'Nuovo Millennio' (2008)
- I. Giardina, *La formulazione delle storie della Meccanica Quantistica*, Bibliopolis, Napoli (1998)

## Research Interests

### Background:

My background is in theoretical and statistical physics. I have been working extensively on disordered and complex systems, both in condensed matter physics and interdisciplinary applications. I have exported and applied techniques developed in statistical physics to deal with complex behavior in other contexts, from multi-agent models of social systems to collective phenomena in biology.

### Current Research Interests:

Ten years ago, together with Andrea Cavagna, I started an entirely new line of research focused on collective behavior in animal groups and biological systems. Since then, our group is devoted to develop new experimental, analytical and numerical tools to investigate collective behavior in animal aggregations. Collective behavior is a widespread phenomenon in biological systems, occurring at several scales and levels of complexity. Animal groups, like insect swarms and bird flocks, offer paradigmatic examples of *emergent self-organization* where collective behavior arises spontaneously, as a consequence of the local interactions between individuals. Interestingly, group behavior often has functional motivations, exhibiting collective skills that go beyond individual abilities. A crucial issue is therefore to understand how self-organization emerges in animal aggregations and how behavioral rules at the individual level regulate collective efficiency and group function. My current research addresses these issues from different angles. Specifically:

- ***Quantitative experimental characterization of collective behavior.*** My group has performed 3D stereo-tracking experiments on various kinds of large biological aggregations: bird flocks and midge swarms in the field, mosquito swarms and stem cells colonies in the lab. In all these cases, our aim is to find aggregate observables capable of describing the nature of collective patterns, the way individuals influence each other, and how behavioral information propagates through the group.
- ***Perturbation-response experiments.*** Our current understanding of collective motion indicates that global coordination might be strongly related to the ability of the group to collectively respond to perturbations. One of my main current interests is to quantitatively investigate this issue: we plan to perform perturbation experiments on natural groups and link the response of the group to the amount of correlations existing between individuals.
- ***Statistical Inference.*** Experimental data can be used to infer information on the effective interactions between individuals generating the collective group behavior. From a theoretical perspective this problem is known as statistical inference. One of my current lines of research focuses on developing novel inference methods, based on the Maximum Entropy approach, and adapt them to the analysis of off-equilibrium systems like animal groups on the move.
- ***Searching for principles.*** From a broader perspective, I am interested in identifying signatures and mechanisms of collective behavior in animal aggregations, understanding how specific these features are to context or species, and whether general common principles might exist. I am interested in linking our current knowledge on active soft and living matter on the micro scale - bio-filaments, bacterial suspensions, cell colonies - to behavioral networks of animal groups moving on the large scale.

## Publication Impact:

(data from Google Scholar – March 2015)

I have authored 60 publications in International Journals. Among them: 1 Nature Physics, 4 Proceedings of the National Academy of Sciences USA, 9 Physical Review Letters, 5 Animal Behaviour, 5 Physical Review B, 1 Europhysics Letters, 1 Quantitative Finance, 9 Journal of Physics A, 2 Plos Computational Biology.

I have written 1 book and 1 book chapter.

### **h-index: 27**

- Number of published articles: 60
- Citations: 3258
- Average citations per item: 54,30
- Total Impact Factor: 233,97

### **10 most cited publications:** (Google-Scholar):

1. *Interaction ruling animal collective behavior depends on topological rather than metric distance: Evidence from a field study*  
M. Ballerini, N. Cabibbo, R. Candelier, A. Cavagna, E. Cisbani, I. Giardina, V.Lecomte, A. Orlandi, G. Parisi, A. Procaccini, M. Viale & V. Zdravkovic V Proc. Natl. Acad. Sci. USA **105**, 1232 (2008). Cit: 688
2. *Scale-free correlations in starling flocks.*  
A. Cavagna, A. Cimarelli, I. Giardina, G. Parisi, R. Santagati, F. Stefanini, M. Viale  
Proc. Natl. Acad. Sci. USA **107**, 11865 (2010). Cit: 256
3. *Thermal model for adaptive competition in a market*  
A. Cavagna, J.P. Garrahan, I. Giardina and D. Sherrington  
Phys. Rev. Lett. **83**, 4429 (1999). Cit: 188
4. *Empirical investigation of starling flocks: a benchmark study in collective animal behavior*  
M. Ballerini, N. Cabibbo, R. Candelier, A. Cavagna, E. Cisbani, I. Giardina, V.Lecomte, A. Orlandi, G. Parisi, A. Procaccini, M. Viale & V. Zdravkovic V Anim Behav **76**, 201 (2008). Cit: 181
5. *Energy landscape of a Lennard-Jones liquid: statistics of stationary points*  
K. Broderix, K.K. Batthacharya, A. Cavagna, A. Zippelius and I. Giardina  
Phys. Rev. Lett. **85**, 5360 (2000). Cit: 160
6. *Geometric approach to the dynamic glass transition*  
T. S. Grigera, A. Cavagna, I. Giardina and G. Parisi  
Phys. Rev. Lett. **88**, 055502 (2002). Cit: 154

7. *Bubbles, crashes and intermittency in agent based market models*  
I. Giardina & J.P. Bouchaud  
Eur. Phys. J. B **31**, 421 (2003). Cit: 144
8. *Statistical mechanics for natural flocks of birds*  
W. Bialek, A. Cavagna, I. Giardina, T. Mora, E. Silvestri, M. Viale, A. M. Walczak  
Proc. Natl. Acad. Sci. USA **109**, 4786 (2012). Cit: 107
9. *Microscopic models for long ranged volatility correlations*  
I. Giardina, J.P. Bouchaud and M. Mezard  
Physica A **299**, 28 (2001). Cit: 105
10. *Random fields and spin glasses: a field theory approach*  
C. De Dominicis & I. Giardina  
Cambridge University Press (2006). Cit: 99

## **Press Coverage**

The seventh starling (Murmuration) - The Guardian

Choreografie ohne Choreografen - NZZ

Birds of a feather ... track seven neighbors to flock together - News at Princeton

How do starlings create those mesmerizing murmurations - Cornell Lab Ornithology

Editorial: Tech is a flock of starlings - Engadget

Flights of Fancy: How birds (and bird-watchers) compute the behavior of a flock on the wing  
- American Scientist

Animal magnetism: modeling flocks of birds using simple attractions - ArsTechnica

Starling Flocks Behave Like Flying Magnets - Wired

The Startling Science of a Starling Murmuration - Wired

Birds flock with scale invariance - Physics World

How starling flocks create their aerobatic displays - BBC

The Smart Swarm - Peter Miller

Amazing Starling Flocks are Flying Avalanches - Wired

Birds network too - Science News

Study of starling formations points way for swarming robots - Daily Telegraph

Statistical Physics is for the Birds - Physics Today

## Full Publication List:

### Books and Book Chapters:

- *Metastable states in glassy systems*  
I. Giardina  
in "Les Houches - Session LXXXV: Complex Systems", J.-P Bouchaud, M. Mezard and J. Dalibard eds., Elsevier, Amsterdam (2007).
- *Random Fields and Spin Glasses*  
C. De Dominicis and I. Giardina  
Cambridge University Press, Cambridge (2006)
- *La Formulazione delle Storie della Meccanica Quantistica*  
I. Giardina  
Bibliopolis, Napoli (1998)

### Peer reviewed research papers:

- *Finite-size scaling as a way to probe near-criticality in natural swarms*  
A. Attanasi, A. Cavagna, L. Del Castello, I. Giardina, S. Melillo, L. Parisi, O. Pohl, B. Rossaro, E. Shen, E. Silvestri, M. Viale  
Phys. Rev. Lett **113**, 238102 (2014)
- *Information transfer and behavioural inertia in starling flocks*  
A. Attanasi, A. Cavagna, L. Del Castello, I. Giardina, TS. Grigera, A. Jelić, S. Melillo, L. Parisi, O. Pohl, E. Shen, M. Viale  
Nature Physics, **10** (9), 691-696 (2014)
- *Collective behaviour without collective order in wild swarms of midges*  
A. Attanasi, A. Cavagna, L. Del Castello, I. Giardina, S. Melillo, L. Parisi, O. Pohl, B. Rossaro, E. Shen, E. Silvestri, M. Viale  
Plos Comput. Biol., **10** e1003697 (2014)
- *Social interactions dominate speed control in poisoning natural flocks near criticality*  
W. Bialek, A. Cavagna, I. Giardina, T. Mora, O. Pohl, E. Silvestri, M. Viale, AM Walczak  
Proc. Natl. Acad. Sci. US **111**, 7212 (2014)
- *Dynamical maximum entropy approach to flocking*  
A. Cavagna, I. Giardina, F. Ginelli, T. Mora, D. Piovani, R. Tavarone, AM Walczak  
Phys. Rev. E, **89**, 042707 (2014)
- *Bird flocks as condensed matter*  
A. Cavagna, I. Giardina  
Ann. Rev. Cond. Matt. Phys. **5**, 183-207 (2014)

- *Flocking and turning: a new model for self-organized collective motion*  
A. Cavagna, L. Del Castello, I. Giardina, TS Grigera, A. Jelic, S. Melillo, T. Mora, L. Parisi, E. Silvestri, M. Viale, AM Walczak  
J. Stat. Phys. **158**, 601-627 (2014)
- *Boundary information inflow enhances correlation in flocking.*  
A. Cavagna, I. Giardina, F. Ginelli  
Phys. Rev. Lett. **110**, 168107 (2013)
- *Diffusion of individual birds in starling flocks*  
A. Cavagna, S. M. Duarte Queiros, I. Giardina, F. Stefanini and M. Viale  
Proc. Royal. Soc. B. **280**, 20122484 (2013)
- *Starling flock networks manage uncertainty in consensus at low cost*  
G F. Young, L. Scardovi, A. Cavagna, I. Giardina, N. E. Leonard  
Plos Comput. Biol. **9** e1002894 (2013)
- *Spatially balanced topological interaction grants optimal cohesion in flocking models*  
M Camperi, A. Cavagna, I. Giardina, G. Parisi, E. Silvestri  
Interface Focus **2**, 715 (2012)
- *Statistical mechanics for natural flocks of birds*  
W. Bialek, A. Cavagna, I. Giardina, T. Mora, E. Silvestri, M. Viale, A. M. Walczak  
Proc. Natl. Acad. Sci. US **109**, 4786 (2012)
- *Propagating waves in starling, *Sturnus vulgaris*, flocks under predation*  
A. Procaccini, A. Orlandi, A. Cavagna, I. Giardina, F. Zoratto, D. Santucci, F. Chiarotti, C. Hemelrijk, E. Alleva, G. Parisi, C. Carere  
Anim. Behav. **82**, 759 (2011)
- *Scale-free correlations in starling flocks*  
Cavagna, A. Cimorelli, I. Giardina, G. Parisi, R. Santagati, F. Stefanini, M. Viale  
Proc. Natl. Acad. Sci. USA **107**, 11865 (2010).
- *Phase-Separation Perspective on Dynamic Heterogeneities in Glass-Forming Liquids*  
C. Cammarota, A. Cavagna, I. Giardina, G. Gradenigo, T. S. Grigera, G. Parisi and P. Verrocchio  
Phys. Rev. Lett. **105**, 055703 (2010)
- *From Empirical Data to Inter-Individual Interactions: Unveiling the Rules of Collective Animal behaviour*  
A. Cavagna, A. Cimorelli, I. Giardina, G. Parisi, R. Santagati, F. Stefanini, R. Tavarone  
Mathematical Models and Methods in Applied Sciences M3AS **20**, 1495 (2010)
- *Large scale behaviour in animal groups*  
A. Cavagna and I Giardina  
Behav. Proc. **84**, 653 (2010)

- *Collective Behaviour in animal groups: theoretical models and empirical studies*  
I. Giardina  
HSFP Journal **2**, 205 (2008)
- *New statistical tools for analyzing structure of animal groups*  
A. Cavagna, A. Cimorelli, I. Giardina, A. Orlandi, G. Parisi, A. Procaccini, R. Santagati and F. Stefanini  
Math Biosc **214**, 32 (2008)
- *The STARFLAG handbook on collective animal behaviour: 2. Three-dimensional analysis*  
A. Cavagna, I. Giardina, A. Orlandi, G. Parisi, and A. Procaccini  
Anim Behav **76**, 237 (2008)
- *The STARFLAG handbook on collective animal behaviour: 1. Empirical methods*  
A. Cavagna, I. Giardina, A. Orlandi, G. Parisi, A. Procaccini, M. Viale and V. Zdravkovic  
Anim Behav **76**, 217 (2008)
- *Empirical investigation of starling flocks: a benchmark study in collective animal behaviour*  
M. Ballerini, N. Cabibbo, R. Candelier, A. Cavagna, E. Cisbani, I. Giardina, V. Lecomte, A. Orlandi, G. Parisi, A. Procaccini, M. Viale & V. Zdravkovic  
Anim Behav **76**, 201 (2008)
- *Interaction Ruling Animal Collective Behaviour Depends on Topological rather than Metric Distance: Evidence from a Field Study*  
M. Ballerini, N. Cabibbo, R. Candelier, A. Cavagna, E. Cisbani, I. Giardina, V. Lecomte, A. Orlandi, G. Parisi, A. Procaccini, M. Viale & V. Zdravkovic  
Proc. Natl. Acad. Sci. USA **105**, 1232 (2008)
- *Off-equilibrium confined dynamics in a system with level-crossing states*  
B. Capone, T. Castellani, I. Giardina, F. Ricci-Tersenghi  
Phys. Rev. B **74**, 144301 (2006)
- *Coordination, intermittency and trends in generalized Minority Games*  
A. Tedeschi, A. De Martino, I. Giardina  
Physica A **358**, 529 (2005)
- *Spatial correlation functions in three-dimensional Ising spin glasses*  
C. De Dominicis, I. Giardina, E. Marinari, O. Martin and F. Zulliani.  
Phys. Rev. B **72**, 014443 (2005)
- *Cavity Method for Supersymmetry Breaking Spin Glasses*  
A. Cavagna, I. Giardina and G. Parisi  
Phys. Rev. B **71** 024422 (2005)

- *Generalized minority games with adaptive trend-followers and contrarians*  
A. De Martino, I. Giardina, M. Marsili, A. Tedeschi  
Phys. Rev. E **70**, 025104 (2004)
- *Numerical study of metastable states in Ising spin glasses*  
A. Cavagna, I. Giardina and G. Parisi  
Phys. Rev. Lett. **92**, 120603 (2004)
- *Supersymmetric complexity in the Sherrington-Kirkpatrick model*  
A. Annibale, A. Cavagna, I. Giardina, G. Parisi  
Phys. Rev. E **68**, 061103 (2003)
- *The role of the Becchi-Rouet-Stora-Tyutin supersymmetry in the calculation of the complexity for the Sherrington-Kirkpatrick model*  
A. Annibale, A. Cavagna, I. Giardina, G. Parisi, E. Trevigne  
J. Phys. A: Math. Gen. **36**, 10937 (2003)
- *A single saddle model for the  $\beta$ -relaxation in supercooled liquids*  
A. Cavagna, I. Giardina and T. S. Grigera  
J. Phys. A: Math. Gen. **36**, 10721 (2003)
- *Statistical mechanics of the mixed majority-minority game with random external information*  
A. De Martino, I. Giardina and G. Mosetti  
J. Phys. A: Math. Gen. **36**, 8935 (2003)
- *On the formal equivalence of the TAP and thermodynamic methods in the SK model*  
A. Cavagna, I. Giardina, G. Parisi and M. Mezard  
J. Phys. A: Math. Gen. **36**, 1175 (2003)
- *Glass and polycrystal states in a lattice spin model*  
A. Cavagna, I. Giardina and T. S. Grigera  
J. Chem. Phys. **118**, 6974 (2003)
- *Glassy dynamics, metastability limit and crystal growth in a lattice spin model*  
A. Cavagna, I. Giardina and T. S. Grigera  
Europhys. Lett. **61**, 74 (2003)
- *Bubbles, crashes and intermittency in agent based market models*  
I. Giardina and J.P. Bouchaud  
Eur. Phys. J. B **31**, 421 (2003)
- *Geometric approach to the dynamic glass transition*  
T. S. Grigera, A. Cavagna, I. Giardina and G. Parisi  
Phys. Rev. Lett. **88**, 055502 (2002)
- *Relaxational dynamics in a single saddle*  
A. Cavagna, TS Grigera, I. Giardina  
J. Phys. A **36**, 10721 (2002)



- *Role of saddles in mean-field dynamics above the glass transition*  
A. Cavagna, I. Giardina and G. Parisi  
J. Phys. A **34** 5317 (2001)
- *Proliferation assisted transport in a random environment*  
I. Giardina, J.P. Bouchaud, and M. Mezard  
J. Phys. A : Math. Gen. (Lett.) **34**, 245 (2001)
- *On a universal mechanism for long ranged volatility correlations*  
J.P. Bouchaud, I. Giardina and M. Mezard  
Quantitative Finance **2**, 212 (2001)
- *Energy landscape of a Lennard-Jones liquid: Statistics of the stationary points*  
K. Broderix, K.K. Batthacharya, A. Cavagna, A. Zippelius and I. Giardina  
Phys. Rev. Lett. **85**, 5360 (2000)
- Reply to comment on *A thermal model for adaptive competition in a market*  
A. Cavagna, J.P. Garrahan, I. Giardina and D. Sherrington  
Phys. Rev. Lett. **85**, 5009 (2000)
- *Index Distribution of Random Matrices with an Application to Disordered Systems*  
A. Cavagna, J.P. Garrahan and I. Giardina  
Phys. Rev. B **61**, 3960 (2000)
- *A new approach for the analytic computation of the instantaneous normal modes spectrum*  
A. Cavagna, I. Giardina, G. Parisi  
J. Phys: Cond. Mat. **12** (29), 6295 (2000)
- *A thermal model for adaptive competition in a market*  
A. Cavagna, J.P. Garrahan, I. Giardina and D. Sherrington  
Phys. Rev. Lett. **83**, 4429 (1999)
- *Analytic computation of the Instantaneous Normal Modes spectrum in low density liquids*  
A. Cavagna, I. Giardina and G. Parisi  
Phys. Rev. Lett. **83**, 108 (1999)
- *Energy distribution of maxima and minima in a one-dimensional random system*  
A. Cavagna, J.P. Garrahan and I. Giardina,  
Phys. Rev. E **59**, 2808 (1999)
- *Quenched complexity of the mean-field p-spin spherical model with external magnetic field*  
A. Cavagna, J.P. Garrahan and I. Giardina  
J. Phys. A: Math. Gen. **32**, 711 (1999)

- *Stationary points of the Thouless-Anderson-Palmer free energy*  
A. Cavagna, I. Giardina and G. Parisi  
Phys. Rev. B **57**, 11251 (1998)
- *An investigation of the hidden structure of states in a mean-field spin glass model*  
A. Cavagna, I. Giardina and G. Parisi  
J. Phys. A: Math. Gen. **31**, 7021 (1997)
- *Structure of metastable states in spin glasses by means of a three replica potential*  
A. Cavagna, I. Giardina and G. Parisi  
J. Phys. A: Math. Gen. **30**, 4449 (1997)
- *On the existence of equivalent quasideterministic domains*  
I. Giardina and A. Rimini  
Found. Phys. **26**, 973 (1996)

#### **Refereed Conference Publications:**

- *Volatility clustering in agent based market models*  
I. Giardina and JP Bouchaud  
Physica A **324**, 6-16 (2003)
- *Microscopic Models for long ranged volatility correlations*  
I. Giardina, J.P. Bouchaud and M. Mezard  
Physica A **299**, 28 (2001)
- *Saddles on the potential energy landscape of a Lennard-Jones Liquid*  
Broderix K; Bhattacharya KK; Cavagna A; Zippelius A, Giardina I
- *Proliferation assisted barrier crossing and population dynamics*  
I. Giardina I, JP Bouchaud and M. Mezard  
AIP CONFERENCE PROCEEDINGS **553**, 35-40 (2001)
- *Exploring the configuration space of glassy models*  
Barrat A; Cavagna A; Franz S; Giardina I and G. Parisi  
Journal de Physique IV **8**, 69-73 (1998)

#### **Submitted papers:**

- *Entropic forces in a non-equilibrium system: Flocks of birds*  
M. Castellana, W. Bialek, A. Cavagna, I. Giardina  
arXiv preprint arXiv:1412.8654 (2014)
- *Emergence of collective changes in travel direction of starling flocks from individual birds fluctuations*

A. Attanasi, A. Cavagna, L. Del Castello, I. Giardina, A. Jelic, S. Melillo, L. Parisi, O. Pohl, E. Shen, M. Viale  
arXiv preprint arXiv:1410.3330 (2014)

- *Silent Flocks*  
A. Cavagna, I. Giardina, TS. Grigera, A. Jelic, D. Levine, S. Ramaswamy, M. Viale  
arXiv preprint arXiv:1410.2868 (2014)
- *Short-range interaction vs long-range correlation in bird flocks*  
A. Cavagna, L. Del Castello, S. Dey, I. Giardina, S. Melillo, L. Parisi, M. Viale  
arXiv preprint arXiv:1407.6887 (2014)
- *Tracking in three dimensions via multi-path branching*  
A. Attanasi, A. Cavagna, L. Del Castello, I. Giardina, A. Jelic, S. Melillo, L. Parisi, E. Shen, E. Silvestri, M. Viale  
arXiv:1305.1495

**Unpublished material:**

- *Meccanica Quantistica, formulazione delle storie e teoria della misurazione*  
I. Giardina  
Laurea Thesis, Universita' degli Studi di Pavia (1994).
- *Structure of metastable states in Spin Glasses by means of the three-replica potential*  
I. Giardina  
PhD Thesis, Universita' di Roma La Sapienza (1997).  
[http://chimera.roma1.infn.it/index\\\_papers\\\_complex.html](http://chimera.roma1.infn.it/index\_papers\_complex.html)

# GUIDO MONTAGNA

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Dipartimento di Fisica  
University of Pavia  
Via A. Bassi 6  
27100 Pavia, Italy

Tel.: +39 0382 987742  
e-mail: guido.montagna@pv.infn.it / guido.montagna@unipv.it

Born in Voghera (Pavia), Italy, 22/01/1964

## PRESENT POSITION

**Associate Professor of Theoretical Physics (since July 2005)**  
**SSD FIS/02: Fisica teorica, modelli e metodi matematici**  
University of Pavia, Italy

## TEACHING

Bachelor in Physics: **Introduction to Modern Physics**  
M. Sc. in Physical Sciences: **Econophysics** (till the present Academic Year)  
Ph.D. in Physics: partial teaching for the course **Electroweak and QCD Field Theories**

## RESEARCH INTERESTS

Theory of fundamental interactions, phenomenology of elementary particles, collider physics, Monte Carlo tools vs. experimental data. Since 2000: interdisciplinary statistical physics, econophysics, physics of complex systems.

## EDUCATION

**INFN**, Pavia Unit, Italy (after national competition)  
*Post-doctoral fellowship in Theoretical Physics* **April 1994 - June 1995**

**University of Pavia**, Pavia, Italy  
*Ph.D. in Theoretical Physics* **Nov. 1990 - Oct. 1993**

- Thesis: *Realistic formulation of  $e^+e^-$  processes around the  $Z^0$  peak and precision physics at LEP*
- Advisor: Oreste Nicosini, INFN, Pavia Unit

**INFN**, Pavia Unit, Pavia, Italy (after national competition)  
*Graduate fellowship in Theoretical Nuclear and Subnuclear Physics* **Jan. 1990 - Oct. 1990**

**University of Pavia**, Pavia, Italy  
*Degree in Physics* **Nov. 1983 - July 1989**

- Thesis: *QED radiative corrections and forward-backward asymmetry at LEP/SLC*
- Advisors: Oreste Nicosini, INFN, Pavia Unit, Luca Trentadue, University of Parma and Francesco Miglietta, University of Pavia. Final grade: 110/110 with honors.
- First two publications (1989): a Phys. Lett. B and a contribution to the CERN Report *Z Physics at LEP 1*

## PROFESSIONAL EXPERIENCE

**National qualification to full professor**, Italy **2014**  
*A2/02: Theoretical physics of fundamental interactions*

**University of Pavia**, Pavia, Italy  
*Associate Professor of Theoretical Physics* **July 2005 - present**  
Present courses:

- Introduction to Modern Physics, Bachelor in Physics
- Econophysics, M. Sc. in Physical Sciences

Previously, in place of Introduction to Modern Physics: Phenomenology of Elementary Particles, M. Sc. in Physical Sciences (till 2011).

Courses in the next Academic Year:

- Introduction to Modern Physics, Bachelor in Physics
- Theories of Fundamental Interactions, M. Sc. in Physical Sciences

**University of Pavia**, Pavia, Italy  
*Assistant Professor (Ricercatore) of Nuclear and Subnuclear Physics* **July 1995 - June 2005**

Teaching assistant for the undergraduate course Quantum Mechanics, Bachelor in Physics. Lecturer of courses on Quantum Electrodynamics and Standard Model Physics for the Ph.D.

**Istituto Universitario di Studi Superiori (IUSS)**, Pavia, Italy

*Lecturer and Teaching Coordinator*

**2004 – 2008**

Teaching coordinator and lecturer for the course Dynamics of Complex Systems, International Master in Methods for Management of Complex Systems, Istituto Universitario di Studi Superiori, Pavia.

**INFN**, Pavia Unit, Italy

*Research Associate in Theoretical Physics (Incarico di Ricerca)*

**July 1995 – present**

RESPONSABILITIES	Member of the board of the Ph.D. program in Physics, University of Pavia	<b>2014 – present</b>
	Member of the Italian editorial board of the Springer series of Physics textbooks for undergraduate students	<b>2005 – present</b>
	Member of the scientific board of the undergraduate courses program of Istituto Universitario di Studi Superiori, Pavia	<b>2006 – 2013</b>
	Co-founder (with V.G. Goggi and O. Nicosini) of the International Master in Methods for Management of Complex Systems, Istituto Universitario di Studi Superiori, Pavia	<b>2004 – 2008</b>
	Member of the scientific committee of the International Master in Methods for Management of Complex Systems, Istituto Universitario di Studi Superiori, Pavia	<b>2004 – 2008</b>
	Coordinator for the INFN Pavia unit of Iniziativa Specifica PR21 – Quantum Field of Fundamental Interactions	<b>1999 – 2005</b>
RESEARCH GRANTS	<b>Commissione IV INFN</b> Iniziativa Specifica “QFT@Colliders”. Member	<b>Jan. 2014 – Present</b>
	<b>PRIN 2010YJ2NYW</b> “Symmetries, masses and mysteries: electroweak symmetry breaking, flavor mixing and CP violation, and dark matter in the LHC era”. Coordinator of the Pavia unit	<b>Feb. 2013 – Feb. 2016</b>
	<b>European contract PITN-GA-2010-264564</b> “LHCPhenoNet, Advanced Particle Phenomenology in the LHC Era”, 7th framework programme of the European Commission. Member	<b>Jan. 2011 – Dec. 2015</b>
	<b>INTAS project 05-1000008-8328</b> “Higher-order effects in $e^+e^-$ annihilation and muon anomalous magnetic moment”. Member	<b>Jan. 2008 – Dec. 2010</b>
CONFERENCE & WORKSHOP ORGANIZATION	Organizer of the workshop “Prospects and precision at the LHC at 14 TeV”, Galileo Galilei Institute for Theoretical Physics, Firenze (with D. de Florian, S. Moch and F. Piccinini)	<b>1/9/2014 – 24/10/2014</b>
	Member of the local organizing committee of the conference “High Precision for Hard Processes (HP2)”, Firenze, 3–5 September 2014	
	Co-organizer of the “First joint experimental and theoretical meeting on the $W$ mass measurement at the LHC”, Firenze, 20–21 October 2014	
	Member of the International Advisory Committee of the International Symposium “Lepton and Hadron Physics at Meson Factories”, Messina, 13–15 October 2013	
	Member of the scientific committee of the 2006 INFN workshop on “Monte Carlo’s, physics and simulations at the LHC”, LNF, Frascati	
	Co-organizer (with O. Nicosini and V. Vercesi) of “IFAE 2006, Italian Meeting of High Energy Physics”, Pavia, 19–21 April 2006	
	Member of the organizing committee of “Frontier Science 2003 – A nonlinear world: the real world”, Pavia, 8–12 September 2003	
WORKING GROUP COORDINATION	Theory convener of the section Electroweak Physics, workshop SM@LHC2015, Firenze, 21-24 April 2015	
	Theory convener of the section Luminosity of the working group on “Radiative corrections and Monte Carlo generators for low energies”, LNF, Frascati	<b>2006 – present</b>
	Theory convener of the working group Electroweak Physics, Italian meeting of High Energy Physics, Parma, April 2002	
	Theory convener of the working group Higgs Physics at LEP, Italian meeting on Physics at LEP, Napoli, April 1998	

REFeree ACTIVITY	<p>Nuclear Physics B, Physics Letters B, Computer Physics Communications, Physica A: Statistical Mechanics and its Applications, Journal of Statistical Mechanics: Theory and Experiment, Quantitative Finance, Journal of Theoretical and Applied Finance</p> <p>Research proposals submitted to the National Science Foundation, USA, the Polish Academy of Science, and the Italian Ministry of University and Research.</p> <p>Ph.D. thesis discussed at the University of Milano and at the University of Milano Bicocca.</p>
SELECTED TALKS	<p>“Electroweak theoretical uncertainties on <math>M_W</math>” <i>2<sup>nd</sup> topical meeting on W mass measurement at LHC</i>, 23–24 February 2015, CERN</p> <p>“W/Z production at the LHC: state of the art of radiative corrections” <i>SM@LHC 2013</i>, 9–12 April 2013, Freiburg, Germany <b>(invited)</b></p> <p>“NNLO massive corrections to Bhabha scattering and theoretical precision of BABAYAGA@NLO” <i>International Conference <math>e^+e^-</math> collisions from <math>\phi</math> to <math>\psi</math></i>, September 19–22 2011, Novosibirsk, Russia</p> <p>“Probing dark forces at GeV-scale colliders” <i>XXXV International Conference of Theoretical Physics Matter to the deepest</i>, 12–18 September 2011, Ustron, Poland <b>(invited)</b></p> <p>“Status and accuracy of the Monte Carlo generators for luminosity measurements” <i>International Conference <math>e^+e^-</math> collisions from <math>\phi</math> to <math>\psi</math></i>, 13–16 October 2009, Beijing, China <b>(invited)</b></p> <p>“Mini-review of Monte Carlo programs for Bhabha scattering” <i>9th Workshop on Elementary Particle Theory: Loops and Legs in Quantum Field Theory</i>, 20–25 April 2008, Sondershausen, Germany <b>(invited)</b></p> <p>“Review of precision calculations for the measurement of electroweak gauge boson production and properties at hadron colliders” <i>The 2007 Europhysics Conference on High Energy Physics</i>, 19–25 July 2007, Manchester, U.K. <b>(invited)</b></p> <p>“Combining electroweak and QCD corrections to weak boson production at hadron colliders” <i>LoopFest VI</i>, 16–18 April 2007, Fermilab, USA</p> <p>“Higher-order QED corrections to W boson mass determination at hadron colliders” <i>International Europhysics Conference on High Energy Physics (HEP 2003)</i>, July 17–23 2003, Aachen, Germany</p> <p>“The quark and the NASDAQ: non-linearity and complexity from particle physics to the real world” <i>Frontier Science 2003</i>, October 17–21 2002, Frascati, Italy <b>(invited)</b></p> <p>“Pricing derivatives by path integral and neural networks” <i>International Econophysics Conference</i>, August 29–31 2002, Bali</p>
POST DOCS (SUPERVISOR)	<p>C.M. Carloni Calame <i>Particle physics phenomenology at the energy and intensity frontiers</i> PRIN project 2010YJ2NYW <b>Nov. 2013 – Nov. 2015</b></p> <p>H. Martinez <i>Precision physics at the LHC: Run II data analysis and Monte Carlo simulations</i> University of Pavia grant “Fondo Giovani” <b>Jan. 2015 – Dec. 2015</b></p> <p>V. Prosperi <i>Standard Model phenomenology at the LHC</i> PRIN2010 and INFN joint financing <b>Dic. 2014 – Mar. 2015</b></p>
PH.D. THESIS (ADVISOR)	<p>V. Prosperi, “Theoretical predictions for <math>W\gamma</math> production in hadronic collisions” University of Pavia, 2014</p> <p>V. Cazzola, “Coupled stochastic processes: analytical characterization and financial applications” University of Pavia, 2011</p> <p>G. Livan, “Spectral properties of products of random matrices: theoretical results and data correlation analysis” University of Pavia, 2011</p>

G. Balossini, "Standard Model precision calculations at lepton and hadron colliders"  
University of Pavia, 2009

E. Cisana, "Non-Gaussian stochastic models and their applications in econophysics"  
University of Pavia, 2008

N. Moreni, "Monte Carlo methods and option pricing"  
University of Paris VI and University of Pavia (co-advisor with B. Lapeyre), 2005

M. Treccani, "Multiple photon corrections to  $W$  and  $Z$  production at hadron colliders"  
University of Pavia, 2004

C.M. Carloni Calame, "Parton Shower approach to QED processes at flavor factories"  
University of Pavia, 2001

SELECTED M.Sc. M. Sorbaro Sindaci, "Dynamics of Kuramoto model on complex networks"  
THESIS (ADVISOR) University of Pavia, Academic Year 2012/2013

L. Parisi, "Money, wealth and income: models of statistical physics"  
University of Pavia, Academic Year 2011/2012

L. Rebecchi, "Random matrix theory with applications to econophysics"  
University of Pavia, Academic Year 2010/2011

E. Cernuschi, "QED structure functions and fermion pair radiation"  
University of Pavia, Academic Year 2009/2010

C. Bignamini, "Monte Carlo simulation of photon pair production in  $e^+e^-$  collisions"  
University of Pavia, Academic Year 2006/2007

L. Fermi, "Stochastic volatility models in econophysics"  
University of Pavia, Academic Year 2006/2007

G. Balossini, "Precision calculation and simulation of the Bhabha process"  
University of Pavia, Academic Year 2004/2005

D. Davio, "Models and simulations of the financial market dynamics"  
University of Pavia, Academic Year 2004/2005

L. Granata, "Precision physics of  $W$  and  $Z$  bosons at hadron colliders"  
University of Pavia, Academic Year 2002/2003

G. Bormetti, "Theory of anomalous diffusion"  
University of Pavia, Academic Year 2001/2002

SELECTED BACHELOR THESIS (ADVISOR) A. Beretta, "From Ising model to financial bubbles"  
University of Pavia, Academic Year 2013/2014

C. Bissolotti, "Dirac fermions and theory of graphene"  
University of Pavia, Academic Year 2013/2014

D. Casati, "Analytical solutions and numerical methods for financial derivatives"  
University of Pavia, Academic Year 2011/2012

M. Cabizza, "Time series analysis and superstatistics"  
University of Pavia, Academic Year 2008/2009

R. Gobetti, "The Aharonov-Bohm effect"  
University of Pavia, Academic Year 2006/2007

L. Foini, "The Berry phase"  
University of Pavia, Academic Year 2006/2007

M. Bertani, "Statistical physics and opinion dynamics"  
University of Pavia, Academic Year 2004/2005

S. Facchini, "Complex networks: models and applications"  
University of Pavia, Academic Year 2003/2004

L. Rossini, "Models and simulations of population dynamics"  
University of Pavia, Academic Year 2003/2004

IUSS THESIS (ADVISOR)	<p>F. Manessi, "Spontaneous symmetry breaking in physics" Academic Year 2010/2011</p> <p>G. Prando, "Power-law distributions in nature and society" Academic Year 2008/2009</p>
DISSEMINATION	<p>"La caccia alla particella di Higgs" <i>Almo Collegio Borromeo</i>, Pavia, 12 November 2013 In <i>Saggi dei Quaderni Borromaici</i> (with O. Nicrosini and F. Piccinini), Vol. 1 (2014) 89</p> <p>"Dalla fisica alla finanza: l'econofisica e i suoi temi di ricerca" <i>Dipartimento di Matematica e Fisica, Università del Sacro Cuore</i>, Brescia, 27 March 2006 &amp; <i>Dipartimento di Economia Politica e Metodi Quantitativi, Università di Pavia</i>, 28 September 2005</p> <p>"Una nuova frontiera della fisica teorica: l'econofisica" <i>Istituto Lombardo, Accademia di Scienze e Lettere</i>, Milano, 9 June 2005 In <i>Rendiconti dell'Istituto Lombardo, Accademia di Scienze e Lettere</i>, Vol. 139 (2005) 175-188</p> <p>"Una nuova offerta formativa: il Master in complessità e sue applicazioni interdisciplinari a Pavia" <i>Fisici in Finanza: professione, ricerca e formazione</i>, Politecnico di Milano, 11 July 2003</p>
OTHER INFORMATION	<p>Member of the examination board for the University grant (Fondo giovani) "Precision physics at the LHC: Run II data analysis and Monte Carlo simulations", University of Pavia <b>Dec. 2014</b></p> <p>Member of the examination board for the admission to the Ph.D. in Physics, XXIX ciclo, University of Pavia <b>Oct. 2013</b></p> <p>Member of the examination board for the University grant (PRIN2010) "Particle physics phenomenology at the energy and intensity frontiers", University of Pavia <b>Sep. 2013</b></p> <p>Member of the examination board for the evaluation of the Ph.D. in Physics, XXIII ciclo, University of Genova <b>Jun. 2011</b></p> <p>Member of the examination board for the evaluation of the Ph.D. in Physics, XXIII ciclo, University of Milano <b>Jan. 2011</b></p> <p>Member of the examination board for the evaluation of the Ph.D. in Physics, XXIII ciclo, University of Pavia <b>Dec. 2010</b></p> <p>Member of the examination board for the evaluation of the Ph.D. in Physics, XX ciclo, University of Milano Bicocca <b>Mar. 2008</b></p> <p>Member of the examination board for the evaluation of the Ph.D. in Physics, XIX ciclo, University of Cagliari <b>Feb. 2007</b></p> <p>Member of the examination board for the evaluation of the Ph.D. in Physics, XVII ciclo, University of Pavia <b>Feb. 2005</b></p> <p>Member of the examination board for the evaluation of the Ph.D. in Physics, University of Paris VI Pierre et Marie Curie <b>Dec. 2004</b></p>

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**Physics at the energy frontier (LHC and Tevatron)**

2003 – present

- *Precision calculation and simulation of Higgs boson decay into four leptons.*
- *Study of the theoretical contributions and uncertainties in the precision measurement of the  $W$  boson mass at the Tevatron and LHC.*
- *Calculation of large electroweak corrections (Sudakov logarithms) to background processes in new physics searches.*
- *Combination of QCD corrections to Parton Showers for  $W/Z + \gamma$  production processes.*
- *Implementation of electroweak corrections in the POWHEG generator. Matching of next-to-leading order (NLO) QCD and electroweak corrections to QCD/QED Parton Shower algorithms.*
- *Calculation of the NLO electroweak and higher-order QED corrections to single  $W/Z$  production processes. **Used and cited by CDF and Tevatron Electroweak Working Group in the precise measurement of the mass of the  $W$  boson at the Tevatron. Used and cited by ATLAS, CMS and LHCb in the measurement of weak boson production and related studies at the LHC.***

**Physics at the intensity frontier (flavor factories)**

1999 – present

- *Development of the Parton Shower approach in QED, in combination with next-to-leading order and next-to-next-to-leading order corrections.*
- *Calculation and simulation of the large-angle Bhabha and QED processes for precision luminosity monitoring. **Used and cited by all experimental collaborations at meson factories for the theory component of the machine luminosity measurement.***
- *Study of the sensitivity of QED radiative processes to new physics (dark photon) searches.*

**Physics at LEP 2 and TeV-scale  $e^+e^-$  colliders**

1995 – 2000 / present

- *Study of the sensitivity of a future circular  $e^+e^-$  accelerator (TLEP) for precision studies of  $Z/W$  bosons, top and Higgs physics, after the discovery of the Higgs boson at the LHC.*
- *Study and simulation of missing energy and multi-photon production process. **Used and cited by all four LEP collaborations in the searches for new physics at LEP 2.***
- *Calculation and simulation of four and six fermion production processes for  $W$  and top physics, as well as for studies of the Higgs sector.*
- *Computation and simulation of multiparticle production processes in association with photons as tools for the measurement of anomalous gauge couplings. **Used and cited by L3 and OPAL collaborations, as well as by the the LEP Electroweak Working Group, for limits on anomalous quartic gauge couplings. Results also quoted by the Particle Data Group.***
- *Calculation of specific new physics processes, like neutralino + photon production and production of a new  $Z'$  boson.*

**Precision physics at the  $Z$  peak**

1989 – 1999

- *Calculation and coding in a fitting program of weak, QED and QCD higher-order corrections to two fermion production processes in  $e^+e^-$  annihilation. **Used and cited by LEP collaborations and LEP Electroweak Working Group in electroweak precision measurements and tests of the Standard Model.***
- *Indirect determination of the top quark and Higgs boson mass from electroweak precision data. **Results quoted by the Particle Data Group.***
- *High-precision calculation of the small-angle Bhabha scattering cross section and contribution to the estimate of the theoretical error to the LEP luminosity measurement. **Estimate of the theoretical uncertainty cited by the LEP Electroweak Working Group in the per mille luminosity measurement at LEP.***
- *Development and applications of the QED Structure Function approach.*

**Econophysics**

2000 – 2010

Partial research work in interdisciplinary statistical physics applied to the analysis and modeling of financial market dynamics.

- *Analytical and numerical characterization of stochastic volatility models, with comparison to financial data.*
- *Development of efficient methods for option pricing and risk measures.*

**HORACE:** Electroweak Monte Carlo program for the simulation of single  $W$  and  $Z$  production at hadron colliders. **Used at the Tevatron and the LHC**

**BabaYaga/BabaYaga@NLO:** QED Parton Shower generator for the simulation of Bhabha scattering and QED processes at GeV-scale electron-positron colliders. **Used at all flavor factories**

**NUNUGPV:** Electroweak Monte Carlo generator for the simulation of single photon and multiphoton events with missing energy in  $e^+e^-$  collisions. **Used at LEP 2**

**SABSPV:** Monte Carlo code for the precision calculation of the small-angle Bhabha scattering cross section at high energies. **Used at LEP 1 and LEP 2**

**TOPAZ0:** Electroweak + QCD fitting program for the indirect determination of the Standard Model parameters (Higgs and top mass) from electroweak precision data. **Used at LEP 1 and LEP 2**

COLLABORATION  
WITH EXP.  
GROUPS

**ATLAS, CMS and LHCb at the LHC** for the measurement of  $W/Z$  hadroproduction cross section

**CDF and D0 at the Tevatron** for the precision measurement of the  $W$  boson mass

**KLOE, BES III, CLEO, BaBar and Belle** for luminosity monitoring at meson factories

**ALEPH, DELPHI, L3 and OPAL at LEP** for the measurement of single photon and multiphoton events with missing energy in  $e^+e^-$  collisions above the  $Z$  peak

**OPAL and the LEP Electroweak Working Group** for the precision calculation of the luminosity cross section at LEP

**ALEPH, DELPHI, L3 and OPAL and the LEP Electroweak Working Group** for electroweak measurements and constraints on the Standard Model parameters at the  $Z$  resonance, in particular mass of the Higgs particle and of the top quark.

WORKING GROUP  
PARTICIPATION

Physics at TeV colliders / Standard Model Working Group

**Les Houches, 2013**

Community Summer Study 2013

**Snowmass, 2013**

Electroweak precision measurements at the LHC

**CERN, 2011 – present**

Radiative corrections and Monte Carlo generators for low energies

**LNF Frascati, 2006 – present**

Physics at TeV colliders / Standard Model Handles and Candles Working Group

**Les Houches 2007**

TeV4LHC / Top and Electroweak Working Group

**Fermilab 2005 – 2006**

Physics at TeV colliders / Standard Model and Higgs Working Group

**Les Houches 2005**

ECFA/DESY Linear Collider Physics

**DESY 1999 – 2000**

Physics at LEP 2

**CERN 1996**

Precision calculations for the  $Z$  resonance

**CERN 1995**

Physics at HERA

**DESY 1990 – 1991**

$Z$  Physics at LEP 1

**CERN 1989**

SUMMARY OF  
RESEARCH PAPERS

Total number of papers: **148 = 134 of Particle Physics + 14 of Econophysics**

Total number of papers in **peer reviewed journals: 78 = 73 of Particle Physics + 5 of Econophysics**

CITATION  
SUMMARY  
(13/05/2015)

Source: Inspire <http://inspirehep.net/>

- *Total number of citations: 4,408*
- *h-index: 33 (Citeable papers) / 26 (Published papers)*

Source: Google Scholar <http://scholar.google.com/>

- *Total number of citations: 4,467*
- *h-index: 38*

Source: ISI Web of knowledge

- *Total number of citations: 1,483*
- *h-index: 21*

Source: SCOPUS

- *Total number of citations: 1,399*
- *h-index: 20*

- SELECTED PUBLICATIONS (CITATIONS FROM INSPIRE)
- S. Forte, A. Nisati, G. Passarino, R. Tenchini, ... , G. Montagna *et al.*  
 “The Standard Model from the LHC to future colliders: a contribution to the Workshop What Next of INFN”  
 arXiv:1505.01279
- S. Boselli, C.M. Carloni Calame, G. Montagna, O. Nicosini and Fulvio Piccinini  
 “Higgs boson decay into four leptons at NLOPS electroweak accuracy”  
 arXiv:1503.07394 , to appear in JHEP.
- M. Bicer, ... , G. Montagna *et al.* [TLEP Design Study Working Group Collaboration]  
 “First Look at the Physics Case of TLEP”  
 JHEP **1401** (2014) 164 (cited 100+)
- L. Barzè, M. Chiesa, G. Montagna, M. Moretti, O. Nicosini, F. Piccinini and F. Tramontano  
 “Electroweak Sudakov corrections to new physics searches at the LHC”  
 Phys. Rev. Lett. **111**, 12 (2013) 121801.
- S. Actis, ... , G. Montagna *et al.*, Report of Working Group on Radiative Corrections and Monte Carlo Generators for Low Energies  
 “Quest for precision in hadronic cross sections at low energy: Monte Carlo tools vs. experimental data”  
 Eur. Phys. J. C **66** (2010) 585-686 (cited 100+)
- G. Bormetti, V. Cazzola, G. Livan, G. Montagna and O. Nicosini  
 “A Generalized Fourier Transform Approach to Risk Measures”  
 J. Stat. Mech. **P01005** (2010)
- G. Bormetti, V. Cazzola, G. Montagna and O. Nicosini  
 “Probability distribution of returns in the exponential Ornstein-Uhlenbeck model”  
 J. Stat. Mech. **P11013** (2008)
- C.M. Carloni Calame, G. Montagna, O. Nicosini and A. Vicini  
 “Precision electroweak calculation of the production of a high transverse-momentum lepton pair at hadron colliders”  
 JHEP **0710** (2007) 109 (cited 100+)
- C.M. Carloni Calame, G. Montagna, O. Nicosini and M. Treccani  
 “Higher order QED corrections to  $W$  boson mass determination at hadron colliders”  
 Phys. Rev. D **69** (2004) 037301 (cited 50+)
- G. Montagna, N. Moreni and O. Nicosini  
 “A path integral way to option pricing”  
 Physica A: Statistical Mechanics and its Applications, **310** (2002) 450-466
- C.M. Carloni Calame, C. Lunardini, G. Montagna, O. Nicosini and F. Piccinini  
 “Large angle Bhabha scattering and luminosity at flavor factories”  
 Nucl. Phys. B **584** (2000) 459-479 (cited 100+)
- “TOPAZ0 4.0: A new version of a computer program for evaluation of deconvoluted and realistic observables at LEP-1 and LEP-2”  
 G. Montagna, O. Nicosini, G. Passarino and F. Piccinini  
 Comput. Phys. Commun. **117** (1999) 278-289 (cited 100+)
- G. Montagna, M. Moretti, O. Nicosini and F. Piccinini  
 “Single photon and multiphoton final states with missing energies at  $e^+e^-$  colliders”  
 Nucl. Phys. B **541** (1999) 31-49 (cited 50+)
- G. Montagna, O. Nicosini, G. Passarino, F. Piccinini and R. Pittau  
 “TOPAZ0: A program for computing observables and for fitting cross-sections and forward-backward asymmetries around the  $Z^0$  peak”,  
 Comput. Phys. Commun. **76** (1993) 328-360 (cited 100+)
- G. Montagna, O. Nicosini, G. Passarino, F. Piccinini and R. Pittau  
 “On a semi-analytical and realistic approach to  $e^+e^-$  annihilation into fermion pairs and to Bhabha scattering within the minimal Standard Model at LEP energies”,  
 Nucl. Phys. B **401** (1993) 3-66 (cited 100+)