CURRICULUM VITÆ of Angelo Vulpiani

Degree in Physics	Cum Laude, Nov. 1977 (Roma "Sapienza")

Main research interests

Keywords	Chaos and Complexity in Dynamical Systems; Disordered Systems; Non-equilibrium Statistical Mechanics; Fully Developed Turbulence; Transport and Reaction/Diffusion.

Professional experience

2000 – present	Full Professor of Theoretical Physics (Univ. Roma "Sapienza")
1991 – 2000	Associate Professor of Mathematical Methods for Physics (Univ. Roma "Sapienza")
1988 – 1991	Associate Professor of Theoretical Physics (Univ. dell'Aquila)
1981 – 1988	Assistant Professor (Univ. Roma "Sapienza")
1978 – 1981	Fellowship (CNR, Roma)

Honours

2008	Outstanding Referee of the American Physical Society (APS)
2004	Elected Fellow of The Institute of Physics (IOP)
Nov. 2016- Oct. 2019	Professor at *Centro Interdisciplinare "B. Segre", Accademia dei Lincei*

National and International membership

INFN (Italian National Institute of Nuclear Physics)

IOP (Institute of Physics)

ISC (Istituto dei Sistemi Complessi, CNR)

Publications and Bibliometric information

author	**9** books, about **260** papers published on peer review international journals (among which **4** long review, of which **3** on Physics Reports, **19** Physical Review Letters) about **40** contributions to conference proceedings and about **40** articles of scientific popularization (including entries of enciclopedias)
editor	**10** book proceedings
h-index	**54** (Google Scholar, Dec. 2016)
total citations	**16543** (Google Scholar)

5 most cited papers	**3024**, **1151**, **1076**, **797**, **588** (Google Scholar)

Member of the Editorial/Advisory Board

Journal of Statistical Mechanics: Theory and Experiments
Journal of Physics A: Mathematical and Theoretical
Mathematics and Mechanics of Complex Systems

Reviewer for: Physical Review Letters, Europhysics Letters, Physical Review E, Chaos, European Physics Journal B, Journal of Physics A, Journal of Statistical Mechanics, Physics of Fluids, Physica D and Physica A.

Main services to the community and science managements

2011– 2013	Coordinator of the Theoretical Group, Dept. of Physics Univ. La Sapienza, Roma
2006– 2012	Member of the Doctoral Study Committee, Dept. of Physics Univ. La Sapienza, Roma
2005– present	Member of the Committe of the Master on Scientific Computation, Univ. La Sapienza, Roma
2005– 2006	Member of the Evalution Panel CSIC (Consejo Superior de Investigaciones Cientificas) Spain
2001– 2004	Member of the Advisory Board of the INFM Researh Center SMC (Statistical Mechanics and Complexity), Roma
1989– 2003	Member of the Scientific Committee of Theoretical Section of GNSM and then INFM

Teaching Activity

Graduate and undergraudate courses

2015– present	*Meccanica Statistica del Non Equilibrio* (Non Equilibrium Statistical Mechanics)
2007– present	*Meccanica Statistica* (Statistical Mechanics)
1995– 2015	*Fisica dei Sistemi Dinamici* (Physics of Dynamical Systems)
2001- 2007	*Probabilità e Statistica* (Probability and Statistics)
1991- 1995	*Metodi Matematici della Fisica* (Mathematical Methods for Physics)
1988- 1991	*Fisica Teorica* (Theoretical Physics)
1978- 1987	Assistant Professor to several courses including: *Fisica Generale I e II, Istituzioni di Fisica Teorica, Fisica Teorica, Fisica Molecolare* (General Physics I and II, Institution of Theoretical Physics, Theoretical Physics, Molecular Physics)
Advanced courses	Several Courses for PhD students in Copenhagen, Kobe, Roma La Sapienza, Politecnico di Torino, Roma Tre, L' Aquila and Parma. About **10** summer school courses.
Students	Supervisor/Advisor of about **50** Master Thesis, **11** PhD students and **12** post-doc.
	Seven of my former students have permanent positions as researcher/professor (five in Italy and two in Europe); six of them work in industrial labs, banks, financial companies or press companies; others have Post Doc positions in Europe and USA.

Visiting Scientist

2011	University P. and M. Curie Paris

1999,2007	University of Palma de Mallorca
1996	University of Stockholm
1991, 1993, 1994	NORDITA Copenhagen
1995, 1996, 1999	Niels Bohr Institute Copenhagen
1991	University of California San Diego
1987, 1988	University of Marseille
1984	University of di Bruxelles
1984	CEA Paris
1978	CECAM Paris

Main national and international grants/projects

2009-2010	MIUR- PRIN *Fluttuazioni: dai sistemi macroscopici alle nanoscale* about 214.000 euro (Principal Investigator)
2005-2006	MIUR- PRIN *Dinamica e statistica di sistemi a molti e pochi gradi di libertà* about 55.000 euro (Research Unit Coordinator)
2003-2004	MIUR-PRIN *Sistemi Complessi e Problemi a Molti Corpi* about 900.000 euro (Principal Investigator)
2002-2005	EU Network *Fluid mechanical stirring and mixing* about 145.000 euro (Leader of the National Team)
2001-2002	MIUR-PRIN *Fisica Statistica, Sistemi Caotici e Disordinati e Sistemi a Molti Elettroni* about 140.000 euro (Research Unit Coordinator)
1999-2000	MIUR- PRIN *Turbolenza sviluppata, trasporto e mixing nei fluidi, caos e complessita' in sistemi estesi, meccanica statistica dei mezzi granulari, struttura elettronica, correlazioni elettroniche* about 290.000 euro (Research Unit Coordinator)
1998-2001	EU Network *Intermittency in turbulent systems* about 160.000 euro (Leader of the National Team)
1997-2000	INFM- PRA (Progetto Ricerca Avanzata) *Turbulence* about 250.000 euro (Principal Investigator)

Conferences/Workshops

Talks	About **160 invited talks** at International Conferences, Workshops or School and about **160 seminars** in Australia, Austria, Belgium, China, Denmark, Finland, France, Germany, Greece, Italy, Japan, Netherlands, Norway, Poland, Portugal, Russia, Spain, Sweden, Switzerland, U.K. and U.S.A.
Organization	Organizer of about **25** Conferences, Workshops or International Schools

The most recent Conferences

2010	*Anomalous Transport: from Billiards to Nanosystems* Sperlonga, Sept. 20-24, 2010;
2012	*Concetti e Tecniche della Probabilità in Fisica, Biologia e Scienze Sociali* Urbino, 3-5 Settembre 2012;
2012	*Si può prevedere il futuro? Ruolo e limiti della scienza* Roma, Museo MAXXI, 10 Dicembre 2012;
2013	*Large deviations and rare events in physics and biology (6-th Paladin Memorial)* Rome, Sept. 23-25, 2013;
2015	*Statistical Mechanics of Non-Hamiltonian Systems* Rome, May 12-13, 2015;
2015	*Non standard transport* L' Aquila, July 15-17, 2015.

Main scientific achievements

Stochastic resonance The concept of stochastic resonance has been introduced about 40 years ago, see ref [1], in the context of the evolution of the earth's climate. Stochastic resonance is a counterintuitive nonlinear mechanism present in systems periodically forced and embedded in a noisy environment: when the noise intensity is in a proper range (neither too large nor too small) the system acquires an enhanced sensitivity towards small external time-dependent forcings. Such a phenomenon highlights the possibility that noise may actually play a constructive role in large classes of both natural and artificially designed systems. In the last 30 years the ideas underlying stochastic resonance were taken up, elaborated and applied in a wide range of problems in physical and biological sciences.

Multifractal inturbulence and chaos In the usual approach to critical phenomena, as well as in turbulence (Kolmogorov theory), the scaling properties are described in terms of few scaling exponents. The multifractal approach, see ref.s [2,4], introduces a generalization of the usual fractal objects (characterized by a unique scaling exponent) in terms of a superposition of fractals with singularity exponent h and dimension $D(h)$. Via the function $D(h)$ it is possible to give an accurate description of many statistical aspects of turbulence [2,4,6]. The multifractal approach is closely linked to the large deviations formalism and it has been successfully used in many different topics as disordered systems, chaotic dynamics and time series analysis[4,20,22].

Chaos in Hamiltonian systems Starting from the celebrated paper by Fermi, Pasta and Ulam the actual relevance of the dynamics (in particular the role of chaos) for the statistical mechanics is still an open problem. I worked on the problem of the presence of an equipartition threshold in nonlinear large Hamiltonian systems, the thermodynamics limit of the Lyapunov exponents and the role of chaotic behavior for the validity of the equilibrium statistical mechanics [3,23,24].

Diffusion, transport and reaction diffusion Traditionally an efficient diffusion in fluids is associated to the presence of turbulence. On the other hand it is possible to have an efficient transport, due to the lagrangian chaos, even in absence of eulerian turbulence. I worked on different aspects of transport, in particular
a) Lagrangian chaos in presence and absence of eulerian turbulence[24]
b) Computation of the diffusion coefficients
c) Anomalous diffusion[10, 24]
d) Preasymptotic properties of diffusive processes [8,24]
e) Reactive front properties in laminar and turbulent field, and on inhomogenous media (e.g. graphs) [13,18]

Complexity in chaotic and disordered systems In many physical contexts it is necessary to generalize the Lyapunov exponents as well as the Kolmogorv-Sinai entropy[7,14]. The finite size Lyapunov exponents and the ϵ entropy are able to characterize the finite-resolution effects on predictability and complexity. Such quantities are powerful tools for the analysis of high dimensional systems (e.g. turbulence) and the transport in fluids and geophysics [8,12,14].

Non equilibrium systems and the fluctuation-dissipation relations The statistical mechanics has been developed for Hamiltonian systems in equilibrium conditions; there are (relatively) few general results for the non equilibrium case in particular for non Hamiltonian systems. Using an approach based on a suitable generalization of the Boltzmann equation I studied granular gases which are important examples of non Hamiltonian systems in non equilibrium (since the dissipative collisions it is necessary to introduce an external feeding mechanism)[9,20]. In particular the possibility to have an H theorem has been investigated[19].
The fluctuation-dissipation relation (FDR) in its original form has been proved for equilibrium systems, therefore in the literature there has been a certain confusion on the range of validity of the FDR[16]. It has been proved, under very general conditions, the existence of a suitable FDR even for non equilibrium systems. In particular I studied several aspects of the entropy production (Cohen-Gallavotti relation) in Markovian processes

and granular gases[17].

List of Selected Publications

Articles

[1] R. Benzi, A. Sutera and A. Vulpiani *The mechanism of stochastic resonance*, Journal of Physics A **14**, L453 (1981)

[2] R. Benzi, G. Paladin, G. Parisi and A. Vulpiani, *On the multifractal nature of fully developed turbulence and chaotic systems* Journal of Physics A **17**, 3521 (1984)

[3] R.Livi, M.Pettini, S.Ruffo, M.Sparpaglione and A. Vulpiani, *Equipartition threshold in nonlinear large hamiltonian systems: the Fermi-Pasta-Ulam model* Physical Review A **31**, 1039 (1985)

[4] G. Paladin and Vulpiani *Anomalous Scaling Laws in Multifractals objects* Physics Reports **156**, 147 (1987)

[5] M.H. Jensen, G. Paladin and A. Vulpiani *Intermittency in a cascade model for three dimensional turbulence* Physical Review A **43**, 798 (1991)

[6] R. Benzi, L. Biferale, G. Paladin, A. Vulpiani and M. Vergassola *Multifractality in the statistics of velocity gradients in turbulence* Physical Review Letters **67**, 2299 (1991)

[7] E. Aurell, G. Boffetta, A. Crisanti, G. Paladin and A. Vulpiani, *Growth of non-infinitesimal perturbations in turbulence* Physical Review Letters **77**, 1262 (1996)

[8] V. Artale, G. Boffetta, A. Celani, M. Cencini and A. Vulpiani, *Dispersion of passive tracers in closed basin: Beyond the diffusion coeffecient* Physics of Fluids, A **9**, 3162 (1997)

[9] A. Puglisi, V. Loreto, U. Marini Bettolo Marconi, A. Petri and A. Vulpiani, *Clustering and Non-Gaussian Behavior in Granular Matter* Physical Review Letters **81**, 3848 (1998)

[10] P. Castiglione, A. Mazzino, P. Muratore-Ginanneschi and A. Vulpiani, *On strong anomalous diffusion* Physica D **134**, 75 (1999)

[11] G. Boffetta, V. Carbone, P. Giuliani, P. Veltri and A.Vulpiani *Power Laws in Solar Flares: Self-Organized Criticality or Turbulence?* Physical Review Letters **83**, 4662 (1999)

[12] M. Cencini, M. Falcioni, E. Olbrich, H. Kantz and A. Vulpiani *Chaos or Noise - Difficulties of a distinction* Physical Review E **62**, 427 (2000).

[13] M. Abel. A. Celani, D. Vergni and A. Vulpiani *Front propagation in laminar flows* Physical Review E **64**, 046307 (2001)

[14] G. Boffetta, M. Cencini, M. Falcioni and A. Vulpiani *Predictability: a way to characterize Complexity* Physics Reports **356**, 367 (2002)

[15] R.Burioni, F. Cecconi, D.Cassi, and A. Vulpiani, *Topological thermal instability and length of proteins* Proteins **55**, 529 (2004)

[16] U. Marini Bettolo Marconi, A. Puglisi, L. Rondoni and A. Vulpiani *Fluctuation-Dissipation: Response Theory in Statistical Physics* Physics Reports **461**, 111 (2008)

[17] A. Puglisi, S. Pigolotti, L. Rondoni and A. Vulpiani *Entropy production and coarse graining in Markov processes* J. Stat. Mech. P05015 (2009)

[18] R. Burioni, S. Chibbaro, D. Vergni and A. Vulpiani *Reaction spreading on graphs* Physical Review E **86**, 055101 (2012)

[19] U. Marini Bettolo Marconi, A. Puglisi and A. Vulpiani *About an H-theorem for systems with non-conservative interactions* J. Stat. Mech. P08003 (2013)

[20] A. Gnoli, A. Puglisi, A. Sarracino and A. Vulpiani *Nonequilibrium Brownian Motion beyond the Effective Temperature* PLOS ONE **9**, e93720 (2014)

Books

[21] A. Crisanti, G. Paladin and A. Vulpiani *Products of Random Matrices in Statistical Physics* (Springer-Verlag, Berlin 1993, Paperback Ed. 2012)

[22] A. Vulpiani *Determinismo e Caos* (Nuova Italia Scientifica, Roma 1994, Carocci, Roma 2004)

[23] T. Bohr, M.H. Jensen, G. Paladin and A. Vulpiani *Dynamical Systems Approach to Turbulence* Cambridge University Press, 1998, Paperback Ed. 2005)

[24] P. Castiglione, M. Falcioni, A. Lesne and A. Vulpiani *Chaos and Coarse Graining in Statistical Mechanics* (Cambridge University Press, 2008) [French version *Physique statistique: chaos et approches multiechelles* (Editions Belin, Paris 2008)]

[25] M. Cencini, F. Cecconi and A. Vulpiani *CHAOS: From Simple Models to Complex Systems* (World Scientific, Singapore 2009)

[26] G. Boffetta e A. Vulpiani *Probabilità in Fisica: un'introduzione* (Springer-Verlag Italia, Milano 2012)

[27] S. Chibbaro, L. Rondoni and A. Vulpiani *Reductionism, Emergence and Levels of Reality* (Springer-Verlag, 2014)

[28] M. Falcioni e A. Vulpiani *Meccanica Statistica Elementare: I fondamenti* (Springer-Verlag Italia, Milano 2014)

[29] A. Vulpiani *Caso, Probabilità e Complessità* (Ediesse, Roma 2014)