Giancarlo Rossi - Curriculum Vitae

PERSONAL INFORMATION

Family name, First name: ROSSI GIANCARLO

Nationality: Italian

Date of birth: January 4th, 1943

URL for web site: http://people.roma2.infn.it/~stringhe/members/rossi.htm

- **EDUCATION**

1973 PhD in Theoretical Physics - Dep. of Physics, Univ. of Roma La Sapienza, Italy
1966 Master (Laurea *cum laude*) in Physics - Dep. of Physics, Univ. of Roma La Sapienza, Italy

- **CURRENT POSITIONS**

2013 – today Retired
1991 – today Unpaid Associate Scientist - Sezione di Roma Tor Vergata, INFN, Italy
2013 – today Unpaid Associate Scientist - Centro Fermi, Roma, Italy
2013 – today Honorary Professor - Dep. of Physics, Univ. of Roma Tor Vergata, Italy

- **PREVIOUS POSITIONS**

1991 – 2013 Full Professor - Dep. of Physics, Univ. of Roma Tor Vergata, Italy
1987 – 1991 Full Professor - Dep. of Physics, Univ. of L'Aquila, Italy
1983 – 1987 Associate Professor - Dep. of Physics, Univ. of Roma Tor Vergata, Italy
1975 – 1983 Assistant Professor - Dep. of Physics, Univ. of Roma La Sapienza, Italy
1971 – 1975 Lecturer - Dep. of Physics, Univ. of L'Aquila, Italy

- **POSITIONS IN FOREIGN INSTITUTIONS**

2014 – 2016 Invited Scientist at the NIC DESY Institute, Zeuthen, Germany
2004 – 2005 Invited Scientist at the NIC DESY Institute, Zeuthen, Germany
2003 – 2004 Invited Scientist at the NIC DESY Institute, Zeuthen, Germany
2000 – 2001 Scientific Associate at the CERN TH Division, Geneva, Switzerland
1983 – 1984 Scientific Associate at the CERN TH Division, Geneva, Switzerland
1979 – 1980 Research Associate at CEA, Saclay, France
1978 – 1979 Research Associate at LPTHE, Universitè de Paris XI, Orsay, France
1975 – 1977 Fellow at the CERN TH Division, Geneva, Switzerland

- **SUPERVISION OF GRADUATE STUDENTS AND POSTDOCTORAL FELLOWS**

1984 – 2013 ∞-ly many students from Italian Universities (Roma La Sapienza, Roma Tor Vergata, L'Aquila, Napoli, Milano, Bologna, ...) and EU Universities & Scientific Institutions

- **TEACHING ACTIVITIES**

2018 – 2019 Multi-body theory (Dep. of Physics, Univ. of Roma Tor Vergata, Italy)
2017 – 2018 Multi-body theory (Dep. of Physics, Univ. of Roma Tor Vergata, Italy)
2016 – 2017 Multi-body theory (Dep. of Physics, Univ. of Roma Tor Vergata, Italy)
2015 – 2016 Multi-body theory (Dep. of Physics, Univ. of Roma Tor Vergata, Italy)
2014 – 2015 Multi-body theory (Dep. of Physics, Univ. of Roma Tor Vergata, Italy)
2013 – 2014 Multi-body theory (Dep. of Physics, Univ. of Roma Tor Vergata, Italy)
1991 – 2013 1) Hilbert spaces (Dep. of Physics, Univ. of Roma Tor Vergata, Italy)
2) Multi-body theory (Dep. of Physics, Univ. of Roma Tor Vergata, Italy)
1987 – 1991 1) Quantum Mechanics (Dep. of Physics, Univ. of L'Aquila, Italy)
2) Analytic functions & Hilbert spaces (Dep. of Physics, Univ. of Roma Tor Vergata, Italy)
1983 – 1987 Analytic functions - Hilbert spaces (Dep. of Physics, Univ. of Roma Tor Vergata, Italy)
1975 – 1983 Classical Mechanics/Electromagnetism (Dep. of Physics, Univ. Roma La Sapienza, Italy)
1970 – 1975 First year Mathematics/Quantum Mechanics (Dep. of Physics, Univ. of L'Aquila, Italy)

- **INSTITUTIONAL RESPONSIBILITIES**

1991 – 2013 Faculty member, University of Roma Tor Vergata, Italy
1991 – 2010 Organizer of the Physics Department Seminars, University of Roma Tor Vergata, Italy
1991 – 2013 Member of the Doctoral School in Physics, University of Roma Tor Vergata, Italy

1991 – 2013 Teaching committee member, Dep. of Physics, University of Roma Tor Vergata, Italy

- **COMMISSIONS OF TRUST**

2018 – today Evaluation Expert for the Research Executive Agency of the European Commission
2018 – today Evaluation Expert REPRISE
2012 – today Review panel member ISCRA
2012 – today Review panel member, University of Southampton, UK
2009 – today Review panel member of the Deutscher Akademischer Austausch Dienst - DAAD, Germany
2000 – today EU Scientific Evaluator of FP6, FP7, Horizon 2020
1997 – today Scientific Evaluator and referee, MIUR, Italy

- **COMPUTATIONAL RESOURCES ALLOCATIONS**

2004 Leibniz - Rechenzentrum (LRZ, Munich - Germany)
2005 Jülich Supercomputing Center (JCS, Jülich - Germany)
2006 IT Center for Science (CSC, Helsinki - Finland)
2007 Jülich Supercomputing Center (JCS, Jülich - Germany)
2009 DEISA European High Performance Computing initiative at CSC
2010 Jülich Supercomputing Center (JCS, Jülich - Germany)
2011 – 2016 5 approved PRACE projects - 3 at the Jülich Supercomputing Center (JCS, Jülic, Germany) and 2 in combination with Fermi (Cineca, Bologna - Italy)

- **MAIN SCIENTIFIC ACHIEVEMENTS**

(1) Formulation of gauge theories in the temporal gauge in terms of the Feynman propagation kernel. The formalism allows to neatly solve the problem of the inability of naïve perturbative theory to reproduce the exponentiation of the Wilson-loop time dependence. The formalism has been recently extended to give a non-perturbative (lattice) definition of the $q\bar{q}$-potential (in collaboration with M. Testa).

(2) Introduction of a new family of QCD baryon and meson multi-quark states, dubbed "baryonium" states, with possibly exotic quantum numbers, resulting from enforcing duality in meson and baryon channels. Belle & Bess brought evidence for the existence of baryonium-like tetra-quark mesons, while pentaquarks have been discovered in 2015 at LHCb. The correct identification of $B\bar{B}$ annihilation channels helps explaining the detected large LHC multiplicities (in collaboration with G. Veneziano).

(3) Construction of a systematic procedure aimed at recovering the continuum chiral symmetry of lattice QCD broken by the Wilson term. This strategy is still employed in all cases where the regularization breaks chiral symmetry (in collaboration with M. Bochicchio, G. Martinelli, L. Maiani, M. Testa).

(4) Formulation of lattice chiral gauge theories of Standard Model type. Though somewhat unpractical, it is the only known consistent way to non-perturbatively deal with a regularized chiral gauge theory, besides the similarly unpractical Lüscher approach (in collaboration with A. Borrelli, G. Martinelli, L. Maiani, R. Sarno, R. Sisto, M. Testa).

(5) Formulation of the instanton calculus in massless and massive SUSY theories that has allowed identifying chiral models where SUSY is dynamically broken (in collaboration with D. Amati, K. Konishi, G. Veneziano, Y. Meurice).

(6) Proof of the validity of the Witten-Veneziano (WV) formula for the η'-mass, based upon using the pure gauge topological susceptibility definition suggested by the exactly chirally invariant overlap fermions. The approach allows extending the construction of topological susceptibility, with the correct chiral limit, to full QCD (in collaboration with L. Giusti, M. Testa, G. Veneziano). These results represent the final step of a long investigation aimed at checking the WV formula in QCD, initiated with the first lattice computation in the pioneering works carried out by G.C. Rossi in the 80s in collaboration with P. di Vecchia, K. Fabricius, G. Veneziano

(7) Extensive study of $\mathcal{N} = 4$ Super Yang-Mills (SYM) theory and its mass- and β-deformations in which i) for the first time a non-perturbative confirmation of the validity of the Maldacena conjecture, beyond the

set of protected operators, was given, based on the instanton computation of a 16-point gluino correlator; ii) a detailed analysis of operator mixing in $\mathcal{N} = 4$ SYM was performed, together with a perturbative study of the finiteness condition of its β-deformation; iii) the calculation of the holomorphic superpotential in many instances of mass- and β-deformed $\mathcal{N} = 4$ SYM theories was carried out exploiting the Dijkgraf-Vafa matrix model approach (in collaboration with M. Bianchi, B. Eden, M. Siccardi, E. Sokatchev, Ya. Stanev).

(8) Introduction of a novel regularization of Wilson fermions where the Wilson term is "twisted" with respect to the quark mass term by an axial transformation. Fermions (dubbed "twisted mass" fermions) must be introduced in pairs in order not to have a θ-angle in the continuum limit of the regularized QCD theory. Comparing with standard Wilson fermions, one gets a number of remarkable benefits i) automatic $O(a)$ improvement of observables, ii) a positive fermion determinant even for non-degenerate quark pairs, iii) a simpler renormalization and mixing pattern of operators, allowing the computation of f_π without the need of any renormalization, and the construction of lattice four-fermion operators (relevant for *K*- and *B*-physics) that to $O(a^2)$ have the same renormalization properties as they have in the formal continuum theory. The twisted-mass approach proved to be extremely successful as witnessed by the large number of accurate results obtained by the European Twisted Mass Collaboration (ETMC) in simulations with 2 as well as 2+1+1 dynamical quarks with masses set at their phenomenological values. The formalism was developed and brought to a workable set-up in a long collaboration with R. Frezzotti.

(9) Identification of a new non-perturbative (NP) mechanism for mass generation in a gauge theory where an irrelevant chiral breaking term (similar to the Wilson term in lattice QCD) is present. The heuristic observation made in lattice QCD for the existence of a dynamically generated and finite quark mass can be elevated to the acceptable level of rigour if the naturalness problem, posed by the need of separating a finite NP mass contribution from the linear divergency that unavoidably goes with it, can be solved. This can indeed be done, providing a viable alternative to the Higgs mechanism. Within this mass generation mechanism all elementary particle masses are proportional to the RGI scale of the theory times powers of the coupling constants of the interaction each particle is subjected to. This circumstance has two major consequences: 1) to get the top mass at its phenomenological value one has to assume that the RGI scale of the theory lies in the TeV range, which in turn implies that there must be a superstrong interactions at this high energy scale waiting to be discovered; 2) mass hierarchy is understood as a consequence of the fact that the strongest is the interaction a particle is subjected to the largest will be its mass. In this scheme a) the 125 GeV resonance recently discovered at LHC is interpreted as a WW/ZZ bound state held together by the exchange of superstrong particles that feel electro-weak interactions and are thus coupled to weak bosons and b) enlarging the particle content of the Standard Model to include the necessary superstrongly interacting particles, unification of gauge couplings is achieved with an accuracy comparable to the one it is obtained in the MSSM. The whole scheme was developed in collaboration with R. Frezzotti. Dr. M. Garofalo contributed to the unification paper.

- **HIGHLIGHTS OF THE LAST FEW YEARS ACTIVITY**

1. Journal papers

1) "Chirally improving Wilson fermions. 1. O(a) improvement" R. Frezzotti and G.C. Rossi, JHEP 0408, 007 (2004)
2) "Chirally improving Wilson fermions. II. Four-quark operators" R. Frezzotti and G.C. Rossi, JHEP 0410, 070 (2004)
3) "Topological susceptibility in full QCD with Ginsparg-Wilson fermions" L. Giusti, G.C. Rossi and M. Testa, Phys. Lett. B 587, 157 (2004)
4) "Twisted mass quarks and the phase structure of lattice QCD" F. Farchioni, R. Frezzotti, K. Jansen, I. Montvay, G.C. Rossi *et al.*, Eur. Phys. J. C 39, 421 (2005)
5) "Reducing cut-off effects in maximally twisted lattice QCD close to the chiral limit" R. Frezzotti, G. Martinelli, M. Papinutto and G.C. Rossi, JHEP 0604, 038 (2006)
6) "Dynamical twisted mass fermions with light quarks" P. Boucaud, *et al.*, Phys. Lett. B650, 304 (2007)
7) "Dynamical Twisted Mass Fermions with Light Quarks: Simulation and Analysis Details" P. Boucaud, *et al.*, Comput. Phys. Commun. 179, 695 (2008)
8) "Light Meson Physics from Maximally Twisted Mass Lattice QCD" R. Baron, *et al.*, JHEP 1008, 097 (2010)

9) "Non-perturbative renormalization of quark bilinear operators with $N_f=2$ (tmQCD) Wilson fermions and the tree-level improved gauge action" M. Constantinou *et al.*, JHEP 1008, 068 (2010)
10) "Lattice QCD determination of m_b, f_B and f_{Bs} with twisted mass Wilson fermions" P. Dimopoulos, *et al.*, JHEP 1201, 046 (2012)
11) "Leading isospin breaking effects on the lattice" G.M. de Divitiis *et al.*, Phys. Rev. D87, 114505 (2013)
12) "*B*-physics from $N_f = 2$ tmQCD: the Standard Model and beyond", N. Carrasco *et al.*, JHEP 1403 (2014) 016
13) "Up, down, strange and charm quark masses with N_f= 2+1+1 twisted mass lattice QCD", N. Carrasco *et al.*, Nucl. Phys. B887 (2014) 19
14) "Nucleon and pion structure with lattice QCD simulations at physical value of the pion mass", A. Abdel-Rehim *et al.*, Phys. Rev. D92 (2015) 11451

2. Research Monographs (2013-2016)
- Reviews and Chapters in books
1) "The role of metals in aggregation. Experiments and ab initio simulations". V. Minicozzi, S. Morante, G.C. Rossi, F. Stellato, N. Christian, K. Jansen, *Int. J. Quant. Chem.* 108:1992, 2008
2) "Theories, models, simulations: a computational challenge", G.C. Rossi, published in "*Sense of Beauty in Physics*", eds. M. D'Elia, K. Konishi, E. Meggiolaro, P. Rossi (Pisa University Press, Pisa, 2006)
3) "Instantons and Supersymmetry", M. Bianchi, S. Kovacs, G.C. Rossi, in "*String Theory and Fundamental Interactions*", Eds. M. Gasperini, J. Maharana, Lect. Notes in Phys. 737, 303, 2008 (Springer, Berlin, 2008)
4) "Metals in Alzheimer disease. A combined experimental and numerical approach" S. Morante and G.C. Rossi, in "*Advances in Alzheimer's research"* (Bentham Science Publishers, 2014)

3. Awards
- In 2004 G.C. Rossi got the "Humboldt Prize" awarded by the Humboldt Foundation (Germany). The Prize was given in recognition of the outstanding and internationally recognized results he has obtained in applying numerical methods in the research area of Quantum Field Theory and Biophysics. Thanks to this generous financial support, he could spent in two consecutive academic years (2004-05 and 2005-06) a period of six months at N.I.C. (DESY - Zeuthen, Germany) working to set up and launch the activities of the European Twisted Mass Collaboration (ETMC) in collaboration with K. Jansen.
- In recognition of the extraordinary scientific success of ETMC, an extension of the Humboldt Prize was awarded to G.C. Rossi in 2013 to support his permanence at N.I.C. (DESY - Zeuthen, Germany) and further push forward the ETMC activities.

4. Major Contributions to the Carrier of excellent Researchers
G.C. Rossi has supervised and inspired the carrier of many excellent young researchers, among which L. Biferale and M. Bianchi (Full Profs., Univ. of Rome Tor Vergata), R. Frezzotti (Associate Prof., Univ. of Rome Tor Vergata), G. Travaglini (Prof., Queen Mary), M. Bochicchio, G. Salina, Ya. Stanev (all three tenured, INFN), S. Capitani (Univ. of Frankfurt), S. Kovacs (Trinity College), C. Pittori (tenured, INAF).

5. Funding ID
- PRIN 2004-2006, local coordinator, local allocated funds 48.400 €
- PRIN 2006-2008, local coordinator, local allocated funds 42.660 €
- PRIN 2009, national coordinator, total allocated funds 250.000 €
- Centro Fermi 2013-2016, "Statistical Mechanics, Field Theory & Supercomputing", 5 yrs grant coordinator
- SUMA 2013-2015, local coordinator in 2013, total allocated funds 1.925.000 €

6. A selection of invited talks in Conferences (last 15 years)
- "Computational Hadron Physics" 2005, Nicosia (Cyprus)
- "ApeNEXT" Meeting 2007, Florence (Italy)
- "Computational Challenges" Meeting 2007, Paris (France)
- "SIAM Conference, MS08" 2008, Philadelphia (USA)
- "QCD: The Modern View of the Strong Interactions" 2009, Berlin (Germany)
- Talks at the International Lattice Symposia in 2005, 2007 and 2013
- "XIII Quark Confinement and the Hadron Spectrum", 31/07-06/08 2018, Maynooth (Ireland)
- "PHOTON 2019", 3-7 June 2019, Frascati (Italy)
- "Lattice QCD", 26-30 August 2019, Santa Fe' (New Mexico, USA)
- "QCD20", 27-30 October 2020, Montpellier (France)

7. Organization of International Conferences (last 12 years)

- XQCD (OCB) International Conference, 150 participants, LNF Frascati, Italy (2008)
- Cargèse School (OCB) International School, 50 participants, Cargèse, France (2009)
- Strings 2009 (Co-Chair) International Conference, 450 participants, Roma, Italy (2009)
- Lattice 2010 (Chair) International Conference, 400 participants, Villa Simius, Italy (2010)
- Lattice 2011 (IAC) International Conference, 400 participants, Lake Tahoe, USA (2011)
- GGI (Chair) International Workshop, 150 participants, Florence, Italy (2012)

8. Refereeing Activity

- Editorial Board of International Journal of Modern Physics and Modern Physics Letters
- Referee for Physical Review E and D, Physical Review Letters, Nuclear Physics, Journal of High Energy Physics, Physics Letters, International Journal of Modern Physics, Modern Physics Letters, Physics Report, Archives of Biochemistry and Biophysics, MDPI Journals.

9. Membership of Scientific Societies

- Member of SIF (Società Italiana di Fisica)
- Member of SIBPA (Società Italiana di Biofisica Pura e Applicata)

10. Major Scientific Collaborations

G.C. Rossi played a pivotal role as a cofounder, local coordinator or key scientist in a number of national and international Scientific Collaborations in the area of theoretical elementary particle physics and high-performance computing in Physics and Biophysics. Among them the most important still active ones are

1) International Collaborations

- Cofounder and spokesman (together with K. Jansen - DESY Zeuthen) of the European Twisted Mass Collaboration (ETMC, http://www-zeuthen.desy.de/~kjansen/etmc) aimed at performing lattice QCD simulations with the "twisted" regularization introduced by R. Frezzotti & himself. ETMC comprises ~50 scientists from 10 European countries. It has published ~120 papers that have collected ~3000 citations.
- Cofounder (together with R. Frezzotti - University of Roma Tor Vergata) of the BSMsimul collaboration aimed at performing numerical simulations of the model described in (9) above. If successful, they could open the way to the construction of a beyond-the-Standard-Model model where the masses of elementary particles have a non-perturbative origin (alternative to the Higgs mechanism), which could naturally explain their hierarchy.

2) National Collaborations

- Local coordinator for the year 2013 of SUMA, a "progetto premiale" aimed at supporting high performance computing - https://web2.infn.it
- Key scientist in the following IS (Iniziative Specifiche)
  1. Biophys (former TO61), aimed at supporting research in Biophysics & Statistical Mechanics
  2. LQCD123 (former RM22), aimed at supporting lattice QCD calculations

11. Extended Scientific Activity

Besides the quite large variety of topics in the area of *Elementary Particle Physics* to which G.C. Rossi has given significant contributions (with 176 papers published in peer-reviewed journals that collected about 9426 citations with $h = 52$ (see https://inspirehep.net), since 1993 he has extended his interests to *Biophysics*, publishing some 43 papers on topics ranging from the study of the protein-DNA recognition mechanism to *ab-initio* simulations of complexes where metals interact with proteins, of which examples are the Alzheimer related amyloid peptides, the Prion protein and the orf7a, orf8 Covid-19 proteins. On Google Scholar the full set of G.C. Rossi papers have collected about 11270 citations with $h = 54$ (see https://scholar.google.it/citations?user=nXwnqC4AAAAJ&hl=it)

Rome, November 15, 2021