

Curriculum Vitae

Pietro Faccioli, Ph.D.

Name: Pietro Faccioli

Date and Place of Birth: February 14-th 1974, Verona, Italy.

Citizenship: Italian

Present Position: *Ricercatore Confermato* (Tenured Investigator)

Scientific Sector: Theoretical Physics

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Other Affiliations : Interdisciplinary Laboratory for Computational Sciences (LISC)
Istituto Nazionale di Fisica Nucleare, Gruppo Collegato di Trento

Previous professional occupations

- 2002 - 2004 Post-doc at European Centre for Theoretical Studies in Nuclear Physics and Related Areas (E.C.T.*)

Academic Titles

- 2002 Ph.D., SUNY at Stony Brook
- 2002 M.A., SUNY at Stony Brook
- 1998 Laurea (Diploma Degree) in Physics from the Trento University. Final grade: 110/110 *ex lode*.

Awards and Grants

- 2009: CNRS grant supporting a long-term visit at the IPhT of CEA (Saclay, France).
- 2003, 2005, 2006, 2007, 2009: "Bruno-Rossi" grant within the INFN-MIT scientist exchange program.
- 2001: "V. Gribov Young Talent in Theoretical Physics" prize, awarded by the "Ettore Majorana" International School in Subnuclear Physics, Erice
- 1996: Imperial College International Diploma, London (awarded to the distinguished students at Imperial College in the academic year 1996-1997)

Extended research periods in foreign research institutions

- From January through June 2009: visiting scientist at IPhT CEA, Saclay (France)
- 2003, 2005, 2006, 2007, 2009: "Bruno-Rossi" visiting scientist at MIT, Cambridge (MA, USA)
- 1999-2002: Ph.D. student at the SUNY at Stony Brook (USA).

Teaching

Regular University courses given at the graduate and undergraduate level:

- Lectures of the graduate course on *Statistical Field Theory*, Trento University, 2011- present.

- Lectures of the graduate course on *Effective Field Theories*, Trento University, 2009.
- Lectures of the course on *Computational Physics Applied to Macro-Molecules*, Trento University, 2006-2008.
- Recitations for the course on *Nuclear and Sub-nuclear Physics*, Trento University, 2009
- Recitations for the course on *Thermodynamics* ("Fisica Generale III UD"), Trento University, 2006-2010.
- Recitations for the course on *Classical Mechanics* ("Fisica Generale I,II UD"), Trento University, 2006-2009.
- Lectures for the graduate course on *Quantum Chromodynamics*, Trento University, 2005-2006.
- Recitations for the course on *Electrodynamics and Relativity* ("Fisica Generale VI UD"), Trento University, 2005.
- Recitations on *Mathematical Calculus*, SUNY at Stony Brook, 1999.
- Recitations on *Experimental Physics*, SUNY at Stony Brook, 1999.

Mentoring activity:

- Supervisor for the following Master theses:
 - 2010 Student: Guglielmo Mazzola, Title: "Thermal fluctuations and reaction rates in high dimensional stochastic systems"
 - 2010 Student: Matteo Bazzanella, Title: "1+1 dimensional quantum field theory models for thin graphene wires"
 - 2008 Student: Alice Lonardi, Title: "Dominant Pathways in the Folding of a β -hairpin"
 - 2008 Student: Emmanuele Autieri, Title: "Dominant Reaction Pathways in Low-Dimensional Stochastic Systems"
 - 2007 Student: Raffaele Millo, Title: "Strong CP Violation in External Magnetic Fields"
 - 2004 Student: Marco Cristoforetti, Title: "Non-Perturbative QCD and Non-Leptonic Weak Decays of Hyperons" (co-adviser)
- Supervisor of the following PhD theses:
 - 2010- Student: Roberto Covino, Title: "Folding Pathways of Globular Proteins from All Atom Simulations" - 2007-2010 Student: Raffaele Millo, Title: "Instanton Theory and Stochastic Quantization" - 2004-2007 Student: Marco Cristoforetti, Title: "Instanton-Induced Chiral Dynamics in Hadrons"

Technical Experience

- Equilibrium and out-of-equilibrium statistical physics.

- All-atom and coarse-grained models for macro-molecules. Computational physics of macro-molecules.
- Quantum and statistical field theory. Effective field theories.
- Covariant Hamiltonian formulations of quantum mechanics on the light front.
- Perturbative and non-perturbative aspects of QCD. Hadron physics phenomenology. Constituent quark models, parton models, soliton models, instanton models.
- Monte Carlo methods for quantum mechanics, quantum field theory and classical statistical physics

Senior Collaborators

- Statistical and Biological Physics: H. Orland (CEA-Saclay), F. Pederiva (Trento), C. Micheletti (SISSA)
- Hadron Structure and Non-perturbative QCD: J.W. Negele (MIT), T. DeGrand (Colorado), E.V. Shuryak (Stony Brook), J.P. Blaizot (CEA-Saclay), M. Traini (Trento), V. Vento (Valencia)

Other Professional Activities

- Referee for the National Science Foundation (NSF) of USA, for research in molecular modeling.
- Referee for European Journal of Physics C, Physics Letters B and Physical Review D, Progress in Particle and Nuclear Physics, Journal of the American Chemical Society, Phil. Magazine, Journal of Chemical Physics
- Organizer of the 2nd International Workshop on "Applications of Theoretical Physics Methods in Biology", ECT* June 2010
- Co-organizer of the 1st International Workshop on "Applications of Theoretical Physics Methods in Biology", ECT* May 2005
- Co-organizer of the ECT* Doctoral Training Program 2006 on "Numerical Techniques in Strongly Interacting Systems".
- Co-organizer of the joint FBK-Trento University-INFN-CNR workshop on "Biophysics of Macromolecular Interactions", Trento, September 2009
- Local Coordinator of the AD-31 INFN scientific project, 2006 to present.
- Local Coordinator of the AuroraScience project (period 2008-2009).
- External Member of the PhD Thesis Examining Committee of the Department of Applied Mathematics, Cambridge University, UK, February 2009

Summary of the Research Activity

Despite the huge gap in the energy scales involved, the internal dynamics of hadrons, nuclei and macro-molecules display many unsuspected analogies. In all such physical systems, the motion of the constituents is largely influenced by strong correlations and by the uncertainties associated to quantum or thermal fluctuations. The interplay of correlations and fluctuations gives rise to non-perturbative phenomena, such as phase-transitions, metastability and collective excitations. In view of such similarities, in my research I extend some of the field theoretical and numerical techniques which were developed in the context of nuclear and high-energy physics, in order to investigate the stochastic dynamics of macro-molecular systems, such as proteins.

Statistical Mechanics and Biological Physics

My main research activity focuses on the investigation of the dynamics of bio-molecules, in equilibrium and non-equilibrium conditions. In particular, I study protein folding, misfolding and aggregation processes, in relationship with kinetics biophysical experiments and in connection with aspects of molecular biology. In the latter context, I am interested in particular in protein-protein interactions involved in cell signaling processes and in the aggregative processes associated to amyloidogenic neuro-degenerative pathologies.

The dynamics of general peptides is characterized by a decoupling of the time scales associated to the internal local conformational transitions (of the order of the ns) from the time scales associated to folding and aggregative reactions (of the order of ms or s). Such a gap in time scales makes it extremely inefficient to investigate such phenomena by means of standard Molecular Dynamics (MD) approaches.

In view of such difficulties, in my research I develop and apply theoretical and computational methods based on statistical and effective field theory techniques. Below is a number of projects I have been involved in:

- *Dominant Reaction Pathways:*
Dominant Reaction Pathways[12] is a path integral based approach to investigate rare conformational transitions of macromolecules. We could show[11, 9, 10] that this method is drastically less computationally expensive than traditional molecular dynamics algorithms and allows for the first time to sample the entire folding transition without investing time in simulating local thermal motion in metastable states. We have recently extended this method to the quantum level, in order to investigate the dynamics of electrons and nuclei in rare chemical reactions occurring at finite temperature [6].
- *Effective field theory for long-time stochastic dynamics:*
We have constructed an effective field theory which allows to describe the long-time stochastic dynamics of large systems, at a low time-resolution power. Using field theoretical diagrammatic methods, we derived effective a perturbative expansion which yields an effective

Fokker-Planck Eq.s which describes the same long-time dynamics of the original one, at a lower time-resolution power. Using such an effective theory, one can performed numerical simulations using large time steps[7, 4].

- *Protein-protein interaction:*

I have been involved in the study of bio-molecular interaction and aggregation particularly in connection with amyloidogenic proteins [13] by means of molecular dynamics simulations.

- *Folding of proteins with topologically non-trivial native structure:*

I am involved in a collaboration aiming to investigate the role of non-native interactions in the promotion of knots in the early stages of the folding.

QCD and Hadron Structure

My scientific interests in Nuclear and High-Energy Physics concerns the study of strong interactions in the vacuum and in hadrons in the context of Quantum-Chromodynamics. Below is a list of research topics I have been involved in:

- *Heavy quark dynamics in the quark-gluon plasma*

In connection with J.P. Blaizot, A. Beraudo and G. Garberoglio, we studied the diffusion of heavy quarks in a hot quark-gluon plasma at temperatures above the QCD deconfinement phase transition. To this end, we developed a path integral approaches which combines the Hard-Thermal Loop effective theory with Monte Carlo simulations[18].

- *Strong CP violation:*

I have been involved in investigating how QCD works, at finite θ angle. My main result in this context is the unveiling of the mechanism according to which, in the presence of strong CP breaking, quantum tunneling phenomena in the QCD vacuum generate an effective and flavor-dependent repulsion between matter and antimatter, leading to a local separation of positive and negative baryon number density in the neutron [27]. Using effective field theories and large N_c expansion, we have investigated the consequences of CP-violation, in the presence of strong magnetic fields, and studied the consequences on magnetars [21].

- *Consequence of the topological structure of the QCD vacuum:*

In collaboration with my PhD advisor (Prof. E.V.Shuryak) I have participated to several studies on the effects of instanton-induced correlation in the light-quark sector of QCD, both at the level of mathematical formalism [34],[35] and in connection with the electro-weak structure of hadrons [31, 32, 33, 30, 29]. During my PhD we found than the instanton-induced short-range non-perturbative correlations can explain the delay of the onset of the perturbative regime in several exclusive reactions and quantitatively reproduce the available data on pion and nucleon form factors, for $Q^2 \gtrsim 1 \text{ GeV}^2$. In subsequent studies we found that the same dynamical mechanism can generates strong diquark correlations which can explain the $\delta I = 1/2$ rule for hyperon decays.

- *Lattice QCD:*

I have collaborated on several projects related to lattice gauge theory. With Prof. Simula

and collaborators, we have studied some quenching artifacts which can be generated by the topological structure of the QCD vacuum [28]. With Prof. J.W. Negele we investigated the dynamical mechanisms involved in the onset of the chiral regime, at small quark masses. With Prof. DeGrand we have defined and analyzed specific combinations of lattice correlation functions which carry specific information on the quantum numbers of the non-perturbative quark-quark interaction provide strong evidence for instanton-induced dynamics in QCD [26, 25, 24, 23]. In collaboration with R.Millo and Dr. L. Scorzato we developed an original technique to use lattice field theory to rigorously construct effective theories in which the relevant degrees of freedom are the curvilinear abscissas parametrizing selected families of vacuum gauge field configurations.

- *Effective field theory and quantum Monte Carlo simulations:*

I have collaborated in the development of a framework to investigate of properties of light nuclei, combining chiral effective field theories and Monte Carlo simulations.

- *Light front dynamics and deeply inelastic scattering phenomenology:*

We developed an approach to the theoretical investigation of deeply inelastic scattering processes of leptons off nucleons in which low-energy hadronic matrix elements are evaluated using relativistic quark models (using with the covariant formulation of the dynamics on the light-front [38, 37, 36]) and the connection with the partonic regime was established with perturbative QCD evolution.

Invited Seminars, Talks and Lectures

Statistical Mechanics and Biological Physics

- "Dominant Pathways in Protein Folding, from Classical to Quantum Calculations", invited talk at the workshop on "Structural Bioinformatics and Computational Biophysics", SISSA July 2011.
- "Effective Field Theories in Statistical Physics", invited lectures for the Statistical and Biological Physics sector of the Doctoral School of SISSA, Trieste, Spring 2011.
- "Dominant reaction pathways of macromolecules: from classical to quantum mechanical calculations", Department of Chemistry, University of Cambridge (UK), February 2011.
- "Dominant reaction pathways of macromolecules: from classical to quantum mechanical calculations", ETH Lugano, February 2011.
- "Stochastic path integral approaches to the dynamics of bio-molecules" Invited lectures at the Finnish Doctoral Programme in Computational Sciences, Lammi (Helsinki), October 2010.

- "Long-Time Stochastic Dynamics of Macromolecules" , University of Texas at Austin, December 2009
- "Dominant Pathways in Rare Chemical and Conformational Reactions", Technischen Universität München, Germany, November 2009
- "Stochastic Theory for the Conformational Transitions of Macromolecules", Orsay (Paris), February 2009
- "Stochastic Dynamics of Macromolecules", Roma Tor Vergata, February 2009
- "Protein Folding with Instantons", Stony Brook (USA), December 2008
- "Reaction Pathways in High Dimensional Spaces", NIH, Bethesda (USA), December 2008
- "Dominant Reaction Pathways in Large Dimensional Systems", University of Bayreuth (Germany), November 2008
- "Stochastic Theory of Protein Folding", CEA Saclay (Paris), Institute de Physique Theorique, February 2008
- "Protein Dynamics from Dominant Folding Pathways", NIH, Bethesda (USA) March 2007
- "Studying Protein Folding Pathways with Quantum Mechanical Methods", MIT, November 2006
- "Stochastic Theory of Protein Folding", Department of Physical Chemistry, Harvard University, Cambridge (USA), November 2006
- "Studying Protein Folding Pathways with Quantum Mechanical Methods", Physics Department, Parma University, October 2006
- "Dominant Protein Folding Pathways ", SISSA, Trieste (Italy), January 2006
- "Protein Folding Pathways from Path Integrals", ECT* Trento (Italy) Board of Directors Meeting, January 2006.

QCD and Hadron Structure

- "Astrophysical Implications of Strong CP Violation", DAMPT, Cambridge University (UK), January 2010.
- "Strong CP Violation in External Magnetic Fields and Anomalous Vacuum Birefringence", Physics Department of Trieste University, May 2009
- "Correlations in Hadrons" Physics Department of the Genoa University, February 2005
- "Are There Diquarks in the Nucleon?", MIT, December 2004
- "Strong CP Breaking and Quark Antiquark Repulsion in QCD", BNL, November 2004

- “Non-perturbative Correlations in Hadrons”, Physics Department of the Stockholm University, October 2004
- “Theory and Applications of Instantons in QCD”, Department for Theoretical Physics of the Turin University, May 2004
- “Instantons, Hadronic Structure and $\Delta I = 1/2$ Rule”, Department for Theoretical Physics of the Turin University, May 2004
- “Instantons and $\Delta I = \frac{1}{2}$ Rule for Non-Leptonic Hyperon Decays.”, Center for Theoretical Physics of the Massachusetts Institute of Technology, Cambridge, December 2003
- “Evidence for Instanton-Induced Dynamics from Lattice Simulations and from Non-Leptonic Weak Decays of Hyperons”, Department of Physics and Astronomy of the State University of New York at Stony Brook, December 2003
- “Non-Perturbative QCD Contributions to the Electro-Magnetic Structure of Hadrons”, National Laboratory of Frascati (Rome), October 2003
- “Topological Aspects of the Chiral Quark-Quark Interaction in QCD”, Physics Department of the Rome-3 University, February 2003
- “Instanton and Electro-Magnetic Form Factors of the Pion”, Thomas Jefferson Laboratory, August 2002
- “Parton Distributions in Light-Front Dynamics”, European Centre for Theoretical Physics and Related Areas, Trento, December 1998
- “Electro-Magnetic Form Factors of Hadrons in the Instanton Liquid Model” , Physics Department of the Trento University, March 2001.

Oral Presentations from Selected Abstracts

Statistical Mechanics and Biological Physics

- ”Dominant reaction pathways from classical to quantum calculations”, Seventh Congress of the International Society for Theoretical Chemical Physics (ISTCP-VII) Tokyo, September 2011.
- ”Quantum effects in protein folding”, presented in the workshop on ”Quantum Physics of Living Matter”, Rome, July 2011.
- ”Dominant pathways in folding dynamics from classical to quantum mechanical simulations”, presented to ”TheoBio 2011”, Funchan (Portugal), June 2011.
- ”Dominant pathways in rare conformational and chemical reactions of Macromolecules”, keynote contribution to ”MOLEC2010”, Curia-Anadia (Portugal), September 2010.

- "Dominant pathways in rare conformational and chemical reactions of Macromolecules", contribution to "Searching for Reaction Coordinates and Order Parameters", Telluride (Colorado), USA, June 2010
- "Dominant pathways in rare conformational and chemical reactions of Macromolecules", contribution to "The Physics of Protein Folding and Aggregation", Bressanone (Italy), February 2010.
- "Folding of beta-hairpins, from Dominant Reaction Pathways", contribution to "Molecular Kinetics", Berlin, May 2009.
- "Stochastic Dynamics and Dominant Protein Folding Pathways", contribution to Workshop "Biophys08", Arcidosso (Gr) Sept. 2008
- "Dominant Reaction Pathways in Large Dimensional Systems", contribution to the "Sigma-Phi" Conference in Statistical Mechanics, Crete 2008
- "Stochastic Theory of Protein Folding", contribution to the XI Conference on Complex Systems "Andalo2008", Andalo (Italy), March 2008.
- "Ab-initio Calculation of Dominant Pathways in Protein Folding", contribution to the XX Sitges Conference on "Statistical Mechanics on Physical Biology: from Molecular Interactions to Cellular Behavior", Sitges (Barcelona), June 2006
- "Path Integral Approach to Protein Folding", contribution to the Collaboration Meeting on "Theoretical Physics Methods in Protein Dynamics", ECT* (Trento), May 2005

QCD and Hadron Structure

- "Chiral Symmetry, Hadron Spectrum and Instantons", contribution to the XII International Conference on Hadron Spectrum "Hadron07", Frascati (Italy) October 2007.
- "Strong CP violation and Magnetic Fields", contribution to the conference "QCD@work 2007", Martina Franca (Italy), June 2007
- "Hadrons without Confinement", contribution to the ECT* workshop on "Quark Confinement, from Light to Heavy Quarks", Trento, October 2006
- "Exploration of Chiral Regime of QCD in the Interacting Instanton Liquid Model", contribution to the INT program on "Exploration of Hadron Spectrum and Structure from Lattice QCD simulations", Seattle April 2006.
- "Instanton-Induced Contribution to Hadron Form Factors", contribution to the workshop "Nucleon 05", Frascati (Rome), October 2005
- "Studying Diquark Correlations in Lattice QCD", contribution to the conference "Lattice 2005", Dublin, July 2005.
- "Instantons and the Structure of the Nucleon at 0 and Finite θ ", contribution to the workshop on "Effective Theories in Nuclear Physics and Lattice QCD", ECT* (Trento), July 2005.

- "Strong CP Breaking and Quark-Antiquark Repulsion", contribution to the conference "QCD@work 2005", Conversano (Bari), June 2005
- "Instanton Contribution to the Electro-Magnetic Structure of Hadrons", contribution to the "X Conference on Theoretical Problems in Nuclear Physics", Cortona (Italy), October 2004
- "Non-Perturbative Structures in Hadrons", lecture given at the "26th International School in Nuclear Physics", Erice, September 2004
- "Instantons, Diquarks and Large N_c ", contribution to the workshop on "Large N_c QCD 2004", Trento, July 2004
- "Non-Perturbative correlations in Hadrons", contribution to the "8th Workshop on Non-Perturbative Quantum Chromodynamics", Paris, June 2004
- "Studying the Role of the 't Hooft Interaction in QCD, by Means of Lattice Simulations" contribution to the session "Mathematical Aspects of QCD" of the "XXI International Symposium on Lattice Gauge Theories (Lattice 2003)", Tsukuba (Japan), July 2003
- "Linking Chiral and Topological Aspects of the Quark-Quark Interaction, in QCD" contribution to the session "Topology and Confinement" of the "International Symposium on Color Confinement (Confinement 2003)", Tokyo, July 2003
- "Instanton Contribution to the Pion and Proton Electro-Magnetic Form Factors at $Q^2 \gtrsim 1 \text{ GeV}^2$ ", contribution to the "2nd International Conference on Nuclear and Particle Physics at Jefferson Laboratory", Dubrovnik, May 2003
- "Topological Dynamics in QCD", contribution to the workshop on "Aspects of Color Confinement and Non-Perturbative QCD", Trento, December 2002
- "Instanton Contribution to the Electro-Magnetic Form Factors of the Nucleon", contribution to the workshop on "The Structure of the Nucleon", Trento, September 2002
- "Leading Instanton Effects in QCD". contribution to the workshop on "Non-Perturbative Methods in QCD", Electro-Magnetic fields", Trento, July 2002
- "Instanton Contribution to the Electro-Magnetic Structure of Hadrons". contribution to the workshop on "Baryons Probed with Quasi-Static: Electro-Magnetic fields", Trento, April 2002
- "Instanton Contribution to the Physics of the Pion and of the Nucleon". contribution to the workshop on "Hadronic Structure from Lattice QCD", Brookhaven National Laboratory, March 2002
- "Non-Perturbative Light-Quark Interaction and Instantons". contribution to the session "New Talents" of the 39-th Ettore Majorana School of Subnuclear Physics, Erice, September 2001

- “Polarized Parton Distribution and Light-Front Dynamics”,
Contribution to the 2nd ICTP International Conference on “Perspectives in Hadronic Physics”,
Triest, May 1999.

Bibliography

Peer Reviewed Articles

Statistical Mechanics and Biological Physics

- [1] "Fluctuations in the Ensemble of Reaction Pathways", G. Mazzola, S. a Beccara, **P. Faccioli**, H. Orland, J. Chem. Phys. **134**, 164109 (2011).
- [2] "Quantum Diffusive Dynamics of Macro-molecular Transitions", S. a Beccara, **P. Faccioli**, G. Garberoglio, accepted for publication in J. Chem. Phys. (2011)
- [3] "Dominant folding pathways of a peptide chain, from *ab-initio* quantum-mechanical simulations", S. a Beccara, **P. Faccioli**, G. Garberoglio, M. Sega, F. Pederiva, H. Orland, arXiv:1007.5235, Journ. Chem. Phys. **134** 024501 (2011) (selected as journal cover).
- [4] "Molecular Dynamics at Low Time Resolution", **P. Faccioli**, Journ. Chem. Phys. **133**, 164106 (2010). Also selected for republishing on the Virtual Journal of Biological Physics Research.
- [5] "Dominant Pathways in Protein Folding: a Direct Validation Against MD Simulations", **P. Faccioli**, A. Lonardi and H.Orland, Journ. Chem. Phys. **133** (2010) 045104.
- [6] "*Ab-initio* Dynamics of Rare Thermally Activated Reactions", S. a Beccara, G. Garberoglio, **P. Faccioli** and F. Pederiva, Journ. Chem. Phys. **132** 111102 (2010) (communicated)
- [7] "Simulating Stochastic Dynamics Using Large Time Steps", O. Corradini, **P.Faccioli** and H.Orland, Phys. Rev. **E80** (2009) 061112.
- [8] "Stochastic Dynamics and Dominant Protein Folding Pathways", **P.Faccioli**, M.Sega, F.Pederiva and H.Orland, Phil. Mag. **88** (2008), 4093.
- [9] "Characterization of Protein Folding from Dominant Reaction Pathways" **P.Faccioli**, J. of Phys. Chem. **B112** (2008) 13756.
- [10] "Dominant Reaction Pathways in High Dimensional Systems", E.Autieri, **P.Faccioli**, M.Sega, F.Pederiva and H.Orland, , J. Chem. Phys. **130** (2009) 064106.
- [11] "Quantitative Protein Dynamics from Dominant Folding Pathways", M.Sega, **P.Faccioli**, F.Pederiva, G Garberoglio and H.Orland, Phys. Rev. Lett. **99** (2007), 118102.

- [12] "Dominant Protein Folding Pathways", **P.Faccioli**, M.Sega, F.Pederiva and H.Orland, Phys. Rev. Lett. **97** (2006), 108101.
- [13] "Molecular Dynamics Simulations Suggests Possible Interaction Patterns at Early Steps of β_2 -microglobulin aggregation", F.Fogolari, A. Corazza, P. Viglino, P. Zuccato, L. Pieri, **P. Faccioli**, V. Bellotti and G. Esposito, Biophys. J. BioFAST: doi:10.1529/biophysj.106.098483 (2006).

Condensed Matter Physics

- [14] "Effective Field Theory for Quantum Electrodynamics of Graphene Wires", **P.Faccioli** and E.Lipparini, Phys. Rev. **B 80**, (2009) 045405
- [15] "The Effect of Interactions on the Conductance of Graphene Nanoribbons", M. Bazzanella, **P.Faccioli** and E.Lipparini, arXiv:1007.1316v1, Phys. Rev. **B**, (2010) in press.

QCD and Hadron Physics

- [16] "Computing the Effective Hamiltonian for Low-Energy Vacuum Gauge Fields", R. Millo and **P. Faccioli**, arXiv:1105.2163, submitted (2011).
- [17] "Quantum Interaction between Non-Perturbative Vacuum Fields", R. Millo, **P. Faccioli** and L. Scorzato, Phys. Rev. **D 81**, 074019 (2010)
- [18] "A Path Integral for Heavy Quarks in a Hot Plasma", A.Beraudo, J.P. Blaizot, **P.Faccioli**, G.Garberoglio, Nucl. Phys. **A 846**, 104 (2010).
- [19] "CP violations in low-energy photon-photon interactions", R. Millo and **P.Faccioli**, Phys. Rev. **D 79**, 065020 (2009).
- [20] "The Scalar Glueball in the Instanton Vacuum" , M.Tichy and **P. Faccioli**, Europ. Phys. Journ. C **63**, 423 (2009).
- [21] "Strong CP Violation in External Magnetic Fields", R.Millo and **P. Faccioli**, Phys. Rev. **D77**, 065013 (2008).
- [22] "Instantons Chiral Dynamics and Hadronic Resonances" M.Cristoforetti, **P. Faccioli**, M. Traini , Phys. Rev. **D75** 054024 (2007).
- [23] "Exploring the Chiral Regime of QCD Using the Instanton Liquid Model", M.Cristoforetti, **P. Faccioli**, M. Traini and J.W. Negele, Phys. Rev. **D75** 034008 (2007).
- [24] "Are There Diquarks in the Nucleon?", M. Cristoforetti, **P. Faccioli**, G. Ripka and M. Traini, Phys. Rev. **D 71** (2005) 114010.
- [25] "Evidence for Instanton-Induced Dynamics, from Lattice QCD", **P. Faccioli** and T.A. DeGrand, Phys. Rev. Lett. **91** (2003) 182001
- [26] "A Systematic Study of Chirality-Mixing Interactions in QCD", **P. Faccioli**, hep-ph/0211383

- [27] “Strong CP Breaking and Quark-Antiquark Repulsion in QCD, at Finite θ ”,
P. Faccioli Phys. Rev. **D71** (Rapid Comm.) (2005) 091502
- [28] “The Neutron Electric Dipole Moment in the Instanton Vacuum: Quenched Versus Unquenched Simulations”,
P. Faccioli, D. Guadagnoli and S. Simula, Phys. Rev. **D 70** (2004) 074017
- [29] “Instantons, Diquarks and the $\Delta I = \frac{1}{2}$ Rule for Hyperon Non-Leptonic Weak Decays”,
M. Cristoforetti, **P. Faccioli**, E.V. Shuryak e M. Traini, Phys. Rev. **D70** (2004) 054016
- [30] “Instanton Contribution to the Electro-Magnetic Form Factors of the Nucleon”,
P. Faccioli, Phys. Rev. **C69** (2004) 065211
- [31] “Proton Electro-magnetic Form Factors in the Instanton Liquid Model”,
P. Faccioli and E.V. Shuryak, Phys. Rev. **D65** (2002) 076002
- [32] “Prediction for the Pion Electro-magnetic Formfactor at $Q^2 > 1 \text{ GeV}^2$ from Instantons”,
P. Faccioli, A. Schwenk and E.V. Shuryak, Phys. Rev. **D67** (2003) 113009
- [33] “Instanton Contribution to the Proton and Neutron Electric Form Factors”,
P. Faccioli, A. Schwenk and E.V. Shuryak, Phys. Lett. **B549** (2002) 93
- [34] “A Systematic Study of the Single Instanton Approximation in QCD”,
P. Faccioli and E.V. Shuryak, Phys. Rev. **D64** (2002) 114020
- [35] “Parameter-Free Calculation of Hadronic Masses from Instantons”,
P. Faccioli, Phys. Rev. **D65** (2002) 094014
- [36] “Orbital Angular Momentum Parton Distributions and Light Front Dynamics”,
F. Cano, **P. Faccioli** and M. Traini, Phys. Rev. **D62** (2000) 054023
- [37] “Probing Relativistic Spin Effect in the Nucleon by Means of Drell-Yang Processes”,
F. Cano, **P. Faccioli** and M. Traini, Phys. Rev. **D62** (2000) 094018
- [38] “Polarized Parton Distributions and Light-Front Dynamics”,
P. Faccioli, M. Traini and V. Vento, Nucl. Phys. **A656** (1999) 400

Selected Conference Proceedings

QCD and Hadron Structure

- [39] ”Investigating the Diquark Structure of the Nucleon By Means of Lattice QCD Simulations”,
P.Faccioli and M.Cristoforetti published in the proceedings of the International Symposium on Lattice Gauge Theories ”Lattice 2005”, Dublin, July 2005.
- [40] ” Dynamical Consequences of Strong CP Breaking ”, **P.Faccioli**, published in the proceedings of the workshop ”QCD@Work 2005”, Conversano (Bari), June 2005.

- [41] “Instanton Contribution to the Electro-magnetic Structure of Hadrons”,
P. Faccioli, published in the proceeding of the “X Convengno su Problemi di Fisica Nucleare Teorica”, Cortona October 6-9 2004
- [42] “Non-Perturbative Short-Range Correlations and the Electro-Magnetic Structure of Hadrons at Large Q^2 ”,
P. Faccioli, invited lecture to be published in the proceeding of the “26th International School in Nuclear Physics”, Erice September 15-24 2004
- [43] “Instanton, Diquarks and Large N_c ”,
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