David Preti

Curriculum Vitae

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Research Interests

- Lattice Field Theories, especially Lattice QCD
- Beyond Standard Model physics on the Lattice
- Non-perturbative aspects of Gauge Theories and Renormalization
- Computational Physics and Monte Carlo Algorithms
- Machine Learning & Artificial Neural Networks, especially Generative Models

Professional Experience

12/2017-current **Postdoctoral Research Fellow**, *INFN-Sezione di Torino*, Turin, Italy.
Collaborators: Prof. M. Panero, Prof. M. Caselle
As a postdoc I branched out my interests to several different aspects of lattice gauge theories, focusing in particular on the numerical implementation and exploration of a UV complete partial composite Higgs scenarios with fermionic matter multiple representation. Strictly related to this project, I am also working in software development, contributing to the advancement of "GRID": a new generation C++ library for lattice simulation mainly developed by the Edinburgh Lattice group. As part of this work I got familiar with Containers, Git and continuous integration systems (like TravisCL). As parallel research lines I am currently active in the development of novel algorithms to implement Monte Carlo simulation on the Lattice, as well as the possibility of a non-perturbative simulation of quantum gravity in 2,3 and 4 dimensions with a self-developed Monte Carlo code base on "Grid".

09–12/2016 **Short term visitor**, *Higgs Centre for Theoretical Physics/University of Edinburgh*, Edinburgh,UK.
Collaborators: Prof. L. Del Debbio, Dr. G. Cossu
During this period as a visiting scientist I joined the development of the code "Grid" a next generation C++ library for Lattice Gauge theory simulations. This code is highly portable and optimized. The numerical libraries take advantage of the latest CPU architectures, setting a new paradigm for future high precision lattice computations. This code have been recently employed in collaboration with Prof. Del Debbio and Dr. Cossu to explore several Beyond the Standard Model scenarios, in particular UV complete partial composite Higgs models (see publication list).

03/2014-09/2017 **Predoctoral Researcher**, *Consejo Superior de Investigaciones Científicas*, Madrid, Spain.
I did my PhD formation as a pre-doctoral researcher (Investigador Predoctoral) funded by the Spanish Research Agency (Agencia Estatal de Investigación) through Centro de Excelencia Severo Ochoa Instituto de Física Teórica (UAM-CSIC). During this time I worked as a researcher in Lattice QCD, developing C and C++ parallelized codes on several HPC (Galileo at Cineca, FinisTerrae2 at CESGA, Marenostrum4 at BSC, Altamira at the IFCA) and data analysis, description and visualization

Education

2014–2017 **PhD in Theoretical Physics**, *Instituto de Física Teórica CSIC/UAM*, Madrid, Spain.

Thesis project: Determination of Fundamental Parameters in the Hadronic Sector of the Standard Model
Supervisor: Prof. C. Pena

During my PhD formation with Prof. Pena I worked mostly on the high precision computation of the renormalization constants as well as the energy scale dependence of several composite operators within and beyond the Standard Model of particles. The most relevant achievement, among the others, is the non-perturbative renormalization of the quark masses which have a great impact in either theoretical and experimentae particle physics research. Alongside with theoretical skills, as a PhD I developed several technical skill mainly devoted to Monte Carlo C/C++ code development (in collaboration with Edinburgh University) and its optimization and parallelization with standard communication protocols like MPI, openMP and statistical data analysis using several self-written Matlab and Mathematica codes, and scripts in Bash and Pearl.

2010–2013 **Master of Science in Physics**, *Sapienza Universitá di Roma*, Rome, Italy.

Thesis Title: Non-Perturbative Renormalization of $\Delta F = 2$ Four-fermion Operators
Supervisor: Dr. M. Papinutto

During my formation as a master student I focused on theoretical aspects of modern physics, with a specific interest in Particle Physics and Quantum Field Theory. With my master thesis, carried out under the guide of Dr. Papinutto in Sapienza University of Rome I approached Lattice discretization of Quantum Field theory and Markov Chain Monte Carlo numerical simulations. Thanks to this thesis I got a deep insight into Renormalization theory and the study of the energy dependence of composite operators which appear in physics processes beyond the Standard Model of particles.

2007–2010 **Bachelor in Physics**, *Sapienza Universitá di Roma*, Rome, Italy.

Thesis Title: Bose-Einstein Condensation in Trapped Gases
Supervisor: Prof. S. Caprara

As a physics student I got a basic knowledge of classical physics, with a particular interest devoted to Statistical Mechanics and Mathematical Physics. In my bachelor thesis I studied the theory which describes the fascinating phenomenon called "Bose-Einstein condensation" in presence of an attractive and repulsive interactions among atoms in "diluted" gas, as well as studying the experimental techniques currently adopted to reach extremely low temperatures (laser and optical cooling) and to implement efficiently optical and magnetic trapping to confine the atomic gas.

Language Skills

Italian:	Native
English:	Fluent
Spanish:	Intermediate
Russian:	Elementary

Technical Skills

OS:	Windows, Linux, Mac OS
HPC experience:	Galileo (CINECA), Marconi (CINECA), Altamira (IFCA), FinisTerrae2 (CESGA), Marenostrum4 (BSC)
Coding Languages:	C/C++, Python, Bash, Perl, MatLab, Mathematica
Utility Programs:	LaTeX, Git, Docker, Jupyter Notebooks, VisualStudio Code, CI systems, GooglePresentation/Keynote/PowerPoint

Soft Skills

Communication:	Public Speaker and Conference Presenter
Flexibility:	Adaptabile, Willing to Change and Learn, Teamwork Oriented
Responsibility:	Leadership, Accountable, Self-disciplined and Conscientious

International Schools

2019 **15th Advanced School Of Parallel Computing**, *CINECA*, Casalecchio di Reno (BO), Italy.
Introduction to massively parallel architectures (Cavazzoni/Emerson, CINECA)
Software Engineering for HPC (Ciancarini, CINI)
Cineca HPC systems (Marani, CINECA)
Introduction to GPU Programming (Bonfá, CINECA)
Accelerated programming models: CUDA, OpenACC, CUDAFortran (E4/Arm)
ARM architecture and Ecosystem (Arm)
Compilers and Tools + Optimisation and Performance (Arm)
Python for HPC (Spallanzani, CINECA)

2016 **Lectures on the Theory of Fundamental Interactions**, *GGI*, Florence, Italy.
Early Universe (P. Creminelli, ICTP)
QFT beyond perturbation theory (L. Giusti, Milano Bicocca U. and INFN)
Effective Field Theories (D. B. Kaplan, U. of Washington and INT, Seattle)
Flavor Physics (Y. Nir, Weizmann Inst.)
Dark Matter (S. Profumo, UC, Santa Cruz)
QCD and Collider Physics (M. Schwartz, Harvard U.)

2015 **Lattice Practices 2015**, *Forschungszentrum Jülich Supercomputing Centre*, Jülich, Germany.
Data analysis (C. Hölbling, Wuppertal U.)
Solvers (A. Frommer and K. Kahl, Wuppertal U.)
Performance Optimization (G. Koutsou, Cyprus Institute)
Computer Architectures (D.Pleiter, JSC/Regensburg U.)
Valence techniques (A. Vaquero, INFN)
Finite temperature QCD (K. Szabo, JSC/Wuppertal U.)

2014 **Lectures on Lattice**, *VII Parma International School of Theoretical Physics*, Parma, Italy.
Introduction to lattice field theories (L. Del Debbio, Edinburgh)
Numerical Methods for lattice QCD (S. Schaefer, DESY NIC)
Lattice Heavy Flavor Physics and Standard Model (M. Della Morte, Odense)
QCD thermodynamics (O. Philipsen, Frankfurt)
Graphene, Topological Insulators and Weyl Semi-metals (P. Buividovich, Regensburg)

PhD Courses

2016 **Advanced topics on Renormalization**, *by A. Vladikas*.

2015 **Anomalies**, *by M.A. Vasquez Mozo*.

2015 **Introduction to String Theory**, *by A. Uranga*.

2015 **Application of Conformal Field Theory**, *by G. Sierra*.

2015 **Introduction to Supersymmetry**, *by L. Fogliani*.

Professional Courses

2019-ongoing **AWS Cloud Practitioner Essentials (Second Edition)**, *AWS training and certification*.

2019-ongoing **Spark and Python for BigData with PySpark**, *by J. Portilla*, Udemy.

2019-ongoing **Python for Data Science and Machine Learning complete Bootcamp**, *by J. Portilla*, Udemy.

2019-ongoing **Learning Python for Data Analysis and Data Visualization**, *by J. Portilla*, Udemy.

2019 **Machine Learning**, *by A. Ng*, Stanford University - Cursera.

2019 **Complete Guide to TensorFlow for Deep Learning with Python**, *by J. Portilla*, Udemy.

2019 **Introduction to TensorFlow for Artificial Intelligence, Machine Learning and Deep Learning**, *by A. Ng*, Coursera.

2019 **Neural Networks and Deep Learning**, *by A. Ng*, Cursera.

2019 **Improving Deep Neural Networks**, *by A. Ng*, Cursera.

2019 **Structuring Machine Learning Projects**, *by A. Ng*, Cursera.

2019 **Convolutional Neural Networks**, *by A. Ng*, Cursera.

2019 **Sequence Models**, *by A. Ng*, Cursera.

Workshop and Conferences

2017 **SM&FT 2017**, *Centro Polifunzionale UniBA*, Bari, IT.
The 17th Workshop on Statistical Mechanics and Non-Perturbative Field Theory

2016 **Lattice 2016**, *University of Southampton*, Southampton, UK.
The 34th International Symposium on Lattice Field Theory

2015 **IV Postgraduate Meeting on Theoretical Physics**, *IFT-CSIC/UAM*, Madrid, Spain.

2015 **Lattice 2015**, *Kobe International Conference Center*, Kobe, Japan.
The 33rd International Symposium of Lattice Field Theory

2015 **eNLarge Horizons**, *IFT-CSIC/UAM*, Madrid, Spain.

Invited Talks

18/06/2018 **Lattice Seminar**, *NIC-DESY Zeuthen/Humboldt University of Berlin*, Berlin, DE.
Non-perturbative renormalization and running of composite operators in the SF schemes

15/11/2017 **Theory Seminar**, *University of Turin*, Turin, IT.
Renormalization of Composite operators in the Schrödinger Functional scheme

26/10/2017 **Theory Seminar**, *Higgs Centre for Theoretical Physics/University of Edinburgh*, Edinburgh, UK.
Running of Composite operators in the Schrödinger Functional scheme

Master Thesis Co-advised

2018 **"Non-Perturbative Renormalization of Tensor Currents"**, *Leonardo Chimirri*, UniTo, University of Turin, Italy.

Teaching

2015-2016 **Assistant Professor**, *"Física - grado en Biología"* , (Physics for Biology).

Research Experience and Interests

My research interests are focused on deepening our understanding of strongly coupled quantum field theories in the Standard Model (SM) and beyond (BSM) including quantum gravity . My main activity is based on non-perturbative aspects of field theories, and their application to high energy particle physics using both analytical and numerical approaches. The latter relies on Monte Carlo (MC) methods which allows for first-principle computations of the theory discretized on a space-time lattice. These techniques are currently implemented on the latest platforms for High Performance Computing (HPC). During my career as a physicist together with theoretical skills I established a series of technical skills in software development (mostly C/C++), scripting (Bash,awk,Pearl), developer tools (Docker, Git, CI systems) and advanced statistical data analysis and visualization (Matlab, Python, Mathematica).
Alongside with Particle Physics I am fascinated by the physics of complex systems. I find particularly interesting Machine Learning, specifically, artificial Neural Networks and their interface with Statistical Mechanics. In this rich landscape I am attracted by the generative models, like Restricted Boltzmann Machines and Generative Adversarial Neural networks or Reinforcement Learning. I am also very keen on the business application of neural networks for processing data. A spectacular success in this field is the word embedding (or in general Natural Language Processing) which is elegantly achieved thanks to the Recurrent Neural Networks. Recently I integrated my academic knowledge of these tools with some self-study attending online courses and participating to Kaggle challenges achieving a good expertise in machine learning and deep learning techniques using standard data science libraries in Python like numpy, pandas, sklearn, seaborn and TensorFlow.

References

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Publications

G. Cossu, L. Del Debbio, M. Panero, **D. Preti**,
Strong dynamics with matter in multiple representations: $SU(4)$ gauge theory with fundamental and sextet fermions,
Submitted to Eur.Phys.J C, arXiv:1904.08885 [hep-lat]

M. Bruno, I. Campos, P. Fritzsch, J. Koponen, C. Pena, **D. Preti**, A. Ramos, and A. Vladikas,
Light and strange quark masses from $N_f = 2 + 1$ simulations with Wilson fermions,
PoS (LATTICE2018), arXiv:1903.04094 [hep-lat]

A. Bussone, I. Herdoíza, C. Pena, **D. Preti**, J.A. Romero, A. Ugarrio
Matching of $N_f = 2 + 1$ CLS ensembles to a tmQCD valence sector ,
PoS (LATTICE2018), arXiv:1903.00286 [hep-lat]

A. Bussone, I. Herdoíza, C. Pena, **D. Preti**, J.A. Romero, A. Ugarrio
First results for charm physics with a tmQCD valence action,
PoS (LATTICE2018), arXiv:1812.05458 [hep-lat]

A. Bussone, S. Chaves, I. Herdoíza, C. Pena, **D. Preti**, J.A. Romero, A. Ugarrio
Heavy-quark physics with a tmQCD valence action,
PoS (LATTICE2018), arXiv:1812.01474 [hep-lat]

I. Campos, P. Fritzsch, C. Pena, **D. Preti**, A. Ramos and A. Vladikas,
Non-perturbative quark mass renormalisation and running in $N_f = 3$ QCD ,
Eur.Phys.J. C78 (2018) no.5, 387.

P. Dimopoulos, G. Herdoíza, M. Papinutto, C. Pena, **D. Preti** and A. Vladikas
Non-Perturbative Renormalisation and

Running of BSM Four-Quark Operators in $N_f = 2$ QCD ,
Eur.Phys.J. C78 (2018) no.7, 579.

G. Herdoíza, C. Pena, **D. Preti**, J.A. Romero, J. Ugarrio,
A tmQCD mixed-action approach to flavour physics
EPJ Web Conf. 175 (2018) 13018

C. Pena and **D. Preti**,
Non-perturbative renormalization of tensor currents: strategy and results for $N_f = 0$ and $N_f = 2$ QCD,
Eur.Phys.J. C78 (2018) no.7, 575 .

M. Papinutto, C. Pena and **D. Preti**,
On the perturbative renormalisation of four-quark operators for new physics,
Eur.Phys.J. C77 (2017) no.6, 376.

I. Campos, P. Fritzsch, C. Pena, **D. Preti**, A. Ramos and T. Vladikas,
Controlling quark mass determinations non-perturbatively in three-flavour QCD,
EPJ Web Conf. 137 (2017) 08006.

I. Campos, P. Fritzsch, C. Pena, **D. Preti**, A. Ramos and A. Vladikas,
Non-perturbative running of quark masses in three-flavour QCD ,
PoS (LATTICE2016) 201, arXiv:1611.09711 [hep-lat].

P. Fritzsch, C. Pena and **D. Preti**,
Non-perturbative renormalization of tensor bilinears in Schrödinger Functional schemes,
PoS (LATTICE2015) 250, arXiv:1511.05024 [hep-lat].

I. Campos, P. Fritzsch, C. Pena, **D. Preti**, A. Ramos and A. Vladikas,
Prospects and status of quark mass renormalization in three-flavour QCD,
PoS (LATTICE2015) 249, arXiv:1508.06939 [hep-lat].

M. Papinutto, C. Pena and **D. Preti**,
Non-perturbative renormalization and running of Delta F=2 four-fermion operators in the SF scheme,
PoS (LATTICE2014) 281, arXiv:1412.1742 [hep-lat].