

Curriculum Vitae of Marco Catillo

PERSONAL DETAILS

Name: Marco Catillo
Date of birth: July 9th, 1992
Place of birth: Rome, Italy
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Github: <https://github.com/mcatillo>

CURRENT POSITION

▷ Postdoctoral position in Theoretical Physics

Institution: Department of Physics, ETH, Zurich, Switzerland
Description: I am currently working on Lattice QCD and numerical simulations regarding the theme of “String breaking in QCD”, through the use of the software package openQ*D (<https://gitlab.com/rcstar/openQxD>) written in C within the RC* collaboration.
Period: January 2021 - present

PREVIOUS JOBS

▷ Postdoctoral position in Theoretical Physics

Institution: Ludwig Maximilian University of Munich (LMU), Munich, Germany
Description: I have worked on computational physics in the field of Theoretical Particle Physics, in particular Lattice QCD, together with Prof. Marina Marinkovic.
Period: January 2020 - December 2020

EDUCATION

▷ Doctor of Philosophy (Ph.D.) in Theoretical Physics

Institution: Karl-Franzens University of Graz, Graz, Austria
Thesis Title: “Dirac eigenmodes and symmetries in QCD”
Supervisor: Prof. Leonid Glozman
Description: My Ph.D. activity in Graz has been focused on the study of the symmetry properties in confinement and deconfinement regime of QCD and the connection with the eigenmodes of the Dirac operator. For this purpose, I have studied the application of Random Matrix Theory in QCD.
Period: March 2016 - June 2019
Grade: Sehr gut (1)

▷ Master’s degree in Theoretical Physics (*Laurea Magistrale in Fisica*)

Institution: University of Rome “La Sapienza”, Rome, Italy
Thesis Title: “Study of tetraquark states on the lattice in Yang-Mills theory”
Supervisors: Prof. Massimo Testa and Prof. Silvano Petrarca
Description: This study has been based on the implementation on the lattice of some numerical techniques based on theoretical ideas of Prof. M. Testa, regarding static color sources in order to obtain static potentials in different color sectors.
Period: October 2013 - December 2015
Grade: 110/110

▷ Bachelor’s degree in Physics (*Laurea Triennale in Fisica*)

Institution: University of Rome “La Sapienza”, Rome, Italy
Thesis Title: “Onde gravitazionali da stelle rotanti”,
(english translation: “Gravitational waves from rotating stars”)
Description: In this thesis, I reviewed the theoretical aspects on how the irregularities of heavy rotating stars, such as neutron stars, can produce gravitational waves and how from their possible detection one could infer some geometric parameters of these stars.
Supervisor: Prof. Leonardo Gualtieri
Period: October 2010 - September 2013
Grade: 109/110

▷ Scientific high school diploma (*Diploma di Maturità Scientifica*)

Institution: Liceo Scientifico Statale “Louis Pasteur”, Rome, Italy
Description: I have finished one year earlier with respect the official duration by virtue of academic merits according to the Italian law DPR n. 122/2009, Art. 6, §2.
Period: September 2006 - July 2010
Grade: 84/100

STUDIES AND EXPERIENCES ABROAD

► Visitor at Stony Brook University

Institution: Stony Brook University, New York, USA

Supervisor: Prof. Jacobus Verbaarschot

Description: During my abroad period I focused on the possibility to have larger symmetries in QCD and their description in terms of Random Matrix Theory models. Moreover I had also the possibility to enlarge my knowledge studying the SYK model, which has important applications in the physics of black holes. In particular I was interested in the study of different physical regimes of this theory, especially in the conformal limit.

Duration: 1 January 2018 - 31 May 2018 (5 months)

► 55th International University week for theoretical physics

Place: Winter School, R  thelstein Castle, Admont, Austria

Duration: 13 February 2017 - 17 February 2017

Link: physik.uni-graz.at/iutp2017/

► International Summer School: Symmetries and Phase Transitions – from Crystals and Superconductors to the Higgs particle and the Cosmos

Place: Technische Universit  t Dresden , Dresden, Germany

Duration: 29 August 2016 - 2 September 2016

Link: tu-dresden.de/mn/internationales/veranstaltungen/sommerschulen/symmetries-and-phase-transitions

ACADEMIC ACTIVITIES

► Teaching activities

In the following I report all teaching activities given at the University which I have done so far.

1.

[<i>Course name:</i> Proseminar: Systems out of equilibrium
	<i>Role:</i> Tutor
	<i>Institution:</i> ETH Zurich
	<i>Period:</i> Winter semester 2022
	<i>Description:</i> I am preparing one master student for the course's examination. This course has been held by Dr. Ramasubramanian Chitra (ETH).
2.

[<i>Course name:</i> Proseminar: Quantum Information: From Foundations to Algorithms
	<i>Role:</i> Tutor
	<i>Institution:</i> ETH Zurich
	<i>Period:</i> Spring semester 2022
	<i>Description:</i> I have prepared 4 Masters students for the course's examination. This course has been held by Dr. Joseph Renes (ETH).
3.

[<i>Course name:</i> Proseminar: The Physics of Leptons
	<i>Role:</i> Tutor
	<i>Institution:</i> ETH Zurich
	<i>Period:</i> Winter semester 2021/22
	<i>Description:</i> I have prepared 4 Masters students for the course's examination. This course has been held by Dr. Achilleas Lazopoulos (ETH).

4.

<i>Course name:</i>	Proseminar: Open questions in particle physics and cosmology
<i>Role:</i>	Tutor
<i>Institution:</i>	ETH Zurich
<i>Period:</i>	Spring semester 2021
<i>Description:</i>	I have prepared 4 Masters students for the course's examination. This course has been held by Dr. Achilleas Lazopoulos (ETH).
5.

<i>Course name:</i>	Classical and Quantum Simulations of Physical Systems
<i>Role:</i>	Assistant
<i>Institution:</i>	Ludwig Maximilian University of Munich (LMU)
<i>Period:</i>	Winter semester 2020/21
<i>Description:</i>	I have given some lessons about quantum computing, in particular an introduction to the package <u>Qiskit</u> of IBM and organize exercises for students on quantum computation, error analysis and so on. The owner of the course has been Prof. Marina Marinkovic (ETH).
6.

<i>Course name:</i>	Introduction to Lattice Gauge Theories
<i>Role:</i>	Assistant
<i>Institution:</i>	Ludwig Maximilian University of Munich (LMU)
<i>Period:</i>	Spring semester 2020
<i>Description:</i>	I have given some lessons on error analysis estimation (jackknife, bootstrap, autocorrelation method and so on) and an introduction to quantum computing. The owner of the course has been Prof. Marina Marinkovic (ETH).

► Workshops

1.

<i>Course name:</i>	Quantum Computing and Quantum Networking
<i>Role:</i>	Assistant
<i>Institution:</i>	Ludwig Maximilian University of Munich (LMU)
<i>Period:</i>	6 September 2021 (one day workshop)
<i>Description:</i>	I have given an introduction to <u>Qiskit</u> of IBM and followed the students through the exercises. The workshop has been organized by Prof. Marina Radulaski (University of California, Davis).

► More

- **Organizer** of the **Theoretical Particle Physics Seminar** at ETH, together with Dr. Achilleas Lazopoulos, Prof. Anastasios Charalampos and Dr. Ben Stefanek, for the Spring semester of 2021, <https://itp.phys.ethz.ch/research/particle/seminar.html>.
- **Organizer** of the **Theoretical Particle Physics Seminar** at ETH, together with Prof. Marina Marinkovic, Dr. Javad Komijani, Dr. Javier Lizana, for the Spring semester of 2022, <https://itp.phys.ethz.ch/research/particle/seminar.html>.

OTHER FORMATIVE ACTIVITIES

During my career, I have been taken other important courses and activities in addition to those provided by the usual academic path. Here I want to mention some of the most interesting ones.

- *EuroHack22: GPU Programming Hackathon.* From 19 to 29 September of 2022. *Place:* via Zoom and in presence at the Hotel De La Paix in Lugano, Switzerland. It has been organized by the Swiss National Supercomputing Centre (CSCS). *Description:* We have created an interface for using gauge

configurations generated with openQ*D in QUDA, which is a software package for running Lattice QCD simulations on GPUs.

- *EPFL OpenACC Bootcamp 2021*. From 9 to 10 September of 2021. *Place*: the course has been provided by the engineer of NVIDIA via Zoom. *Description*: Intensive course on the use of OpenACC for the GPU programming.
- *Advanced Parallel Programming with MPI and OpenMP*. From November 30 until December 2, 2020. *Place*: via Zoom from the High Performance Computing Center Stuttgart (HLRS) from the University of Stuttgart. *Description*: intensive course on the use of MPI and OpenMP in the context of C/C++ programming.
- *Intel Hackathon*. From May 17 to 19, 2021. *Place*: via Zoom and organized by Prof. Biagio Lucini. *Description*: training on the use of OpenMP in order to speedup the code openQ*D for Lattice QCD simulations.
- *Python Basics: for doctoral Students in Natural Sciences*. October 28, 2016. *Place*: University of Graz. *Description*: intensive course on the use of Python for scientific research.

RESEARCH PROJECTS

- It has been approved my research project (PROJECT-ID-423) for the use of computational resources of Piz Daint of the Swiss National Supercomputing Centre (CSCS, <https://www.cscs.ch/>) for a period of 12 months, from October 2021 until October 2022.

Project title: String breaking in QCD using C* boundary conditions.

Users: Dr. Marco Catillo (ETH Zurich), Prof. Marina Marinkovic (ETH Zurich), Prof. Pedro Bicudo (Universidade de Lisboa), Dr. Nuno Cardoso (Universidade de Lisboa)

Principal Investigator: Dr. Marco Catillo

RESEARCH INTERESTS

From my master thesis and subsequently in my whole scientific path in academia, I have mainly worked on Lattice QCD simulations and in the implementation of algorithms for improving the signal to noise ratio in numerical simulations. My interests are therefore mostly devoted on algorithms. I have been also interested in increasing as much as I could my programming skills especially in C, Python but also not research oriented programming languages such as Javascript, Perl, Mysql, etc. From the physics side, my interests have been various. I have studied problems concerning topology in QCD, such as the role of instantons, monopoles and dyons, also from the analytical side. I have been working on Random Matrix Theory (RMT), especially its connection with QCD and its relation with chiral symmetry breaking. For a short period I have been also concentrated in the study of SYK model, exploiting RMT concepts to it. Recently also my attention has been focused in quantum computing and possible implementation of algorithms for lattice simulations on potential quantum computers. Nevertheless this is still in progress. In summary, my research interests are

1. Non-perturbative methods in QCD
2. Random Matrix Theory
3. Theoretical aspects of lattice gauge theories
4. Algorithms for Lattice QCD
5. Quantum computing

SKILLS

Programming skills: During my education from the Bachelor to the most recent Postdoc, I had the opportunity to learn several programming tools which has been useful for my research activity.

- *C*; scientific knowledge. Used for all kind of numerical simulations, especially for Lattice QCD.
- *C++*; scientific knowledge for what concern the use of classes and a bit of functional programming.
- *Perl*; basic knowledge, mostly used for regular expressions and small simple scripts.
- *Python*; knowledge for scientific purposes, i.e. data analysis and numerical simulations.
- *HTML*, *CSS*, *Javascript*; basic knowledge for developing small webpages.
- *MySQL*; medium knowledge.
- *LaTeX*; as preferred markup language for writing scientific papers.

Most used software: The list of software which I encountered in my studies is pretty long. However here I give just what I believe are the most important ones and for which I have more experience.

- *Mathematica*. Concerning my research papers, I have used this mainly for analytical derivations, which maybe were too long and complicated to perform by hand; as help for proving theorems; and for some data analysis too.
- *Matlab*. I have used this for running some numerical simulations regarding Random Matrix Theory, both for applications in QCD and SYK model.
- *OriginLab*. Used for data analysis, during my period as student, for several University courses.
- *ROOT C++ (CERN)*. It has been my preferred tool for data analysis for the course of Nuclear Physics during my Master, and also intensively used at the beginning of my PhD.
- Most common text editors for coding, like *GNU Emacs*, *gedit*, *Vim*, *Nano*, *Windows Notepad*, *Kate*, *Atom*, *Xcode*, *Visual Studio* and so on.
- Software for plotting. Mainly *Gnuplot* and *Matplotlib*, but also the tools for plotting already integrated in the aforementioned software.
- Jupyter notebook.

Frequently used packages and libraries:

Here I just give a list of interesting packages and libraries which I have been using during my research career.

- *LAPACK/ARPACK*. Used for solving eigenvalue problems in Lattice QCD.
- *OpenMP*, *MPI*. Used for speedup codes of Lattice QCD, exploiting parallelization on CPUs, especially used in openQ*D.
- *OpenACC*, *CUDA C*. At basic level, in order to exploit parallelization on GPUs.
- *GMP*. As library for setting numerical precision in C codes.

Operative systems: I have had experience with the three most common operative systems. *GNU/Linux*, specifically *Ubuntu* and *KDE*; *Windows*, from the old version of *Windows 98* up to the most recent one; *macOS*, from the version 10.9 of *Mavericks* up to the current version.

Other programming experiences: During my research activity, I have learned the usage of clusters and supercomputers, like PizDaint of CSCS in Switzerland (during my Postdoc at ETH in Zurich), and HLRN in Germany (during my PostDoc at LMU, in Munich). I have a long experience with the terminal, shell

and bash. This last for writing small scripts in order to organize the jobs to be sent to clusters and/or supercomputers.

I have also matured an experience on Quantum computing, in particular in the use of *Qiskit* from IBM, for which I have taught to students the basics of such new kind computation at the **Workshops** with Prof. Marina Radulaski aforementioned and during the course of **Classical and Quantum Simulations of Physical Systems** with Prof. Marina Marinkovic.

Foreign languages:

- Italian. Mother tongue
- English. Professional knowledge. TOEFL certification, score: 91/120.
- German. Basic knowledge. ÖSD certification, level B1.

AWARDS AND GRANTS

I have finished the high school one year before the scheduled date for the regular course of study, by virtue of academic merits, according to the Italian law “DPR n.122 / 2009, Article 6, paragraph 2”.

TALKS AND POSTERS

In the following list are indicated in chronological order all talks and posters given in conferences, workshops and seminars at which I have participated.

1. **Talk** at FunQCD22. *Place*: Valencia, Spain. *Title*: “Chiralspin symmetry group and its presence in QCD” *Period*: June 2022. *Website*: <https://sites.google.com/view/funqcd22/>.
2. **Talk** at XXXIII International Workshop on High Energy Physics (Hard Problems of Hadron Physics: Non-Perturbative QCD & Related Quests). *Place*: via Zoom, intended to be in Protvino, Russia. *Title*: “Chiralspin symmetry and confinement in QCD”. *Period*: November 2021. *Website*: <https://indico.ihep.su/event/607/overview>.
3. **Talk** at APLAT 2020, “Asia-Pacific Symposium for Lattice Field Theory”. *Place*: Asia/Tokyo, web conference via zoom. *Title*: “From QCD string breaking to quarkonium spectrum”. *Period*: August 2020. *Website*: <https://conference-indico.kek.jp/event/113/>.
4. **Talk** at Excited QCD 2020. *Place*: Krynica Zdrój, Poland. *Title*: “From string breaking to quarkonium spectrum”. *Period*: February 2020. *Website*: <https://indico.cern.ch/event/827578>.
5. **Talk** at ACHT 2018, “Non-Perturbative Methods in Quantum Field Theory”. *Place*: Leibnitz, Austria. *Title*: “Chiralspin symmetry and baryons”. *Period*: September 2018. *Website*: <https://physikindico.uni-graz.at/event/1/>.
6. **Talk** at “Quantum Chromodynamics and Its Symmetries”. *Place*: Oberwölz, Austria. *Title*: “Baryon parity doublets and chiralspin symmetry”. *Period*: September 2018. *Website*: <http://physik.uni-graz.at/oberwoelz2018/>.
7. **Talk** at Stony Brook University, New York, USA. *Place*: Stony Brook University, Stony Brook, NY 11790, USA. *Title*: “On the emergence of particular symmetries in QCD”. *Period*: May 2018. *Website*: https://sites.google.com/a/stonybrook.edu/nuclear_theory_seminars/.
8. **Talk** at “Technical Advances in Lattice Field Theory”. *Place*: University of Southern Denmark, CP-Origins, Odense, Denmark. *Title*: “Distribution of the Dirac eigenmodes in QCD and random matrix theory”. *Period*: December 2017. *Website*: <https://www.cp3-origins.dk/home/>.

9. **Talk** at *35th International Symposium on Lattice Field Theory*, Lattice 2017. *Place*: Granada, Spain. *Title*: “Distribution of the Dirac modes in QCD”. *Period*: June 2017. *Website*: <http://wpd.ugr.es/~lattice2017/>.
10. **Poster** at *55th International University week for theoretical physics*, Winter School. *Place*: Admont, Austria. *Title*: “Distribution of the Dirac modes in QCD”. *Period*: February 2017. *Website*: <http://physik.uni-graz.at/iutp2017/>.
11. **Talk** at “Monitoring Workshop Graz – Jena – Wien”. *Place*: Erwin Schrödinger International Institute for Mathematics and Physics, Vienna, Austria. *Title*: “Distribution of the Dirac modes in QCD”. *Period*: December 2016. *Website*: <http://www.dkpi.at/event/dk-joint-meeting-grazwienjena/>.
12. **Talk** at *Gauge topology: from lattice to colliders*, Workshop in ECT*. *Place*: ECT*, European Center for Theoretical Studies in Nuclear Physics and Related Areas, Trento, Italy. *Title*: “Distribution of the Dirac modes in QCD”. *Period*: November 2016. *Website*: <http://www.ectstar.eu/node/1668>.

SCIENTIFIC WORKS

Below, I report all my scientific papers. The complete list can be also found on [arXiv](#) or on [INSPIRE HEP](#).

1. **First results on QCD+QED with C* boundary conditions**

Lucius Bushnaq (Trinity Coll., Dublin), Isabel Campos (Cantabria Inst. of Phys.), Marco Catillo (ETH, Zurich (main)), Alessandro Cotellucci (Humboldt U., Berlin), Madeleine Dale (INFN, Rome2 and INFN, Rome) et al.

e-Print: [2209.13183](#) [hep-lat]

2. **Implementing noise reduction techniques into the OpenQ*D package**

Lucius Bushnaq (Trinity Coll., Dublin), Isabel Campos (Cantabria Inst. of Phys.), Marco Catillo (Zurich, ETH), Alessandro Cotellucci (Humboldt U., Berlin), Madeleine Evie Beth Dale (Rome U. and INFN, Rome and Cyprus U.) et al.

e-Print: [2201.09729](#) [hep-lat]

DOI: [10.22323/1.396.0363](#)

Published in: PoS LATTICE2021 (2022), 363,

3. **Baryon masses from full QCD+QED\$C\$ simulations**

Madeleine Evie Beth Dale (Rome U. and INFN, Rome and Cyprus U.), Lucius Bushnaq (Trinity Coll., Dublin), Isabel Campos (Cantabria U., Santander and Cantabria Inst. of Phys.), Marco Catillo (ETH, Zurich (main)), Alessandro Cotellucci (Humboldt U., Berlin) et al.

e-Print: [2112.12767](#) [hep-lat]

DOI: [10.22323/1.396.0373](#)

Published in: PoS LATTICE2021 (2022), 373,

4. **Chiral spin symmetry and confinement**

Marco Catillo (Zurich, ETH)

e-Print: [2112.06850](#) [hep-lat]

DOI: [10.21468/SciPostPhysProc.6.016](#)

Published in: SciPost Phys.Proc. 6 (2022), 016,

5. **A chiral-spin symmetry in QCD in Minkowski spacetime**

Marco Catillo (Zurich, ETH)

e-Print: [2111.07324](#) [hep-lat]

DOI: [10.1103/PhysRevD.105.114512](#) (publication)

Published in: Phys.Rev.D 105 (2022) 11, 114512

6. **On SU(2)CS-like groups and invariance of the fermionic action in QCD**
 Marco Catillo (Zurich, ETH)
 e-Print: [2109.03532](#) [hep-lat]
 DOI: [10.1142/S0217751X22501020](#)
 Published in: Int.J.Mod.Phys.A 37 (2022) 16, 2250102, Int.J.Mod.Phys.A 37 (2022), 2250102
7. **An update on QCD+QED simulations with C* boundary conditions**
 RC* Collaboration • Jens Luecke (Humboldt U., Berlin and DESY, Zeuthen) et al.
 e-Print: [2108.11989](#) [hep-lat]
 DOI: [10.22323/1.396.0293](#)
 Published in: PoS LATTICE2021 (2022), 293
8. **Gap in the Dirac spectrum and quark propagator symmetries in lattice QCD**
 Marco Catillo (ETH, Zurich (main))
 e-Print: [2102.07224](#) [hep-lat]
9. **From string breaking to quarkonium spectrum**
 Marco Catillo (Munich U., ASC), Marina Krstić Marinković (Munich U., ASC), Pedro Bicudo (Taguspark, IST), Nuno Cardoso (Taguspark, IST)
 e-Print: [2005.05723](#) [hep-lat]
 DOI: [10.5506/APhysPolBSupp.14.93](#)
 Published in: Acta Phys.Polon.Supp. 14 (2021), 93
10. **Chiral-spin symmetry emergence in baryons and eigenmodes of the Dirac operator**
 Marco Catillo (Graz U.), Leonid Ya. Glozman (Graz U.), Christian B. Lang (Graz U.)
 e-Print: [1904.01969](#) [hep-ph]
 DOI: [10.1103/PhysRevD.99.094040](#)
 Published in: Phys.Rev.D 99 (2019) 9, 094040
11. **Dirac eigenmodes and symmetries in QCD**
 Marco Catillo (Graz U.)
 Ph.D. Thesis
12. **Baryon parity doublets and chiral spin symmetry**
 M. Catillo (Graz U.), L.Ya. Glozman (Graz U.)
 e-Print: [1804.07171](#) [hep-ph]
 DOI: [10.1103/PhysRevD.98.014030](#)
 Published in: Phys.Rev.D 98 (2018) 1, 014030
13. **Distribution law of the Dirac eigenmodes in QCD**
 M. Catillo (Graz U.), L. Ya. Glozman (Graz U.)
 e-Print: [1709.01886](#) [hep-lat]
 DOI: [10.1142/S0217751X18500549](#)
 Published in: Int.J.Mod.Phys.A 33 (2018) 10, 1850054
14. **Distribution of the Dirac modes in QCD**
 M. Catillo (Graz U.), L. Ya. Glozman (Graz U.)
 e-Print: [1707.07055](#) [hep-lat]
 DOI: [10.1051/epjconf/201817504005](#)
 Published in: EPJ Web Conf. 175 (2018), 04005

I hereby give my consensus that my personal data provided with this application are used for all the procedures involved and required by this selection.