

# Curriculum Vitae ac Studiorum

Nazario Tantalo

- **personal information**

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## SCIENTIFIC ACTIVITY

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My research activity has been mostly focused on the study of the non-perturbative dynamics and phenomenology of strong interacting particles. I have also worked on Biological systems of medical relevance. In particular, I have given relevant contributions to:

- the study of the chiral regime of Quantum Chromo Dynamics (QCD) by performing, for the first time, numerical simulations of the two dynamical flavour formulation of the theory in physical volumes. These results have been obtained in collaboration with the CERN group.
- the understanding of the aggregation mechanism of amyloid fibrils, complex biological structures formed by some proteins. In collaboration with the ETH group, we have obtained important quantitative results for the protein  $A\beta$  responsible for the neuro-degenerative Alzheimer's disease.
- the solution of the problem of the discretization of spatial momenta on a finite volume. Our group at Tor Vergata has proposed a method to solve this problem that is now widely used within the lattice community in order to obtain theoretical predictions of high phenomenological relevance.
- the non-perturbative study of heavy-flavour physics. In collaboration with the DESY group, we have developed efficient strategies to approach the difficult problem of  $b$ -physics on the lattice and obtained important results such as the theoretical calculation of the  $B \mapsto D^{(*)} \ell \nu$  decay rates as a function of the momentum transfer.
- the study of electromagnetic (QED) corrections to hadronic processes. Recently, I have given fundamental contributions in this field.

In a collaboration among the three Universities of Rome, the RM123 collaboration, we have devised an efficient method to calculate QED radiative corrections to QCD processes. We have used this method to calculate the mass splitting of charged hadrons and, for the first time, the decay rates  $K \mapsto \ell \nu(\gamma)$  and  $\pi \mapsto \ell \nu(\gamma)$ . These decay rates are crucial inputs for the extraction of the CKM matrix elements of the first row and QED radiative corrections must be taken into account to match the experimental precision.

In a collaboration with the CERN group, we have solved the long-standing problem of the definition of a charged state on a finite volume within the framework of local quantum field theory. On the basis of these theoretical results, I have recently founded a new international collaboration, the RC\* collaboration. Within the RC\* collaboration we have developed a state-of-the-art software package to perform QCD+QED simulations and made it publicly available to the scientific community (see <https://gitlab.com/rcstar/openQxD>).

I have been awarded of a Scientific Associate fellowship from CERN and visited for short periods many institutions, e.g. DESY, ETH, ORSAY, and several Universities in Europe. I have been a member of organizing committees of workshops and international conferences, such as LATTICE2010, and referee for important journals, such as JHEP, Physics Letters B, Nuclear Physics B and Science. My scientific papers currently have more than 2200 citations with an  $h$ -index of 23 (Google Scholar).

I have been a member of the scientific board of the project “Problemi Interdisciplinari riconducibili a Simulazioni Numeriche su Larga Scala” of the “Museo Storico della Fisica e Centro Studi e Ricerche E. Fermi”. Within this project, led by Prof. R. Petronzio, I have directed a large computing center with several super-computers. Many research groups from international institutions have used these resources to perform state-of-the-art numerical simulations in research fields ranging from particle physics to biological and medical science. For example, the website Madgraph that allows to perform Monte Carlo calculations of hadronic cross-sections for LHC physics has been developed by the authors within this initiative and it has been running for five years on the E. Fermi PC clusters.

I’m a member of the LQCD123 INFN initiative and I have been a member of the APE collaboration and of the INFN committee for super-computing resources in theoretical physics. I have also been a member of the INFN committee for the Fubini prize.

The computational and theoretical physics group of Tor Vergata has recently obtained an Horizon2020 Grant for an European Joint Doctorate called STIMULATE. The institutions participating to the STIMULATE international training network are the Humboldt-Universitaet zu Berlin, the Bergische Universitaet of Wuppertal, the University of Cyprus, the Cyprus Institute, the University of Ferrara, the Rheinisch-Westfaelische Technische Hochschule of Aachen, the Hebrew University of Jerusalem and the University of Rome Tor Vergata. I’m a member of this project.

I’m the PI of the project PLNUGAMMA recently funded by the University fo Rome Tor Vergata to perform the first non-perturbative calculation of the QED radiative corrections real-photon-emission contributions to the leptonic decay rates of light and heavy-light pseudoscalar mesons.

I’m a member of the research Local Evaluation Committee (GLV) of the INFN. The groups has the responsibility of collecting, analyzing and evaluating the research products of the INFN.

## POSITIONS

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- **October 2017**

**Associate Professor in Theoretical Physics**  
Abilitation for the position of Full Professor (2019–2025)  
University of Rome Tor Vergata  
Via O. Raimondi 18, 00173 Rome (Rome) Italy

- October 2017
- November 2010

**Research Staff, Permanent**  
 University of Rome Tor Vergata  
 Via O. Raimondi 18, 00173 Rome (Rome) Italy

- March 2015
- March 2014

**Scientific Associate**  
 CERN Physics Department  
 1211 Geneva 23, Switzerland

- November 2010
- December 2007

**Research Staff, Non-Permanent**  
 Istituto Nazionale di Fisica Nucleare I.N.F.N.  
 Via E. Fermi 40, 00044 Frascati (Rome) Italy

- April 2007
- May 2005

**Research Fellow**  
 Istituto Nazionale di Fisica Nucleare I.N.F.N.  
 Via E. Fermi 40, 00044 Frascati (Rome) Italy

- November 2010
- March 2004

**Scientific Collaborator**  
 Museo Storico della Fisica e Centro Ricerche “E. Fermi”  
 Compendio Viminale, 00184 (Rome) Italy

- October 2001
- June 2001

**Scientific Collaborator**  
 Università degli Studi di Roma “La Sapienza”  
 Piazzale A. Moro 5, 00185 (Rome) Italy

## TEACHING

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- →
- 2019

*Quantum Field Theory and Particle Physics*  
 University of Rome Tor Vergata  
 course for undergraduate and Ph.D students

- →
- 2011

*Complements: Relativistic Quantum Mechanics*  
 University of Rome Tor Vergata  
 main course: *Relativistic Quantum Mechanics*, Prof. A. Salvio  
 course for undergraduate students

- 2018
- 2016

*Phenomenology of the Elementary Particles*  
 University of Rome Tor Vergata  
 course for undergraduate and Ph.D students

- 2018
- 2017

*Classical Field Theory*  
 University of Rome Tor Vergata  
 course for undergraduate students

- 2018
  - 2015
- Complements: Quantum Field Theory and Particle Physics*  
University of Rome Tor Vergata
- main course: *Quantum Field Theory and Particle Physics*, Prof. M. Bianchi  
course for undergraduate and Ph.D. students
- 
- 2014
  - 2011
- Lattice Gauge Theories*  
University of Rome Tor Vergata
- course for undergraduate and Ph.D. students
- 
- 2012
  - 2004
- Complements: Quantum Field Theory and Particle Physics*  
University of Rome Tor Vergata
- main course: *Quantum Field Theory and Particle Physics*, Prof. R. Petronzio  
course for undergraduate and Ph.D. students
- 
- 2002
- Complements: Classical Mechanics*  
University of Rome Tor Vergata
- main course: *Classical Mechanics*, Prof. G.C. Rossi  
course for undergraduate students

## EDUCATION

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- 11-10-2005
- Ph.D. in Physics  
University of Rome Tor Vergata  
Advisor: Prof. Roberto Petronzio
- 
- 25-05-2001
- Master Degree in Physics  
Università degli Studi di Roma “La Sapienza”  
Advisor: Prof. Nicola Cabibbo

## CONFERENCES

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Over the years I had to opportunity to give talks at several conferences and workshops. Here I list some of the invited and plenary talks:

- 2019
- Talk: QED radiative corrections to hadronic decays.  
CERN Theory colloquium and plenary talk at the Advances in  
Lattice Gauge Theory 2019 workshop, Geneva, Switzerland.

- 2018

Talk:  $|V_{us}/V_{ud}|$  from  $K_{\mu 2}/K_{\pi 2}$ .  
 10th International Workshop on the CKM Unitarity Triangle (CKM 2018), Heidelberg, Germany.
- 2017

Organization of the International Symposium in honour of R. Petronzio.  
 Monte Porzio Catone, Italy.
- 2014

Talk: Review of the Lattice QCD results.  
 8th International Workshop on the CKM Unitarity Triangle (CKM 2014), Vienna, AU
- 2013

Talk: Isospin Breaking Effects in Lattice QCD  
 The XXXI International Symposium on Lattice Field Theory, Mainz, Germany
- 2012

Talk: Lattice QCD calculations of isospin corrections to  $K_{l2}$  and  $K_{l3}$  decays.  
 7th International Workshop on the CKM Unitarity Triangle (CKM 2012), Cincinnati, USA
- 2011

Talk: Lattice flavour physics.  
 2011 Europhysics Conference On High Energy Physics: HEP 2011 (EPS-HEP2011), Grenoble, France
- 2011

Talk: Lattice QCD in view of the SuperB.  
 XVII SuperB Workshop and Kick Off Meeting, La Biodola, Italy
- 2010

Member of the Organizing Committee of LATTICE 2010  
 The XXVIII International Symposium on Lattice Field Theory, Villasimius, Italia
- 2008

Talk: Future prospects for LQCD form factors calculations.  
 5th International Workshop on the CKM Unitarity Triangle (CKM 2008), Rome, Italy
- 2008

Talk: Heavy-light meson's physics in Lattice QCD.  
 34th International Conference on High Energy Physics (ICHEP 2008), Philadelphia, USA
- 2006

Talk: Lattice calculations for B and K mixing.  
 4th International Workshop on the CKM Unitarity Triangle (CKM 2006), Nagoya, Japan

- [1] L. Giusti, S. Petrarca, B. Taglienti and N. Tantalo, “Remarks on the gauge dependence of the RI / MOM renormalization procedure,” *Phys. Lett. B* **541** (2002) 350 [hep-lat/0205009].
- [2] M. Guagnelli, F. Palombi, R. Petronzio and N. Tantalo, “f(B) and two scales problems in lattice QCD,” *Phys. Lett. B* **546** (2002) 237 [hep-lat/0206023].
- [3] M. Guagnelli, R. Petronzio and N. Tantalo, “The Lattice scale at large beta in quenched QCD,” *Phys. Lett. B* **548** (2002) 58 [hep-lat/0209112].
- [4] G. M. de Divitiis, M. Guagnelli, R. Petronzio, N. Tantalo and F. Palombi, “Heavy quark masses in the continuum limit of quenched lattice QCD,” *Nucl. Phys. B* **675** (2003) 309 [hep-lat/0305018].
- [5] G. M. de Divitiis, M. Guagnelli, F. Palombi, R. Petronzio and N. Tantalo, “Heavy light decay constants in the continuum limit of quenched lattice QCD,” *Nucl. Phys. B* **672** (2003) 372 [hep-lat/0307005].
- [6] G. M. de Divitiis, R. Petronzio and N. Tantalo, “On the discretization of physical momenta in lattice QCD,” *Phys. Lett. B* **595** (2004) 408 [hep-lat/0405002].
- [7] L. Del Debbio, L. Giusti, M. Luscher, R. Petronzio and N. Tantalo, “Stability of lattice QCD simulations and the thermodynamic limit,” *JHEP* **0602** (2006) 011 [hep-lat/0512021].
- [8] U.F. Röhrig, A. Laio, N. Tantalo, M. Parrinello and R. Petronzio, “Stability and structure of oligomers of the Alzheimer peptide  $A\beta_{16-22}$ : from dimer to the 32-mer,” *BIOPHYSJ* **91**:3217 (2006)
- [9] L. Del Debbio, L. Giusti, M. Luscher, R. Petronzio and N. Tantalo, “QCD with light Wilson quarks on fine lattices (I): First experiences and physics results,” *JHEP* **0702** (2007) 056 [hep-lat/0610059].
- [10] L. Del Debbio, L. Giusti, M. Luscher, R. Petronzio and N. Tantalo, “QCD with light Wilson quarks on fine lattices. II. DD-HMC simulations and data analysis,” *JHEP* **0702** (2007) 082 [hep-lat/0701009].
- [11] G. M. de Divitiis, E. Molinaro, R. Petronzio and N. Tantalo, “Quenched lattice calculation of the  $B \mapsto D\ell\nu$  decay rate,” *Phys. Lett. B* **655** (2007) 45 [arXiv:0707.0582 [hep-lat]].
- [12] G. M. de Divitiis, R. Petronzio and N. Tantalo, “Quenched lattice calculation of semileptonic heavy-light meson form factors,” *JHEP* **0710** (2007) 062 [arXiv:0707.0587 [hep-lat]].
- [13] D. Guazzini, R. Sommer and N. Tantalo, “Precision for B-meson matrix elements,” *JHEP* **0801** (2008) 076 [arXiv:0710.2229 [hep-lat]].
- [14] G. M. de Divitiis, R. Petronzio and N. Tantalo, “Quenched lattice calculation of the vector channel  $B \mapsto D^*\ell\nu$  decay rate,” *Nucl. Phys. B* **807** (2009) 373 [arXiv:0807.2944 [hep-lat]].
- [15] M. Antonelli, D. M. Asner, D. A. Bauer, T. G. Becher, M. Beneke, A. J. Bevan, M. Blanke and C. Bloise *et al.*, “Flavor Physics in the Quark Sector,” *Phys. Rept.* **494** (2010) 197 [arXiv:0907.5386 [hep-ph]].
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- [17] N. Tantalo, “Computer simulations of the theory of strong interactions,” *Nuovo Cim. C* **32N2** (2009) 267.
- [18] G. M. de Divitiis, R. Petronzio and N. Tantalo, “Distance preconditioning for lattice Dirac operators,” *Phys. Lett. B* **692** (2010) 157 [arXiv:1006.4028 [hep-lat]].
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- [20] B. Blossier *et al.* [ALPHA Collaboration], “Parameters of Heavy Quark Effective Theory from Nf=2 lattice QCD,” *JHEP* **1209** (2012) 132 [arXiv:1203.6516 [hep-lat]].

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- [26] B. Lucini, A. Patella, A. Ramos and N. Tantalo, “Charged hadrons in local finite-volume QED+QCD with  $C^*$  boundary conditions,” *JHEP* **1602** (2016) 076 doi:10.1007/JHEP02(2016)076 [arXiv:1509.01636 [hep-th]].
- [27] V. Lubicz, G. Martinelli, C. T. Sachrajda, F. Sanfilippo, S. Simula and N. Tantalo, “Finite-Volume QED Corrections to Decay Amplitudes in Lattice QCD,” *Phys. Rev. D* **95** (2017) no.3, 034504 doi:10.1103/PhysRevD.95.034504 [arXiv:1611.08497 [hep-lat]].
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## CONFERENCE PROCEEDINGS

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- [38] N. Tantalo, “Remarks on the discretization of physical momenta in lattice QCD,” Nucl. Phys. Proc. Suppl. **140** (2005) 332 [hep-lat/0409037].
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- [48] N. Tantalo, “Lattice flavour physics,” PoS EPS **-HEP2011** (2011) 179.
- [49] G. M. de Divitiis, P. Dimopoulos, R. Frezzotti, V. Lubicz, G. Martinelli, R. Petronzio, G. C. Rossi and F. Sanfilippo *et al.*, “Lattice QCD calculation of strong isospin breaking effects,” arXiv:1202.5222 [hep-lat].
- [50] N. Tantalo, “Lattice calculation of isospin corrections to  $K_{l2}$  and  $K_{l3}$  decays,” arXiv:1301.2881 [hep-lat].
- [51] N. Tantalo, “Isospin Breaking Effects on the Lattice,” arXiv:1311.2797 [hep-lat].
- [52] M. Papinutto, F. Piccinini, A. Pilloni, A. D. Polosa and N. Tantalo, “A Tentative Description of  $Z_{c,b}$  States in Terms of Metastable Feshbach Resonances,” arXiv:1311.7374 [hep-ph].
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- [54] V. Lubicz, N. Carrasco, G. Martinelli, C. Sachrajda, N. Tantalo, C. Tarantino and M. Testa, “QED corrections to hadronic processes: a strategy for lattice QCD,” PoS CD **15** (2016) 023.
- [55] V. Lubicz, G. Martinelli, C. T. Sachrajda, F. Sanfilippo, S. Simula, N. Tantalo and C. Tarantino, “Electromagnetic corrections to the leptonic decay rates of charged pseudoscalar mesons: lattice results,” PoS LATTICE **2016** (2016) 290 [arXiv:1610.09668 [hep-lat]].
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- [58] V. Lubicz, G. Martinelli, C. T. Sachrajda, F. Sanfilippo, S. Simula and N. Tantalo, “Electromagnetic Corrections to Hadronic Decays from Lattice QCD,” J. Phys. Conf. Ser. **800** (2017) no.1, 012005. doi:10.1088/1742-6596/800/1/012005
- [59] D. Giusti, V. Lubicz, G. Martinelli, C. Sachrajda, F. Sanfilippo, S. Simula and N. Tantalo, PoS LATTICE **2018** (2019) 266 doi:10.22323/1.334.0266 [arXiv:1811.06364 [hep-lat]].



- [60] I. Campos, P. Fritzsche, M. Hansen, M. K. Marinkovi?, A. Patella, A. Ramos and N. Tantalo, EPJ Web Conf. **175** (2018) 09005 doi:10.1051/epjconf/201817509005 [arXiv:1710.08839 [hep-lat]].
- [61] M. Hansen, B. Lucini, A. Patella and N. Tantalo, EPJ Web Conf. **175** (2018) 09001 doi:10.1051/epjconf/201817509001 [arXiv:1710.08838 [hep-lat]].
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