

Quantum Computing/Technologies and HEP in Portugal

Yasser Omar

contact.yasser@pqi.pt

PQI – Portuguese Quantum Institute

DM, Instituto Superior Técnico, Universidade de Lisboa

Physics of Information and Quantum Technologies Group, CeFEMA



The Teams

- **Instituto Superior Técnico, ULisbon (CeFEMA, PQI)**

2 Professors, 1 Researcher, 1 PhD Student, 1 Master Student

- **UCoimbra (CFisUC)**

2 Professors, 1 Undergraduate Student

- **UMinho (LIP)**

2 Professors, 2 Researchers, 3 Master Students

Research Projects and Funding

- **QuantHEP – Quantum Computing Solutions for High-Energy Physics**

IST/CeFEMA, QuantERA/0001/2019, 01/2020 – 12/2023, 250 k€

- **QEntHEP – Quantum Entanglement in High Energy Physics**

IST/IT, FCT EXPL/FIS-PAR/1604/2021, 01/2022 – 06/2023, 50 k€

- **HEPQC – Quantum Computation in High Energy Physics**

IST/IT, FCT CERN/FIS-COM/0036/2019, 09/2020 – 08/2022, 30 k€

- **Exploring quantum machine learning as a tool for present and future high energy physics colliders**

UMinho/LIP, FCT CERN/FIS-COM/0004/2021, 02-2022 – 01-2024, 30 k€

- **Quantum Simulation of Particle Scattering Processes**

PQI, FCT PT-CERN PhD Grant, 01/2024 – 12/2026

Research Highlights

PHYSICAL REVIEW D

covering particles, fields, gravitation, and cosmology

Highlights Recent Accepted Collections Authors Referees Search Press About Editorial Team

Quantum speedup for track reconstruction in particle accelerators

D. Magano, A. Kumar, M. Kālis, A. Locāns, A. Glos, S. Pratapsi, G. Quinta, M. Dimitrijevs, A. Rivošs, P. Bargassa, J. Seixas, A. Ambainis, and Y. Omar

Phys. Rev. D **105**, 076012 – Published 19 April 2022

Physics Letters B 843 (2023) 138000



ELSEVIER

Contents lists available at [ScienceDirect](#)

Physics Letters B

journal homepage: www.elsevier.com/locate/physletb



Adiabatic quantum algorithm for multijet clustering in high energy physics

Diogo Pires^a, Yasser Omar^{a,b}, João Seixas^{a,c,*}

^a Instituto Superior Técnico, Dep. Física, Universidade de Lisboa, Portugal

^b Instituto de Telecomunicações, Physics of Information and Quantum Technologies Group, Lisbon, Portugal

^c Centro de Física e Engenharia de Materiais Avançados (CeFEMA), Instituto Superior Técnico, Av. Rovisco Pais 1, 1049-001 Lisboa, Portugal



Research Highlights

PHYSICAL REVIEW B


covering condensed matter and materials physics

[Highlights](#) [Recent](#) [Accepted](#) [Collections](#) [Authors](#) [Referees](#) [Search](#) [Press](#) [About](#) [Editorial Team](#)

Strain engineering of photoinduced topological phases in two-dimensional ferromagnets

T. V. C. Antão and N. M. R. Peres

Phys. Rev. B **107**, 235410 – Published 13 June 2023

 > [hep-ph](#) > [arXiv:2211.03233](#)

Search...

[Help](#) |

High Energy Physics - Phenomenology

[Submitted on 6 Nov 2022 (v1), last revised 30 Mar 2023 (this version, v3)]

Fitting a Collider in a Quantum Computer: Tackling the Challenges of Quantum Machine Learning for Big Datasets

[Miguel Caçador Peixoto](#), [Nuno Filipe Castro](#), [Miguel Crispim Romão](#), [Maria Gabriela Jordão Oliveira](#), [Inês Ochoa](#)

Research Highlights

PHYSICAL REVIEW D

covering particles, fields, gravitation, and cosmology

[Highlights](#) [Recent](#) [Accepted](#) [Collections](#) [Authors](#) [Referees](#) [Search](#) [Press](#) [About](#) [Editorial Team](#)

Entanglement and scattering in quantum electrodynamics: S matrix information from an entangled spectator particle

Juan D. Fonseca, B. Hiller, J. B. Araujo, I. G. da Paz, and M. Sampaio
Phys. Rev. D **106**, 056015 – Published 20 September 2022

PHYSICAL REVIEW D

covering particles, fields, gravitation, and cosmology

[Highlights](#) [Recent](#) [Accepted](#) [Collections](#) [Authors](#) [Referees](#) [Search](#) [Press](#) [About](#) [Editorial Team](#)

Open Access

Measuring QED cross sections via entanglement

Jonas B. Araujo, B. Hiller, I. G. da Paz, Manoel M. Ferreira, Jr., Marcos Sampaio, and H. A. S. Costa
Phys. Rev. D **100**, 105018 – Published 19 November 2019

Contributions to Roadmaps

arXiv > quant-ph > arXiv:2307.03236

Search...

Help | Advance

Quantum Physics

[Submitted on 6 Jul 2023]

Quantum Computing for High-Energy Physics: State of the Art and Challenges. Summary of the QC4HEP Working Group

Alberto Di Meglio, Karl Jansen, Ivano Tavernelli, Constantia Alexandrou, Srinivasan Arunachalam, Christian W. Bauer, Kerstin Borrás, Stefano Carrazza, Arianna Crippa, Vincent Croft, Roland de Putter, Andrea Delgado, Vedran Dunjko, Daniel J. Egger, Elias Fernandez-Combarro, Elina Fuchs, Lena Funcke, Daniel Gonzalez-Cuadra, Michele Grossi, Jad C. Halimeh, Zoe Holmes, Stefano Meloni, Antonio Mezzacapa, Roggero, Julian Schuhmacher, Koji Terashi, Jordi Tura, Ce

arXiv > physics > arXiv:2203.08805

Search...

Help | Advance

Physics > Data Analysis, Statistics and Probability

[Submitted on 15 Mar 2022 (v1), last revised 8 Dec 2022 (this version, v2)]

Quantum computing for data analysis in high energy physics

Andrea Delgado, Kathleen E. Hamilton, Prasanna Date, Jean-Roch Vlimant, Duarte Magano, Yasser Omar, Pedrame Bargassa, Anthony Francis, Alessio Gianelle, Lorenzo Sestini, Donatella Lucchesi, Davide Zuliani, Davide Nicotra, Jacco de Vries, Dominica Dibenedetto, Miriam Lucio Martinez, Eduardo Rodrigues, Carlos Vazquez Sierra, Sofia Vallecorsa, Jesse Thaler, Carlos Bravo-Prieto, su Yeon Chang, Jeffrey Lazar, Carlos A. Argüelles, Jorge J. Martinez de Lejarza

Contributions to Research Programmes

CERN Accelerating science

[Sign in](#) [Directory](#)



QUANTUM
TECHNOLOGY
INITIATIVE

[ABOUT](#) - [RESEARCH](#) - [COLLABORATION](#) [QUANTUM HUB](#) [EDUCATION](#) - [NEWS & EVENTS](#) [RESOURCES](#) [SEARCH](#)

CERN Quantum Technology Initiative

Accelerating Quantum Technology Research and Applications

Portugal is contributing to shaping and steering the CERN Quantum Technology Initiative.

Bringing the QC & HEP Communities together

Launched from Portugal:



[HOME](#)

[FUTURE TALKS](#)

[PREVIOUS TALKS](#)

[ORGANISING COMMITTEE](#)

[CONTACT](#)

|

[Q](#)

QUANTUM COMPUTATION AND HIGH-ENERGY PHYSICS SEMINAR

JOIN OUR ONLINE SESSIONS

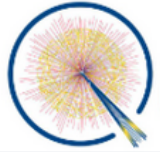
SUBSCRIBE TO THE MAILING LIST

12,864 views

quanthep-seminar.org

Bringing the QC & HEP Communities together

Launched from Portugal:



QuantHEP QuantHEP Conference – Quantum Technologies and High-Energy Physics Conference

QuantHEP Conference – Quantum Technologies and High-Energy Physics Conference

The QuantHEP Conferences aim:

- to present and discuss ideas and results on how Quantum Technologies can help address scientific challenges in High-Energy Physics (HEP), and how in turn HEP can bring new insights into Quantum Information Science;
- to bring the QT and HEP communities closer together and foster their scientific collaboration.

The acronym QuantHEP comes from the merging of the names of the sections of the arXiv used by the QT and HEP communities, respectively: Quantum Physics (quant-ph), and High-Energy Physics (hep-ex, hep-lat, hep-ph, hep-th).

The first QuantHEP Conference will take place in Bari, Italy, on 25-27 September 2023.

With the goal of making the QuantHEP Conferences a community-driven annual meeting, a Steering Committee has been established.

Steering Committee

Andris Ambainis, ULatvia
Ignacio Cirac, MPQ Garching
Alberto Di Meglio, CERN
Elisa Ercolessi, UBologna
Karl Jansen, DESY
Dieter Lüst, LMU Munich
Joe Lykken, Fermilab
Simone Montangero, UPadova
Yasser Omar, PQI & IST, ULisbon
Giorgio Parisi, URome La Sapienza
Saverio Pascazio, UBari
Antonio Zoccoli, INFN
Peter Zoller, IQOQI & UInnsbruck

quanthep.org

Events celebrating quantum science and technology

- 400+ events
- Double of 2022!
- All continents
- 140+ in Europe
- China > 1M audience

In Summary

- **Portugal has very strong expertise in HEP and in QC/Quantum Technologies, and an active emerging community exploring the interface of these two domains**
 - 5 research projects (+350 k€), 2 FCT PhD scholarships
 - 10+ publications and preprints
 - 1 completed PhD thesis, 1 ongoing PhD thesis, 3 ongoing master theses
- **Quantum Computing/Technologies & HEP is still a new domain**
 - Local community is still small, but with good international collaborations
 - Specific funding is scarce, but local community is showing very good competitiveness
 - Useful hardware still far away, but Quantum Computing could be a game changer
 - Rich and promising domain for novel TH and EXP research, as well as technology development

Portugal can have, and is having, a say in the development of Quantum Computing & HEP!

Extra slides

Contributing Novel Research Directions

arXiv > quant-ph > arXiv:2305.07692

Search...

Help |

Quantum Physics

[Submitted on 12 May 2023]

Towards Quantum Simulation of Bound States Scattering

Matteo Turco, Gonalo M. Quinta, Joao Seixas, Yasser Omar

arXiv > hep-ph > arXiv:2207.03303

Search...

Help | Advan

High Energy Physics - Phenomenology

[Submitted on 7 Jul 2022]

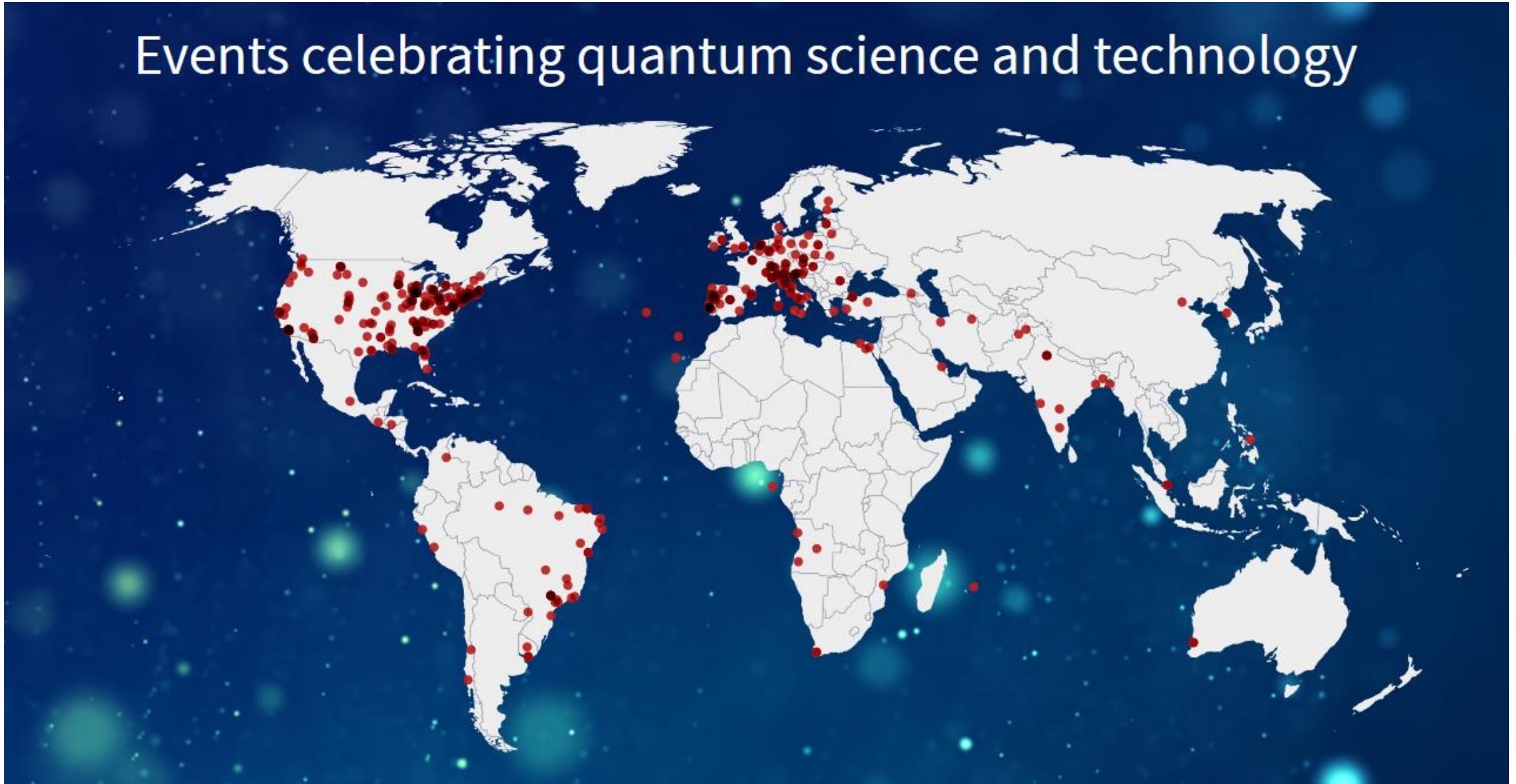
Predicting leptonic CP violation via minimization of neutrino entanglement

Gonalo M. Quinta, Alexandre Sousa, Yasser Omar

We show how a minimization principle of quantum entanglement between the oscillating flavors of a neutrino leads to a unique prediction for the CP-violation phase in the neutrino sector without assuming extra symmetries in the Standard Model. We find a theoretical prediction consistent with either no CP-violation or a very small presence of it.

Joins us in 2024! Submit your event!

Events celebrating quantum science and technology



worldquantumday.org

 [@WorldQuantumDay](https://twitter.com/WorldQuantumDay)

