

# Nayara Fonseca

Curriculum Vitae

May 2023

## Contact

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## Experience

### Current

#### Research Fellow

UKRI Horizon Europe Guarantee Marie Skłodowska-Curie Fellowship Award.

Project: *Phenomenology of Deep Learning*.

[Rudolf Peierls Centre for Theoretical Physics](#),

Department of Physics, University of Oxford.

Host: [Prof. Ard Louis](#).

May 2023 – Present.

### Previous

#### Research Scientist

[IBM Research, Daresbury Lab](#), Warrington, United Kingdom.

May 2022 – April 2023.

- Search for physics extremes with generative deep learning; machine learning for equation solving; optimization in physics-informed neural networks.

#### Postdoctoral Researcher

[International Centre for Theoretical Physics \(ICTP\)](#), Trieste, Italy.

October 2019 – September 2021.

- Dark matter model building and phenomenology; machine learning for field localization in theory space.

#### Postdoctoral Researcher

[Deutsches Elektronen-Synchrotron \(DESY\)](#), [Theory Group](#), Hamburg, Germany.

October 2016 – September 2019.

- Physics beyond the Standard Model; interplay between particle physics and early universe cosmology; effective field theory tools to generate large hierarchy of scales.

#### Exchange PhD Student

[Center for Theoretical Physics](#), MIT, Cambridge, USA.

Host: [Prof. Jesse Thaler](#).

January 2014 – December 2014.

- Dark matter phenomenology combining complementary data from astrophysics, cosmology, and collider physics.

## Education

**Ph.D. in Theoretical Physics** (Particle Physics), August 2016.  
Department of Mathematical Physics, University of São Paulo, Brazil.  
Thesis: “[Theories with Large Hierarchy of Scales](#)”.  
Advisor: [Prof. Gustavo Burdman](#).

**Master of Science** (Physics), August 2011.  
Department of Mathematical Physics, University of São Paulo, Brazil.  
Dissertation: “[Dimensional Deconstruction and Flavor Violation](#)”.  
Advisor: [Prof. Gustavo Burdman](#).

**Bachelor of Science** (Physics), June 2009  
Gleb Wataghin Physics Institute, University of Campinas, Brazil.  
Monograph: “Classical Solutions in Yang-Mills Theory”.  
Advisor: [Prof. Alberto Saa](#).

## Academic Visits and Other Positions

**Queen Mary University of London, United Kingdom.**  
Postdoctoral Researcher at the Centre for Theoretical Physics.  
October 2021 – November 2021.

**Lawrence Berkeley National Laboratory, Berkeley, USA.**  
Visitor Research Scholar.  
October 2018 – November 2018.

**DESY Theory Group, Hamburg, Germany.**  
Host: [Prof. Géraldine Servant](#).  
Exchange PhD Student.  
September 2015 – May 2016.

**Complutense University of Madrid, Spain.**  
Undergraduate Exchange Program.  
September 2006 – February 2007.

## Analytical Skills and Background in CS and ML

- **Programming:** Python, Mathematica, C.
- **ML/Statistical Libraries/Packages:** TensorFlow, PyTorch, NumPy, Scikit-learn, Pandas, Statsmodels.
- **Formal Education in Mathematics:** Calculus, Linear Algebra, Differential Equations, Numerical Calculus, Complex Analysis, Probability, Algorithms and Programming, etc.
- **Related Coursework and Self-Study:** Custom Models, Layers, and Loss Functions with TensorFlow (Coursera, July 2021); [ML Theory for Physicists](#) (DESY, Dec. 2020 – Mar. 2021); Data Science Bootcamp (Udemy, Nov. 2020), Algorithmic Toolbox (Coursera, May 2020); open sources such as freeCodeCamp.
- **Optimization using a Genetic Algorithm for Particle Physics:** Parameter space searching of physical observables via a genetic algorithm used in two publications (JHEP and PRD) which are part of my Doctoral Thesis.
- **High School with a dual degree in Informatics (Programming, Database, Web design, Hardware):** Awarded internship at the National Siderurgy Company (Brazil) (1.5% top), prize for best Informatics Final Project team (2.5% top).

## Preprints and Publications

- For all publications see [\[arXiv\]](#) [\[nayarafonseca.com/publications\]](http://nayarafonseca.com/publications).
- JHEP and Phys. Rev. D are top journals in the field, see, e.g., [Google Scholar High Energy and Nuclear Physics top publications](#).
- [17] N. Fonseca, V. Guidetti, and Will Trojak, *Probing optimisation in physics-informed neural networks*. ICLR 2023 Workshop on Physics for Machine Learning [[OpenReview](#)] [[arXiv:2303.15196](#)].
- [16] N. Fonseca and V. Guidetti, *Similarity and Generalization: From Noise to Corruption*. [[arXiv:2201.12803](#)].
- [15] N. Fonseca and E. Morgante, *Probing photophobic (rel)axion dark matter*. [[Phys. Rev. D. 103, 015011 \(2021\)](#)] [[arXiv:2009.10974](#)].
- [14] N. Fonseca, E. Morgante, R. Sato, G. Servant, *Relaxion Fluctuations (Self-stopping relaxion) and Overview of Relaxion Stopping Mechanisms*. [[JHEP 05 \(2020\) 080](#)] [[arXiv:1911.08473](#)].
- [13] N. Fonseca, E. Morgante, R. Sato, G. Servant, *Axion Fragmentation*. [[JHEP 04 \(2020\) 010](#)] [[arXiv:1911.08472](#)].
- [12] N. Fonseca, B. von Harling, L. de Lima, C. S. Machado, *Super-Planckian axions from near-conformality*. [[Phys. Rev. D 100, 105019 \(2019\)](#)] [[arXiv:1906.10193](#)].
- [11] N. Fonseca and E. Morgante, *Relaxion Dark Matter*. [[Phys. Rev. D 100, 055010 \(2019\)](#)] [[arXiv:1809.04534](#)].
- [10] N. Fonseca, E. Morgante and G. Servant, *Higgs relaxation after inflation*. [[JHEP 1810 \(2018\) 020](#)] [[arXiv:1805.04543](#)].
- [9] N. Fonseca, B. von Harling, L. de Lima, and C. S. Machado, *A warped relaxion*. [[JHEP 1807 \(2018\) 033](#)] [[arXiv:1712.07635](#)].
- [8] N. Bernal, C. S. Fong, and N. Fonseca, *Sharing but not caring: Dark Matter and the Baryon Asymmetry of the Universe*. [[JCAP 1609 \(2016\) 005](#)] [[arXiv:1605.07188](#)].
- [7] N. Fonseca, L. de Lima, C. S. Machado, and R. D. Matheus, *Large field excursions from a few site relaxion model (N-Relaxion)*. [[Phys. Rev. D94 \(2016\) 015010](#)] [[arXiv:1601.07183](#)].
- [6] N. Fonseca, L. Necib and J. Thaler, *Dark Matter, Shared Asymmetries, and Galactic Gamma Ray Signals*. [[JCAP 1602 \(2016\) 052](#)] [[arXiv:1507.08295](#)].
- [5] N. Fonseca, R. Z. Funchal, A. Lessa, and L. Lopez-Honorez, *Dark Matter Constraints on Composite Higgs Models*. [[JHEP 1506 \(2015\) 154](#)] [[arXiv:1501.05957](#)].
- [4] G. Burdman, N. Fonseca, and G. Lichtenstein, *Resonances from Quiver Theories at the LHC*. [[Phys. Rev. D88 \(2013\) 116006](#)] [[arXiv:1308.5988](#)].
- [3] G. Burdman, N. Fonseca, and L. Lima, *Full-hierarchy Quiver Theories of Electroweak Symmetry Breaking and Fermion Masses*. [[JHEP 1301 \(2013\) 094](#)] [[arXiv:1210.5568](#)].
- Thesis and Dissertation
- [2] *Theories with Large Hierarchy of Scales*. Ph.D. Thesis, University of São Paulo, 2016.
- [1] *Dimensional deconstruction and flavor violation*. Master’s Dissertation (In Portuguese), University of São Paulo, 2011.

## Organization of International Events

- Joint Workshop with the Institute for Basic Science (Korea) and the ICTP (Italy), <https://indico.ibs.re.kr/event/445/>, October 2021.

- Joint Workshop with the Institute for Basic Science (Korea) and the ICTP (Italy), <https://indico.ibs.re.kr/event/366/>, October 2020.
- Mainz Institute for Theoretical Physics Scientific Program (Particle Physics and Cosmology), <https://indico.mitp.uni-mainz.de/event/262/>, July 2020 (Postponed to July 2022 due to COVID-19).

## Awards, Funding, and Distinctions

- 2022:** Marie Skłodowska-Curie Postdoctoral Fellowship Award at the University of Oxford (236k EUR).
- 2019:** 3-year Postdoctoral Research Fellow Position at ICTP, Trieste.
- 2018:** European Union’s Horizon 2020 Research and Innovation Staff Exchange Program (Berkeley Lab).
- 2016:** 3-year Postdoctoral Research Fellow Position at DESY Theory Group, Hamburg.
- 2015 – 2016:** FAPESP\* Exchange Program Fellowship (DESY Theory Group).
- 2014:** CNPq† Exchange Program Fellowship (Center for Theoretical Physics, MIT).
- 2011 – 2016:** FAPESP Ph.D. Fellowship.
- 2009 – 2011:** FAPESP M.S. Fellowship.
- 2008 – 2009:** FAPESP Undergraduate Scholarship.
- 2007 – 2008:** CNPq Undergraduate Scholarship.
- 2006:** CNPq Undergraduate Scholarship.
- 2006:** Santander Scholarship (Complutense University of Madrid).

\*FAPESP: São Paulo Research Foundation.

†CNPq: National Council for Scientific and Technological Development (Brazil).

## Talks and Seminars

- Machine Learning at the Galileo Galilei Institute [[YouTube](#)], Florence, September 2022.
- IBM Research Brazil, Rio de Janeiro, August 2022.
- ‘Similarity Learning/Double Descent/Pheno Deep Learning’ [[YouTube](#)], Universidad Autónoma de Madrid, April 2022.
- ‘Phenomenology of Deep Learning’, The Latin American Symposium of High Energy Physics (SILAFEA) [[YouTube](#)], November 2021.
- ‘Theory of Deep Learning and Physics’, Institute for Fundamental Physics of the Universe in Trieste, April 2021.
- Workshop on probing beyond Standard Model physics at different scales, Magnus-Haus Berlin, January 2020.
- Scuola Internazionale Superiore di Studi Avanzati, ICTP-SISSA Pheno Postdoc Day, Trieste, Italy, December 2019.
- Invisible 2019 Workshop (Neutrinos, Dark Matter and Dark Energy), Valencia, Spain, June 2019.
- Workshop ‘Search for New Physics in the Horizon’, Korea University, Seoul, May 2019.
- Stanford Institute for Theoretical Physics, USA, November 2018.
- Lawrence Berkeley National Laboratory, USA, October 2018.
- Workshop ‘Beyond Standard Model: Where do we go from here?’, The Galileo Galilei Institute, Florence, Italy, September 2018.
- CERN TH Institute on Physics at the LHC and Beyond, Geneva, Switzerland, August 2018.
- Mainz Institute for Theoretical Physics, Johannes Gutenberg Universität Mainz, Germany, June 2018.
- 21st International Conference From the Planck Scale to the Electroweak Scale, Bonn, Germany, May 2018.
- Workshop on Cosmological Probes of BSM - from the Big Bang to the LHC, Benasque, Spain, May 2018.
- Institut de Física d’Altes Energies, Universitat Autònoma de Barcelona, May 2018.
- Dalitz Seminar in Fundamental Physics, Department of Physics, University of Oxford, UK, April 2018.
- Confronting Naturalness: from LHC to Future Colliders, DESY Hamburg, Germany, April 2018.

- Workshop on Axions at the crossroads, European Centre for Theoretical Studies in Nuclear Physics and Related Areas, Trento, Italy, November 2017.
- DESY Theory Workshop – Fundamental physics in the cosmos: The early, the large and the dark Universe, Hamburg, Germany, September 2017.
- Theory Seminar at the Bethe Center for Theoretical Physics, Bonn, Germany, June 2017.
- The 29th Rencontres de Blois on Particle Physics and Cosmology, Blois, France, May 2017.
- DESY Theory Workshop – Rethinking Quantum Field Theory, Hamburg, Germany, September 2016.
- ICTP South American Institute for Theoretical Physics, São Paulo, Brazil, August 2015.
- MIT Center for Theoretical Physics Journal Club, Cambridge, March 2014.

## Participation in Events Connecting Machine Learning and Science

- IBM-Oxford Alliance Symposium, Oxford UK, June 2022.
- Workshop on Theory of Deep Learning, Isaac Newton Institute for Mathematical Sciences, Cambridge UK, August 2021.
- Conference on Mathematics of Machine Learning, Center for Interdisciplinary Research, Bielefeld University, August 2021.
- ‘Youth in High-Dimensions’ Conference, International Centre for Theoretical Physics in Trieste, June 2021.
- Workshop on Artificial Scientist Discovery, Max Planck Institute for the Science of Light in Erlangen, June 2021.
- ‘Youth in High-dimensions’: Machine Learning, High-dimensional Statistics and Inference for the New Generation, International Centre for Theoretical Physics in Trieste, June 2020.
- Workshop on Science of Data Science, International Centre for Theoretical Physics in Trieste, September 2019.

## Peer Review

PRD (Since 2017); PRL (Since 2017); JHEP (Since 2020), ICML 2022.

## Student Supervision

- Master Thesis Tutor Sep. 2020 – Feb. 2021  
Fidele Twagirayezu, East African Institute of Fundamental Research – Rwanda
- Master Internship Co-supervisor at DESY June 2017 – Sep. 2017  
Augustin Vanrientvelde, École Polytechnique – France

## Community

- IBM Geometric Deep Learning Journal Club (organizer) Dec. 2022
- ICTP Phenomenology Virtual Journal Club (organizer) May 2020 – June 2021
- ICTP Particle Physics Seminars (co-organizer) Oct. 2019 – Sep. 2021
- DESY Theory Journal Club (co-organizer) Oct. 2017 – Sep. 2019
- DESY Theory Friday Cookies (co-organizer) Nov. 2016 – July 2019
- DESY Theory Christmas Party (co-organizer) 2015
- DESY Theory Works Outing (co-organizer) 2015

## Languages

Portuguese (native), English (fluent), Spanish (basic).