Nayara Fonseca

Curriculum Vitae

November 2024

Contact

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Experience

Current Position

Research Fellow	May 2023 – Present
University of Oxford, Rudolf Peierls Centre for Theoretical Physics	Oxford, UK

UKRI Horizon Europe Guarantee Marie Skłodowska-Curie Fellowship Award
Project: *Phenomenology of Deep Learning*

Previous Positions

Research Scientist	May 2022 – April 2023
IBM Research	Daresbury, UK

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

Postdoctoral Researcher	October 2019 – September 2021
International Centre for Theoretical Physics (ICTP)	Trieste, Italy

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

Postdoctoral Researcher	October 2016 – September 2019
Deutsches Elektronen-Synchrotron (DESY)	Hamburg, Germany

- 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	January 2014 – December 2014
Center for Theoretical Physics, MIT	Cambridge, USA

Host: Prof. Jesse Thaler.

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

Education

Ph.D. in Theoretical Physics, August 2016.
Thesis: "Theories with Large Hierarchy of Scales".
Master of Science in Physics, August 2011.
Department of Mathematical Physics, University of São Paulo, Brazil.
Advisor: Prof. Gustavo Burdman.

Bachelor of Science in Physics, June 2009
Gleb Wataghin Physics Institute, University of Campinas, Brazil.
Advisor: Prof. Alberto Saa.

Skills and Background in CS, ML, and AI

- **OpenAI Contractor:** Consulting services (Summer 2024).

- **AI Safety:** AI Alignment Course by BlueDot Impact (AI Safety Fundamentals) with the final project titled: "Polygenic skills: What is the effect of combined tasks?" (March–June 2024).

- **Programming and ML/Stat Libraries/Packages:** Python, Mathematica, TensorFlow, PyTorch, NumPy, Scikit-learn, Pandas.

- **Formal Education in Mathematics:** Calculus, Linear Algebra, Differential Equations, Numerical Calculus, Complex Analysis, Probability, Algorithms and Programming, etc.

- **Related Coursework and Self-Study:** Generative AI with Large Language Models (Coursera); Custom Models, Layers, and Loss Functions with TensorFlow (Coursera); ML Theory for Physicists (DESY); Data Science Bootcamp (Udemy); Algorithmic Toolbox (Coursera); 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.

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.

Preprints and Publications

– In machine learning papers, an asterisk (*) denotes equal contribution. In theoretical high energy physics, the convention is to order the author list alphabetically.

– Journal of High Energy Physics (JHEP) and Physical Review D (PRD) are top journals in the field, see, e.g., Google Scholar High Energy and Nuclear Physics top publications.

[18] Y. Nam*, N. Fonseca*, S. H. Lee, C. Mingard, A. A. Louis, *An exactly solvable model for emergence and scaling laws.* Accepted at NeurIPS 2024; ICML 2024 Workshop on High-dimensional Learning Dynamics [HiLD] [arXiv].

[17] N. Fonseca*, V. Guidetti*, and Will Trojak*, *Probing optimisation in physics-informed neural networks.* ICLR 2023 Workshop on Physics for Machine Learning [Physics4ML] [arXiv].

[16] N. Fonseca* and V. Guidetti*, *Generalizing similarity in noisy setups: the DIBS phenomenon.* European Conference on Artificial Intelligence (ECAI) 2023 [ECAI 2023] [arXiv].

[15] N. Fonseca and E. Morgante, *Probing photophobic (rel)axion dark matter.* Physical Review D [PRD] [arXiv].

[14] N. Fonseca, E. Morgante, R. Sato, G. Servant, *Relaxion Fluctuations (Self-stopping relaxion) and Overview of Relaxion Stopping Mechanisms.* Journal of High Energy Physics [JHEP] [arXiv].

[13] N. Fonseca, E. Morgante, R. Sato, G. Servant, *Axion Fragmentation.* Journal of High Energy Physics [JHEP] [arXiv].

[12] N. Fonseca, B. von Harling, L. de Lima, C. S. Machado, *Super-Planckian axions from near-conformality.* Physical Review D [PRD] [arXiv].

[11] N. Fonseca and E. Morgante, *Relaxion Dark Matter.* Physical Review D [PRD] [arXiv].

[10] N. Fonseca, E. Morgante and G. Servant, *Higgs relaxation after inflation.* Journal of High Energy Physics [JHEP] [arXiv].

[9] N. Fonseca, B. von Harling, L. de Lima, and C. S. Machado, *A warped relaxion.* Journal of High Energy Physics [JHEP] [arXiv].

[8] N. Bernal, C. S. Fong, and N. Fonseca, *Sharing but not caring: Dark Matter and the Baryon Asymmetry of the Universe.* Journal of Cosmology and Astroparticle Physics [JCAP] [arXiv].

[7] N. Fonseca, L. de Lima, C. S. Machado, and R. D. Matheus, *Large field excursions from a few site relaxion model (N-Relaxion).* Physical Review D [PRD] [arXiv].

[6] N. Fonseca, L. Necib and J. Thaler, *Dark Matter, Shared Asymmetries, and Galactic Gamma Ray Signals.* Journal of Cosmology and Astroparticle Physics [JCAP] [arXiv].

[5] N. Fonseca, R. Z. Funchal, A. Lessa, and L. Lopez-Honorez, *Dark Matter Constraints on Composite Higgs Models.* Journal of High Energy Physics [JHEP] [arXiv].

[4] G. Burdman, N. Fonseca, and G. Lichtenstein, *Resonances from Quiver Theories at the LHC.* Physical Review D [PRD] [arXiv].

[3] G. Burdman, N. Fonseca, and L. Lima, *Full-hierarchy Quiver Theories of Electroweak Symmetry Breaking and Fermion Masses.* Journal of High Energy Physics [JHEP] [arXiv].

– Thesis and Dissertation

[2] *Theories with Large Hierarchy of Scales.*
Ph.D. Thesis, University of São Paulo.

[1] *Dimensional deconstruction and flavor violation.*
Master's Dissertation (In Portuguese), University of São Paulo.

Awards, Funding, and Distinctions

2022: Marie Skłodowska-Curie Postdoctoral Fellowship Award at the University of Oxford (EUR 236,000).
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 MSc. 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).

Organization of International Events

- Mainz Institute for Theoretical Physics Scientific Program (Particle Physics and Cosmology), July 2022 [link].

- Joint Workshop between the Institute for Basic Science (Korea) and the ICTP (Italy), Oct. 2021 [link].

- Joint Workshop between the Institute for Basic Science (Korea) and the ICTP (Italy), Oct. 2020 [link].

Talks and Seminars (Selected)

- AI Security Reading Group, Mathematical Institute, University of Oxford, November 2024.
- Machine Learning at the Galileo Galilei Institute [YouTube], Florence, September 2022.
- IBM Research Brazil, Rio de Janeiro, August 2022.
- 'Pheno DL: Similarity Learning and Double Descent' [YouTube], U. Autónoma de Madrid, April 2022.
- 'Phenomenology of Deep Learning', The Latin American Symposium of High Energy Physics (SILAFAE) [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 ML and Sciences

- Physics for AI and AI for Physics: Landscaping Workshop, Institute of Physics, London, November 2024.
- 'Beyond the symbols vs signals debate' meeting, The Royal Society, London, October 2024.
- Workshop on 'Theoretical Physics for Deep Learning', Aspen Center for Physics, Colorado US, June 2023.
- Machine Learning Program at the Galileo Galilei Institute, Florence, September 2022.
- 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.

Student Supervision and Teaching

- *MSc Dissertation Supervisor.* Thomas Weatherbee, University of Oxford, Oct. 2024 – Present.
- *MSc Dissertation Supervisor.* Runze Feng, University of Oxford, Oct. 2024 – Present.
- *MSc Dissertation Supervisor.* Samuel Dudley, University of Oxford, Oct. 2024 – Present.
- *MSc Dissertation Supervisor.* Lysander Mawby, Title: "Scale in Deep Learning: Algorithmic Datasets and Sudden Performance Changes", University of Oxford, Oct. 2023 – June 2024.
- *MSc Dissertation Tutor.* Fidele Twagirayezu, East African Institute of Fundamental Research (Rwanda), Sep. 2020 – Feb. 2021.
- *Internship Co-supervisor at DESY.* Augustin Vanrientvelde, École Polytechnique (France), June 2017 – Sep. 2017.

Professional Activities and Community

- *Dissertation Assessor*, University of Oxford, June 2023 and June 2024.
- *Examiner for DPhil Confirmation of Status*, University of Oxford, January 2024.
- *Peer Review:* ICML 2022, JHEP (Since 2020); PRD (Since 2017); PRL (Since 2017).
- 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.