# Carlos Heredia Pimienta

*IAMM Research*

## PERSONAL DETAILS


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| *Born:* | 28.07.1993 |


## EDUCATION

**Ph.D. in Physics** Oct/20 - Mar/23

*University of Barcelona (UB), Barcelona, Spain*

- Category: Mathematical Physics
- Ph.D.'s thesis: Nonlocal Lagrangian formalism
- Supervisor: Prof. Josep Llosa

**Master in Astrophysics, Particle Physics and Cosmology** Sep/16 - Jun/17

*University of Barcelona (UB), Barcelona, Spain*

- Category: Mathematical Physics
- Master's thesis: Hamilton-Jacobi formalism for non-involutive systems
- Supervisor: Prof. Josep M. Pons

**Bachelor's Degree in Physics** Sep/11 - Jan/16

*University of Barcelona (UB), Barcelona, Spain*

## WORK EXPERIENCE

**Senior Data Scientist at DAMM** *(DAMM)* Oct/23 - Today

*Barcelona, Spain*

Specialised in: Forecasting with statistical, machine learning and deep learning tools.

**Assistant Professor at University of Barcelona** *(Department: FQA)* Sep/22 - Sep/23

*Barcelona, Spain*

Teaching: Subjects related to mathematics, physics and numerical methods.

**Business Intelligence Consultant at Ernst & Young** *(EY)* Sep/17 - Oct/20

*Barcelona, Spain*

Specialised in Machine Learning, Big Data and Data Analytics for the Hospitality industry.

## PUBLICATIONS

**When Nonlocal Total Derivatives Are Not Variationally Trivial**
*Carlos Heredia [**arXiv:** 2611.14612 **(hep-th)**]*

**Integrable Elasticity via Neural Demand Potentials**
*Carlos Heredia and Daniel Roncel [**Expert Syst. Appl. 334 134600**]*

**From Adam to Adam-Like Lagrangians: Second-Order Nonlocal Dynamics**
*Carlos Heredia [**arXiv:** 2602.09101 **(cs.LG)**]*

**Nonlocal Mechanics**
*Carlos Heredia and Josep Llosa [**J. Phys. A: Math. Theor. 59** 295207]*

**Modeling AdaGrad, RMSProp, and Adam with integro-differential equations**
*Carlos Heredia [**arXiv:** 2411.09734 **(cs.LG)**]*

**Are nonlocal Lagrangian systems fatally unstable?**
*Carlos Heredia and Josep Llosa [**arXiv:** 2403.19777 **(hep-th)**]*

**Electromagnetic interaction models for Monte Carlo simulation of protons and alpha particles**
*Francesc Salvat and Carlos Heredia [**Nucl. Instrum. Meth. B 546** 165157]*

**Nonlocal Lagrangian fields and the second Noether theorem. Non-commutative $U(1)$ gauge theory**
*Carlos Heredia and Josep Llosa [**J. High Energ. Phys.** 04(2024)021]*

**[Ph.D. Thesis] Nonlocal Lagrangian formalism**
*Carlos Heredia [**arXiv:** 2304.10562 **(hep-th)**]*

**Infinite derivatives vs integral operators. The Moeller-Zwiebach paradox**
*Carlos Heredia and Josep Llosa [**J. Phys. A: Math. Theor. 57** 235202]*

**Nonlocal Lagrangian fields: Noether's theorem and Hamiltonian formalism**
*Carlos Heredia and Josep Llosa [**Phys. Rev. D 105** 126002]*

**Infinite-derivative linearized gravity in convolutional form**
*Carlos Heredia, Ivan Kolář, Josep Llosa, Francisco José Maldonado Torralba, and Anupam Mazumdar [**Class. Quantum Grav. 39** 085001]*

**Nonlocal Lagrangian Mechanics: Noether's theorem and Hamiltonian formalism**
*Carlos Heredia and Josep Llosa [**J. Phys. A: Math. Theor. 54** 425202]*

**Energy-momentum tensor for the electromagnetic field in a dispersive medium**
*Carlos Heredia and Josep Llosa [**J. Phys. Commun. 5** 055003]*

## COLLABORATIONS

**NTT Research — Harvard University** *(Phi Lab)* Dec/23 - Nov/24
*Boston, USA*

Collaboration with Dr. Hidenori Tanaka on researching Lagrangian formulation and symmetries in adaptive optimizers (e.g., RMSProp, Adam) for deep learning dynamics.

**ICCUB — University of Barcelona** *(Group: ICCUB)* Sep/23 - Today
*Barcelona, Spain*

Collaborations with Prof. Josep Llosa and Prof. Francesc Salvat in projects based on the study of higher-order Lagrangians and charged particle transport with Penelope/Penhan.

**Van Swinderen Institute — University of Groningen** *(RUG)* Sep/21 - Mar/23
*Groningen, Netherlands*

Collaborations with Prof. Anupam Mazumdar and Dr. Ivan Kolar in projects based on the study of modified theories of gravity.

**ICCUB — University of Barcelona** *(Group: ICCUB)* Jan/18 - Oct/20
*Barcelona, Spain*

Collaboration with Prof. Josep Llosa in a project based on the study of nonlocal theories.

**IFAE — Autonomous University of Barcelona** *(Group: IFAE)* Jan/16 - Oct/16
*Barcelona, Spain*

Collaboration with Prof. Oriol Pujolàs and Dr. Matteo Baggioli in a project based on the study of the conductive properties of graphene through holographic methods for condensed matter.

## POSTERS & TALKS

**Eficiencia promocional y Dynamic pricing**
*Databricks Barcelona User Group 2026, Pier 01, Spain*

**Modeling AdaGrad, RMSProp, and Adam with Integro-Differential Equations**
*Deep Learning Barcelona Symposium 2025, Spain*

**Decoding Non-Locality**
*Center for Theoretical Physics of the Universe (Prof. Masahide Yamaguchi), Korea*

**Navegando en la No Localidad**
*I Congreso Trujillano de Gravitación y Cosmología, Perú*

**Extending Noether's Theorem to Nonlocal Theories**
*Machine Learning in Mathematics and Theoretical Physics 2023, University of Oxford*

**Noether's Theorem for Nonlocal Lagrangians**
*Symmetry 2023 - The 4th International Conference on Symmetry, Barcelona, Spain*

**Noether's theorem for non-local theories**
*Van Swinderen Institute (Anupam Mazumdar's group), University of Groningen*

**Noether's theorem for non-local Lagrangian mechanics**
*Cosmology Journal Club, University of Barcelona*

**Energy-momentum tensor for the electromagnetic field in a dispersive medium**
*HSE Study Center Voronovo, Moscow*

## THESIS SUPERVISION

**Forecasting Face-Off: From ARIMA to Deep Learning in Financial Market Predictions**
*Student: Marcos Heredia, type: Master's thesis, year: 2024, Institution: CRM, Barcelona*

## TEACHING

**S23: Practical sessions of principles of Laboratory Practice - #363980**
*Electronic Engineering and Telecommunications, University of Barcelona*

**S23: Problems of Multivariable Calculus - #360570**
*Physics, University of Barcelona*

**F22: Problems of Calculus 1 - #366693**
*Biomedical engineering, University of Barcelona*

**F22: Problems of Calculus 1 - #360569**
*Physics, University of Barcelona*

**F22: Problems of Fundamentals of Mechanics - #360563**
*Physics, University of Barcelona*

## SUMMER/WINTER SCHOOLS & CONFERENCES

**Mathematical Foundations of Machine Learning** *(Link)* Jan/26
*Centre de Recerca Matemàtica, Barcelona, Spain*

**Machine Learning in Mathematics and Theoretical Physics** *(Link)* Jul/23
*University of Oxford, United Kingdom*

**Sym. 2023 - The 4th International Conference on Symmetry** *(Link)* Jun/23
*The AXA Convention Center, Barcelona, Spain*

**Moscow International School of Physics 2020** *(Link)* Mar/20
*HSE Study Center Voronovo, Moscow, Russia*

**XIII Tonale Winter School in Cosmology** *(Link)* Dec/19
*University of Heidelberg, Passo del Tonale, Italy*

**TAE 2019 - COST Training School in High Energy Physics** *(Link)* Sep/19
*Centro de Ciencias de Benasque Pedro Pascual, Huesca, Spain*

## SKILLS

**Programming skills**

- *Fortran 95 // Mathematica 10 // ABAP // R // Python // SQL*

**Simulation**

- *Penelope // Penhan*

**AI tools**

- *Azure // DataBricks // Pytorch // Git*

## DISSEMINATION

**Institut de Formació Contínua (IL3) - Inteligencia Artifical**
*Recerca experimental i clínica en microbiota*

**Book - Chapter 2: Quantum-World**
*Books - Dissemination*

**Nit de la Recerca - Intel·ligència artificial i humanitat. Perills i avantatges**
*UB Divulga*

**The beauty of symmetries**
*Severo Ochoa Coffee Talk, CIMNE, Polytechnic University of Catalonia*

## ACADEMIC REFEREE

**Journal of Physics A: Mathematical and Theoretical, ISSN: 1751-8121**
*Iop science, Journal*

**Nuclear Physics B journal, ISSN: 1873-1562**
*Elsevier Publishing, Journal*

**Classical and Quantum Gravity journal, ISSN: 1361-6382**
*IOP Publishing, Journal*

**Selectivitat PAU 2023 - Member of the examining board and proofreader**
*Catalonia, Spain*

## LANGUAGES

**Spanish** *(mother tongue)*, **Catalan** *(C1)*, **English** *(C1)*

## FUNDINGS

**COST - TAE2019 HEP** *Cost - Funding* 2019