

# Carlos Heredia Pimienta

## IAMM Research

### PERSONAL DETAILS

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*Born:* 28.07.1993

### EDUCATION

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**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

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**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

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### Integrable Elasticity via Neural Demand Potentials

Carlos Heredia and Daniel Roncel [*Expert Syst. Appl.* [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

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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

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**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

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### 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

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### 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

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### Mathematical Foundations of Machine Learning ([Link](#))

*Centre de Recerca Matemàtica, Barcelona, Spain*

Jan/26

### Machine Learning in Mathematics and Theoretical Physics ([Link](#))

*University of Oxford, United Kingdom*

Jul/23

### Sym. 2023 - The 4th International Conference on Symmetry ([Link](#))

*The AXA Convention Center, Barcelona, Spain*

Jun/23

### Moscow International School of Physics 2020 ([Link](#))

*HSE Study Center Voronovo, Moscow, Russia*

Mar/20

### XIII Tonale Winter School in Cosmology ([Link](#))

*University of Heidelberg, Passo del Tonale, Italy*

Dec/19

### TAE 2019 - COST Training School in High Energy Physics ([Link](#))

*Centro de Ciencias de Benasque Pedro Pascual, Huesca, Spain*

Sep/19

## SKILLS

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### Programming skills

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

### Simulation

- Penelope // Penhan

## AI tools

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

## DISSEMINATION

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**Institut de Formació Contínua (IL3) - Inteligencia Artificial**

*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

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**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

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

## FUNDINGS

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

2019