

Jordi Gaset Rifà

WoS Researcher ID: AAE-7166-2019 • SCOPUS Author ID: 57192909624 • ORCID: 0000-0001-8796-3149

Professor at CUNEF University. Currently working on geometric formulations of field theories.

Summary

I am a professor at CUNEF university. I have a degree in mathematics and physics and a doctorate in applied mathematics from the UPC.

My research is organized in two blocks. I use multisymplectic geometry to study classical field theories, especially general relativity. In two articles resulting from my doctoral thesis (Hilbert-Einstein and Metric-Affine: 2018-19), I clearly formulate the covariant Hamiltonian formalism of general relativity and establish equivalences between different formalisms. To characterize field theory solutions I have introduced the concept of geometric gauge and developed techniques to reduce it. I have collaborated with M. Castrillón from the UCM and S. Capriotti from the U. Nacional del Sur. I am directing M. Doniz's thesis on the multisymplectic formulation of Horndenski's theory of Gravity.

I have made relevant contributions to contact geometry and its applications. It has been collaborative work with researchers from the UPC and the ICMAT, but, as this is an individual evaluation, I will highlight my main contributions. I have developed the concept of dissipated quantity and its relationship with symmetries (New contributions: 2020). I have detected and solved problems in higher-order systems (Higher-Order: 2021) and in singular systems (Time-dependent: 2022). I am leading the generalization of contact geometry to field theories. Especially relevant is the recent article, carried out in collaboration with M. de León, where we introduced Multicontact geometry. It is a foundational paper with great potential. I have directed two TFGs in the application of the new techniques that we have developed for electromagnetism and general relativity.

I have participated in various competitive projects. The last of them (PID2021-125515NB-C21) as a researcher. I have been an invited speaker at the Workshop on Multisymplectic Geometry and Applications in Metz (2018). I have organized the XVI Young Researchers Workshop in Geometry, Mechanics, and Control at the CRM (Barcelona, 2021).

I have given extensive teaching at the UPM, UAB, UNIR, UPM and CUNEF, to students of diverse profiles. I have taught undergraduate and postgraduate courses, both in the field of mathematics and physics. I have made teaching material for new UNIR degrees, which include notes, exercises, and videos. To highlight, I have created and taught the course of Cosmology and Large-Scale Structure of the Universe of the Master's Degree in Astrophysics at UNIR. I have directed TFGs and several TFM. I have participated in study evaluation commissions.

Education

Doctoral degree in Applied Mathematics

Thesis Title: *A Multisymplectic Approach to Gravitational Theories*

Supervisor: *Narciso Román-Roy*

Universitat Politècnica de Catalunya, 25 July 2018.

Master in Astrophysics, Particle Physics and Cosmology

Universitat de Barcelona, 01 February 2014.

Graduate in Mathematics

Universitat Politècnica de Catalunya, 19 June 2012.

Graduate in Physics

Universitat de Barcelona, 01 June 2014.

Professional Appointments

Professor

CUNEF Universidad: Teaching undergraduate courses at the School of Engineering and Technology.

September 2023 – present

Professor (Ayudante doctor)

Universidad Politécnica de Madrid: Taught undergraduate courses at ETSMFMN.

January 2023 – August 2023

Professor

Universidad Internacional de la Rioja: Taught undergraduate and post-graduate courses at the School of Engineering and Technology.

September 2021 – January 2023

Post-doctoral Researcher

Universitat Autònoma de Barcelona: Taught undergraduate courses in mathematics and physics at the Faculty of Science.

September 2019 – August 2021

Scientific contributions

Papers in Journals

1. J. Gaset, A. López-Gordón, X. Rivas “Symmetries, conservation and dissipation in time-dependent contact systems”, *Fortschritte der Physik*, 2300048, 2023. (doi.org/10.1002/prop.202300048)
2. J. Gaset, M. Doniz “Multisymplectic Formalism for Cubic Horndeski Theories”, *Physica Scripta*, 2023. (doi.org/10.1088/1402-4896/acdd2f)
3. J. Gaset, A. Mas, “A variational derivation of the field equations of an action-dependent Einstein-Hilbert Lagrangian”, *Journal of Geometric Mechanics*, **15** (1), 357-374, (2023) (doi.org/10.3934/jgm.2023014)
4. M. de León, J. Gaset, MC Muñoz-Lecanda, X. Rivas, N. Román-Roy, “Multicontact formulation for non-conservative field theories”, *Journal of Physics A: Mathematical and Theoretical*, **56**, 025201, 2023. (doi.org/10.1088/1751-8121/acb575)
5. M. de León, J. Gaset, X. Gràcia, MC Muñoz-Lecanda, X. Rivas, “Time-dependent contact mechanics”, *Monatshefte für Mathematik*, **201**, 1149-1183, 2023. (doi.org/10.1007/s00605-022-01767-1)
6. J. Gaset, M. Lainz, A. Mas, X. Rivas, “The Herglotz variational principle for dissipative field theories”, preprint, 2022, arXiv:2211.17058.
7. J. Gaset, “Geometric gauge freedom in multisymplectic field theories”, preprint, 2022, arXiv:2209.1121.
8. J. Gaset, A. Marín-Salvador, “Application of Herglotz’s Variational Principle to Electromagnetic Systems with Dissipation”, *International Journal of Geometric Methods in Modern Physics*, **19** (10), 2250156, 2022. (doi.org/10.1142/S0219887822501560)
9. M. de León, J. Gaset, M. Lainz, “Inverse problem and equivalent contact systems”, *Journal of Geometry and Physics*, **176**, 104500, 2022. (doi.org/10.1016/j.geomphys.2022.104500) .
10. J. Gaset, N. Román-Roy, “Symmetries and gauge symmetries in multisymplectic first and second-order Lagrangian field theories: electromagnetic and gravitational fields”, *Revista de la Real Academia de Ciencias Canaria*, **32**, 2021.
11. D. Adame-Carrillo, J. Gaset, N. Román-Roy, “The second-order problem for k-presymplectic Lagrangian field theories. Application to the Einstein–Palatini model”. *Revista de la Real Academia de Ciencias Exactas, Físicas y Naturales*, **116** (20), 2022. (doi.org/10.1007/s13398-021-01136-x)
12. M. de León, J. Gaset, M. Lainz, M. C. Muñoz-Lecanda, N. Román-Roy, “Higher-order contact mechanics”, *Annals of Physics*, **425**, 168396, 2021. (doi.org/10.1016/j.aop.2021.168396)
13. J. Gaset, X. Gràcia, MC Muñoz-Lecanda, X. Rivas N. Román-Roy, “A k-contact Lagrangian formulation for nonconservative field theories”, *Reports on Mathematical Physics*, **87** (3), 2021. (doi.org/10.1016/S0034-4877(21)00041-0)
14. S. Capriotti, J. Gaset, N. Román-Roy, L. Salomone, “Griffiths Variational Multisymplectic Formulation for Lovelock Gravity”, *General Relativity and Gravitation*, **52** (74), 2020. (doi.org/10.1007/s10714-020-02725-8)
15. M. de León, J. Gaset, M. Lainz, X. Rivas, N. Román-Roy, “Unified Lagrangian-Hamiltonian Formalism for Contact Systems”, *Fortschritte der Physik*, **68** (8), 2000045, 2020. (doi.org/10.1002/prop.202000045)
16. J. Gaset, X. Gràcia, MC Muñoz-Lecanda, X. Rivas, N. Román-Roy, “New contributions to the Hamiltonian and Lagrangian contact formalisms for dissipative mechanical systems and their symmetries”, *International Journal of Geometric Methods in Modern Physics*, **17** (06), 2050090, 2020. (doi.org/10.1142/S0219887820500905)
17. J. Gaset, X. Gràcia, MC Muñoz-Lecanda, X. Rivas, N. Román-Roy, “A contact geometry framework for field theories with dissipation”, *Annals of Physics*, **414**, 168092, 2020. (doi.org/10.1016/j.aop.2020.168092)
18. J. Gaset, N. Román-Roy, “New multisymplectic approach to the Metric-Affine (Einstein-Palatini) action for gravity”, *J. Geometric Mechanics*, **11** (3), 361-396, 2019. (doi.org/10.3934/jgm.2019019)
19. J. Gaset, N. Román-Roy, “Multisymplectic unified formalism for Einstein-Hilbert Gravity”, *J. Math. Phys.*, **59** (3), 032502, 2018. (doi.org/10.1063/1.4998526).
20. J. Gaset, P.D. Prieto-Martínez, N. Román-Roy, “Variational principles and symmetries on multisymplectic manifolds” *Communications in Mathematics*, **24** (2), 2016. (doi.org/10.1515/cm-2016-0010)
21. J. Gaset, N. Román-Roy, “Order reduction, projectability and constraints of second-order field theories and higher-order mechanics”, *Reports on Mathematical Physics*, **78** (3), 327-337, 2016. (doi.org/10.1063/1.4940047)

Talks

- *Geometría para físicos: formalismo multisimpléctico* Invited talk at Seminario de Física Gravitacional y Geométrica, University of Veracruz. Online, September 2023.
- *Action-dependent Gravity* Geometric Foundations of Gravity 2023. Tartu, June 2023.
- *Application of contact geometry to physical systems: What do they teach us?* XXIII Winter Meeting on Geometry, Mechanics and Control Theory. Zaragoza, January 2022.
- *Multisymplectic formulation of Einstein-Hilbert and Einstein-Palatini models.* Thematic GMC Day: Multisymplectic models of General Relativity and Gravitation. Online, June 2021.
- *Utiyama's Theorem and its Generalizations.* XXII Winter Meeting on Geometry, Mechanics and Control. Online, February 2021.
- *Multisymplectic equivalence of gravitational models.* Geometric Mechanics and Control Seminar, ICMAT. Madrid, February 2020.
- *Modelizar con geometría de contacto.* Seminario de Álgebra, Geometría y Topología de la Universidad Complutense de Madrid. Madrid, February 2020.
- *A contact geometry approach to symmetries in systems with dissipation.* Women in Geometry and Topology, Centre de Recerca Matemàtica. Bellaterra, September 2019.
- *Geometric equivalence and symmetries in field theories: the gravitational case.* Differential Geometry and Applications, University of Hradec Králové. Hradec Králové, September 2019.
- *Structure of the solutions of General Relativity, and other field theories, from a geometric point of view.* Seminar at Facultad de Ciencias Matemáticas, Universidad Complutense Madrid. Madrid, February 2019.
- *Equivalencia geométrica (multisimpléctica) de los modelos de Einstein-Hilbert y Einstein-Palatini en RG.* XX Winter Meeting on Geometry, Mechanics and Control Theory. Zaragoza, January 2019.
- *Second-order multisymplectic field theories: Korteweg-de Vries and Gravitational models.* Invited talk at Workshop on Multisymplectic Geometry and Applications. Metz, September 2018.
- *Multisymplectic approach to Symmetries in Field Theories.* VI Iberoamerican meeting on Geometry, Mechanics and Control. Guanajuato, August 2018.
- *Symmetries for multisymplectic theories: the Einstein-Palatini model.* XIX Winter Meeting on Geometry, Mechanics and Control Theory. Zaragoza, January 2018.
- *Symmetries in multisymplectic field theories.* 4 Congreso de jóvenes investigadores. València, September 2017.
- *Order reduction and constraints of second-order field theories and higher-order mechanics. Applications to Einstein-Hilbert lagrangian.* CSAC. Barcelona, September 2016.

Chapters in books

- J. Gaset, "A contact geometry approach to symmetries in systems with dissipation", *Geometry of Varieties and Application*, Trends in Mathematics, Research Perspectives CRM Barcelona. (doi.org/10.1007/978-3-030-84800-2.12)
- J. Gaset, N. Román-Roy, "Multisymplectic formulation of Lagrangian models in gravitation", *Geometry of Varieties and Application*, Trends in Mathematics, Research Perspectives CRM Barcelona. (doi.org/10.1007/978-3-030-84800-2.3)

Research Stay

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| Excellence Cluster Origins in Garching
<i>Reduction of multisymplectic structures.</i> Invited distinguished visitor. | 10-18, August 2023 |
| University of Warsaw
<i>Reduction of multisymplectic structures.</i> Research visit. | January 2023 |
| Universidad Complutense de Madrid
<i>Gauge invariant variational problems of higher-order.</i> Post-doctoral visit. | March 2020 |

Other Research-related activities

Supervision of thesis

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| Doctoral Thesis
Student. Mauricio Dóniz Hernández
Title. Multisymplectic formulation of Generalized Gravity
Expected date of defence. July 2024. | Doctorate in Applied Mathematics, UPC |
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- Master Thesis** Master in Mathematical Engineering, UNIR
Student. Cristhian Guillermo Otalora Vasquez
Title. Diseño y desarrollo de simulador de eventos dinámicos en tuberías basado en lenguaje Java.
Date of defence. January 2023.
- Master Thesis** Master in Mathematical Engineering, UNIR
Student. Hugo Rolando Sánchez Quispe
Title. Implementación de métodos de aprendizaje para medir la severidad de moniliasis en el cultivo de cacao.
Date of defence. January 2023.
- Master Thesis** Master in Mathematical Engineering, UNIR
Student. María Cristina Rodríguez de la Guía
Title. Estudio de la transición energética en la Unión Europea.
Date of defence. January 2023.
- Master Thesis** Master in Mathematical Engineering, UNIR
Student. Iván Gabriel Mafla Bolaños
Title. Estudio de energía oscura y expansión cosmológica con galaxias de alto redshift del experimento HETDEX.
Date of defence. July 2022.
- Master Thesis** Master in Mathematical Engineering, UNIR
Student. Inés Palomo Rumschisky
Title. Modelos predictivos de la afiliación de profesores al partido nazi alemán.
Date of defence. July 2022.
- Bachelor Thesis** Bachelor's Degree in Physics, UAB
Student. Adrià Marín Salvador
Title. Applications of Herglotz's variational principle to describe electromagnetic systems with dissipation.
Date of defence. July 2021.
- Bachelor Thesis** Bachelor's Degree in Physics, UAB
Student. Arnau Mas Dorca
Title. A variational derivation of the field equations of an action-dependent Einstein-Hilbert Lagrangian
Date of defence. July 2021.

Research projects and grants

- Geometric Methods in Mechanics, Field Theories and Differential Equations.** January 2022 - August 2025, UPC
Project. D2021-125515NB-21 .
Principal Investigators. N. Román Roy, X. Gràcia Sabaté.
Funding body. Ministerio de Ciencia e Innovación.
Amount of subsidy. 24648 euros.
Participation. Researcher.
- Métodos Iterativos para Continuación en Geometría de Contacto** September 2022 - August 2024, UNIR
Principal Investigator. Daniel Pérez Palau
Funding body. Universidad Internacional de La Rioja
Amount of subsidy. 1300 euros.
Participation. Researcher.
- Geometría, Física, Control y Aplicaciones** January 2019 - December 2022, UPC
Project. PGC2018-098265-B-C33 (Coordinated Project: PGC2018-098265-B)
Principal Investigators. N. Román Roy, X. Gràcia Sabaté.
Funding body. Ministerio de Ciencia, Innovación y Universidades.
Amount of subsidy. 19481 euros.
Participation. Collaborator.
- Aspectos Geométricos en Mecánica, Control, Teoría de Campos y Gravitación** January 2015 - June 2019, UPC
Project. MTM2014-54855-P
Principal Investigators. N. Román Roy(UPC) .
Funding body. Ministerio de Economía y Competitividad.
Amount of subsidy. 57112 euros.
Participation. Collaborator.

Organized Conferences

- XVI Young Researchers Workshop in Geometry, Mechanics and Control** December 1-3, 2021, CRM
Multisymplectic models of General Relativity and Gravitation June 14, 2021, Barcelona

Peer Review

I have collaborated in the following journals as a peer reviewer: Journal of Mathematical Physics; Journal of Nonlinear Science; Mathematics; Mathematical Methods in the Applied Sciences; Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences; Reports on Mathematical Physics.

Colaboraciones multidisciplinares

Collaboration with Dr. Nadia McGowan on the study of color in film. This project has led to a published article: N. McGowan, J. Gaset, "Methodology for a Comparative Quantitative Analysis of Film Color: A Comparison between Cannes and Box-office results" *Visual Studies*, (2023). (doi.org/10.1080/1472586X.2023.2168741).

Divulgación Científica

I have participated as an expert at TV3 and Rac1.

Teaching Experience

Undergraduate

Càlcul I	Grau en Enginyeria en Tècniques Industrials	(2018/19 UPC)
Mètodes Matemàtics I	Shared in several majors	(2018/19 UPC)
Àlgebra	Grau en Enginyeria de Sistemes Audiovisuals	(2018/19 UPC)
Càlcul I	Grau en Física	(2019/20, 2020/21 UAB)
Càlculo de Diverses Variables	Grau en Física	(2019/20 UAB)
Física	Grau en Matemàtiques	(2019/20 UAB)
Càlculo y métodos numéricos	Grado en Ciencia de Datos	(2021/22 UNIR)
Àlgebra y Matemàtica Discreta	Grado en Matemàtica Computacional	(2021/22 UNIR)
Anàlisis Funcional	Grado en Matemàtica Computacional	(2021/22 UNIR)
Física Actual	Grado en Física	(2021/22 UNIR)
Matemàtiques 2	Grado en Enginyeria del Medio Natural	(2022/23 UPM)
Matemàtiques 2	Grado en Enginyeria Forestal	(2022/23 UPM)
Probabilitat e Inferència Estadística	Grado en Enginyeria Informàtica	(2023/24 CUNEF)
Inferència Estadística	Doble Grado en Economia e Enginyeria Matemàtica	(2023/24 CUNEF)

Postgraduate

Lenguaje y Estándares para la Red	MU en Diseño y Producción Multimedias	(2020-2022 UNIR)
Programación	MU en Diseño y Producción Multimedias	(2020-2022 UNIR)
Cosmología y Estructura del Universo a Gran Escala	MU en Astrofísica y Técnicas de Observación en Astronomía	(2021/22 UNIR)

Teaching Innovation Projects

Methodologies to improve the teaching of programming to students with an artistic training. (2021 UNIR)

Teaching Material

Lenguaje y Estándares para la Red	MU en Diseño y Producción Multimedia	(2020 UNIR)
Programación	MU en Diseño y Producción Multimedia	(2020 UNIR)
Física actual	Grado en Física	(2021 UNIR)
Càlculo y Mètodes Numèrics	Grado en Diseño y Desarrollo de Videojuegos	(2021 UNIR)
Àlgebra y Matemàtica Discreta	Grado en Diseño y Desarrollo de Videojuegos	(2021 UNIR)
Cosmología y Estructura del Universo a Gran Escala	MU en Astrofísica y Técnicas de Observación en Astronomía	(2021 UNIR)

STEM Barcelona

Setembre 2017 – Gener 2018

Tutor of a mathematical workshop for high school students. The aim is to promote the knowledge, competences and scientific vocation among students, and to promote equal opportunities.

Employment

Data Analyst

June 2018 – November 2018

Barcelona: External Data Analyst for Prenomics, providing data analysis and algorithms applied to business intelligence.

Tutoring

2013 – 2019

Teaching and tutoring students on science at different levels: High school, undergraduate, post-grade.

Data Analyst

August 2012 – September 2013

Sant Cugat, Barcelona: Data Analyst in the department of innovation at AIA (Aplicaciones en Informática Avanzada).
My duties included data analysis, algorithm design, presentation of projects, data bases.

Skills

Technical expertise

C++, Visual Basic, Java, JavaScript, Python, R, MATLAB, MAPLE, MySQL, HTML, CSS

Natural languages

English (good command, B2), Spanish (native), Catalan(native)).
