David Machado Pérez

Assistant Professor – Faculty of Physics, University of Havana

Nationality: Cuban | **Email:** david.machado@fisica.uh.cu | **ORCID:** 0000-0002-2498-8098 | **Google Scholar profile**

Address: Center for Complex Systems, Faculty of Physics, University of Havana, San Lázaro y L, Vedado, La Habana 10400, Cuba

Research interests: Statistical Physics ● Disordered Systems ● Complex Systems ● Out-of-equilibrium dynamics on random graphs ● Combinatorial optimization ● Theoretical ecology

Bibliometrics (Google Scholar, Oct. 2026): 100 citations | h-index 7 | i10-index 5 | 14 peer-reviewed articles + 1 preprint

● WORK EXPERIENCE

09/2019 – Current ● HAVANA, CUBA

ASSISTANT PROFESSOR FACULTY OF PHYSICS, UNIVERSITY OF HAVANA

Researcher at the Center for Complex Systems of the Faculty of Physics (formerly the Group of Complex Systems and Statistical Physics). My research focuses on the out-of-equilibrium dynamics of disordered systems on random graphs, local closures of the master equation, stochastic algorithms for hard combinatorial optimization problems, and the dynamics of ecological and social models on sparse networks. I teach courses on advanced Mathematics for physics students and supervise undergraduate and Master's theses.

Academic ranks: Assistant Student (2017–2019) ● Professor in Training (2019–2021) ● Instructor (2021–2024) ● Assistant Professor (2024–present).

06/2024 – 06/2026 ● ROME, ITALY

POSTDOCTORAL RESEARCHER PHYSICS DEPARTMENT, SAPIENZA UNIVERSITY OF ROME

Member of the "Statistical Mechanics and Complexity" group. Postdoctoral position funded by the PRIN 2022 PNRR project *"When deep learning is not enough: creating hard benchmarks and physics-inspired algorithms for combinatorial optimization problems"*. Research on algorithmic thresholds of stochastic local-search algorithms, benchmarking of graph neural networks on hard constraint satisfaction problems, and local equations for the generalized Lotka–Volterra model on sparse graphs, while maintaining my collaborations with the University of Havana.

● EDUCATION & TRAINING

2021 – 2024 ● HAVANA, CUBA

PHD IN PHYSICS UNIVERSITY OF HAVANA

Thesis: "Dinámica de variables discretas en grafos aleatorios" *(Dynamics of discrete variables on random graphs)*, defended May 2024 | **Supervisor:** Dr. Roberto Mulet Genicio | Center for Complex Systems, Faculty of Physics.

Awarded the prize for the **Best Doctoral Thesis in the Area of Natural Sciences in Cuba (2024)** by the Cuban Ministry of Higher Education.

09/2014 – 09/2019 ● HAVANA, CUBA

LICENTIATE IN PHYSICS FACULTY OF PHYSICS, UNIVERSITY OF HAVANA

Final grade: 4.98 / 5 (Golden Diploma, top of the class) | **Thesis:** *The Cavity Master Equation: a study of the diluted p-spin ferromagnet.*

● RESEARCH GRANTS & PROJECTS

2027 – 2029 ● PARIS, FRANCE – BATH, UK – HAVANA, CUBA

CO-LEADER CNRS INTERNATIONAL RESEARCH PROJECT (IRP)

RISE – Reconstructing Interactions in Sparse Ecosystems. Selected in the CNRS IRP 2026 call. Three-year international collaboration (budget of up to €15,000 per year, mainly for researcher and student mobility) between the LPTM, CY Cergy Paris Université (France; project leader Dr. Matteo Negri), the Department of Mathematical Sciences, University of Bath (UK; co-leader Dr. Pietro Valigi) and the Faculty of Physics, University of Havana (co-leader D. Machado). The project develops Local Fokker–Planck Equations and machine-learning methods (pseudo-likelihood, graph neural networks) to infer sparse, asymmetric species interactions from ecological data, and includes the co-supervision of a postgraduate student from the University of Havana.

06/2024 – 06/2026 • ROME, ITALY

PARTICIPANT (POSTDOCTORAL RESEARCHER) PRIN 2022 PNRR, ITALIAN MINISTRY OF UNIVERSITY AND RESEARCH

"When deep learning is not enough: creating hard benchmarks and physics-inspired algorithms for combinatorial optimization problems", Sapienza University of Rome.

• INSTITUTIONAL RESPONSIBILITIES

2026 – Current • UNIVERSITY OF HAVANA

Member of the Scientific Council of the University of Havana

Current • FACULTY OF PHYSICS, UNIVERSITY OF HAVANA

Substitute member of the Scientific Council of the Faculty of Physics

• PEER REVIEW

Referee for the following journals (13 reports in total):

- **Physical Review E** – 6 manuscripts (2024: 1; 2025: 2; 2026: 3).
- **Physical Review Research** – 3 manuscripts: 2 as independent referee (2025, 2026) and 1 joint report as co-reviewer invited by the appointed referee (2023).
- **Revista Cubana de Física** – 4 manuscripts (2023: 1; 2024: 2; 2026: 1).

• PUBLICATIONS

Reverse chronological order. **D. Machado** = D. Machado Pérez; † = student supervised by D. Machado.

[1] **Benchmarking graph neural networks in solving hard constraint satisfaction problems** 2026 – preprint
G. Skenderi, L. Buffoni, F. D'Amico, **D. Machado**, R. Marino, M. Negri, F. Ricci-Tersenghi, C. Lucibello, M. C. Angelini, arXiv:2602.18419 [cond-mat.dis-nn] (2026).

[2] **Belief propagation with informed initialization in combinatorial optimization problems** 2026
D. Machado, R. Mulet, A. Pérez, Revista Cubana de Física **43**(1), 4–12 (2026).

[3] **Local equations for the generalized Lotka–Volterra model on sparse asymmetric graphs** 2026
D. Machado, P. Valigi, T. Tonolo, M. C. Angelini, SciPost Physics **21**(1), 008 (2026).

[4] **Algorithmic thresholds in combinatorial optimization depend on the time scaling** 2026
M. C. Angelini, M. Avila-González†, F. D'Amico, **D. Machado**, R. Mulet, F. Ricci-Tersenghi, Physical Review X **16**, 011045 (2026).

[5] **Local equations describe unreasonably efficient stochastic algorithms in random K-SAT** 2025
D. Machado, J. González-García, R. Mulet, Proceedings of the National Academy of Sciences **122**(49), e2510153122 (2025).

[6] **Heterophobic interactions hinder consensus formation in sparse random networks** 2025
A. Castro†, T. M. Pham, E. Ortega, **D. Machado**, Physical Review E **112**, 064309 (2025).

[7] **Dynamic cavity method in fully-asymmetric models** 2025
J. González-García, **D. Machado**, Revista Cubana de Física **42**(1), 12–19 (2025).

[8] **Improved mean-field dynamical equations are able to detect the two-step relaxation in glassy dynamics at low temperatures** 2023
D. Machado, R. Mulet, F. Ricci-Tersenghi, Journal of Statistical Mechanics: Theory and Experiment **2023**, 123301 (2023).

[9] **A closure for the master equation starting from the dynamic cavity method** 2023
E. Aurell, **D. Machado**, R. Mulet, Journal of Physics A: Mathematical and Theoretical **56**, 17LT02 (2023).

[10] **Modeling the neural activity of *Caenorhabditis elegans* through neural message passing** 2023
Y. Hernández-Hernández†, **D. Machado**, R. Mulet, Revista Cubana de Física **40**(1), 39 (2023).

[11] **Dynamics of epidemics from cavity master equations: susceptible-infectious-susceptible models** 2022
E. Ortega, **D. Machado**, A. Lage-Castellanos, Physical Review E **105**, 024308 (2022).

[12] **From random point processes to hierarchical cavity master equations for stochastic dynamics of disordered systems in random graphs: Ising models and epidemics** 2021

D. Machado, R. Mulet, Physical Review E **104**, 054303 (2021).

[13] **The cavity master equation: average and fixed point of the ferromagnetic model in random graphs** 2020

E. Domínguez, **D. Machado**, R. Mulet, Journal of Statistical Mechanics: Theory and Experiment **2020**, 073304 (2020).

[14] **Theory of non-equilibrium local search on random satisfaction problems** 2019

E. Aurell, E. Domínguez, **D. Machado**, R. Mulet, Physical Review Letters **123**, 230602 (2019).

[15] **Exploring the diluted ferromagnetic p-spin model with a cavity master equation** 2018

E. Aurell, E. Domínguez, **D. Machado**, R. Mulet, Physical Review E **97**, 050103(R) (2018).

TEACHING EXPERIENCE

09/2017 – Current • HAVANA, CUBA

PROFESSOR FACULTY OF PHYSICS, UNIVERSITY OF HAVANA

Current courses (academic year 2026–2027): Differential Equations; Complex Variables.

Previous courses: Analytic Geometry; Algebra; Mathematical Analysis; Ordinary Differential Equations; Second-Order Partial Differential Equations (Mathematical Methods of Physics II).

Voted best professor of the Faculty of Physics by the students (academic year 2020–2021).

Fall 2024 & Fall 2025 • ROME, ITALY

TEACHING ASSISTANT PHYSICS DEPARTMENT, SAPIENZA UNIVERSITY OF ROME

Laboratory sessions of the course *Fisica Computazionale* (Computational Physics) for the Bachelor's degree in Physics, taught once in each of the two academic years of my postdoc (2024–2025 and 2025–2026).

THESIS SUPERVISION

All theses defended at the Faculty of Physics, University of Havana. Original titles in Spanish; English translation in italics.

2026 • M.Sc. in Physics • SOLE SUPERVISOR

Alejandro Castro Cabrera – "Dinámica de opiniones en grafos aleatorios: interacciones heterofóbicas y viabilidad del consenso" *(Opinion dynamics on random graphs: heterophobic interactions and the viability of consensus).* Results published in Phys. Rev. E **112**, 064309 (2025).

2026 • M.Sc. in Physics • CO-SUPERVISED WITH DR. R. MULET

Martín Avila González – "Umbrales algorítmicos en el ensemble random K-SAT: comportamiento del algoritmo Simulated Annealing según la escala temporal" *(Algorithmic thresholds in the random K-SAT ensemble: behavior of Simulated Annealing as a function of the time scaling).* Results published in Phys. Rev. X **16**, 011045 (2026).

2023 • Licenciatura in Physics • CO-SUPERVISED WITH DR. R. MULET

Martín Avila González – "Modelación de algoritmos de búsqueda local para el K-SAT: Simulated Annealing y Walk-SAT" *(Modeling local-search algorithms for K-SAT: Simulated Annealing and WalkSAT).*

2022 • Licenciatura in Physics • CO-SUPERVISED WITH DR. R. MULET

Yeslaine Hernández Hernández – "Modelación de la actividad neuronal del *Caenorhabditis elegans* mediante algoritmos de trasmisión de mensajes" *(Modeling the neural activity of C. elegans through message-passing algorithms).* Results published in Rev. Cubana Fís. **40**(1), 39 (2023).

HONOURS AND AWARDS

2025 • CUBAN NATIONAL ACADEMY OF SCIENCES

Award of the Cuban National Academy of Sciences in the Area of Natural and Exact Sciences

2024 • CUBAN MINISTRY OF HIGHER EDUCATION

Best Doctoral Thesis in the Area of Natural Sciences in Cuba

2024 • UNIVERSITY OF HAVANA

Distinguished Young Professor and Researcher Award of the University of Havana

2024 • UNIVERSITY OF HAVANA

University of Havana's Award to the Scientific Work

2021 • FEDERATION OF UNIVERSITY STUDENTS

Best Professor of the Faculty of Physics voted by the students, academic year 2020–2021

2020 • UNIVERSITY OF HAVANA

Award to the Student's Scientific Work given by the Principal of the University of Havana

2019 • UNIVERSITY OF HAVANA

Award to Scientific Merit given by the Principal of the University of Havana

2019 • UNIVERSITY OF HAVANA

Golden Diploma graduated top of the class

2016 • CUBAN SOCIETY OF PHYSICS

Bronze Medal at the National University Physics Olympiad

• INTERNATIONAL EXPERIENCE AND COLLABORATIONS

2024 – 2026 • ROME, ITALY

Two-year postdoctoral position at the Physics Department, Sapienza University of Rome ("Statistical Mechanics and Complexity" group).

2023 • TRIESTE, ITALY

One-month visit to the Quantitative Life Sciences group, ICTP.

2023 • ROME, ITALY

Three-month visit to the Physics Department, Sapienza University of Rome, collaborating with Prof. Federico Ricci-Tersenghi.

2022 • ROME, ITALY

Three-month visit to the Physics Department, Sapienza University of Rome, collaborating with Prof. Federico Ricci-Tersenghi.

2019 • TRIESTE, ITALY

One-month visit to the ICTP, collaborating with Prof. Matteo Marsili.

2018 • STOCKHOLM, SWEDEN

Two-month visit to NORDITA and KTH, collaborating with Prof. Erik Aurell.

Main collaborators: R. Mulet, A. Lage-Castellanos (University of Havana); F. Ricci-Tersenghi, M. C. Angelini (Sapienza University of Rome); E. Aurell (KTH Stockholm); M. Negri (CY Cergy Paris Université); P. Valigi (University of Bath).

• CONFERENCES, SCHOOLS & SEMINARS

Invited seminars and oral contributions

02/2026 • UNIVERSITY OF HAVANA, CUBA

International School on Statistical Inference from Biological Data – oral contribution.

07/2025 • FLORENCE, ITALY

29th International Conference on Statistical Physics (STATPHYS29) – oral contribution.

03/2025 • SAPIENZA UNIVERSITY OF ROME, ITALY

Seminar: "Approximate master equations for algorithmic dynamics in hard combinatorial optimization" – "Statistical Mechanics and Complexity" seminar series.

01–02/2025 • LES HOUCHES, FRANCE

Workshop "Towards a theory for typical-case algorithmic hardness" – short talk "Approximate master equations for algorithmic dynamics in hard combinatorial optimization" and poster "Algorithmic thresholds in combinatorial optimization depend on the time scaling".

01/2025 • FACULTY OF PHYSICS, UNIVERSITY OF HAVANA, CUBA

Seminar: "Benchmarking algorithms for hard combinatorial optimization"

08–09/2024 • CATANIA, ITALY

3rd International School of the Italian Society of Statistical Physics – flash talk.

06/2023 • COMPLEXITY SCIENCE HUB, VIENNA, AUSTRIA

Seminar: "Two approximate approaches to the continuous-time dynamics of discrete variables in random graphs"

04/2023 • SAPIENZA UNIVERSITY OF ROME, ITALY

Journal-club seminar on "Large deviations in stochastic dynamics over graphs through Matrix Product Belief Propagation" (S. Crotti and A. Braunstein) – "Statistical Mechanics and Complexity" seminar series.

08/2022 • ONLINE

Canadian-Cuban-American-Mexican Graduate Student Physics Conference – oral presentation.

04/2022 • SAPIENZA UNIVERSITY OF ROME, ITALY

Seminar: "Dynamic cavity method for the continuous time: Ising models, epidemics and local-search algorithms" – "Statistical Mechanics and Complexity" seminar series.

02/2018 • NORDITA, STOCKHOLM, SWEDEN

Seminar: "Cavity master equation applied to the diluted ferromagnetic p-spin" – "Complex Systems and Biological Physics" seminar series.

2017, 2020, 2024 • UNIVERSITY OF HAVANA, CUBA

XIV, XV and XVI Symposia of the Cuban Physics Society

Posters, schools and workshops

07/2025 • BOCCONI UNIVERSITY, MILAN, ITALY

Learning and Optimization in High Dimension – STATPHYS29 Satellite – poster.

07/2024 • CARGÈSE, FRANCE

Cargèse Summer School and Workshop on Complex and Glassy Systems – poster.

11/2023 • UNIVERSITY OF HAVANA, CUBA

ICTP School on Collective Animal Behavior

05–06/2023 • ICTP, TRIESTE, ITALY

Youth in High-Dimensions: Recent Progress in ML, High-Dimensional Statistics and Inference – poster.

02–03/2019 • ICTP, TRIESTE, ITALY

Spring College on the Physics of Complex Systems – poster; final grade: Excellent.

02/2019 • UNIVERSITY OF HAVANA, CUBA

International School "Statistical Physics Approaches to Systems Biology"

• LANGUAGE SKILLS

Mother tongue: Spanish | **Other languages:** English, Italian

Last updated: October 2026