Juan Pablo Carrillo-Mora

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Education

PhD. in Physics | *Universitat de Barcelona* 2024–Present
Thesis supervisor: Demian Levis Barcelona, Spain
Title: Non-equilibrium statistical physics of chiral active and actuated particles systems

MSc. in Physics | *Universidad de Chile* 2021–2023
(Honors: summa cum laude) Santiago, Chile
Thesis supervisors: María Luisa Cordero and Moniellen Pires Monteiro
Title: Motility of soil bacteria *Bradyrhizobium diazoefficiens* in microfluidic devices

BSc. in Physics | *Universidad Católica del Maule* 2017–2021
(Honors: summa cum laude) Talca, Chile

Grants, Scholarships and Awards

FPI Fellowship | *Agencia Estatal de Investigación MCIU and ESF+* 2024–Present
Predoctoral researcher contract

Becas Chile PhD Scholarship | *Agencia Nacional de Investigación y Desarrollo (ANID)* 2024–Present
Funding for doctoral studies abroad

National Master Fellowship | *Agencia Nacional de Investigación y Desarrollo (ANID)* 2022–2023
Full tuition funding and salary for MSc. degree

Outstanding Student | *Universidad Católica del Maule* 2021
Award for outstanding academic performance in undergraduate studies

Sapere Aude Internal Funding for Research | *VRIP Universidad Católica del Maule* 2021
Funding for research project entitled *Entropy production in excitable cells and their ion channels* in collaboration with Dr. Carlos Paiva

Honors Scholarship | *Universidad Católica del Maule* 2018–2020
Full funding of undergraduate tuition for outstanding academic performance

Research

Research Interests: Active Matter, Biophysics, Microfluidics, Non-equilibrium Statistical Physics.

Internships and Stays:

∗ Research stay "*Dynamic self-assembly of colloidal rotors at fluid interfaces*" October 2024
at Laboratory of Colloids, Polymers and Interfaces (GSC), Universidad Complutense de Madrid Madrid, Spain

∗ Research internship "*Growth and motility of soil bacteria*" January 2020
at Laboratory of Out-of-Equilibrium Matter LMFE, Universidad de Chile Santiago, Chile

Research Projects:

Ongoing Collaborations | *LMFE–UCH, Gulliver–ESPCI, GISC–UCM* Present
Research funded by *Millennium Nucleus Physics of Active Matter* and others

- Clustering of active particles in narrow microchannels
- Bio-convection patterns formed by magnetotactic bacteria
- Collective dynamics of confined self-aligning polar active agents
- Motility induced phase separation in evolving domains

PhD. Thesis Project | *Universitat de Barcelona* 2024–Present

Research funded by *Agencia Estatal de Investigación (AEI) MCIU* and *European Social Fund Plus (ESF+)*

- Non-equilibrium statistical physics of dense systems of active and chiral particles
- Dynamics, transport and phase transitions in self-aligning active particles systems
- Dynamic self-assembly of actuated magnetic colloids in liquid interfaces

MSc. Thesis | *Universidad de Chile* 2021–2023

Research funded by *Millennium Nucleus Physics of Active Matter* and *Agencia Nacional de Investigación y Desarrollo (ANID)*

- Effects of confinement on the motility of bacteria in synthetic soils
- Active diffusion of soil bacteria in disordered porous media
- Effects of shear flows on the motility and self-agglutination of soil bacteria

BSc. Project | *Universidad Católica del Maule* 2020–2021

Research funded by *Vicerrectoría de Investigación y Postgrado (VRIP)*

- Entropy production by transmembrane ionic flows in electrically excitable cells

Publications

1. J.P. Carrillo-Mora and D. Levis. Emergent run-and-spin dynamics in self-aligning active Brownian dumbbells. Manuscript in preparation.

2. J.P. Carrillo-Mora*, E. Rosas*, A. Garcés and I. Bordeu. Optimal collective transport of constrained self-aligning active particles. Manuscript in preparation.

3. M. Pires-Monteiro*, J.P. Carrillo-Mora*, N. Gutiérrez, A.R. Lodeiro, V.I. Marconi and M.L. Cordero. New tool to measure diffusion in a population of motile bacteria. Manuscript in preparation.

4. J.P. Carrillo-Mora and C. Paiva-Sánchez. Entropy production due to transmembrane ion fluxes in excitable cells. Manuscript in preparation.

5. J.P. Carrillo-Mora, A. Garcés and D. Levis. Depinning and activated motion of chiral self-propelled robots. Manuscript under review. Pre-print (arXiv): 2506.20610.

6. J.P. Carrillo-Mora, M. Pires-Monteiro, V. Marconi, M.L. Cordero, R. Brito and R. Soto. (2025). Preventing clustering of active particles in microchannels. Manuscript accepted for publication in Communications Physics (DOI: 10.1038/s42005-025-02283-y). Pre-print (arXiv): 2505.12067.

7. M. Pires-Monteiro, J.P. Carrillo-Mora, N. Gutiérrez, S. Montagna, A.R. Lodeiro, M.L. Cordero and V.I. Marconi. (2025). Soil-mimicking microfluidic devices reveal restricted flagellar motility of *Bradyrhizobium diazoefficiens* under microconfinement. Communications Biology **8**, 662 (2025).

8. J.P. Carrillo-Mora, M. Pires-Monteiro, A.R. Lodeiro, V.I. Marconi and M.L. Cordero. Damage and recovery of flagella in soil bacteria exposed to shear within long microchannels. Physics of Fluids **37**, 012027 (2025). Selected as *Editor's Pick* in Physics of Fluids.

9. J.P. Carrillo-Mora, C. Paiva-Sánchez, J.L. Guevara and J. Gutiérrez. Rocket mechanics: design of an inter/transdiciplinary didactic proposal. Estudios Pedagógicos **50**, 2 (2024).

* Equal contribution.

Conferences, Schools and Workshops

29th International Conference on Statistical Physics – STATPHYS29 2025
· Organized by *International Union of Pure and Applied Physics – IUPAP* and *SIFS* Florence, Italy
· Poster titled "*Emergent run-and-spin dynamics of self-aligning active Brownian dumbbells*"

Thematic program - Active Matter: the synergy between Maths and Physics 2025
· School and international conference at Institut Henri Poincaré (IHP Paris) Paris, France
· Poster titled "*Rotational depinning and activation dynamics of a chiral self-propelled robot*"

School on Non-Equilibrium Statistical Physics 2025
· Organized by *Facultad de Física, Universitat de Barcelona* Barcelona, Spain
· Advanced school on classical and quantum non–equilibrium statistical physics

Intelligent Soft Matter Workshop 2024
· Organized by *Soft Matter Composites SoftComp Network of Excellence* Salou, Spain
· Poster titled "*Run-and-spin dynamics of self-aligning active Brownian dumbbells*"

Madrid–Barcelona Active and Actuated Matter Day – BARMAD 2024 2024
· Organized by *Facultad de Ciencias Físicas, Universidad Complutense de Madrid* Madrid, Spain
· Talks and free discussions in the field of active and actuated matter

XI GEFENOL Summer School on Statistical Physics of Complex Systems 2023
· Organized by *GEFENOL & UBICS, Universitat de Barcelona* Barcelona, Spain
· Talk titled "*Measuring motility of soil bacteria in a microfluidic porous media model*"

XXIII Chilean Physics Symposium 2022
· Organized by *Sociedad Chilena de Física* Valparaíso, Chile
· Poster titled "*Effects of shear on the motility of soil bacteria Bradyrhizobium diazoefficiens*"

School and Conference Physics of Active Matter 2022
· Organized by *Millennium Nucleus Physics of Active Matter* Coyhaique, Chile
· Poster titled "*Effects of shear on the motility of soil bacteria Bradyrhizobium diazoefficiens*"

WE–Heraeus Summer School: Active Matter and Complex Media 2022
· Organized by Université Grenoble Alpes, Institut d'Etudes Scientifiques de Cargèse Corsica, France
· Talk titled "*Measuring motility of soil bacteria in a microfluidic porous media model*"

APS March Meeting 2022 2022
· Organized by *American Physical Society* Chicago, USA
· Talk titled "*Visualization and modeling of soil bacteria under confinement*"

Physics Summer School 2021
· Organized by *Facultad de Ciencias, Universidad del BioBio* Concepción, Chile
· Introduction to the research areas of postgraduate programs in Physics at the faculty

The Physics of Life Summer School 2020
· Organized by *Center for the Physics of Biological Function, Princeton University* Online
· Introduction frontiers topics in biological physics and active matter

Teaching

Teacher – *Universitat de Barcelona, Barcelona, Spain* 2024–Present

— Courses:

∗ TER–L20 Thermodynamics Laboratory (4th semester BS Physics)

Teacher Assistant – *Universidad de Chile, Santiago, Chile* 2021–2023

— Courses:

* FI2003 Experimental Methods (3rd semester Common Engineering Programme)
* FI6030 Introduction to Microfabrication Techniques (elective course for 7th–8th semester BS Physics and for Graduate Studies in Physics)

Teacher – *Universidad Católica del Maule, Talca, Chile* 2021

— Courses:

* PBM–423 Physics and Chemistry II (8th semester Basic General Education Programme)

Teacher Assistant – *Universidad Católica del Maule, Talca, Chile* 2018–2020

— Courses:

* PCI–111 Natural Sciences, Physics Module (1st semester BS Education in Sciences)
* CCI–123 Physics I (2nd semester Commercial Engineering Programme)
* IND–212 Physics I (3rd semester Industrial Engineering Programme)
* PCI–123 General Physics I (2nd semester BS Education in Sciences)
* PCM–321 Physics (6th semester BS Education in Chemistry)
* TME–124 Physics in Medical Technology Laboratory (2nd semester BS Medical Technology)
* QYF–125 Physics Applied to the Pharmaceutical Sciences (2nd semester Chemistry and Pharmacy Degree)
* PCM–311 Electromagnetism (5th semester BS Education in Physics)

Supervision

Thesis

- Andreu Gironella, *Self-organisation of robot assemblies*, Bachelor's thesis in Physics, Universitat de Barcelona, 2025. Co–supervisor: Demian Levis.

Internships

- Constanza Rivas, summer internship: "*Collective phenomena in active matter interacting with different geometries: experiments with Hexbugs*", Universidad de Chile, 2023. Co–supervisors: María Luisa Cordero, Rodrigo Soto and Edgardo Rosas.
- Agustín Lorca, summer internship: "*Accumulation of Hexbugs robots on a wall*", Universidad de Chile, 2023. Co–supervisors: Rodrigo Soto and Edgardo Rosas.
- Fernanda Padró, summer internship: "*Characterisation of flagellar systems in soil bacteria*", Universidad de Chile, 2023. Co–supervisors: Moniellen Pires-Monteiro and María Luisa Cordero.

Outreach

General Audience

- Workshop presenter *"Emergència i auto–organització"* in the *XI Festa de la Ciència UB*, May 30–31, 2025, Barcelona, Spain.
- Workshop presenter *"Emergència i auto–organització"* in the *X Festa de la Ciència UB*, May 11–12, 2024, Barcelona, Spain.
- Workshop presenter *"Física de la Materia Activa"*, *Biblioteca de Santiago*, October 11, 2023, Santiago, Chile.

Skills

- **Languages:** Spanish, English.
- **Coding:** Python, MATLAB, C, LaTeX.
- **Software:** FIJI (ImageJ), BioTracker, AutoCAD, Fusion360, Adobe Illustrator.
- **Experimental:** Maskless optical lithography, Soft lithography, Bright-field and fluorescence optical microscopy, Bacterial culture, Particle tracking, FDM 3D printing.

References

Prof. Demian Levis
Computing and Understanding Collective Action (CUCA) Lab,
University of Barcelona Institute of Complex Systems (UBICS),
Condensed Matter Physics Department, Faculty of Physics,
Universitat de Barcelona, Martí i Franquès 1, Barcelona, Spain
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Prof. María Luisa Cordero
Out–of–Equilibrium Matter Lab (LMFE),
Physics Department, Faculty of Physical and Mathematical Sciences,
Universidad de Chile, Avenida Blanco Encalada 2008, Santiago, Chile
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