# 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 constrained self-aligning polar active agents
- Self–propelled particles 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 chiral active particles
- Dynamics, transport and phase transitions in self-aligning active particles systems
- Dynamic self-assembly of colloidal rotors at fluid 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*, E. Rosas*, A. Garcés and I. Bordeu. Optimal collective transport of constrained self-aligning active particles. Manuscript in preparation.

2. M. Pires-Monteiro*, J.P. Carrillo-Mora*, N. Gutiérrez, A.R. Lodeiro, V.I. Marconi and M.L. Cordero. Effective diffusion of motile bacteria in disordered porous media. Manuscript in preparation.

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

4. 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.

5. 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.

6. 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).

7. 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.

8. 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

**Self-Organizing and Evolving Active Matter International Workshop** 2025
· Organized by *Max Planck Institute for the Physics of Complex Systems MPIPKS* Dresden, Germany
· Poster titled "*Rotational rectification and depinning transition in self-aligning chiral active particles under translational forcing: theory and experiments*"

**Statistical Physics of Living Systems Flagship Workshop** 2025
· *Centre Européen de Calcul Atomique et Moléculaire (CECAM)* Lausanne, Switzerland
· Talks and discussions in the field of soft living matter (remote attendance)

**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: "*Characterization 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**
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**Prof. María Luisa Cordero**
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