

# Pedro E. Harunari

POSTDOCTORAL RESEARCHER · STATISTICAL PHYSICS

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## Personal Profile

Currently, I hold a postdoctoral researcher position at the University of Luxembourg, working under the supervision of Prof. Massimiliano Esposito. My Ph.D. in physics was obtained from the University of São Paulo, Brazil, where I engaged in extensive research and teaching activities. As an active researcher in statistical physics, my focus is on understanding and taming fluctuations of systems outside thermal equilibrium, alongside their thermodynamic properties. I am particularly interested in extending the description of stochastic thermodynamics in the presence of hidden degrees of freedom by pinpointing the relevant quantities, deriving practical expressions for real-world challenges, and connecting to the study of phase transitions, biophysics, chemical reaction networks, complex systems, and more.

## Education

### University of Luxembourg

Postdoctoral researcher

- Member of the group Complex Systems and Statistical Mechanics
- Supervised by Prof. Massimiliano Esposito

Luxembourg, Luxembourg

Dec 2022 - Current

### University of São Paulo

Doctorate in Physics

- Thesis: "The role of time in nonequilibrium: transition-based coarse-graining, phase transitions and heat engines"  
DOI:10.11606/T.43.2022.tde-14122022-084103
- Advisor: Prof. Dr. Carlos E. Fiore
- Allowed to join the program without a Master's degree
- Approved with the highest grades in every course
- Teaching assistant experience during three semesters, both in graduate and undergraduate levels

São Paulo, Brazil

Mar 2018 - Nov 2022

### University of São Paulo

Bachelor in Physics

- 1.5 years of research training activities
- One semester as teaching assistant
- Complementary courses at: IMPA, CBPF and ICTP-SAIFR

São Paulo, Brazil

Feb 2014 - Nov 2017

## List of Publications

10 articles published in internationally renowned journals and one preprint.

From Google Scholar: 154 citations, h-index 7.

- F Avanzini, M Bilancioni, V Cavina, S Dal Cengio, M Esposito, G Falasco, D Forastiere, N Freitas, A Garilli, PE Harunari, V Lecomte, A Lazarescu, SGM Srinivas, C Moslonka, I Neri, E Penocchio, WD Piñeros, M Polettini, A Raghu, P Raux, K Sekimoto, A Soret, "Methods and Conversations in (Post)Modern Thermodynamics"  
arXiv preprint 2311.01250 2023
- F Hawthorne, PE Harunari, MJ de Oliveira, CE Fiore, "Nonequilibrium thermodynamics of the majority vote model"  
Entropy **25** (8), 1230 2023
- PE Harunari, A Garilli, and M Polettini, "The beat of a current"  
Physical Review E **107** (4), L042105 2022
- PE Harunari, A Dutta, M Polettini, and É Roldán, "What to learn from a few visible transitions' statistics?"  
Physical Review X **12**, 041026 2022
- IN Mamede, PE Harunari, BAN Akasaki, K Proesmans, and CE Fiore, "Obtaining efficient thermal engines from interacting Brownian particles under time-periodic drivings"  
Physical Review E **105** (2), 024106 2022
- CE Fiore, PE Harunari, CEF Noa, and GT Landi, "Current fluctuations in nonequilibrium discontinuous phase transitions"  
Physical Review E **104** (6), 064123 2021
- PE Harunari, S Fernando Filho, CE Fiore, and A Rosas, "Maximal power for heat engines: Role of asymmetric interaction times"

- Physical Review Research **3** (2), 023194 2021
- PE Harunari, CE Fiore, and K Proesmans, “Exact statistics and thermodynamic uncertainty relations for a periodically driven electron pump”  
Journal of Physics A: Mathematical and Theoretical **53** (37), 374001 2020
  - CEF Noa, PE Harunari, MJ de Oliveira, and CE Fiore, “Entropy production as a tool for characterizing nonequilibrium phase transitions”  
Physical Review E **100** (1), 012104 2019
  - JM Encinas, PE Harunari, MM de Oliveira, and CE Fiore, “Fundamental ingredients for discontinuous phase transitions in the inertial majority vote model”  
Scientific reports **8** (1), 1-9 2018
  - PE Harunari, MM de Oliveira, and CE Fiore, “Partial inertia induces additional phase transition in the majority vote model”  
Physical Review E **96** (4), 042305 2017

## Work Experience

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### (Post)Modern Thermodynamics - School and workshop

Luxembourg, Luxembourg

Organizer

Dec 2022

- Approximately, 100 participants from abroad and 30 from Luxembourg
- Conference consisting of 10 school lectures, 8 workshop sessions, and one poster session.
- Shared teaching duties of the lecture “Continuous-time Markov chain: basics, first-passages and thermodynamics” with Ken Sekimoto.
- Editorial duties on the preparation of lecture notes “Methods and Conversations in (Post)Modern Thermodynamics”.
- Co-organizers: Matteo Polettini, Vasco Cavina, William Piñeros.

### The Abdus Salam International Centre for Theoretical Physics (ICTP)

Trieste, Italy

Visiting researcher

May 2022 – Jun 2022

- Visitor at Édgar Roldán’s group.

### University of Luxembourg

Luxembourg, Luxembourg

Visiting researcher

Apr 2021 – Feb 2022

- Visitor at Massimiliano Esposito’s Complex Systems and Statistical Mechanics group.
- Supervised by Matteo Polettini.

### University of Aalto

Helsinki, Finland

Visiting researcher

Dec 2021 – Jan 2022

- Visitor at Jukka Pekola’s PICO group.

### The Abdus Salam International Centre for Theoretical Physics (ICTP)

Trieste, Italy

Visiting researcher

Jul 2021 – Sep 2021

- Visitor at Édgar Roldán’s group.

### Statistical Physics seminar series

online

Organizer

2020

- 21 seminars virtually presented during the COVID lockdown, mostly by professors, for a broad audience of students and researchers across Brazil and other countries. Co-organizer: Carlos E. Fiore.

### University of São Paulo

São Paulo, Brazil

Teaching assistant

2018 - 2020

- Thermodynamics (2020);
- Statistical Mechanics (2018 and 2019);
- Graduate level Statistical Mechanics (2018).

### University of São Paulo

São Paulo, Brazil

Undergraduate researcher

2015 - 2017

- Research training program.
- Supervisors: Mário J. de Oliveira (2015-2016), and Carlos E. Fiore (2016-2017).

## Skills

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**Programming** Python, Mathematica, C.

**Miscellaneous** Usage of clusters,  $\LaTeX$ , Ubuntu Linux, teaching.

## Prizes and Grants

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- 2023 **Honorable mention for distinguished Ph.D. thesis in Exact and Earth Sciences**, University of São Paulo
- 2023 **Best Ph.D. thesis in Statistical and Computational Physics (national level)**, Brazilian Physical Society
- 2022 **Best Ph.D. thesis prize**, Institute of Physics - University of São Paulo
- 2022 **Honorable mention for distinguished publication**, Institute of Physics - University of São Paulo
- 2021 **Internship grant**, grant for 11 months of internship abroad (BEPE - FAPESP)
- 2018 **Ph.D. fellowship**, FAPESP 4 years grant for the Doctorate without Masters degree program
- 2017 **Undergrad research fellowship**, FAPESP grant for the Undergraduate research program
- 2016 **Undergrad research fellowship**, CNPq grant for the Undergraduate research program

## Events attended

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### XXVII Sitges Conference on Statistical Mechanics

Universitat de Barcelona

*Sitges, Spain*

2023

- [Talk](#): “Thermodynamics at the beat of transitions”

### Workshop on Stochastic Thermodynamics - WOST IV

The Abdus Salam International Centre for Theoretical Physics (ICTP)

*online*

2023

- [Talk](#): “Fluctuation relation at the beat of a current”

### Physics of Life: Students and Postdocs Edition

The Center for the Physics of Biological Function, CUNY/Princeton

*New York, United States of America*

2023

- [Talk](#): “Thermodynamics through the lens of transitions”

### Fluctuations and First Passage Problems

NORDITA

*Stockholm, Sweden*

2023

- [Talk](#): “Thermodynamics at the beat of transitions”

### Journées de Physique Statistique, 42nd edition

École Normale Supérieure de Paris

*Paris, France*

2023

- [Talk](#): “Transition-based coarse-graining”

### The 47th Conference of the Middle European Cooperation in Statistical Physics

MECO 47

*Erice, Italy*

2022

- [Poster](#): “Inferences from Statistics of a Few Observable Transitions”

### Autumn meeting

Brazilian Physical Society

*São Paulo, Brazil*

2022

- [Poster](#): “Inferences from Statistics of a Few Observable Transitions”

### National Statistical Physics Meeting

Universidade Federal de São João del-Rei (UFSJ)

*online*

2021

- [Talk](#): “Inferences from Statistics of a Few Observable Transitions”

### Statistical Physics of Complex Systems

The Abdus Salam International Centre for Theoretical Physics (ICTP)

*Trieste, Italy*

2021

- [Poster](#): “Entropy production fluctuation in phase transitions”

### Bangalore School on Statistical Physics XII

International Center for Theoretical Sciences (ICTS)

*online*

2021

### Autumn meeting

Brazilian Physical Society

*online*

2021

- [Talk](#): “Entropy Production fluctuations in nonequilibrium transitions”

### Workshop on Stochastic Thermodynamics - WOST II

Santa Fe Institute

*online*

2021

### APS March Meeting

American Physical Society

*online*

2021

- [Talk](#): “Quantitative comparison of different time-periodic Thermodynamic Uncertainty Relations”

### Quantum Thermodynamics of Non-equilibrium systems

Donostia International Physics Center

*online*

2020

## Statistical Physics Seminar Series

University of São Paulo

- [Talk](#): “Stochastic Thermodynamics: Schnakenberg, FT and TUR”

online

2020

## Autumn meeting

Brazilian Physical Society

- [Talk](#): “Stochastic pump as a model to study nonequilibrium properties”

online

2020

## Quantum Thermodynamics for Young Scientists

Wilhelm and Else Heraeus-Foundation

- [Poster](#): “Time asymmetric reciprocity relations for an arbitrarily long single-particle stochastic pump and its exact solution”

Bad Honnef, Germany

2020

## “Coloquinhão”

series of talks organized by IFT-UNESP, ICTP-SAIFR students

- [Invited talk](#): “Stochastic Thermodynamics: basics and some modern aspects”

São Paulo, Brazil

2019

## Physics Giants: Einstein Week

series of talks organized by USP students

- [Invited talk](#): “Einstein’s contributions to Statistical Mechanics”

São Paulo, Brazil

2019

## Languages

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**English** Full professional proficiency

**Portuguese** Native proficiency

**Spanish** Limited working proficiency

## Peer-review contributions

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Physical Review X Quantum, Journal of Physics A: Mathematical and Theoretical, Journal of Physics Communications

**References available upon request.**