# 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** *Luxembourg, Luxembourg*

Postdoctoral researcher *Dec 2022 - Current*

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

**University of São Paulo** *São Paulo, Brazil*

Doctorate in Physics *Mar 2018 - Nov 2022*

- 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

**University of São Paulo** *São Paulo, Brazil*

Bachelor in Physics *Feb 2014 - Nov 2017*

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

## List of Publications

8 articles published in internationally renowned journals and one preprint.

From Google Scholar: 113 citations, h-index 7.

- PE Harunari, A Garilli, and M Polettini, "*The beat of a current*"
  arXiv preprint arXiv:2205.05060, accepted in Physical Review E as a letter *2022*
- PE Harunari, A Dutta, M Polettini, and E 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

**(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.
- 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

**Programming** Python, Mathematica, C.
**Miscellaneous** Usage of clusters, LaTeX, Ubuntu Linux, teaching.

## Prizes and Grants

2022 **Institute of Physics - University of São Paulo**, best PhD thesis
2022 **Institute of Physics - University of São Paulo**, honorable mention for distinguished publication
2021 **FAPESP**, grant for 11 months of internship abroad (BEPE)
2018 **FAPESP**, grant of 4 years for the Doctorate without Masters degree program
2017 **FAPESP**, grant for the Undergraduate research program
2016 **CNPq**, grant for the Undergraduate research program

## Events attended

**Physics of Life: Students and Postdocs Edition** *New York, United States of America*
The Center for the Physics of Biological Function, CUNY/Princeton *2023*
• Talk: "Thermodynamics through theh lens of transitions"

**Fluctuations and First Passage Problems** *Stockholm, Sweden*
NORDITA *2023*
• Talk: "Thermodynamics at the beat of transitions"

**Journées de Physique Statistique, 42nd edition** *Paris, France*
École Normale Supérieure de Paris *2023*
• Talk: "Transition-based coarse-graining"

**The 47th Conference of the Middle European Cooperation in Statistical Physics** *Erice, Italy*
MECO 47 *2022*
• Poster: "Inferences from Statistics of a Few Observable Transitions"

**Autumn meeting** *São Paulo, Brazil*
Brazilian Physical Society *2022*
• Poster: "Inferences from Statistics of a Few Observable Transitions"

**National Statistical Physics Meeting** *online*
Universidade Federal de São João del-Rei (UFSJ) *2021*
• Talk: "Inferences from Statistics of a Few Observable Transitions"

**Statistical Physics of Complex Systems** *Trieste, Italy*
The Abdus Salam International Centre for Theoretical Physics (ICTP) *2021*
• Poster: "Entropy production fluctuation in phase transitions"

**Bangalore School on Statistical Physics XII** *online*
International Center for Theoretical Sciences (ICTS) *2021*

**Autumn meeting** *online*
Brazilian Physical Society *2021*
• Talk: "Entropy Production fluctuations in nonequilibrium transitions"

**Stochastic Thermodynamics II** *online*
Santa Fe Institute *2021*

**APS March Meeting** *online*
American Physical Society *2021*
• Talk: "Quantitative compartison of different time-periodic Thermodynamic Uncerainty Relations"

**Quantum Thermodynamics of Non-equilibrium systems** *online*
Donostia International Physics Center *2020*

**Statistical Physics Seminar Series** *online*
University of São Paulo *2020*
• Talk: "Stochastic Thermodynamics: Schnakenberg, FT and TUR"

**Autumn meeting** *online*
Brazilian Physical Society *2020*
• Talk: "Stochastic pump as a model to study nonequilibrium properties"

**Quantum Thermodynamics for Young Scientists** *Bad Honnef, Germany*
Wilhelm and Else Heraeus-Foundation *2020*
• Poster: "Time assymetric reciprocity relations for an arbitrarily long single-particle stochastic pump and its exact solution"

***"Coloquinho"*** *São Paulo, Brazil*

series of talks organized by IFT-UNESP, ICTP-SAIFR students *2019*

- Invited talk: "Stochastic Thermodynamics: basics and some modern aspects"

**Physics Giants: Einstein Week** *São Paulo, Brazil*

series of talks organized by USP students *2019*

- Invited talk: "Einstein's contributions to Statistical Mechanics"

## Languages

**English** Full professional proficiency
**Portuguese** Native proficiency
**Spanish** Llimited working proficiency

## Peer-review contributions

(3) Journal of Physics A: Mathematical and Theoretical, (1) Journal of Physics Communications

**References available upon request.**