Giorgio Nicoletti

Contacts

Room 232, Quantitative Life Sciences
ICTP, Trieste, Italy
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Skills

Programming

Advanced Knowledge

Python | Wolfram Mathematica

Basic Knowledge

C++ | Matlab | Julia | R | Bash

Tools

Latex | Powerpoint & MS Office | HTML | CSS | Inkscape

Languages

native: Italian

fluent: English

intermediate: French

beginner: German, Japanese

Research experience

International Center for Theoretical Physics — *Trieste, Italy*
Postdoctoral researcher — 2024 - present
Quantitative Life Sciences section, with prof. Antonio Celani

École Polytechnique Fédérale de Lausanne — *Lausanne, Switzerland*
Postdoctoral researcher — 2023 - 2024
Laboratory of Ecohydrology, with prof. Andrea Rinaldo

Tübingen University — *Tübingen, Germany*
Visiting Ph.D. student — Sept 2022 - Dec 2022
"Self-organization of neuronal networks" group, with prof. Anna Levina

Max Planck Institute for the Physics of Complex Systems — *Dresden, Germany*
Visiting Ph.D. student — June 2022 - July 2022
Division of Biological Physics, with Dr. Daniel M. Busiello

Education

Ph.D. in Physics *cum laude* — *University of Padova*
Thesis: *Information and Criticality in Complex Stochastic Systems* — 2019 - 2023
Supervisors: prof. Amos Maritan and prof. Samir Suweis

Master's Degree in Physics *cum laude* — *University of Padova*
Thesis: *Scaling and Renormalization Group for models of neural activity* — 2017 - 2019
Final grade: 110/110 *cum laude*, GPA: 29.93/30

Erasmus+ scolarship — *Paris-Sud University*
International Master in Physics of Complex System, ECTS GPA: A/A — 2018 - 2019

Bachelor's Degree in Physics *cum laude* — *University of Padova*
Thesis: *A Bayesian interpretation of quantum probability* — 2014 - 2017
Final grade: 110/110 *cum laude*, GPA: 29.19/30

Invited talks

Information propagation across timescales — *Trieste, Italy*
International Center for Theoretical Physics — *4th Apr 2024*

Tuning transduction from hidden observables to optimize information harvesting — *Trieste, Italy*
"Information processing and decision-making in biology" workshop, ICTP — *11th Mar 2024*

Survival and coexistence in spatially explicit metapopulation models — *Padova, Italy*
"Emergent dynamical patterns of disordered systems with applications to natural communities" workshop — *18th Dec 2023*

Information theory in stochastic processes and complex systems — *Dresden, Germany*
Max Planck Institute for the Physics of Complex Systems — *13th Jul 2022*

What can phase transitions and criticality teach us about brain dynamics? — *Stockholm, Sweden*
BrainNet workshop, KTH Royal Institute of Technology — *23rd - 24th May 2022*

Unfolding complex systems with information theory — *Online*
Young Seminars of the Italian Society of Statistical Physics — *10th Mar 2022*

Publications

Excitation-inhibition balance controls information encoding in neural populations — **Phys. Rev. Lett.**
G. Barzon, D. M. Busiello, G. Nicoletti — *134 (6), 068403 (2025)*

Information interference driven by environmental activity — **Phys. Rev. Research**
G. Nicoletti, D. M. Busiello — *6 (4), 043275 (2024)*

Landscape and environmental heterogeneity support coexistence in competitive metacommunities
PNAS
121 (44) e2410932121 (2024)
P. Padmanabha*, G. Nicoletti*, D. Bernardi*, S. Suweis, S. Azaele, A. Rinaldo, A. Maritan (*equal contribution)

Information propagation in Gaussian processes on multilayer networks
J. Phys. Complex.
5, 045004 (2024)
G. Nicoletti, D. M. Busiello

Tuning transduction from hidden observables to optimize information harvesting
Phys. Rev. Lett.
133, 158401 (2024)
G. Nicoletti, D. M. Busiello
Physical Review Letters Editors' Suggestion and viewpoint in the APS "Physics" magazine

Information propagation in multilayer systems with higher-order interactions across timescales
Phys. Rev. X
14 (2) 021007 (2024)
G. Nicoletti, D. M. Busiello

Prenatal experience with language shapes the brain
Science Advances
9 (47), eadj3524 (2023)
B. Mariani, G. Nicoletti, G. Barzon, M. C. O. Barajas, M. Shukla, R. Guevara, S. Suweis, J. Gervain

Emergent encoding of dispersal network topologies in spatial metapopulation models
PNAS
120 (46) e2311548120 (2023)
G. Nicoletti*, P. Padmanabha*, S. Azaele, S. Suweis, A. Rinaldo, A. Maritan (*equal contribution)

The emergence of scale-free fire outbreaks in Australia
iScience
26 (3) 106181 (2023)
G. Nicoletti, L. Saravia, F. Momo, A. Maritan, S. Suweis
Best poster award at the conference "Stochastic Models and Experiments in Ecology and Biology 2021" Venice, Italy

Mutual information in changing environments: Nonlinear interactions, out-of-equilibrium systems, and continuously varying diffusivities
Phys. Rev. E
106, 014153 (2022)
G. Nicoletti, D. M. Busiello

Information-driven transitions in projections of underdamped dynamics
Phys. Rev. E
106, 014118 (2022)
G. Nicoletti, A. Maritan, D. M. Busiello

Criticality and network structure drive emergent oscillations in a stochastic whole-brain model
J. Phys. Complex.
3, 025010 (2022)
G. Nicoletti*, G. Barzon*, B. Mariani, M. Formentin, S. Suweis (*equal contribution)

Disentangling the critical signatures of neural activity
Sci. Rep.
12, 10770 (2022)
B. Mariani, G. Nicoletti, M. Bisio, M. Maschietto, S. Vassanelli, S. Suweis
Featured in the "Top 100 papers in Neuroscience" published by Scientific Reports in 2022

Mutual information disentangles interactions from changing environments
Phys. Rev. Lett.
127, 228301 (2021)
G. Nicoletti, D. M. Busiello
Physical Review Letters Editors' Suggestion, viewpoint in the APS "Physics" magazine and highlight in PRL's weekly tip sheet for reporters

Neuronal avalanches across the rat somatosensory barrel cortex and the effect of single whisker stimulation
Front. Syst. Neur.
15:709677 (2021)
B. Mariani, G. Nicoletti, M. Bisio, M. Maschietto, R. Oboe, A. Leparulo, S. Suweis, S. Vassanelli

Scaling and criticality in a phenomenological renormalization group
Phys. Rev. Research
2, 023144 (2020)
G. Nicoletti, S. Suweis, A. Maritan

Preprints

A novel metric for species vulnerability and coexistence in spatially-extended ecosystems
arXiv
2503.10288 (2025)
D. Bernardi, G. Nicoletti, P. Padmanabha, S. Suweis, S. Azaele, A. Rinaldo, A. Maritan

Optimal information gain at the onset of habituation to repeated stimuli
arXiv
2301.12812 (2025)
G. Nicoletti, M. Bruzzone, S. Suweis, M. Dal Maschio, D. M. Busiello

Finite size scaling of survival statistics in metapopulation models
arXiv
2412.18448 (2024)
A. Doimo, G. Nicoletti, D. Bernardi, P. Padmanabha

Multiscale nonlinear integration drives accurate encoding of input information
arXiv
2411.11710 (2024)
G. Nicoletti, D. M. Busiello

Unveiling gene perturbation effects through Gene Regulatory Networks inference from single-cell transcriptomic data
bioRxiv
2024.05.10.593314 (2024)
C. Corridori, M. Romeike, G. Nicoletti, C. Buecker, S. Suweis, S. Azaele, G. Martello

A network-based method for extracting the organization of brain-wide circuits from reconstructed connectome datasets
bioRxiv
2023.05.21.541471 (2023)
K. K. H. Manjunatha, M. Bruzzone, G. Nicoletti, S. Suweis, M. Dal Maschio

Contributed talks and posters

ENAC Research Day 2024 — *Lausanne, Switzerland*, 9^{th} Sept 2024
Poster: Landscape and habitat heterogeneity drive niche coexistence in dispersing ecological metacommunities

Stochastic Models and Experiments in Ecology and Biology 2024 — *L'Aquila, Italy*, 28^{th} - 31^{st} May 2024
Talk: Spatially disordered environments stabilize competitive metacommunities

SIGNAL24: Information Processing, Noise, and Adaptation in Living Systems — *Dresden, Germany*, 15^{th} - 19^{th} Apr 2024
Talk: Information propagation across timescales in multiscale systems

Italian Conference on Complex Systems 2023 — *Naples, Italy*, 9^{th} - 11^{th} Oct 2023
Poster: Emergent encoding of dispersal network topologies in spatial metapopulation models

28th International Conference on Statistical Physics — *Tokyo, Japan*, 7^{th} - 11^{th} Aug 2023
Talk: The architecture of information processing in biological systems

Brain Criticality Meeting 2022 — *Online*, 7^{th} - 9^{th} Nov 2022
Poster: Criticality and network structure drive emergent oscillations in a stochastic whole-brain model

Conference on Complex Systems 2022 — *Palma de Mallorca, Spain*, 17^{th} - 21^{st} Oct 2022
Talk: Criticality and network structure drive emergent oscillations in a stochastic whole-brain model
Talk: Information-driven transitions in optimal projections of underdamped dynamics

Bernstein Conference 2022 — *Berlin, Germany*, 14^{th} - 16^{th} Sept 2022
Poster: Disentangling the critical signatures of neural activity: avalanches, spatial correlations and information

Conference on Complex Systems 2021 — *Lyon, France*, 25^{th} - 29^{th} Oct 2021
Talk: Disentangling the role of external and intrinsic dynamics on the critical signatures of neural activity
Talk: Modeling the emergence of scale-free fire outbreaks in Australia
Poster: Disentangling internal interactions from noisy environments through mutual information

Stochastic Models and Experiments in Ecology and Biology 2021 — *Venice, Italy*, 22^{nd} - 25^{th} June 2021
Poster: Modeling the emergence of scale-free fire outbreaks in Australia

Brain Criticality Virtual Meeting — *Online*, 6^{th} - 9^{th} Oct 2020
Poster: What can a phenomenological Renormalization Group teach us about criticality in a network of neurons?

Bernstein Conference 2020 — *Online*, 29^{th} Sept - 1^{st} Oct 2020
Poster: Scaling and criticality in a phenomenological renormalization group

Italian Conference on Complex Systems — *Trento, Italy*, 1^{st} - 3^{rd} July 2019
Poster: Scaling and Renormalization Group for the activity of neurons

Attended schools and workshops

Emergence of Information in Molecular Systems (MOLINFO) — *Munich, Germany*, 22^{nd} Jul - 2^{nd} Aug 2024
Workshop

Winter Workshop on Complex Systems 2022 — *Arc-et-Senans, France*, 24^{th} - 28^{th} Jan 2022
Workshop

Beg Rohu Summer School on "Statistical Mechanics and Emergent Phenomena in Biology" — *St. P. Quiberon, France*, 30^{th} May - 12^{th} June 2021
School

Computational and Theoretical Models in Neuroscience — *Venice, Italy*, 9^{th} - 16^{th} Sept 2019
School

Organized conferences

Robustness, Adaptability and Critical Transitions in Living Systems — *Lyon, France*, 27^{th} Oct 2021
Main organizer
Satellite of the Conference on Complex Systems 2021

Teaching experience and supervision

2025 **An introduction to information theory for stochastic biological systems**, PhD course in Physics, University of Padova — *Main lecturer*

2025 **Co-supervision of one Master's thesis**, EPFL, ICTP — *Co-supervision*

2023 **Fundamental of Information Systems**, Master's Degree in Data Science, University of Padova — *Teaching assistant*

2022 - 23 **Advanced Statistical Mechanics**, PhD course in Physics, University of Padova — *Invited lecturer*

2022 - 23 **Physics with applications to biological systems**, Bachelor's Degree in Biology of Human and Environmental Health, University of Padova — *Teaching assistant*

2021 - 23 **Co-supervision of two Master's thesis and two Bachelor's thesis**, Department of Physics and Astronomy, University of Padova — *Co-supervision*

2021 - 22 **Models of Theoretical Physics**, Master's Degree in Physics of Data, University of Padova *Teaching assistant*

2020 - 22 **IT and Bioinformatics**, Bachelor's Degree in Biology and Molecular Biology, University of Padova *Teaching assistant*

HONORS AND AWARDS

7th Oct 2024 **Physical Review Letters Editors' Suggestion and viewpoint in "Physics" magazine** for the article *Tuning transduction from hidden observables to optimize information harvesting*, Phys. Rev. Lett. 133, 158401 (2024)

12th Mar 2023 **Featuring in the "Top 100 papers in Neuroscience" published by Scientific Reports in 2022** for the article *Disentangling the critical signatures of neural activity*, Sci. Rep. 127, 12, 10770 (2022)

29th Nov 2022 **Graduate Alumni Award** awarded to the best graduate student of the School of Science of the University of Padova

Dec 2021 **Winner of the SECS travel grant** funded by the *Young Researchers in Complex Systems Society*

22nd Nov 2021 **Physical Review Letters Editors' Suggestion, viewpoint in "Physics" magazine and highlight in PRL's weekly tip sheet for reporters** for the article *Mutual information disentangles interactions from changing environments*, Phys. Rev. Lett. 127, 228301 (2021)

25th Jun 2021 **Best Poster Award** for "Modeling the emergence of scale-free fire outbreaks in Australia" at *Stochastic Models and Experiments in Ecology and Biology 2021*, ECLT, Venice, Italy. Sponsored by MDPI

Feb 2017 **Student grant** for the best students enrolled in scientific degrees, granted by University of Padova

10th Oct 2014 **Best student award** for the best high school students in Italy, awarded by the Italian Ministry for Education

SERVICE AND MEMBERSHIPS

I have reviewed for **PNAS**, **Physical Review X**, **Physical Review Letters**, **Physical Review Research**, **Physical Review E**, **iScience**, **Entropy**, and **PLOS Computational Biology**.

2024 - present Member of the **Italian Society of Statistical Physics**

2021 - present Member of the **Complex Systems Society**

2021 - 2023 Member of the **Italian Society of Physics**

2021 - 2023 **Elected representative** in the PhD Program Committee and the Academic Board of the PhD program, Department of Physics and Astronomy, University of Padova