

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

POSTDOCTORAL RESEARCHER

Quantitative Life Sciences section, with prof. Antonio Celani

Trieste, Italy

2024 - PRESENT

École Polytechnique Fédérale de Lausanne

POSTDOCTORAL RESEARCHER

Laboratory of Ecohydrology, with prof. Andrea Rinaldo

Lausanne, Switzerland

2023 - 2024

Tübingen University

VISITING PH.D. STUDENT

"Self-organization of neuronal networks" group, with prof. Anna Levina

Tübingen, Germany

SEPT 2022 - DEC 2022

Max Planck Institute for the Physics of Complex Systems

VISITING PH.D. STUDENT

Division of Biological Physics, with Dr. Daniel M. Busiello

Dresden, Germany

JUNE 2022 - JULY 2022

EDUCATION

Ph.D. in Physics *cum laude*

THESIS: *Information and Criticality in Complex Stochastic Systems*

Supervisors: prof. Amos Maritan and prof. Samir Suweis

University of Padova

2019 - 2023

Master's Degree in Physics *cum laude*

THESIS: *Scaling and Renormalization Group for models of neural activity*

Final grade: 110/110 *cum laude*, GPA: 29.93/30

University of Padova

2017 - 2019

Erasmus+ scholarship

INTERNATIONAL MASTER IN PHYSICS OF COMPLEX SYSTEM, ECTS GPA: A/A

Paris-Sud University

2018 - 2019

Bachelor's Degree in Physics *cum laude*

THESIS: *A Bayesian interpretation of quantum probability*

Final grade: 110/110 *cum laude*, GPA: 29.19/30

University of Padova

2014 - 2017

INVITED TALKS AND SEMINARS

From timescales to information processing in stochastic biological systems

IV INTERNATIONAL SUMMER SCHOOL OF THE ITALIAN STATISTICAL PHYSICS SOCIETY

Lecce, Italy

18th Sept 2026

Spatial ecological communities on dispersal networks: from metapopulation capacity to coexistence through disorder

V CONFERENCE OF THE ITALIAN SOCIETY OF STATISTICAL PHYSICS

Parma, Italy

25th Jun 2026

Information processing in multiscale biological systems: from transduction mechanisms to decision-making processes

UNIVERSITY OF TOKYO

Tokyo, Japan

27th Mar 2026

Decoding behavior: inference of decision-making processes with interpretable agent models

PADOVA NEUROSCIENCE CENTER

Padova, Italy

14th Nov 2025

Information propagation across timescales

INTERNATIONAL CENTER FOR THEORETICAL PHYSICS

Trieste, Italy

4th Apr 2024

Tuning transduction from hidden observables to optimize information harvesting

"INFORMATION PROCESSING AND DECISION-MAKING IN BIOLOGY" WORKSHOP, ICTP

Trieste, Italy

11th Mar 2024

Survival and coexistence in spatially explicit metapopulation models

"EMERGENT DYNAMICAL PATTERNS OF DISORDERED SYSTEMS WITH APPLICATIONS TO NATURAL COMMUNITIES" WORKSHOP

Padova, Italy

18th Dec 2023

Information theory in stochastic processes and complex systems

MAX PLANCK INSTITUTE FOR THE PHYSICS OF COMPLEX SYSTEMS

Dresden, Germany

13th Jul 2022

What can phase transitions and criticality teach us about brain dynamics?

BRAINNET WORKSHOP, KTH ROYAL INSTITUTE OF TECHNOLOGY

Stockholm, Sweden

23rd - 24th May 2022

Unfolding complex systems with information theory

YOUNG SEMINARS OF THE ITALIAN SOCIETY OF STATISTICAL PHYSICS

Online

10th Mar 2022

PUBLICATIONS

Balancing information and dissipation with partially observed fluctuating signals

G. NICOLETTI, I. DI TERLIZZI, D. M. BUSIELLO

Physical Review Letters Editors' Suggestion and viewpoint in the APS "Physics" magazine

PHYS. REV. LETT.

137, 127101 (2026)

Decoding behavior with minimal and interpretable agent models

G. NICOLETTI, A. CELANI

PLOS COMP. BIO.

22 (8), e1014585 (2026)

Habitat heterogeneity and dispersal network structure as drivers of metacommunity dynamics

G. NICOLETTI*, D. BERNARDI*, A. DOIMO*, P. PADMANABHA*, A. RINALDO, S. SUWEIS, S. AZAELE, A. MARITAN (* EQUAL CONTRIBUTION)

J. STAT. MECH.

084003 (2026)

Generalized scaling of blue metabolism in river basins

G. NICOLETTI, E. BERTUZZO, P. PADMANABHA, F. BASSANI, S. BONETTI, A. MARITAN, A. RINALDO

WATER RES. RES.

62, e2025WR041131 (2026)

Unveiling gene perturbation effects through gene regulatory networks inference from single-cell transcriptomic data

C. CORRIDORI, M. ROMEIKE, G. NICOLETTI, C. BUECKER, S. SUWEIS, S. AZAELE, G. MARTELLO

PLOS COMP. BIO.

22 (4), e1014067 (2026)

Information-directed sampling for bandits: a primer

A. HIRLING, G. NICOLETTI, A. CELANI

J. STAT. MECH.

4, 043402 (2026)

Stochastic processes with multiple temporal scales: timescale separation and information

G. NICOLETTI, D. M. BUSIELLO

J. STAT. MECH.

12, 124004 (2025)

Fast nonlinear integration drives accurate encoding of input information in large multiscale systems

G. NICOLETTI, D. M. BUSIELLO

COMM. PHYSICS

8, 437 (2025)

Optimal information gain at the onset of habituation to repeated stimuli

G. NICOLETTI, M. BRUZZONE, S. SUWEIS, M. DAL MASCHIO, D. M. BUSIELLO

ELIFE

13:RP99767 (2025)

Finite size scaling of survival statistics in metapopulation models

A. DOIMO, G. NICOLETTI, D. BERNARDI, P. PADMANABHA

PHYS. REV. E

111 (6), 064415 (2025)

Excitation-inhibition balance controls information encoding in neural populations

G. BARZON, D. M. BUSIELLO, G. NICOLETTI

PHYS. REV. LETT.

134 (6), 068403 (2025)

Information interference driven by environmental activity

G. NICOLETTI, D. M. BUSIELLO

PHYS. REV. RESEARCH

6 (4), 043275 (2024)

Landscape and environmental heterogeneity support coexistence in competitive metacommunities

G. NICOLETTI*, P. PADMANABHA*, D. BERNARDI*, S. SUWEIS, S. AZAELE, A. RINALDO, A. MARITAN (*EQUAL CONTRIBUTION)

PNAS

121 (44) 2410932121 (2024)

Information propagation in Gaussian processes on multilayer networks

G. NICOLETTI, D. M. BUSIELLO

J. PHYS. COMPLEX.

5, 045004 (2024)

Tuning transduction from hidden observables to optimize information harvesting

G. NICOLETTI, D. M. BUSIELLO

Physical Review Letters Editors' Suggestion and viewpoint in the APS "Physics" magazine

PHYS. REV. LETT.

133, 158401 (2024)

Information propagation in multilayer systems with higher-order interactions across timescales

G. NICOLETTI, D. M. BUSIELLO

PHYS. REV. X

14 (2) 021007 (2024)

Prenatal experience with language shapes the brain

B. MARIANI, G. NICOLETTI, G. BARZON, M. C. O. BARAJAS, M. SHUKLA, R. GUEVARA, S. SUWEIS, J. GERVAIN

SCIENCE ADVANCES

9 (47), eadj3524 (2023)

Emergent encoding of dispersal network topologies in spatial metapopulation models

G. NICOLETTI*, P. PADMANABHA*, S. AZAELE, S. SUWEIS, A. RINALDO, A. MARITAN (*EQUAL CONTRIBUTION)

PNAS

120 (46) 2311548120 (2023)

The emergence of scale-free fire outbreaks in Australia

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

ISCIENCE

26 (3) 106181 (2023)

Mutual information in changing environments: Nonlinear interactions, out-of-equilibrium systems, and continuously varying diffusivities

G. NICOLETTI, D. M. BUSIELLO

PHYS. REV. E

106, 014153 (2022)

Information-driven transitions in projections of underdamped dynamics

G. NICOLETTI, A. MARITAN, D. M. BUSIELLO

PHYS. REV. E

106, 014118 (2022)

Criticality and network structure drive emergent oscillations in a stochastic whole-brain model

G. NICOLETTI*, G. BARZON*, B. MARIANI, M. FORMENTIN, S. SUWEIS (*EQUAL CONTRIBUTION)

J. PHYS. COMPLEX.

3, 025010 (2022)

Disentangling the critical signatures of neural activity

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

SCI. REP.

12, 10770 (2022)

Mutual information disentangles interactions from changing environments

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

PHYS. REV. LETT.

127, 228301 (2021)

Neuronal avalanches across the rat somatosensory barrel cortex and the effect of single whisker stimulation

B. MARIANI, G. NICOLETTI, M. BISIO, M. MASCHIETTO, R. OBOE, A. LEPARULO, S. SUWEIS, S. VASSANELLI

FRONT. SYST. NEUR.

15:709677 (2021)

Scaling and criticality in a phenomenological renormalization group

G. NICOLETTI, S. SUWEIS, A. MARITAN

PHYS. REV. RESEARCH

2, 023144 (2020)

PREPRINTS

Universal thermokinetic decomposition of short-time information fluctuations

G. NICOLETTI, D. M. BUSIELLO

ARXIV

:2605.29957 (2026)

Emergence of information interference in stochastic systems with non-diagonal noise and switching environments

A. MARCHETTI, D. M. BUSIELLO, G. NICOLETTI

ARXIV

2605.13556 (2026)

Rare but Resilient: Dispersal diversity buffers species vulnerability

D. BERNARDI, G. NICOLETTI, P. PADMANABHA, S. SUWEIS, S. AZAELE, S. A. LEVIN, A. RINALDO, A. MARITAN

ARXIV

2604.26589 (2026)

Pulse desynchronization of neural populations by targeting the centroid of the limit cycle in phase space

R. GUEVARA, M. ZENARI, G. NICOLETTI, E. MARINI, S. SUWEIS, S. AZAELE, M. FORMENTIN

ARXIV

arXiv:2603.12878 (2026)

Plasticity-induced multistability on fast and slow timescales enables optimal information encoding and spontaneous sequence discrimination

G. BARZON, D. M. BUSIELLO, G. NICOLETTI

ARXIV

2509.13867 (2025)

The somatosensory barrel cortex controls the spindle thalamocortical oscillation by frequency locking

R. GUEVARA, M. TAMBARO, M. MASCHIETTO, A. LEPARULO, C. CHECCHETTO, G. NICOLETTI, B. MARIANI, S. SUWEIS, S. VASSANELLI

BIORxIV

2025.07.09.662963 (2025)

A novel metric for species vulnerability and coexistence in spatially-extended ecosystems

D. BERNARDI, G. NICOLETTI, P. PADMANABHA, S. SUWEIS, S. AZAELE, A. RINALDO, A. MARITAN

ARXIV

2503.10288 (2025)

A network-based method for extracting the organization of brain-wide circuits from reconstructed connectome datasets

K. K. H. MANJUNATHA, M. BRUZZONE, G. NICOLETTI, S. SUWEIS, M. DAL MASCHIO

BIORxIV

2023.05.21.541471 (2023)

CONTRIBUTED TALKS AND POSTERS

From Biological Complexity to Evolutionary Principles (EPIC Assembly Symposium 2026)

POSTER: PROCESSING INFORMATION FROM PARTIALLY OBSERVED SIGNALS IN BIOLOGICAL SYSTEMS WITH ENERGETIC CONSTRAINTS

Tokyo, Japan

14th - 16th Mar 2026

Neurophysics of Active Sensing, KITP

TALK: INFERENCE OF DECISION-MAKING STRATEGIES WITH FINITE MEMORY STATES

Santa-Barbara, USA

10th - 16th Aug 2025

International Physics of Living Systems (iPoLS) Annual Meeting

TALK: OPTIMIZING TRANSDUCTION OF INFORMATION FROM HIDDEN OBSERVABLES IN BIOLOGICAL SYSTEMS WITH A LIMITED ENERGY BUDGET

Urbana-Champaign, USA

28th Jul - 1st Aug 2025

29th International Conference on Statistical Physics

TALK: TUNING TRANSDUCTION FROM HIDDEN OBSERVABLES TO OPTIMIZE INFORMATION HARVESTING WITH A LIMITED ENERGY BUDGET

Firenze, Italy

13th - 18th Jul 2025

ENAC Research Day 2024

POSTER: LANDSCAPE AND HABITAT HETEROGENEITY DRIVE NICHE COEXISTENCE IN DISPERSING ECOLOGICAL METACOMMUNITIES

Lausanne, Switzerland

9th Sept 2024

Stochastic Models and Experiments in Ecology and Biology 2024

TALK: SPATIALLY DISORDERED ENVIRONMENTS STABILIZE COMPETITIVE METACOMMUNITIES

L'Aquila, Italy

28th - 31st May 2024

SIGNAL24: Information Processing, Noise, and Adaptation in Living Systems

TALK: INFORMATION PROPAGATION ACROSS TIMESCALES IN MULTISCALE SYSTEMS

Dresden, Germany

15th - 19th Apr 2024

Italian Conference on Complex Systems 2023

POSTER: EMERGENT ENCODING OF DISPERSAL NETWORK TOPOLOGIES IN SPATIAL METAPOPULATION MODELS

Naples, Italy

9th - 11th Oct 2023

28th International Conference on Statistical Physics

TALK: THE ARCHITECTURE OF INFORMATION PROCESSING IN BIOLOGICAL SYSTEMS

Tokyo, Japan

7th - 11th Aug 2023

Brain Criticality Meeting 2022

POSTER: CRITICALITY AND NETWORK STRUCTURE DRIVE EMERGENT OSCILLATIONS IN A STOCHASTIC WHOLE-BRAIN MODEL

Online

7th - 9th Nov 2022

Conference on Complex Systems 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

Palma de Mallorca, Spain

17th - 21st Oct 2022

Bernstein Conference 2022

POSTER: DISENTANGLING THE CRITICAL SIGNATURES OF NEURAL ACTIVITY: AVALANCHES, SPATIAL CORRELATIONS AND INFORMATION

Berlin, Germany

14th - 16th Sept 2022

Conference on Complex Systems 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

Lyon, France

25th - 29th Oct 2021

Stochastic Models and Experiments in Ecology and Biology 2021

POSTER: MODELING THE EMERGENCE OF SCALE-FREE FIRE OUTBREAKS IN AUSTRALIA

Venice, Italy

22nd - 25th June 2021

Brain Criticality Virtual Meeting

POSTER: WHAT CAN A PHENOMENOLOGICAL RENORMALIZATION GROUP TEACH US ABOUT CRITICALITY IN A NETWORK OF NEURONS?

Online

6th - 9th Oct 2020

Bernstein Conference 2020

POSTER: SCALING AND CRITICALITY IN A PHENOMENOLOGICAL RENORMALIZATION GROUP

Online

29th Sept - 1st Oct 2020

Italian Conference on Complex Systems

POSTER: SCALING AND RENORMALIZATION GROUP FOR THE ACTIVITY OF NEURONS

Trento, Italy

1st - 3rd July 2019

ATTENDED SCHOOLS AND WORKSHOPS

Brains, Minds and Machines

SCHOOL

Woods Hole, USA

8th Aug - 28th Aug 2026

Emergence of Information in Molecular Systems (MOLINFO)

WORKSHOP

Munich, Germany

22nd Jul - 2nd Aug 2024

Winter Workshop on Complex Systems 2022

WORKSHOP

Arc-et-Senans, France

24th - 28th Jan 2022

Beg Rohu Summer School on "Statistical Mechanics and Emergent Phenomena in Biology"

SCHOOL

St. P. Quiberon, France

30th May - 12th June 2021

Computational and Theoretical Models in Neuroscience

SCHOOL

Venice, Italy

9th - 16th Sept 2019

ORGANIZED CONFERENCES

Information and Decisions Across Scales: Constraints and Optimality in Neural and Biological Networks (IDEAS)

MAIN ORGANIZER

Conference at the Max Planck Institute for the Physics of Complex Systems

Dresden, Germany

18th - 22nd May 2026

Robustness, Adaptability and Critical Transitions in Living Systems

MAIN ORGANIZER

Satellite of the Conference on Complex Systems 2021

Lyon, France

27th Oct 2021

TEACHING EXPERIENCE AND SUPERVISION

2026	Reinforcement Learning , ICTP Diploma Program and University of Trieste	Main lecturer
2025	Ecology and Evolution , ICTP Diploma Program, SISSA, and University of Trieste	Invited lecturer
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

AWARDS, HONORS AND MEDIA COVERAGE

- 14th Sept 2026 **Physical Review Letters Editors' Suggestion, viewpoint in the magazine "Physics", and Phys.org feature article** for the paper *Balancing information and dissipation with partially observed fluctuating signals*, Phys. Rev. Lett. 137, 127101 (2026)
- 13th Jul 2025 **"Giovanni Paladin" prize** for the best PhD thesis on topics in statistical physics and complex systems for the years 2022-2024. Awarded at the inaugural ceremony of the 29th International Conference on Statistical Physics by the Italian Association for Statistical Physics (SIFS)
- 3rd Apr 2025 **Entropy Outstanding Reviewer Award** awarded to five outstanding reviewers of the journal *Entropy* in 2024
- 9th Mar 2025 **Phys.org feature article** for the paper *Excitation-Inhibition balance controls information encoding in neural populations*, Phys. Rev. Lett. 134, 068403 (2025)
- 7th Oct 2024 **Physical Review Letters Editors' Suggestion, viewpoint in the magazine "Physics", and Phys.org feature article** for the paper *Tuning transduction from hidden observables to optimize information harvesting*, Phys. Rev. Lett. 133, 158401 (2024)
- 22nd Nov 2023 **Press release by the American Association for the Advancement of Science, coverage by international news outlets (The Times, Daily Mail, El Pais, Le Figaro, Corriere della Sera, and more), and popular science publications (New Scientists, Nature Italy, PsyPost, Science Alert, and more)** for the paper *Prenatal experience with language shapes the brain*, Science Advances 9 (47), eadj3524 (2023)
- 12th Mar 2023 **Featuring in the "Top 100 papers in Neuroscience" published by Scientific Reports in 2022** for the paper *Disentangling the critical signatures of neural activity*, Sci. Rep. 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
- 22nd Nov 2021 **Physical Review Letters Editors' Suggestion, viewpoint in "Physics" magazine and highlight in PRL's weekly tip sheet for reporters** for the paper *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

Reviewer for **Nature Reviews Physics, Nature Communications, PNAS, Physical Review X, Physical Review Letters, PRX Life, Communications Physics, Physical Review Research, Physical Review E, Journal of Statistical Mechanics, New Journal of Physics, iScience, Entropy**, and **PLOS Computational Biology**.

2021 - 2024 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