

# Edmilson Roque dos Santos

Research interests: Dynamical Systems, Ergodic Theory, Synchronization, Sparse Recovery methods, Reservoir Computing.

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🌐 <https://github.com/edmilson-roque-santos>

## PROFESSIONAL APPOINTMENTS

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### Postdoctoral Researcher

Sep 2025 – to date

NONLINEAR DYNAMICS AND TIME SERIES ANALYSIS

MAX PLANCK INSTITUTE FOR THE PHYSICS OF COMPLEX SYSTEMS

Project: *Learning sparse network dynamics from data*

### Research Associate

Feb 2023 – May, 2025

CLARKSON CENTER FOR COMPLEX SYSTEMS SCIENCE

CLARKSON UNIVERSITY

NSF-NIH CRCNS: *Functional Brain Networks with Tensioned Stability for Optimal Processing*

## EDUCATION

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### PhD. in Applied Mathematics

Feb 2018 – Jan 2024

ICMC-USP AND IMPERIAL COLLEGE LONDON (PARTIALLY SUPPORTED BY ROYAL SOCIETY).

Project Title: *Reconstruction of Complex Networks from Data*

Supervisor: Prof. Dr. Tiago Pereira

Co-Supervisor: Prof. Dr. Sebastian van Strien

### MSc. in Physics

Feb. 2016 – Feb. 2018

IFSC-USP

Thesis title: *Discontinuous transitions to collective dynamics in star motifs of coupled oscillators*

Supervisor: Prof. Dr. Tiago Pereira

Co-Supervisor: Dr. Jaap Eldering

### Bachelor in Physics

Feb. 2012 – Dec. 2015

IFSC-USP

Undergraduate research title: *Models in Explosive Synchronization*

Supervisor: Prof. Dr. Francisco Aparecido Rodrigues

## PUBLICATIONS

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### PREPRINTS AND IN PREPARATION

1. Edmilson Roque dos Santos and Erik Bollt. “On the emergence of numerical instabilities in Next Generation Reservoir Computing”. <https://arxiv.org/abs/2505.00846>. Under review in Chaos (2025).
2. Edmilson Roque dos Santos. *Reconstruction of bursting network dynamics from data*. (2024). Under review in Physica D.
3. Edmilson Roque dos Santos, Sebastian van Strien, and Tiago Pereira. “Ergodic Basis Pursuit induces Divide-and-Conquer Network Reconstruction”. In preparation.

### JOURNAL PUBLICATIONS

1. Yuanzhao Zhang, Edmilson Roque dos Santos, Huixin Zhang, and Sean P. Cornelius. “How more data can hurt: Instability and regularization in next-generation reservoir computing”. <https://doi.org/10.1063/5.0262977>. Chaos 35, 073102 (2025).
2. Tiago Pereira, Edmilson Roque dos Santos, Sebastian van Strien. “Robust reconstruction of sparse network dynamics”. <https://iopscience.iop.org/article/10.1088/1361-6544/add3b0>, Nonlinearity 38 055031 (2025).

3. Anil Kumar, Edmilson Roque dos Santos, Paul J. Laurienti, and Erik Bollt. “Symmetry breaker governs synchrony patterns in neuronal inspired networks”. *Chaos* 34, 113115 (2024). <https://doi.org/10.1063/5.0209865>
4. Erik Bollt, Jeremie Fish, Anil Kumar, Edmilson Roque dos Santos, and Paul J. Laurienti. “Fractal Basins as a Mechanism for the Nimble Brain”. *Sci Rep* 13, 20860 (2023). <https://doi.org/10.1038/s41598-023-45664-5>.
5. Juliano Genari, Guilherme T. Goedert, Sérgio H.A. Lira, Krerley Oliveira, Adriano Barbosa, et al. “Quantifying protocols for safe school activities”. *PLoS ONE* 17(9): e0273425 (2022). <https://doi.org/10.1371/journal.pone.0273425>
6. Marcel Novaes, Edmilson Roque dos Santos, Tiago Pereira. “Recovering sparse networks: Basis adaptation and stability under extensions”. *Physica D: Nonlinear Phenomena* 424 132895, (2021). <https://doi.org/10.1016/j.physd.2021.132895>
7. Jaap Eldering, Jeroen Lamb, Tiago Pereira, Edmilson Roque dos Santos. “Chimera states through invariant manifold theory”. *Nonlinearity* 34-5344, (2021). <https://dx.doi.org/10.1088/1361-6544/ac0613>

## GRANTS AND HONORS

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|             |   |
|-------------|---|
| 2025        | SIAM Travel Awards - Life Sciences and Dynamical Systems Travel Fund by Dr. Simone Bianco.                              |
| 2018 - 2022 | Doctoral Scholarship: The São Paulo Research Foundation, FAPESP.  |
| 2016 - 2018 | Grant: Coordination for the Improvement of Higher Education Personnel, CAPES.   |
| 2015        | Garfields Medal: Best Oral Presentation in Symposium of Mathematics to the Undergraduate course (SiM 2015) at ICMC-USP. |
| July 2015   | Research internship at PIK under the supervision of Prof. Jurgen Kurths - The São Paulo Research Foundation, FAPESP.    |
| 2014 - 2015 | Undergraduate Scientific Initiation Scholarship: The São Paulo Research Foundation, FAPESP.                             |

## CONFERENCES AND INVITED TALKS

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| May, 11. 2025      | MS41 - Invariant Sets in Dynamics: Applications and Future Directions. SIAM Conference on Applications of Dynamical Systems 2025. <i>Switching Between Multiple Invariant Sets in Neuronal-Inspired Network Dynamics</i> . (Invited talk) |
| Dec, 18. 2024      | (Network) Dynamical Systems. University of São Paulo, São Carlos. <i>Symmetry breaker governs synchrony patterns in neuronal inspired networks</i> . (Contributed talk)   |
| Oct, 7. 2024       | Applied Math Seminars. University of Ottawa, Canada. <i>Metastability of chimeras states in coupled networks</i> . (Invited talk)   |
| July, 8 - 12. 2024 | Fourth Symposium of Machine Learning on Dynamical Systems. Fields Institute, Toronto - Canada <i>Ergodic Basis Pursuit induces exact (and robust) sparse network reconstruction</i> . (Contributed talk)                                  |
| Mar, 20 - 22. 2024 | NERCCS 2024: Seventh Northeast Regional Conference on Complex Systems. Potsdam, NY - USA. <i>Dynamics of synchrony patterns on networks</i> . (Contributed talk)  |
| Feb, 5. 2024       | Oberseminar Dynamics. TUM, Munich - Germany. <i>Ergodic Basis Pursuit induces robust reconstruction of sparse network dynamics</i> . (invited talk - online format)   |
| Oct, 27. 2023      | C3S2 Seminars. The Clarkson Center for Complex Systems Science, Potsdam, NY - USA. <i>Reconstruction of coupled sparse networks from data</i> . (invited talk)  |
| Mar, 22 - 24. 2023 | NERCCS 2023: Sixth Northeast Regional Conference on Complex Systems. <i>Ergodic Basis Pursuit induces robust network reconstruction</i> . (contributed talk)  |

- Jan, 9 - 11. 2023 Dynamics Days US 23. *Ergodic basis pursuit induces robust reconstruction of weakly coupled sparse networks.* (contributed talk - online format)
- Dec, 17-18. 2022 Mathematical Physics Days 2022. *Reconstruction of Weakly Coupled Sparse Networks from Data.* (invited talk - online format)
- Sep, 12 - 21. 2022 Inverse Network Dynamics - NETDAT22. MPI for the Physics of Complex Systems, Dresden - Germany. *Ergodic basis pursuit induces robust reconstruction of sparse networks.* (contributed talk)
- Jun, 20 - 23. 2022 Rényi 100. Hungarian Academy of Sciences, Budapest - Hungary. *Ergodic basis pursuit induces robust reconstruction of sparse networks.* (poster presentation)
- May, 6. 2022 Free University of Berlin (FUB). Berlin - Germany. *Ergodic basis pursuit induces robust reconstruction of sparse networks.* (presentation)
- May, 5. 2022 Potsdam Institute for Climate Impact Research (PIK). Potsdam - Germany. *Ergodic basis pursuit induces robust reconstruction of sparse networks.* (presentation)
- May, 5. 2022 Weierstrass Institute for Applied Analysis and Stochastic (WIAS). Berlin - Germany. *Ergodic basis pursuit induces robust reconstruction of sparse networks.* (presentation)
- May, 4. 2022 University of Potsdam. Potsdam - Germany. *Ergodic basis pursuit induces robust reconstruction of sparse networks.* (presentation)
- May, 23 - 27. 2021 SIAM Conference on Applications of Dynamical Systems (DS21). *Ergodicity implies stable reconstruction of sparse network dynamics.* (invited talk - online format)
- April, 29. 2021 Dynamical Systems and Networks Seminars. Courant Institute of Mathematical Sciences, New York - USA. *Chimera states through invariant manifold theory.* (invited talk - online format)
- Oct, 07 - 11. 2019 V Escola Brasileira de Sistemas Dinâmicos. UFMG - Belo Horizonte, MG - Brazil. *Chimera states through invariant manifold theory.* (poster presentation)
- Aug, 26 - Sep, 01. 2018 V Workshop and School on Dynamics, Transport and Control in Complex Networks - ComplexNet. INPE, Cachoeira Paulista, SP - Brazil. *Discontinuous transitions to collective dynamics in star motifs of coupled oscillators.* (poster presentation)
- Jul, 27 - 31. 2015 International Workshop on Dynamics of Coupled Oscillators: 40 years of the Kuramoto Model. MPI for the Physics of Complex Systems, Dresden - Germany.  
Title: *Influence of frequency distribution on the discontinuous phase transition in networks of Kuramoto oscillators.* (poster presentation)
- Sep, 17 - 19. 2014 Undergraduate Research Project Highlights 22° SIICUSP -The University of São Paulo's International Symposium of Undergraduate Research (SIICUSP) São Paulo - Brazil.  
Title: *Influence of frequency distribution on the discontinuous phase transition in networks of Kuramoto oscillators.* (poster presentation)
- Oct, 6 - 11. 2014 III Workshop and School on Dynamics, Transport and Control in Complex Networks - ComplexNet. São José dos Campos, SP - Brazil.  
Title: *Influence of frequency distribution on the discontinuous phase transition in networks of Kuramoto oscillators.* (contributed talk)

## VISITING

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- Mar - Jun 2022 Imperial College London, London, UK.  
PROF. DR. SEBASTIAN VAN STRIEN AND PROF. DR. JEROEN LAMB
- Dec 2019 - Mar 2020 Imperial College London, London, UK.  
PROF. DR. SEBASTIAN VAN STRIEN AND PROF. DR. JEROEN LAMB
- Jan - May, 2019 Imperial College London, London, UK.  
PROF. DR. SEBASTIAN VAN STRIEN AND PROF. DR. JEROEN LAMB
- Jan - Feb, 2018 Imperial College London, London, UK.  
PROF. DR. JEROEN LAMB

Jul - Aug, 2015      Potsdam Institute for Climate Impact Research - PIK, Potsdam, Germany  
 PROF. DR. JURGEN KURTHS

## ORGANIZING

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NERCCS 2024  
 CO-ORGANIZATION WITH PROF. DR. CHUNLEI LIANG, PROF. DR. ERIK BOLLT, DR. GOLSHAN MADRAKI, AND DR. JEREMIE FISH  
 Mar 20 - 22, 2024

Dynamical systems research seminars at ICMC-USP  
 CO-ORGANIZATION WITH DR. ZHENG BIAN  
 2022 - 2023

Dynamical systems research seminars  
 ORGANIZATION OF SEMINARS AT IMPERIAL COLLEGE LONDON  
 Jun - Jul, 2022

NetDynamics Seminars between ICMC-USP and Nodds Lab – Dr. Deniz Eroglu’s group from Kadir Has University (KHAS)  
 CO-ORGANIZATION WITH DR. ELIF YUNT.  
 Apr - Dec, 2021

São Paulo Dynamical Systems days  
 CO-ORGANIZATION WITH PROF. DR. TIAGO PEREIRA AND PROF. DR. ALI TAHZIBI  
 Oct 24 - 26, 2018

SIFSC 4 - Semana Integrada de Física de São Carlos  
 CO-ORGANIZATION WITH UNDERGRADUATE AND GRADUATE STUDENTS FROM IFSC-USP  
 2014

SIFSC 3 - Semana Integrada de Física de São Carlos  
 CO-ORGANIZATION WITH UNDERGRADUATE AND GRADUATE STUDENTS FROM IFSC-USP  
 2013

## PEER REVIEW

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*Physical Review Letters; Physical Review E; Physica A: Statistical Mechanics and its Applications; and Physica D: Nonlinear Phenomena*

## PROGRAMMING LANGUAGES

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Advanced *Python*  
 Basic *C++*, *Fortran*, *Matlab*, *Julia*, *Mathematica*

## TEACHING

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TA for Linear Algebra and Ordinary Differential Equations  
 UNIVERSITY OF SÃO PAULO  
 Undergraduate Course  
 2019

TA for Advanced Laboratory of Physics  
 UNIVERSITY OF SÃO PAULO  
 Undergraduate Course  
 2017

TA for Mathematical Physics  
 UNIVERSITY OF SÃO PAULO  
 Undergraduate Course  
 2017

## EXTRA ACTIVITIES

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Modcovid19.  
 Participation in a large collaboration group formed by different Brazilian institutions to model COVID-19 in Brazil, in particular, model validation of COMORBUISS software, which can be accessed in the following link:  
<https://comorbuss.org/Home>.  
 2020 - 2022

Judge during the finals in Brazil.  
 INTERNATIONAL YOUNG PHYSICISTS TOURNAMENT (IYPT)  
 2014