# GABRIEL TRINDADE

## CONTACT

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## PROFILE

Bachelor in Physics from the Institute of Physics of São Carlos (IFSC-USP), the student completed a master's degree at the Institute of Mathematical and Computational Sciences (ICMC-USP) in the area of differential geometry. Currently, he is a PhD candidate in physics at the Fresnel Institute and Aix-Marseille University (AMU), working on geometric information theory and its applications in light polarization. He has experience in Ricci flow on surfaces, information geometry, and real hyperbolic geometry.

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## EDUCATION

### Bachelor in Physics

**University of São Paulo (USP)**

2017-2021

**Final work:** An introduction to Ricci flow on surfaces (available here)

**Advisor:** Prof. Dr. Carlos Henrique Grossi Ferreira

### Master's degree in Mathematics

**University of São Paulo (USP)**

2021-2023

**Dissertation:** From statistical models to alpha-connections: an overview of information geometry (available here)

**Keywords:** Information geometry, Fisher metric, Amari-Chentsov tensor, Statistical models, Statistics

**Advisor:** Prof. Dr. Carlos Henrique Grossi Ferreira

### Doctoral scholarship search

**Aix-Marseille Université**
**Institut Fresnel**

2024 - present

**Specialization:** Physics and Material Sciences - Theoretical and Mathematical Physics

**Project:** Extrinsic statistics for complex covariance matrices and partially polarized light

**Advisors:** Prof. Dr. Emmanuel Chevallier
Prof. Dr. André Nicolet

## COMPLEMENTARY EDUCATION

**2024** 2x2 Matrices or split-quaternions: applied to the study of hyperbolic space
Brazilian Mathematical Society (SBM)
Credit hours: 4h

**2024** Generating Functions and the Counting of Symmetric (0,1) Matrices
Brazilian Mathematical Society (SBM)
Credit hours: 4h

**2024** The Differential Geometry of Domes: From Ancient Western Architecture to Brazilian Indigenous Constructions
Brazilian Mathematical Society (SBM)
Credit hours: 4h

**2024** Selberg's Lemma and Applications
Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM)
Credit hours: 4h

**2022** Great Moments in the History of Mathematics
University of São Paulos (USP)
Credit hours: 15h

**2022** An Introduction to Percolation
University of São Paulos (USP)
Credit hours: 14h

**2021** Real Analysis
University of São Paulos (USP)
Credit hours: 60h

**2021** Differential geometry of curves and surfaces in Minkowski space
Federal University of Paraíba (UFPB)
Credit hours: 14h

**2020** Hyperbolic geometry without coordinates
University of São Paulos (USP)
Credit hours: 12h

**2019** Linear structures in geometry
University of São Paulos (USP)
Credit hours: 12h

**2019** Solution of the LSM for a (seemingly) insolvable problem
University of São Paulos (USP)
Credit hours: 6h

**2018** Introduction to general relativity
Federal University of São Carlos (UFSCar)
Credit hours: 4h

**2014 - 2016** Technical course in IT
Centro Paulo Souza
Credit hours: 1520h

**2013** Junior Scientific Initiation Program
Brazilian Olympiad of Public School Mathematics (OBMEP)
Credit hours: 80h

**2012** Junior Scientific Initiation Program
Brazilian Olympiad of Public School Mathematics (OBMEP)
Credit hours: 80h

## RESEARCH ACTIVITIES

### Introduction to Ricci flow

**Instituto de Física de São Carlos - IFSC-USP**

2020-2020

This project focused on studying prerequisites for understanding the Ricci flow, covering results from analysis on manifolds, tensor calculus, and Riemannian geometry.

**Advisor:** Prof. Dr. Carlos Henrique Grossi Ferreira

Funded by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq)

### An introduction to Ricci flow on surfaces

**Instituto de Física de São Carlos - IFSC-USP**

2020-2021

This project aimed to study results of the Ricci curvature flow on surfaces, focusing on those with non-positive Euler characteristic and providing qualitative insights into this flow in three dimensions.

**Advisor:** Prof. Dr. Carlos Henrique Grossi Ferreira

Funded by Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP)

### From statistical models to alpha-connections: an overview of information geometry

**Instituto de Ciências Matemáticas e de Computação - ICMC-USP**

2021-2023

This project consisted of a presentation on the geometry of information, organized as a compilation of fundamental concepts and results in the field, as well as applications in quantum information theory for the calculation of geometric quantum speed limits. Thus, statistical models were studied from Riemannian geometry. Furthermore, finite information geometry was explored, starting from an extrinsic approach and introducing the alpha-geometry. Additionally, dualistic manifolds and statistical manifolds were investigated, and through this intrinsic approach to information geometry, flat information geometry was studied.

**Advisor:** Prof. Dr. Carlos Henrique Grossi Ferreira

Funded by Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP)

### Extrinsic statistics for complex covariance matrices and partially polarized light

**Institut Fresnel**

2024 - present

This PhD research aims to develop new statistical tools for analyzing the polarization state of partially polarized light, represented by 2×2 complex Hermitian matrices. Traditional Euclidean methods are inadequate as they don't respect the transformations induced by Jones matrices modeling material interactions. To address this, the study will explore non-isometric embeddings into Euclidean spaces that align with these transformations. This approach will be applied to polarization and covariance matrices - including block-Toeplitz matrices from radar signal processing - to tackle problems involving random electromagnetic waves

**Advisors:** Prof. Dr. Emmanuel Chevallier
                Prof. Dr. André Nicolet

Funded by AMU - Ministère Enseignement Supérieur

## PROFESSIONAL EXPERIENCE

### Instructor of the workshop "An Introduction to Information Geometry"

Instituto de Ciências Matemáticas e de Computação - ICMC-USP

2023

- Workshop held during the Summer Program in Mathematics at ICMC-USP
- The goal was to disseminate basic knowledge about information geometry among undergraduate students
- The candidate produced introductory lecture notes on the topic and presents here

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## EVENTS

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| **2020** | Tenth Integrated Week of Undergraduate and Graduate Studies at the Institute of Physics of São Carlos - SIFSC 10 <br> Work: An introduction to Ricci flow on surfaces <br> Member of the organizing committee |
| **2020** | XXIII Mathematics Symposium for Undergraduates - SiM <br> Work: An introduction to Ricci flow |
| **2023** | Workshop - ICMC Summer Program in Mathematics <br> Work: An introduction to information geometry |
| **2023** | Geometry in Algebra and Algebra in Geometry VII <br> Work: An introduction finite information geometry |
| **2023** | Workshop on Algebraic Topology and Applications |
| **2024** | Brazilian Biennial of Mathematics |
| **2024** | XXI School of Differential Geometry |
| **2024** | XXVII Brazilian School of Probability <br> Work: Information geometry: when statistics meets geometry |

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## AWARDS AND TITLES

**Medal in the Brazilian Public School Mathematics Olympiad**

2011 - Silver      2012 - Bronze      2013-Silver

**Medal in the Brazilian Public School Physics Olympiad**

2014 - Bronze      2015 - Bronze

**Honorable Mention in the Brazilian Public School Mathematics Olympiad (2014, 2015, 2016)**

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## TOPICS OF INTEREST

- Information geometry
  - Dualistic manifolds and statistical manifolds
  - Finite and infinite information geometry
  - Alpha-geometry
  - Geometric analysis in information theory
  - Hessian geometry in information geometry
- Hyperbolic geometry
- Geometric information theory
- Geometric algorithms in tensor spaces
- Geometric statistics tools for polarization
- Quantum information theory
- Applications of information geometry in Physics
- Dissemination of information geometry

## TECHNICAL SKILLS

- Python programming
- LaTex
- Inkscape

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## LANGUAGES

**Portugues**     Native language
**English**       Advanced
**French**        Basic

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## REFERENCES

### Emmanuel Chevallier

**Professor at Aix-Marseille Université**
PhD supervisor
emmanuel.chevallier@univ-amu.fr

### André Nicolet

**Professor at University Aix-Marseille Université**
Director of PhD thesis
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### Carlos Henrique Grossi Ferreira

**Professor at University of São Paulo**
Undergraduate, graduate, and master's thesis research supervisor
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### Diogo de Oliveira Soares Pinto

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