

# Julien Froustey

PHD IN PHYSICS

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## Current position

### N3AS Postdoctoral Fellow

UC Berkeley / NC State University

NETWORK FOR NEUTRINOS, NUCLEAR ASTROPHYSICS, AND SYMMETRIES

2022 –

Main collaborators: Pr. Gail McLaughlin, Pr. James Kneller, Dr. Evan Grohs, Dr. Sherwood Richers.

My research focuses on the evolution of neutrinos in a variety of situations, such as the early Universe and dense astrophysical environments (core-collapse supernovae, neutron star mergers). An accurate modelling of neutrino transport in these environments remains a major challenge. I have developed and applied a range of approximations to describe efficiently neutrino evolution in contexts such as neutrino decoupling before primordial nucleosynthesis, the evolution of primordial neutrino asymmetries or fast flavor oscillations in a neutron star merger.

## Education

### PhD in Theoretical Physics

Institut d'Astrophysique de Paris,  
Sorbonne Université

“THE UNIVERSE AT THE MEV ERA: NEUTRINO EVOLUTION AND COSMOLOGICAL OBSERVABLES”

2019 – 2022

under the supervision of Dr. Cyril Pitrou.

### Agrégation externe de physique-chimie option physique

Sorbonne Université,  
Ecole Normale Supérieure

RANK 1EX/78

2018 – 2019

High-level competitive examination for teachers, with a major in physics and chemistry.

### Master 2 ICFP – Theoretical Physics

Ecole Normale Supérieure

INTERNATIONAL CENTRE FOR FUNDAMENTAL PHYSICS

2017 – 2018

- *Courses taken included:* Quantum field theory, General relativity, Advanced statistical physics, Numerical physics, Invariances in physics and Group theory, Renormalization group theory, Cosmology, String theory.
- Obtained with First Class Honors (18.04/20).

### Licence in Physics

Ecole Normale Supérieure,  
Université Paris-Diderot

LICENCE FIP (“FORMATION INTERUNIVERSITAIRE DE PHYSIQUE”)

2015 – 2016

- *Courses taken included:* Equilibrium statistical physics, Quantum mechanics, Hydrodynamics, Special relativity and Electromagnetism, Solid state physics, Analytical mechanics, Introduction to Astrophysics.
- Obtained with First Class Honors (18.98/20).

### Admission to the Ecole Normale Supérieure

8<sup>TH</sup> RANK

2015

After two years of “classes préparatoires” MPSI-MP\* at the Lycée Louis-le-Grand (Paris, France).

## Publications

- [5] **J. Froustey, S. Richers, E. Grohs et al.**, *Neutrino fast flavor oscillations with moments: linear stability analysis and application to neutron star mergers*, accepted in Phys. Rev. D, [2311 . 11968].
- [4] **E. Grohs, S. Richers, S. Couch, F. Foucart, J. Froustey et al.**, *Two-moment neutrino flavor transformation with applications to the fast flavor instability in neutron star mergers*, accepted in The Astrophysical Journal, [2309 . 00972].
- [3] **J. Froustey and C. Pitrou**, *Primordial neutrino asymmetry evolution with full mean-field effects and collisions*, JCAP **03**, 065 (2022), [2110 . 11889].
- [2] **J. Froustey, C. Pitrou and M.C. Volpe**, *Neutrino decoupling including flavour oscillations and primordial nucleosynthesis*, JCAP **12**, 015 (2020), [2008 . 01074].
- [1] **J. Froustey and C. Pitrou**, *Incomplete neutrino decoupling effect on big bang nucleosynthesis*, Phys. Rev. D **101**, 043524 (2020), [1912 . 09378].

## CONFERENCE PROCEEDINGS

- [2] **J. Froustey et al.**, *Neutrino flavor transformation with moments: application to fast flavor instabilities in neutron star mergers*, to be published in Proceedings of Science. [TAUP2023](#)
- [1] **J. Froustey**, *Precision calculation of neutrino evolution in the early Universe*, J. Phys.: Conf. Ser. **2156**, 012013 (2021), [2110 . 11296]. [TAUP2021](#)

## BOOKS

- [1] **J. Fillette, J. Froustey and H. Roussille**, *Physique pour l'agrégation : Mécanique classique et relativiste, Physique quantique et nucléaire, Thermodynamique, Physique statistique*, De Boeck Supérieur (2023). Undergraduate-level textbook for the physics' "agrégation", a competitive exam for civil service in the French public education system.

## Presentations

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- 10/23 **NucAstro group meeting**, "Moment linear stability analysis for neutrino fast flavor oscillations in a neutron star merger" [NC State University](#)
- 08/23 **TAUP 2023**, "Moment neutrino evolution equations: application to fast flavor instability in neutron star mergers" [University of Vienna](#)
- 07/23 **INT Program: Astrophysical neutrinos and the origin of elements**, "Moment neutrino evolution equations: application to fast flavor instability in neutron star mergers" [Institute for Nuclear Theory](#)
- 04/23 **NucAstro group meeting**, "Evolution of primordial neutrino asymmetries" [NC State University](#)
- 04/23 **CNP seminar**, "Various approximations around the Quantum Kinetic Equations" [Virginia Tech](#)
- 03/23 **N3AS Meeting**, "Various approximations around the Quantum Kinetic Equations" [UC Berkeley](#)
- 10/22 **NucAstro group meeting**, "A precision calculation of neutrino decoupling" [NC State University](#)
- 05/22 **IPhT seminar**, "Primordial neutrino asymmetry evolution in the early Universe" [IPhT](#)
- 04/22 **NBIA seminar**, "Primordial neutrino asymmetry evolution in the early Universe" [Virtual](#)
- 02/22 **Journal-club + Informal seminar**, "Neutrino evolution in the early Universe" [TTK, Aachen](#)
- 02/22 **LAPTh seminar**, "Primordial neutrino asymmetry evolution in the early Universe" [Virtual](#)
- 12/21 **Café-club GECO**, "A precision calculation of neutrino decoupling" [Virtual](#)
- 10/21 **Sydney-CPPC seminar**, "Primordial neutrino asymmetry evolution in the early Universe", [Video](#) [Virtual](#)
- 08/21 **TAUP 2021**, "Precision calculation of neutrino evolution in the early Universe", [Video](#) [Virtual](#)
- 06/21 **WIN 2021**, "Precision calculation of neutrino evolution in the early Universe", Poster [Virtual](#)
- 04/21 **Workshop: Latest Advances in the Physics of BBN and Neutrino Decoupling**, Invited Speaker [Virtual](#)
- 12/20 **ICAP meeting**, [Virtual](#)
- 12/20 **APC Theory seminar**, Université de Paris [Virtual](#)
- 11/20 **GDR Neutrino meeting**, WG 3: Neutrinos in the Universe [Virtual](#)
- 11/20 **LUTH seminar**, Observatoire de Paris [Virtual](#)
- 10/20 **GReCO seminar**, Institut d'Astrophysique de Paris [IAP, Paris](#)

## Experience

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### ACADEMIC

- 2022– **Referee**, Journal of Cosmology and Astroparticle Physics.
- 2023– **Research mentor**, with David Yang, undergraduate student at UC Berkeley, working on effective descriptions of neutrino oscillations in cosmological environments. [N3AS mentorship program](#)
- 2021 **Endorser**, Snowmass 2021 Letter of Interest: Cosmological Neutrinos

## TEACHING ACTIVITIES

2020–2021 **Teaching assistant**, Teaching students taking the Agrégation competitive exam in physics.

2020–2021 **Teaching assistant**, *Mechanics-Physics* and *Waves and Electromagnetism* courses.

2016–2018 **Oral examiner**, Training for oral examinations in physics in CPGE (“colles”) in the classes of Professors A. Perrin, N. Schlosser, J. Llodra-Perez and J. Delpuech.

*Sorbonne  
Université, ENS-PSL  
Sorbonne Université  
Lycées Condorcet,  
Louis-le-Grand*

## INTERNSHIPS

### Graduate (M2) Research internship

“NEUTRINO SPECTRAL DISTORTIONS IN THE EARLY UNIVERSE”

supervised by Dr. CYRIL PITROU.

*Institut d’Astrophysique de Paris  
(Paris, France)*

*Apr. 2018 – Jun. 2018*

### Graduate (M1) Research internship

“DYNAMICS OF VORTICES IN 2D BOSE SUPERFLUIDS”

supervised by Pr. P.C.E. STAMP.

*University of British Columbia  
(Vancouver, Canada)*

*Feb. 2017 – Jul. 2017*

### Undergraduate (L3) Research internship

“ELASTOCAPILLARY WINDLASS: DYNAMICAL STUDY AND PROSPECTS FOR APPLICATIONS”

supervised by Dr. ARNAUD ANTKOWIAK.

*Jean le Rond d’Alembert Institute,  
UPMC (Paris, France)*

*Jun. 2016 – Jul. 2016*

## Skills

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### LANGUAGES

**French**, Mother tongue

**English**, Fluent

**Spanish**, Written and spoken

### IT SKILLS

**Programming**, Python (advanced), Mathematica, C++

## Interests and Activities

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### RESPONSIBILITIES

2023 **North Carolina State University**, Member of the Physics Diversity, Equity and Inclusion committee.

2021–2022 **Institut d’Astrophysique de Paris**, PhD representative.

2019–2020 **Institut d’Astrophysique de Paris**, Organiser of a series of PhD seminars in an informal setting.

### ASSOCIATIONS

2016 **Sportive association**, Ecole Normale Supérieure, Paris, France (Treasurer).

2018–2022 **Festivities Committee**, Bias, 40170 France (Treasurer).

### LEISURE

**Music**, Trumpet player in amateur marching bands and orchestra.