

Julien Froustey

PHD IN PHYSICS

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Current position

N3AS Postdoctoral Fellow

UC Berkeley / NC State University /

UC San Diego

2022 –

NETWORK FOR NEUTRINOS, NUCLEAR ASTROPHYSICS, AND SYMMETRIES

Main collaborators: Gail McLaughlin, James Kneller, Francois Foucart, George Fuller, Evan Grohs, 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.

Keywords: neutrino physics, flavor oscillations, Quantum Kinetic Equations, neutrino transport, early Universe cosmology, dense astrophysical environments

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

8TH RANK

2015

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

Publications

UNDER REVIEW

- [12] **G. Barenboim, J. Froustey, C. Pitrou and H. Sanchis**, *Primordial neutrinos fade to gray: constraints from cosmological observables*, [2504.07178].
- [11] **A. Suliga, P. Cheong, J. Froustey et al.**, *Non-conservation of lepton numbers in the neutrino sector could change the prospects for core collapse supernova explosions*, submitted to Phys. Rev. Lett. [2410.01080].

PEER-REVIEWED PUBLICATIONS

- [10] **E. Grohs, S. Richers, J. Froustey et al.**, *Advection Algorithms for Quantum Neutrino Moment Transport*, Phys. Rev. D **111**, 083018 (2025), [2501.07540].
- [9] **J. Kneller, J. Froustey et al.**, *Quantum Closures for Neutrino Moment Transport*, Phys. Rev. D **111**, 063046 (2025), [2410.00719].
- [8] **J. Froustey, J. Kneller and G. McLaughlin**, *Quantum maximum entropy closure for small flavor coherence*, Phys. Rev. D **111**, 063022 (2025), [2409.05807].
- [7] **S. Richers, J. Froustey, S. Ghosh, F. Foucart and J. Gomez**, *Asymptotic-state prediction for fast flavor transformation in neutron star mergers*, Phys. Rev. D **110**, 103019 (2024), [2409.04405].
- [6] **J. Froustey and C. Pitrou**, *Constraints on primordial lepton asymmetries with full neutrino transport*, Phys. Rev. D **110**, 103551 (2024), [2405.06509].
- [5] **J. Froustey, S. Richers, E. Grohs et al.**, *Neutrino fast flavor oscillations with moments: linear stability analysis and application to neutron star mergers*, Phys. Rev. D **109**, 043046 (2024), [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*, ApJ **963** 11 (2024), [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

- [3] **Y. Liu, K. Yao, J. Hong, J. Froustey et al.**, *Ternary Tree Fermion-to-Qubit Mapping with Hamiltonian Aware Optimization*, 31st IEEE International Symposium on High-Performance Computer Architecture (HPCA-31), [2409.02010].
- [2] **J. Froustey et al.**, *Neutrino flavor transformation with moments: application to fast flavor instabilities in neutron star mergers*, PoS TAUP2023, 341 (2024), [2402.09274]. 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.

Experience

ACADEMIC

- 2022– **Referee**, Physical Review Letters, Physical Review D, Journal of Cosmology and Astroparticle Physics, Physics Letters B.
- 2023–2025 **Research mentor**, with David Yang, undergraduate student at UC Berkeley, working on the thermalization of sterile neutrino species in the early Universe. N3AS mentorship program
- Endorser**,
- Snowmass 2021 Letter of Interest: Cosmological Neutrinos,
 - “Neutrino Theory in the Precision Era,” contribution to the European Strategy for Particle Physics 2025 Update.

TEACHING ACTIVITIES

2022–2025 **Mentor and scorer**, Mentoring for the 2022 edition of the International Physics Olympiad, and scorer for the French selection test since 2024.

2020–2021 **Teaching assistant**, Labs, oral and written exams for students taking the Agrégation competitive exam in physics (Master's level).

Sorbonne
Université, ENS-PSL

2020–2021 **Teaching assistant**,
• Mechanics-Physics [MEPY1], 1st-year undergraduate level,
• Waves and Electromagnetism [LU2PY021], 2nd-year undergraduate level.
Problem solving sessions with large online part (Covid-19 pandemic).

Sorbonne Université

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

Lycées Condorcet,
Louis-le-Grand

OUTREACH

04/2024 **Web article**, *Quelques secondes après le Big Bang : sus aux neutrinos* [“A few seconds after the Big Bang: on to neutrinos”], Le Rayon, a website destined to young French physicists.

10/2021 **Host at the science village**, as part of the Science Festival of Sorbonne Université, a yearly outreach event welcoming the public on the University campus. Co-organizer of the booth of the Institut d’Astrophysique de Paris with Pr. Arnaud Cassan.

INTERNSHIPS

Graduate (M2) Research internship

Institut d’Astrophysique de Paris
(Paris, France)

“NEUTRINO SPECTRAL DISTORTIONS IN THE EARLY UNIVERSE”
supervised by Dr. CYRIL PITROU.

Apr. 2018 – Jun. 2018

Graduate (M1) Research internship

University of British Columbia
(Vancouver, Canada)

“DYNAMICS OF VORTICES IN 2D BOSE SUPERFLUIDS”
supervised by Pr. P.C.E. STAMP.

Feb. 2017 – Jul. 2017

Undergraduate (L3) Research internship

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

“ELASTOCAPILLARY WINDLASS: DYNAMICAL STUDY AND PROSPECTS FOR APPLICATIONS”
supervised by Dr. ARNAUD ANTOKOWIAK.

Jun. 2016 - Jul. 2016

Presentations

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| 03/25 | APS Global Physics Summit , “Quantum closures for neutrino moment transport” | Anaheim |
| 02/25 | SoCalDM #3 Workshop , “Fun with primordial neutrino asymmetries” | UC Irvine |
| 02/25 | CERN Neutrino Platform Pheno Week , “(No) constraints on primordial neutrino asymmetries” | CERN |
| 01/25 | GReCO seminar , “Angular moments for neutrino transport: the quantum case” | IAP, Paris |
| 12/24 | High-Energy Physics Seminar , “Closures for Quantum Neutrino Moment Transport” | UC San Diego |
| 10/24 | COSMO’24 conference , “Constraints on primordial lepton asymmetries with quantum neutrino transport” | Kyoto University |
| 10/24 | Astrophysics and Cosmology Seminar , “Neutrino flavor transformation in dense environments: two case studies” | UC San Diego |
| 09/24 | NucAstro group meeting , “Closures for Quantum Neutrino Moment Transport” | NC State University |
| 07/24 | Neutrino Frontiers workshop , “Neutrino flavor transformation in dense environments” | GGI, Firenze |
| 06/24 | N3AS Meeting , “Neutrino flavor instabilities in neutron star mergers” | UC Berkeley |
| 04/24 | APS April Meeting , “Neutrino fast flavor oscillations with moments: linear stability analysis and application to neutron star mergers” | Sacramento |
| 03/24 | Rising Researchers Seminar , “New approaches to collective neutrino oscillations” | Virtual |

02/24	NucAstro group meeting , “New constraints on primordial neutrino asymmetries”	NC State University
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

Skills

LANGUAGES

French	Mothertongue
English	Fluent
Spanish	Written and spoken

IT SKILLS

Programming Python (advanced), Mathematica, C++

Interests and Activities

RESPONSIBILITIES

2024–2025	Network for Neutrinos, Nuclear Astrophysics and Symmetries (N3AS) , Postdoc co-chair of the Professional Development 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.
Driver's license ,	since 2015.