Thomas Flöss

Postdoctoral researcher in cosmology

tsfloss@gmail.com tsfloss tsfloss

thomasfloss.com 0000-0002-8245-780X

I am a postdoc at the University of Vienna. I work primarily on using late-time cosmological probes, such as the CMB, galaxy surveys, and intensity mapping (e.g. 21-cm) to study the primordial universe, particularly cosmic inflation through primordial non-Gaussianity. In my research, I make use of analytical, numerical and state-of-the-art machine learning (ML) methods. Additionally, I like to think about formal aspects of cosmology such as consistency conditions and the cosmological bootstrap. I have also studied the amplitude double copy, its application to cosmology, and a possible connection with massive gravity. I received my PhD from the University of Groningen in 2024.

Professional Experience

2024 – *present*

Postdoc in theoretical and computational cosmology, University of Vienna
Researcher and teaching assistant ("University Assistant") in the cosmology group led by Univ.-Prof. Oliver Hahn

2020 – 2024

PhD in Theoretical Cosmology (cum laude), University of Groningen Thesis: A Skewed Perspective on the Universe Advisors: Prof. Diederik Roest, Dr. Daan Meerburg, Prof. Léon Koopmans

- Determined the feasibility of a lunar-based 21-cm survey for constraining primordial non-Gaussianity using the three- and four-point correlation function
- Uncovered the impact and importance of including non-Gaussian covariance when constraining primordial non-Gaussianity using the bispectrum
- Developed and quantified ML-based reconstruction methods for recovering the information content of summary statistics lost due to non-Gaussian covariance
- Applied state-of-the-art generative ML models to probabilistic CMB-lensing reconstruction
- Derived duality-invariant non-linear electrodynamics from massive gravity

During my PhD I co-authored 7 research papers of which 5 as first author.

Education

2016 – 2018

MSc. Theoretical Physics, Utrecht University
Thesis: *Inflationary Consistency Conditions and Shift-Symmetric Cosmologies*
Advisors: Dr. Enrico Pajer and Dr. Garrett Goon. | GPA: 4.0/4.0

2013 – 2016

BSc. Physics & Astronomy, Utrecht University
Thesis: *Quantum Fluctuations and Magnon-Magnon Interactions in Antiferromagnets*
Advisors: Prof. Rembert Duine and Dr. Scott Bender. | GPA: 4.0/4.0

Awards & Grants

Sept 2020

Fundamentals of the Universe PhD Scholarship, University of Groningen
Research proposal: *Sensing in the Dark: exploring the early universe through the Dark Ages.*

Research Visits

Sept – Nov 2023 — Center for Computational Astrophysics (Flatiron Institute), New York, USA
Guest researcher with Franscisco Villaescusa-Navarro and William Coulton

Teaching & Mentoring

2023 — Co-supervisor MSc. student Jelte Bottema, University of Groningen
2021 — Co-supervisor MSc. student Jorik Melsen, University of Groningen
2022 — Teaching Assistant, General Relativity (MSc. course), University of Groningen
2020 — Co-supervisor MSc. students Tim de Wild and Tom Westerdijk, University of Groningen
2017 — Teaching Assistant, Calculus II (BSc. course), Utrecht University

Organization

2020 – 2023 — Cosmology Journal Club, University of Groningen
2020 – 2021 — Seminar Series on Cosmological Correlators and Bootstrap, University of Groningen
2015 — Physics Symposium "Physical Creativity", Utrecht University

Skills

Languages — English (Fluent), Dutch (Native), German (Proficient)
Coding — Python, JAX, TensorFlow, julia, PyTorch, C/C++, LaTeX, Mathematica (incl. xAct), GitHub

Public Codes (see GitHub)

- PolyBin3D: a GPU accelerated unwindowed power spectrum and bispectrum estimator in Python (together with Oliver Philcox)
- BFast: a GPU accelerated FFT bispectrum estimator in JAX (Python)
- PyNG: Fisher forecast primordial non-Gaussianity including non-Gaussian covariance
- 21cmDA: Fisher forecast primordial non-Gaussianity from the Dark Ages' 21-cm signal

Talks & Posters

July 2024 — Cosmology in the Adriatic, Split, Croatia (contributed talk)
July 2024 — New Strategies for Cosmology from Galaxy Surveys, Sexten, Italy (contributed talk)
Oct 2023 — Dunkley group meeting, Princeton University
Oct 2023 — CMBAS/CCA group meeting, Flatiron Institute
May 2023 — Weniger group meeting, GRAPPA, University of Amsterdam
Mar 2023 — Netherlands Theoretical Cosmology (THC) meeting
Dec 2022 — Hill group meeting, Columbia University
Sep 2022 — PNG2022, International Conference, ITF Madrid (contributed talk)
May 2022 — Kapteyn Institute Lunch Talk, University of Groningen
Apr 2022 — Fundamentals of the Universe Symposium, University of Groningen (invited talk)
Apr 2022 — State of the Universe Seminar, TIFR, India (invited talk, online)
Feb 2022 — Friday Journal Club, KICP, UChicago (invited talk, online)
Sept 2021 — Fundamentals of the Universe Symposium, University of Groningen (poster)

Research Publications

[1] **T. Flöss**, W. R. Coulton, A. J. Duivenvoorden, F. Villaescusa-Navarro, and B. D. Wandelt, "Denoising diffusion delensing: reconstructing the non-Gaussian CMB lensing potential with diffusion models," *Mon. Not. Roy. Astron. Soc.*, vol. 533, no. 1, pp. 423–432, 2024. DOI: 10.1093/mnras/stae1818. arXiv: 2405.05598 [astro-ph.CO].

[2] O. H. E. Philcox and **T. Flöss**, "PolyBin3D: A Suite of Optimal and Efficient Power Spectrum and Bispectrum Estimators for Large-Scale Structure," Apr. 2024. arXiv: 2404.07249 [astro-ph.CO].

[3] **T. Flöss**, D. Roest, and T. Westerdijk, "Non-linear Electrodynamics from Massive Gravity," Aug. 2023, Submitted to JHEP. arXiv: 2308.04349 [hep-th].

[4] G. Orlando, **T. Flöss**, P. D. Meerburg, and J. Silk, "Local non-Gaussianities from cross-correlations between the CMB and 21-cm," Jul. 2023, Submitted to PRD. arXiv: 2307.15046 [astro-ph.CO].

[5] **T. Flöss** and P. D. Meerburg, "Improving constraints on primordial non-Gaussianity using neural network based reconstruction," May 2023, Accepted in JCAP. arXiv: 2305.07018 [astro-ph.CO].

[6] **T. Flöss**, M. Biagetti, and P. D. Meerburg, "Primordial non-Gaussianity and non-Gaussian covariance," *Phys. Rev. D*, vol. 107, no. 2, p. 023 528, 2023. DOI: 10.1103/PhysRevD.107.023528. arXiv: 2206.10458 [astro-ph.CO].

[7] **T. Flöss**, T. de Wild, P. D. Meerburg, and L. V. E. Koopmans, "The Dark Ages' 21-cm trispectrum," *JCAP*, vol. 06, no. 06, p. 020, 2022. DOI: 10.1088/1475-7516/2022/06/020. arXiv: 2201.08843 [astro-ph.CO].

References

Prof. Diederik Roest
Full Professor
University of Groningen, NL
PhD advisor
d.roest@rug.nl

Dr. Daan Meerburg
Assistant Professor
University of Groningen, NL
PhD advisor
p.d.meerburg@rug.nl

Dr. Franscisco Villaescusa-Navarro
Associate Research Scientist
Flatiron Institute, New York, USA
Scientific collaborator
fvillaescusa@flatironinstitute.org