

# Thomas Flöss

## Postdoctoral researcher in cosmology

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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 Francisco Villaescusa-Navarro and William Coultun



## 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)  
 New Strategies for Extracting Cosmology from Galaxy Surveys, Sexten, Italy (contributed talk)  
Oct 2023  Dunkley group meeting, Princeton University  
 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)  
 State of the Universe Seminar, TIFR, India (invited talk, online)  
Feb 2022  Friday Journal Club, KICP, UChicago (invited talk, online)




## Talks & Posters (continued)

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Sept 2021     Fundamentals of the Universe Symposium, University of Groningen (poster)

## Research Publications


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- [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. 023528, 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

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### **Prof. Diederik Roest**

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### **Dr. Daan Meerburg**

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### **Dr. Francisco Villaescusa-Navarro**

Associate Research Scientist  
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Scientific collaborator  
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