

Thomas Flöss

PhD student in Theoretical Cosmology

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I am a PhD student at the University of Groningen in the Netherlands. 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 as well as modern 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.

Professional Experience

2020 – Present

📌 **PhD student in Theoretical Cosmology**, University of Groningen

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
- Derived duality-invariant non-linear electrodynamics from massive gravity

My research so far has resulted in 5 research papers of which 4 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 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


- Oct 2023  Dunkley group meeting, Princeton University
-  CMBAS/CCA group meeting, Flatiron Institute
- May 2023  Weniger group meeting, GRAPPA, University of Amsterdam
- Mar 2023  NL 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)
- Sept 2021  Fundamentals of the Universe Symposium, University of Groningen (poster)

Research Publications


- [1] 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].
- [2] **T. Flöss**, D. Roest, and T. Westerdijk, “Non-linear Electrodynamics from Massive Gravity,” Aug. 2023, Submitted to JHEP. arXiv: 2308.04349 [hep-th].
- [3] 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].
- [4] **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].
- [5] **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].
- [6] **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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