

# M. Sten Delos

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## RESEARCH INTERESTS

November 1, 2023

Dark matter and gravitational dynamics

Origins of matter and structure in the universe

## PROFESSIONAL EXPERIENCE

Sept. 2023-present	<b>Carnegie Observatories</b> CTAC Postdoctoral Fellow	[Pasadena, CA, USA]
Sept. 2020-Aug. 2023	<b>Max Planck Institute for Astrophysics</b> Postdoctoral Fellow	[Garching, Germany]
May 2020-Sept. 2020	<b>University of North Carolina at Chapel Hill</b> Postdoctoral Research Associate	[Chapel Hill, NC, USA]
Aug. 2016-May 2020	<b>University of North Carolina at Chapel Hill</b> Graduate Research Assistant Graduate Teaching Assistant	[Chapel Hill, NC, USA]
Jan. 2016-May 2016	<b>Guilford Technical Community College</b> Adjunct Instructor	[Jamestown, NC, USA]
Aug. 2010-May 2012	<b>State University of New York at Stony Brook</b> Graduate Teaching Assistant	[Stony Brook, NY, USA]

## EDUCATION

May 2020	<b>University of North Carolina at Chapel Hill</b> Ph.D. in Physics Thesis: “Probing the early universe using dark matter minihalos” Advisor: Adrienne Erickcek	[Chapel Hill, NC, USA]
May 2015	<b>State University of New York at Stony Brook</b> M.A. in Physics	[Stony Brook, NY, USA]
May 2010	<b>University of Virginia</b> B.S. in Physics and Mathematics <i>with Highest Distinction</i>	[Charlottesville, VA, USA]

## HONORS

- 2023 CTAC Fellowship
- 2020 MPA Postdoctoral Fellowship
- 2019 Dissertation Completion Fellowship (UNC-Chapel Hill)
- 2019 North Carolina Space Grant Graduate Research Fellowship
- 2019 Kenan Trust Graduate Student Research Grant (UNC-Chapel Hill)
- 2010 Sigma Pi Sigma Physics Honor Society

## PROFESSIONAL SERVICE AND OUTREACH

Lecture: “The physical bases for the structures of collisionless dark matter halos.”

Postdoc/staff lecture series on cosmology, MPA, May 2023,

<https://wwwmpa.mpa-garching.mpg.de/~komatsu/lectureseries/2023.html>.

Outreach article: “The lingering imprint of the first cosmic structures.”

MPA Research Highlight, February 2023,

<https://www.mpa-garching.mpg.de/1069215/hl202302>.

Referee for *Monthly Notices of the Royal Astronomical Society*, *Physical Review D*, and *Physical Review Letters*.

Grant reviewer for *North Carolina Space Grant*.

Organizer of cosmology group meetings at the Max Planck Institute for Astrophysics.

Senior graduate student pre-candidacy mentoring team at UNC-Chapel Hill.

## PRESENTATIONS

### *Invited Conference and Seminar Presentations*

“Prompt cusps of dark matter.”

- Astro-seminar at the University of Southern California; Los Angeles, CA, USA; October 2023.
- Cosmology and Gravitation seminar at the Perimeter Institute for Theoretical Physics; Waterloo, ON, Canada; October 2023.
- Astrophysics seminar at the University of North Carolina at Chapel Hill; Chapel Hill, NC, USA; August 2023.

“Prompt cusp formation from the cosmological initial conditions.”

*Mathematical Justification for the Kinetic and Fluid Equations of Plasmas and Self-Gravitating Systems*; Marseille, France; July 2023.

“Prompt cusps of dark matter halos.”

- Astrophysical and Cosmological Relativity seminar at the Albert Einstein Institute; Postdam, Germany; May 2023
- Cosmology seminar at the Helsinki Institute of Physics; Helsinki, Finland; April 2023.
- Seminar at the Lorentz Institute; Leiden, The Netherlands; February 2023.
- Seminar at the Strasbourg Observatory; Strasbourg, France; February 2023.

“Primordial black holes and ultradense halos.”

- UCLA TEPAPP Seminar; Los Angeles, CA; May 2023
- Padova cosmology journal club; Padua, Italy; March 2023

“The structures of dark halos.”

Institute Seminar at the Max Planck Institute for Astrophysics; Garching, Germany; January 2023.

“Prompt cusps and the dark matter annihilation signal.”

- Particle and Astroparticle Theory Seminar at the Max Planck Institute for Nuclear Physics; Heidelberg, Germany; November 2022.
- SFB1258 Neutrinos and Dark Matter colloquium; Garching, Germany; October 2022.

“Prompt cusps of the first halos.”

- Cosmology Seminar at the Max Planck Institute for Astrophysics; Garching, Germany; September 2022.
- ICAP Meeting at the Institut d'Astrophysique de Paris; Paris, France; September 2022.

“Density profiles of the first halos & microhalo evolution through stellar encounters.”

*News from the Dark 7*; Montpellier, France; June 2022.

“Stellar streams and dark substructure.”

Munich Dark Matter Meeting; Munich, Germany; March 2022

“Observational signatures of early matter domination.”

Particle seminar at Carleton University; Ottawa, Canada; September 2021.

“Perturbed stellar streams in the diffusion regime.”

Ringberg Meeting of the MPA Galaxy Group; Kreuth, Germany; July 2021.

“The first dark matter halos as probes of cosmology.”

CGI Seminar at the University of California, Santa Cruz; Santa Cruz, CA, USA; April 2021.

“Probing cosmology using dark matter microhalos.”

- Joint Cambridge-LMU online cosmology workshop; January 2021.
- Fermilab CPC Seminar; Batavia, IL, USA; November 2020.
- Seminar at the Perimeter Institute; Waterloo, ON, Canada; February 2020.

“Predicting the dark matter distribution at the smallest scales.”

Munich/Garching *Dark Matter Day* mini-workshop; Garching, Germany; October 2020.

“The first dark matter halos as probes of cosmology.”

Institute Seminar at the Max Planck Institute for Astrophysics; Garching, Germany; October 2020.

### *Contributed Conference Presentations*

“Prompt cusps of dark matter halos”

*Cosmology from Home*; July 2023.

“Primordial black holes and ultradense halos”

*Black Hole and Gravitational-Wave Day*; Garching, Germany; May 2023.

“Prompt cusps of the first halos.”

*COSMO’22*; Rio de Janeiro, Brazil; August 2022.

“The gamma-ray signature of an early matter-dominated era.”

- *APS April Meeting*; Denver, CO, USA; April 2019.
- *Eighth International Fermi Symposium*; Baltimore, MD, USA; October 2018.

“Constraining the primordial power spectrum using minihalos.”

*APS April Meeting*; Columbus, OH, USA; April 2018.

## **PUBLICATION LIST**

### *Submitted Journal Articles*

**M. Sten Delos.** “Can prompt cusps of WIMP dark matter be detected as individual gamma-ray sources?” [arXiv:2310.15214].

**M. Sten Delos,** Michael Korsmeier, Axel Widmark, Carlos Blanco, Tim Linden, and Simon D. M. White. “Limits on dark matter annihilation in prompt cusps from the isotropic gamma-ray background.” [arXiv:2307.13023].

Himanish Ganjoo and **M. Sten Delos.** “Simulations of gravitational heating due to early matter domination.” [arXiv:2306.14961].

### *Refereed Journal Articles*

**M. Sten Delos** and Simon D. M. White. “Prompt cusps and the dark matter annihilation signal.” *JCAP* 10 (2023) 008 [arXiv:2209.11237].

**M. Sten Delos,** Kayla Redmond, and Adrienne L. Erickcek. “How an era of kination impacts substructure and the dark matter annihilation rate.” *Phys. Rev. D* **108**, 023528 (2023) [arXiv:2304.12336].

**M. Sten Delos.** “Massive prompt cusps: a new signature of warm dark matter.” *MNRAS: Letters* **522**, L78 (2023) [arXiv:2302.03040].

**M. Sten Delos** and Gabriele Franciolini. “Lensing constraints on ultradense dark matter halos.” *Phys. Rev. D* **107**, 083505 (2023) [arXiv:2301.13171].

**M. Sten Delos** and Joseph Silk. “Ultradense dark matter haloes accompany primordial black holes.” *MNRAS* **520**, 4370 (2023) [arXiv:2210.04904].

**M. Sten Delos** and Simon D. M. White. “Inner cusps of the first dark matter haloes: Formation and survival in a cosmological context.” *MNRAS* **518**, 3509 (2023) [arXiv:2207.05082].

**M. Sten Delos** and Tim Linden. “Dark matter microhalos in the solar neighborhood: Pulsar timing signatures of early matter domination.” *Phys. Rev. D* **105**, 123514 (2022) [arXiv:2109.03240].

**M. Sten Delos** and Fabian Schmidt. “Stellar streams and dark substructure: the diffusion regime.” *MNRAS* **513**, 3682 (2022) [arXiv:2108.13420].

Rouzbeh Allahverdi, Mustafa A. Amin, Asher Berlin, Nicolás Bernal, Christian T. Byrnes, **M. Sten Delos**, Adrienne L. Erickcek, Miguel Escudero, Daniel G. Figueroa, Katherine Freese, *et al.* “The First Three Seconds: a Review of Possible Expansion Histories of the Early Universe.” *Open J. Astrophys.* **4** (2021) [arXiv:2006.16182].

**M. Sten Delos**, Tim Linden, and Adrienne L. Erickcek. “Breaking a dark degeneracy: The gamma-ray signature of early matter domination.” *Phys. Rev. D* **100**, 123546 (2019) [arXiv:1910.08553].

Carlos Blanco, **M. Sten Delos**, Adrienne L. Erickcek, and Dan Hooper. “Annihilation signatures of hidden sector dark matter within early-forming microhalos.” *Phys. Rev. D* **100**, 103010 (2019) [arXiv:1906.00010].

**M. Sten Delos**. “Evolution of dark matter microhalos through stellar encounters.” *Phys. Rev. D* **100**, 083529 (2019) [arXiv:1907.13133].

**M. Sten Delos**. “Tidal evolution of dark matter annihilation rates in subhalos.” *Phys. Rev. D* **100**, 063505 (2019) [arXiv:1906.10690].

**M. Sten Delos**, Margie Bruff, and Adrienne L. Erickcek. “Predicting the density profiles of the first halos.” *Phys. Rev. D* **100**, 023523 (2019) [arXiv:1905.05766].

**M. Sten Delos**, Adrienne L. Erickcek, Avery P. Bailey, and Marcelo A. Alvarez. “Density profiles of ultracompact minihalos: Implications for constraining the primordial power spectrum.” *Phys. Rev. D* **98**, 063527 (2018) [arXiv:1806.07389].

**M. Sten Delos**, Adrienne L. Erickcek, Avery P. Bailey, and Marcelo A. Alvarez. “Are ultracompact minihalos really ultracompact?” *Phys. Rev. D Rapid Communications* **97**, 041303(R) (2018) [arXiv:1712.05421].

## TEACHING EXPERIENCE

### **University of North Carolina at Chapel Hill** [Chapel Hill, NC, USA]

Spring 2019      Cosmology (TA)  
Fall 2017      Graduate Quantum Mechanics I (TA)  
Summer 2017      Introductory Calculus-based Electromagnetism and Quanta (TA)  
Spring 2017      Introductory Calculus-based Electromagnetism and Quanta (TA)  
Fall 2016      Introductory Calculus-based Mechanics and Relativity (TA)

### **Guilford Technical Community College** [Jamestown, NC, USA]

Spring 2016      Conceptual Physics

### **State University of New York at Stony Brook** [Stony Brook, NY, USA]

Spring 2012      Physics for Life Sciences I (TA)  
Fall 2011      Physics for Life Sciences II (TA)  
Spring 2011      Physics for Life Sciences II (TA)  
Fall 2010      Physics for Life Sciences I (TA)

## CO-ADVISED STUDENTS

**Himanish Ganjoo** (2019-present) [Faculty Advisor: Katherine Mack]  
Graduate Student, *North Carolina State University & Perimeter Institute*

**Margie Bruff** (2018-2019) [Faculty Advisor: Adrienne Erickcek]  
Undergraduate Student, *University of North Carolina at Chapel Hill*

## REFERENCES

**Simon White**  
Emeritus Director, *Max Planck Institute for Astrophysics*  
swhite@mpa-garching.mpg.de

**Fabian Schmidt**  
Scientific Staff, *Max Planck Institute for Astrophysics*  
fabians@mpa-garching.mpg.de

**Adrienne Erickcek** (Ph.D. Thesis Advisor)  
Associate Professor of Physics and Astronomy, *University of North Carolina at Chapel Hill*  
erickcek@physics.unc.edu

**Joseph Silk**  
Professor of Physics, *Institut d'astrophysique de Paris, Université Pierre-et-Marie-Curie*  
Homewood Professor of Physics and Astronomy, *Johns Hopkins University*  
Emeritus Savilian Professor, *University of Oxford*  
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