SAMUEL D. MCDERMOTT

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EDUCATION

University of Michigan 2008-2014
Dissertation Advisor: Dr. Kathryn M. Zurek Ph.D., Physics

University of Pennsylvania 2005-2008
Research Advisor: Dr. Marija Drndic B.A., Physics and B.A., Math

ACADEMIC EXPERIENCE

University of Chicago Sept 2022-present
Department of Astronomy & Astrophysics Chicago, IL and Philadelphia, PA
permanent research staff

Fermi National Accelerator Laboratory Sept 2017 - Sept 2022
Theory Division Chicago, IL
Schramm Fellow

SUNY Stony Brook Sept 2014 - Sept 2017
C. N. Yang Institute for Theoretical Physics Stony Brook, NY
postdoctoral research associate

AWARDS AND RECOGNITION

Fermi National Accelerator Laboratory
· Schramm Fellowship 2019-2022
· URA Thesis Award 2015
· Predoctoral Theory Fellowship 2013-2014

University of Michigan
· Rackham Predoctoral Fellowship 2013-2014

University of Pennsylvania
· *Summa cum Laude*, with Distinction in Physics 2008
· Benjamin Franklin Scholar and Phi Beta Kappa scholar 2008
· Dean's List 2005-2008

CODE

Packages (Co-)Authored

· `wavpool`, developed in collaboration with M. Voetberg and Brian Nord for arXiv:2306.08734 May 2023
+ python package written in `pytorch` to produce a `wavpool` neural network block
+ performs a multiresolution decomposition of two dimensional data, trains dense networks in parallel on this decomposition, and sums the layers in a way that enforces sparsity of the wavelet representation
+ outperforms a comparable convolutional neural network on benchmark tasks

· `gcepy` Sept 2022
+ python package for sampling parameter space of models of the Galactic center excess
+ relies on jax for all basic definitions, building up to a log-likelihood for the model given the data
+ repository provides an ipynb demonstrating use of dynesty and numpyro to derive parameter constraints

· `dmdd`, ascl:1506.002, developed in collaboration with Vera Gluscevic for use in arXiv:1506.04454 Oct 2015
+ python package that enables simulation and Bayesian posterior analysis of nuclear-recoil data from dark matter direct detection experiments for a wide variety of theories of dark matter-nucleon interactions
+ used by seven experimental collaborations to set official limits

Skills

- high-dimensional sampling for accurate parameter estimation, including uncertainty propagation
- machine learning with a variety of modern deep architectures, including transformers, convolutional neural nets, and novel architectures utilizing the multiresolution analysis of the wavelet transform
- high-performance computing, including the `slurm` workload manager and GPUs (with both Apple MPS and NVIDIA CUDA architectures)

Partial list of python packages used

- in current development: numpy, scipy, jax, numpyro, stan, dynesty, pytorch, h5py
- in prior experience: keras/tensorflow, scikit-learn, cython

COMMUNITY ACTIVITIES

I am committed to organizing to improve the diversity, equity, and inclusion of the communities I am a member of. To that end, I belong to the following organizations.

Particles 4 Justice 2018-present
member
Particles 4 Justice originally convened to refute a damaging and factually incorrect talk about sexism given at CERN in 2018. More recently, we called for a #strikeforblacklives which, paired with the simultaneous call to #shutdownstem, resulted in a halt to the activities of a substantial fraction of the particle physics community on 10 June, 2020. This became a day of reflection and learning for white researchers and a day of much-needed rest for our Black colleagues. Our strike call was signed by over 5000 researchers, was heeded by hundreds of research groups (including several major experimental collaborations and multiple national laboratories), and led to a one-day halt to APS publications and the suspension of the daily arXiv mailing.

Fermilab Inclusivity Journal Club 2017-2022
member
The Inclusivity Journal Club read academic literature on equity, diversity, and inclusivity, including best practices in hiring and evaluation in research groups. We convene several a times a year, occasionally with external speakers. The IJC is a Laboratory Resource Group funded via Fermilab's Office of Diversity and Inclusion.

Teaching and Mentoring

- guest lectures for graduate seminar PHYS/BIOL 5566 "Machine Learning Methods In Natural Science Modeling", at the University of Pennsylvania
- mentored in Fermilab SIST summer program (Caleb Levy)
- developing new deep neural net architecture with postbac at Fermilab (Maggie Voetberg)
- working on continuous gravitational wave data analysis with undergraduate at University of Pennsylvania (Kevin Chen)

TALKS

Colloquia and Summary Talks

- Argonne National Laboratory Physics Division Jan 27, 2022
- University of Utah Department of Physics & Astronomy Jan 25, 2022
- King's College London Theoretical Particle Physics & Cosmology Oct 25, 2021
- Brookhaven Forum 2021 Nov 3, 2021
- University of Victoria Department of Physics & Astronomy Mar 9, 2020

Invited Talks, selected (full list available upon request)

- Theory Seminar, University of Minnesota (declined) Jan 20, 2023
- Dark Cosmos Seminar, Princeton University (declined) Nov 1, 2022
- Carnegie Mellon University Stellar Tests of Gravity Workshop Mar 18, 2022
- 4D Seminar, University of California Berkeley Feb 14, 2022
- Carleton HEP Seminar Nov 8, 2021
- INT Workshop Sept 21, 2021
- BSM PANDEMIC Series Sept 14, 2021

- Particles and Nuclei International Conference — Sept 8, 2021
- Cambridge (Mass.) High Energy Workshop 2021 - Axion Physics — July 28, 2021
- APS DPF 2021 — July 13, 2021
- The 16th Marcel Grossman Meeting — July 8, 2021
- Cosmology from Home — July 7, 2021
- A Rainbow of Dark Sectors, Aspen Center for Physics — Apr 1, 2021
- HEP Seminar, UC Santa Barbara — Nov 16, 2020
- APEC Seminar, Kavli IPMU — Oct 21, 2020
- SITP Seminar, Stanford University — Oct 15, 2020
- High Energy Theory Seminar, Brown University — Oct 14, 2020
- High Energy Physics Seminar, Caltech — Oct 12, 2020
- Israeli Joint Particle Physics Seminar, Hebrew University — Jun 24, 2020
- Perimeter Institute Seminar — Apr 28, 2020
- MCFP Seminar, University of Maryland — Apr 26, 2020
- Theory Seminar, Notre Dame — Feb 23, 2020
- N3AS Seminar — Feb 2, 2020
- Thursday Seminar, CERN Th — Mar 19, 2020
- New Techniques for Dark Matter Discovery, TRIUMF — Mar 12, 2020
- CCPP Seminar, New York University — Jan 31, 2020
- YITP-Brookhaven Joint Seminar, Stony Brook University — Jan 29, 2020
- Informal Seminar, Harvard University — Jan 24, 2020
- Nuclear and Particle Theory Seminar, MIT — Oct 28, 2019
- Exceptional Seminar, CERN Th — Sept 30, 2019
- Brown Bag Seminar, University of Michigan — Oct 31, 2018
- Cosmic Controversies, KICP — Oct 7, 2019
- No Stone Unturned Workshop, Utah — Aug 7, 2019
- AAS "Meeting within a Meeting", St. Louis — June 11, 2019
- LSST Dark Matter Workshop, KICP — Aug 5, 2019
- Theory Seminar, Argonne National Lab — April 9, 2019
- Kavli Institute for Theoretical Physics — Apr 10, 2018
- Theoretical Physics Seminar, Brandeis University — Feb 15, 2018
- Theoretical Astrophysics Seminar, Fermilab — Feb 5, 2018
- Particle Theory Seminar, Perimeter Institute — Dec 1, 2017
- Theory Seminar, SLAC — Oct 20, 2017
- 4D Seminar, Berkeley — Oct 18, 2017
- Particle Theory Seminar, Boston University — Oct 11, 2017
- CFP Seminar, University of Maryland — Apr 10, 2017
- HEP Seminar, Johns Hopkins University — Oct 25, 2016
- High Energy Physics Seminar, Caltech — Apr 25, 2016
- Astro Coffee, IAS — Feb 3, 2016
- Pheno & Vino, Princeton — Feb 2, 2016
- Galileo Galilei Institute workshop — Sep 30, 2015
- URA Thesis Award Presentation, Fermilab Users Meeting — June 10, 2015
- Cornell Particle Theory Seminar — Apr 10, 2015
- Los Alamos T2 Seminar — Dec 5, 2013
- SLAC Theoretical Physics Seminar — Oct 30, 2013
- Fermilab Theory Seminar — Oct 17, 2013

PAPERS over 4500 total citations, $h = 32$, 10 *Letters* (as of August 30, 2023, via INSPIRE-hep)

Authors are listed in alphabetical order *unless* a list identifier is added after the arXiv number, in which case names are in order of contribution. Mentee contributions denoted with *.

49. Samuel D. McDermott, M. Voetberg, and Brian Nord. *WavPool: A New Block for Deep Neural Networks.* arXiv:2306.08734 [cs.LG]

48. Samuel D. McDermott, Yi-Ming Zhong, and Ilias Cholis. *A Phantom Menace: On the Morphology of the Galactic Center Excess.* Mon. Not. Roy. Astron. Soc. **522**, no.1, L21-L25 (2023). arXiv:2209.00006 [astro-ph].

47. Jeremy Sakstein, Djuna Croon, and Samuel D. McDermott. *Axion Instability Supernovae.* Phys. Rev. D 105, 095038 (2022). arXiv:2203.06160 [astro-ph].

46. Ilias Cholis, Yi-Ming Zhong, Samuel D. McDermott, and Joseph P. Surdutovich*. *The Return of the Templates: Revisiting the Galactic Center Excess with Multi-Messenger Observations.* Phys. Rev. D 105, no.10, 103023 (2022). arXiv:2112.09706 [astro-ph].

45. Marcela Carena, Nina M. Coyle, Yingying Li, Samuel D. McDermott, and Yuhsin Tsai. *Cosmologically Degenerate Fermions.* Phys. Rev. D **106**, no.8, 083016 (2022). arXiv:2108.02785.

44. Susan Gardner, Samuel D. McDermott, and Brian Yanny. *The Milky Way, Coming into Focus: Precision Astrometry Probes its Evolution, and its Dark Matter.* Prog. Part. Nucl. Phys. 121, 103904 (2021). arXiv:2106.13284.

43. Pierce Giffin, John Lloyd, Samuel D. McDermott, and Stefano Profumo. *Neutron Star Quantum Death by Small Black Holes.* Phys. Rev. D 105, 123030 (2022). arXiv:2105.06504.

42. Eric J. Baxter, Djuna Croon, Samuel D. McDermott, and Jeremy Sakstein. *Find the Gap: Black Hole Population Analysis with an Astrophysically Motivated Mass Function.* Astrophys. J. Lett. 916, no.2, L16 (2021). arXiv:2104.02685 [astro-ph].

41. Carlos Blanco, Yonatan Kahn, Benjamin Lillard, and Samuel D. McDermott, *Dark Matter Daily Modulation With Anisotropic Organic Crystals.* Phys. Rev. D 104, 036011 (2021). arXiv:2103.08601.

40. James M. Cline, Guillermo Gambini*, Samuel D. McDermott, and Matteo Puel, *Late-Time Dark Matter Oscillations and the Core-Cusp Problem.* JHEP 04, 223 (2021). arXiv:2010.12583.

39. Jeremy Sakstein, Djuna Croon, Samuel D. McDermott, Maria C. Straight and Eric J. Baxter, *Beyond the Standard Model Explanations of GW190521.* Phys. Rev. Lett. 125, no.26, 261105 (2020). arXiv:2009.01213.

38. Djuna Croon, Samuel D. McDermott, and Jeremy Sakstein. *Missing in Action: New Physics and the Black Hole Mass Gap.* Phys. Rev. D 102, no. 11, 115024; selected as an **Editor's Choice** article. arXiv:2007.07889.

37. Djuna Croon, Samuel D. McDermott, and Jeremy Sakstein. *Missing in Axion: where are XENON1T's big black holes?* Phys. Dark Univ. 32, 100801 (2021). arXiv:2007.00650.

36. Djuna Croon, Gilly Elor, Rebecca Leane, and Samuel D. McDermott. *Supernova Muons: New Constraints on Z' Bosons, Axions, and ALPs.* JHEP 01, 107 (2021). arXiv:2006.13942.

35. Celeste Keith*, Dan Hooper, Samuel D. McDermott, and Nikita Blinov. *Constraints on Primordial Black Holes From Big Bang Nucleosynthesis Revisited.* Phys. Rev. D 102, no.10, 103512 (2020). arXiv:2006.03608 [astro-ph].

34. Dan Hooper, Gordan Krnjaic, John March-Russell, Samuel D. McDermott, and Rudin Petrossian-Byrne*. *Hot Gravitons and Gravitational Waves From Kerr Black Holes in the Early Universe.* arXiv:2004.00618.

33. Samuel J. Witte, Salvador Rosauro-Alcaraz, Samuel D. McDermott, and Vivian Poulin. *Dark Photon Dark Matter in the Presence of Inhomogeneous Structure.* JHEP 06, 132 (2020). arXiv:2003.13698 [astro-ph].

32. Yi-Ming Zhong, Samuel D. McDermott, Ilias Cholis, and Patrick J. Fox. *A New Mask for An Old Suspect: Testing the Sensitivity of the Galactic Center Excess to the Point Source Mask.* Phys. Rev. Lett. 124, no.23, 231103 (2020). arXiv:1911.12369 [astro-ph].

31. Samuel D. McDermott and Samuel J. Witte. *The Cosmological Evolution of Light Dark Photon Dark Matter.* Phys. Rev. D 101, 063030 (2020). arXiv:1911.05086.

30. Gordan Krnjaic and Samuel D. McDermott. *Implications of BBN Bounds for Cosmic Ray Upscattered Dark Matter.* Phys. Rev. D 101, no.12, 123022 (2020). arXiv:1908.00007.

29. Nikita Blinov, Kevin J. Kelly, Gordan Krnjaic, and Samuel D. McDermott. *Constraining the Self-Interacting Neutrino Interpretation of the Hubble Tension.* Phys. Rev. Lett. 123, no. 19, 191102 (2019). arXiv:1905.02727.

28. Dan Hooper, Gordan Krnjaic, and Samuel D. McDermott. *Dark Radiation and Superheavy Dark Matter from Black Hole Domination.* JHEP 08, 001 (2019). arXiv:1905.01301.

27. Samuel D. McDermott and Michael S. Turner. *Nuclear Kinetic Equilibrium During Big Bang Nucleosynthesis.* arXiv:1811.04932.

26. Samuel D. McDermott, Sanjay Reddy, and Srimoyee Sen. *A Deeply Bound Dibaryon is Incompatible with Neutron Stars and Supernovae.* Phys. Rev. D 99, no. 3, 035013 (2019). arXiv:1809.06765.

25. Rouven Essig, Samuel D. McDermott, Hai-Bo Yu, and Yi-Ming Zhong. *Constraining Dissipative Dark Matter Self-Interactions.* Phys. Rev. Lett. 123, no. 12, 121102 (2019). arXiv:1809.01144.

24. Dan Hooper, Gordan Krnjaic, Andrew J. Long, and Samuel D. McDermott. *WIMPflation.* Phys. Rev. Lett. 122, no. 9, 091802 (2019). arXiv:1807.03308.

23. Asher Berlin, Dan Hooper, Gordan Krnjaic, and Samuel D. McDermott. *Severely Constraining Dark Matter Interpretations of the 21-cm Anomaly.* Phys. Rev. Lett. 121, no. 1, 011102 (2018); selected as an **Editor's Choice** article. arXiv:1803.02804.

22. Bhaskaran Balaji*, Ilias Cholis, Patrick J. Fox, and Samuel D. McDermott. *Analyzing the Gamma-ray Sky with Wavelets.* arXiv:1803.01952 [astro-ph]. Phys. Rev. D 98, no. 4, 043009 (2018).

21. Jae Hyeok Chang*, Rouven Essig, and Samuel D. McDermott. *Supernova 1987A Constraints on Sub-GeV Dark Sectors, Millicharged Particles, the QCD Axion, and an Axion-like Particle.* JHEP 09, 051 (2018). arXiv:1803.00993.

20. Dan Hooper and Samuel D. McDermott. *Robust Constraints and Novel Gamma-Ray Signatures of Dark Matter That Interacts Strongly With Nucleons.* Phys. Rev. D 97, 115006 (2018). arXiv:1802.03025.

19. Samuel D. McDermott. *Is Self-Interacting Dark Matter Undergoing Dark Fusion?* Phys. Rev. Lett. 120, 221806 (2018); selected as an **Editor's Choice** article. arXiv:1711.00857.

18. Samuel D. McDermott, Hiren H. Patel, and Harikrishnan Ramani*. *Dark Photon Decay Beyond The Euler-Heisenberg Limit.* Phys. Rev. D 97, no. 7, 073005 (2018). arXiv:1705.00619.

17. Samuel Witte*, Vera Gluscevic, and Samuel D. McDermott. *Prospects for Distinguishing Dark Matter Models Using Annual Modulation.* JCAP 02, no. 02, 044 (2017). arXiv:1612.07808.

16. Jae Hyeok Chang*, Rouven Essig, and Samuel D. McDermott. *Revisiting Supernova 1987A Bounds on Dark Photons.* JHEP 01, 107 (2017). arXiv:1611.03864.

15. Samuel D. McDermott, Patrick Meade, and Harikrishnan Ramani*. *Singlet Scalar Resonances and the Diphoton Excess.* Phys. Lett. B 755, 353 (2016). arXiv:1512.05326.

14. Samuel D. McDermott, Ilias Cholis, Patrick J. Fox, and Samuel K. Lee. *Wavelet-Based Techniques for the Gamma-Ray Sky.* JCAP 07, 07, 045, (2016). arXiv:1512.00012 [astro-ph].

13. Asher Berlin*, Dan Hooper, and Samuel D. McDermott. *Dark matter elastic scattering through Higgs loops.* Phys. Rev. D 92, no. 12, 123531 (2015). arXiv:1508.05390.

12. Hooman Davoudiasl, Dan Hooper, and Samuel D. McDermott. *Inflatable Dark Matter.* Phys. Rev. Lett. 116, 031303 (2016); selected as an **Editor's Choice** article. arXiv:1507.08660.

11. Vera Gluscevic, Moira Gresham, Samuel D. McDermott, Annika H. G. Peter, and Kathryn M. Zurek. *Identifying the Theory of Dark Matter with Direct Detection.* JCAP 12, 12, 057 (2015). arXiv:1506.04454.

10. Samuel D. McDermott. *Lining up the Galactic Center Gamma-Ray Excess.* Phys. Dark Univ. 7-8, 12 (2015). arXiv:1406.6408.

9. Asher Berlin*, Pierre Gratia*, Dan Hooper, and Samuel D. McDermott. *Hidden Sector Dark Matter Models for the Galactic Center Gamma-Ray Excess.* Phys. Rev. D 90, 015032 (2014). arXiv:1405.5204.

8. Asher Berlin*, Dan Hooper, and Samuel D. McDermott. *Simplified Dark Matter Models for the Galactic Center Gamma-Ray Excess.* Phys. Rev. D 89, 115022 (2014). arXiv:1404.0022.

7. Ilias Cholis, Dan Hooper, and Samuel D. McDermott. *Dissecting the Gamma-Ray Background in Search of Dark Matter.* JCAP 02, 014 (2014). arXiv:1312.0608 [astro-ph].

6. Rouven Essig, Eric Kuflik, Samuel D. McDermott, Tomer Volansky, and Kathryn M. Zurek. *Constraining Light Dark Matter with Diffuse X-Ray and Gamma-Ray Observations.* JHEP 11, 193 (2013). arXiv:1309.4091.

5. Clifford Cheung, Samuel D. McDermott, and Kathryn M. Zurek. *Inspecting the Higgs for New Weakly Interacting Particles.* JHEP 04, 074 (2013). arXiv:1302.0314.

4. Eric Kuflik, Samuel D. McDermott, and Kathryn M. Zurek. *Neutrino Phenomenology in a 3+1+1 Framework*. Phys. Rev. D 86, 033015 (2012). arXiv:1205.1791.
3. Samuel D. McDermott, Hai-Bo Yu, and Kathryn M. Zurek. *The Dark Matter Inverse Problem: Extracting Particle Physics from Scattering Events*. Phys. Rev. D 85, 123507 (2012). arXiv:1110.4281.
2. Samuel D. McDermott, Hai-Bo Yu, and Kathryn M. Zurek. *Constraints on Scalar Asymmetric Dark Matter from Black Hole Formation in Neutron Stars*. Phys. Rev. D 85, 023519 (2012). arXiv:1103.5472.
1. Samuel D. McDermott, Hai-Bo Yu, and Kathryn M. Zurek. *Turning off the Lights: How Dark is Dark Matter?* Phys. Rev. D 83, 063509 (2011). arXiv:1011.2907.

CONFERENCE AND WORKSHOP ORGANIZING

Dark Matter in Compact Objects, Stars, and in Low Energy Experiments Aug 1-Sep 2, 2022
Institute for Nuclear Theory, University of Washington
- co-organized with Masha Baryakhtar, George Fuller, and Sanjay Reddy
- $106,400 grant from the Institute for Nuclear Theory
- 75 international participants
- co-authored the application materials and co-organized the invitation list
- replaced in organizer list (travel conflicts) following successful application

Next Frontiers in the Search for Dark Matter Aug 26-Oct 11, 2019
Galileo Galilei Institute, Arcetri, Italy
- co-organized with Marco Battaglieri, Laura Baudis, Francesco D'Eramo, Claudia Frugiuele, Eric Kuflik, Tongyan Lin, Hitoshi Murayama, and Stefano Profumo
- inclusive organizing budget for six-week workshop and five-day conference
- > 100 international participants
- co-authored the application materials, co-organized applications for attendance, and moderated scientific activities during the workshop and conference

New Directions in the Search for Light Dark Matter Particles June 4-7, 2019
Fermilab and KICP
- co-organized with Dan Bauer, Dan Baxter, Yonatan Kahn, Gordan Krnjaic, and Noah Kurinsky
- $24,525 grant from the Gordon and Betty Moore Foundation
- 50 international participants
- co-authored the application materials, co-organized the invitation list, and moderated scientific activities during the workshop

Beyond WIMPs: from Theory to Detection March 27-29, 2017
Simons Center for Geometry and Physics, Stony Brook
- co-organized with Rouven Essig, Jeremy Mardon, Peter Sorensen, Tomer Volansky, and Tien-Tien Yu
- inclusive organizing budget for three-day conference
- 30 international participants
- invited participants and co-organized workshop sessions

REVIEW EFFORTS

Journal Referee
- Astrophysical Journal since: 2021
- MNRAS Letters 2018
- Physics Letters B 2017
- Physical Review Letters 2014
- Journal of High Energy Physics 2013
- Physical Review D 2011

Grant Review Panel
- NSF Astronomy Division (declined) March 2022

PRESS

Hershberger, Scott. "Physics at Tiniest Scale Could Explain 'Impossible' Black Holes" *Symmetry Magazine*, 16 December 2020.

Hershberger, Scott. "If Betelgeuse goes boom: How DUNE would respond to a nearby supernova." *Fermilab News*, 5 October 2020.

Sakstein, Jeremy and Croon, Djuna, and SDM. "Beyond the Standard Model Explanations of GW190521." *Newsletter of the CERN Experimental Physics Department*, 29 September 2020.

Hekkenberg, Ans. "Overschot straling centrum Melkweg niet te verklaren met donkere materie" (Dutch) *newscientist.nl*, 8 September 2020.

Fadelli, Ingrid. "Could recently spotted dim point sources explain the galactic center excess (GCE)?" *Phys.org*, 14 July 2020.

Muñoz, Julian and Loeb, Abraham. "The First Stars May Shed Light on Dark Matter." *APS Physics*, 2 July 2018.

Conover, Emily. "If real, dark fusion could help demystify this physics puzzle." *Science News*, 6 June 2018.

Inglis-Arkell, Esther. "'Inflatable Dark Matter' Could Explain Why We See Less Than Many Theories Predict." *Gizmodo*, 18 January 2016.