Adrian Thompson, Ph.D.

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Education

PhD Physics, Texas A&M University — 2023
Advisor: Dr. Bhaskar Dutta

B.S. Physics & B.A. Mathematics, University of California, Santa Cruz — 2015
Advisor: Dr. Jason Nielsen — 2015

Research Experience

Postdoctoral Scholar, **Northwestern University** (2023 – present)

◇ **Proposed future neutrino experiments** to capture TeV neutrinos from a future muon collider, demonstrating sub-percent precision capability in electroweak observables. arXiv:2505.00152

◇ **New gauge forces and mediators**: Uncovered enhancements to heavy neutrino production from gauge-mediated channels in $U(1)_{B-L}$ at SBN, DUNE, and DarkQuest experiments. Explored neutrino-induced backgrounds with `Genie` for heavy axion searches at DUNE. *PRD.111.055036*, arXiv:2507.21228

◇ **Demonstrated interconnections** between binary pulsar data and laboratory bounds on the strength of B-violating dark matter interactions and its connection to Baryogenesis. *PRD.110.115010*.

◇ **Showed complementarity** between stopped-pion spallation source experiments and beam-focused neutrino experiments in searches for explanations to the MiniBooNE anomaly at CCM. *PRD.107.095036*

Graduate Student Researcher, **Texas A&M University** (2017 – 2023)

◇ **Explained anomalies** in accelerator neutrino data from the MiniBooNE experiment by proposing new particle theories. Developed a python Runge-Kutta transport (`RKHorn`) for charged pion focusing through the booster neutrino beam magnetic horns. *PRL.129.111803*

◇ **Rectified formalism discrepancies in Bragg-Primakoff coherence** of solar axions due to absorption effects in ordered crystal; refined theoretical grounding for solar axion searches (Ph.D. Thesis, *JHEP02(2024)190*).

◇ **Led the theory effort** for signal modeling and hypothesis testing in a search of heavy axions with the CCM collaboration. *PRD.109.095017*

◇ **Opened new search strategies** at reactor, spallation source, and accelerator neutrino experiments for dark matter and axion-like particles. *PRL.124.211804*, *PRD.107.095010*, *PRL.126.201801*

◇ **Neutrino physics from accelerators and mother nature**: Investigated scalar and vector neutrino non-standard interactions impact on oscillation and scattering with solar, atmospheric, and beam neutrinos. Proposed a global analysis strategy to resolve degeneracies leveraging Bayesian techniques. *JHEP09(2020)106*

Travel, Workshops, and Community Efforts

◇ Organizer for the *PIKIMO*-19 phenomenology meeting at Northwestern University (November 2025)

◇ Organizer for weekly high energy physics seminars at Northwestern University across experimental particle physics, phenomenology, amplitudes and formal theory (Fall 2024 – present)

◇ Aspen Center for Physics: Summer Workshop, "*Collider Physics at the LHC and Beyond*" (Aspen, Colorado): June 16-29, 2025.

◇ Fermilab Affiliate, 2023 – present

◇ Fermilab Wine and Cheese Seminar, June 16, 2023: Presented *"Searches for Physics Beyond the Standard Model with Coherent CAPTAIN Mills"* on behalf of the CCM collaboration.

◇ Attended the 2023 CEνNS-Neutrino School held from March 27 - 29, 2023, at the Technical University of Munich

◇ ICHEP 2022 (Bologna, Italy): On behalf of the IsoDAR collaboration presented the latest results and excellent prospects for the IsoDAR experiment's neutrino, dark matter, and axion physics programs.

◇ TASI 2020 (Virtual): Participated in the first ever *virtual* TASI workshop, collaborated and networked with future colleagues in virtual spaces while sharpening my skillset.

◇ Texas A&M Qatar (Doha, Qatar): Traveled for graduate student research grant in collaboration with Dr. Teruki Kamon and Dr. Othmane Bouhali for simulation R&D of gas electron multipliers (GEMs) with novel mechanisms for electron gain and transport.

Teaching Experience and Outreach

◇ Introductory Physics Recitation and Laboratory, Fall 2017 - Fall 2019.

◇ *Texas A&M Physics Festival 2018, 2019, 2021, and 2022* - Rubens tube demonstration.

◇ Private tutoring for undergraduate physics, engineering, and introductory science. 2014-2015.

Awards

◇ Recipient of the Outstanding Graduate Presentation Award - *Texas Section APS*, November 2020

Computational Skillset

Python	FeynRules, FeynCalc, FeynArts
Mathematica	MadGraph, Pythia, Delphes
C++, ROOT	HPRC, SLURM
R	
Javascript, HTML, mySQL	

Code Repositories and Databases

♠ axion-like particles and related phenomenology; available on github: athompson-tamu/alplib.

♣ Runge-Kutta magnetic field transport of charged mesons in the BNB focusing horns athompson-tamu/RKHorn

♡ eXdb: a particle physics experiments database https://athompson-git.github.io/experiments.html

Industry Work Experience

Software Quality Analyst - *Waymo* (the Google Self-Driving Car) contracted by *Adecco E&T*, Mountain View, CA. Autonomous vehicle simulation design and regression testing. Modeling of nominal human drivers. C++, SQL, Javascript. September 2015 - July 2017.

Consultant - *Metaculus Inc.*, Santa Cruz, CA. Consulting and writing for `metaculus.com`, a forecasting and prediction community. Generating questions on modern issues in physics, mathematics, biotechnology, technology, and engineering. In collaboration with Dr. Anthony Aguirre and Dr. Greg McLaughlin. December 2015 - June 2016.

Authored Publications and Preprints

Primary Contributions

1. **T. Cheng**, **M. Hostert**, **P. A. N. Machado**, **N. Mishra**, **A.T.**, "Standard Candles for Supernova Neutrino Detection at DUNE". arXiv:2606.18337

2. **B. Dutta**, **D. Goswami**, **A. Karthikeyan**, **V. Pandey**, **Z. Tabrizi**, **A.T.**, **R. G. Van de Water** "Prying Open the Dark Sector Window with SBND Off-Target Mode". arXiv:2603.25818

3. **M. Hostert**, **M. Pospelov**, **A.T.**, "Kaon decay constraints on vector bosons coupled to nonconserved currents". *Phys. Rev. D* **113** (2026) 11, 115003 arXiv:2602.19479

4. **J. Gehrlein**, **A. Thapa**, **A.T.**, "Enhanced active-sterile neutrino polarizability at the intensity frontier". *Phys. Rev. D* **113** (2026) 11, 115062, arXiv:2512.07691

5. **V. Brdar**, **B. Dutta**, **W. Jang**, **D. Kim**, **I. M. Shoemaker**, **Z. Tabrizi**, **A.T.**, **J. Yu** "Finding BSM Needles in Electromagnetic Haystacks at DUNE". *Phys. Rev. D* **113** (2026) 3, 035023, arXiv:2507.21228

6. **A. de Gouvêa**, **A.T.** "Electroweak Observables in Neutrino-Electron Scattering from a Muon Storage Ring". *JHEP* **12** (2025) 098 . arXiv:2505.00152

7. **F. Capozzi**, **B. Dutta**, **G. Gurung**, **W. Jang**, **I. M. Shoemaker**, **A.T.**, **J. Yu** "Enhancing the Sensitivity to Seesaw Predictions in Gauged $B - L$ Scenarios". *Phys. Rev. D* **111** (2025) 5, 055036 arXiv:2410.08981

8. **R. Allahverdi**, **A.T.**, **M. Zakeri**, "Insights from binary pulsars and laboratories into baryon number violation: Implications for GeV dark matter". *Phys. Rev. D* **110** (2024) 11, 115010 arXiv:2409.08178.

9. **B. Dutta**, **S. Ghosh**, **K. J. Kelly**, **T. Li**, **A.T.**, **A. Verma** "Non-standard neutrino interactions mediated by a light scalar at DUNE". *JHEP* **07** (2024) 213 arXiv:2401.02107

10. **B. Dutta**, **J. B. Dent**, **A.T.**, "Bragg-Primakoff Axion Photoconversion in Crystal Detectors". *JHEP* **02** (2024) 190 arXiv:2307.04861.

11. **F. Capozzi**, **B. Dutta**, **G. Gurung**, **W. Jang**, **I. M. Shoemaker**, **A.T.**, **and J. Yu**, "New Constraints on ALP Electron and Photon Couplings from ArgoNeuT and the MiniBooNE Beam Dump". *Phys. Rev. D* **108**, 075019 arXiv:2307.03878

12. **B. Dutta**, **S. Ghosh**, **T. Li**, **A.T.**, **and A. Verma**, "Non-standard neutrino interactions in light mediator models at reactor experiments". *JHEP* **03** (2023) 163 arXiv:2209.13566

13. **L. Waites**, **A.T.**, **A. Bungau**, **J. M. Conrad**, **B. Dutta**, **W-C. Huang**, **D. Kim**, **M. Shaevitz**, **and J. Spitz**, "Axion-Like Particle Production at Beam Dump Experiments with Distinct Nuclear Excitation Lines". *Phys. Rev. D* **107** (2023) 9, 095010 arXiv:2207.13659

14. **A. Bhattarai**, **V. Brdar**, **B. Dutta**, **W. Jang**, **D. Kim**, **I. M. Shoemaker**, **Z. Tabrizi**, **A.T.**, **J. Yu**, "Probing new physics at DUNE operating in a beam-dump mode". *Phys. Rev. D* **107** (2023) 5, 055043 arXiv:2206.06380

15. **J. Alonso *et al.***, "Neutrino physics opportunities with the IsoDAR source at Yemilab" *Phys. Rev. D.* **105** (2022) 5, 052009 arXiv:2111.09480. Invited contribution to theory prediction for a dark boson search utilizing nuclear transition lines.

16. **B. Dutta**, **D. Kim**, **A.T.**, **R. T. Thornton**, **R. Van de Water**, "Solutions to the MiniBooNE Anomaly from New Physics in Charged Meson Decays". *Phys. Rev. Lett.* **129** (2022) 11, 111803. arXiv:2110.11944

17. **F. Capozzi**, **B. Dutta**, **G. Gurung**, **W. Jang**, **A.T.**, **J. Yu**, **I. M. Shoemaker**. "Extending the Reach of Leptophilic Boson Searches at DUNE and MiniBooNE with Bremsstrahlung and Resonant Production". *Phys. Rev. D.* **104** (2021) 11, 115010 arXiv:2108.03262

18. **J. B. Dent**, **B. Dutta**, **A. Jastram**, **D. Kim**, **A. Kubik**, **R. Mahapatra**, **S. Rajendran**, **H. Ramani**, **A.T.**, **S. Verma**, "Pathfinder for a High Statistics Search for Missing Energy In Gamma Cascades". *Phys. Rev. D.* **105** (2022) 1, 115030 arXiv:2105.07007

19. **V. Brdar**, **B. Dutta**, **W. Jang**, **D. Kim**, **I. M. Shoemaker**, **Z. Tabrizi**, **A.T.**, **J. Yu**, "Axion-like Particles at Future Neutrino Experiments: Closing the Cosmological Triangle". *Phys. Rev. Lett.* **126** (2021) 20,201801 arXiv:2006.15118

20. **J. B. Dent**, **B. Dutta**, **J. L. Newstead**, **A.T.**, "Inverse Primakoff Scattering as a Probe of Solar Axions at Liquid Xenon Direct Detection Experiments" *Phys. Rev. Lett.* **125** (2020) 13,131805 arXiv:2006.15118

21. **B. Dutta**, **D. Kim**, **S. Liao**, **J-C. Park**, **S. Shin**, **L. E. Strigari**, **A.T.**, "Searching for Dark Matter Signals in Timing Spectra at Neutrino Experiments". *JHEP* **01** (2022) 144 arXiv:2006.09386

22. **B. Dutta**, **R. F. Lang**, **S. Liao**, **S. Sinha**, **L. E. Strigari**, **A.T.**, "A global analysis strategy to resolve neutrino NSI degeneracies with scattering and oscillation data" *JHEP* **09** (2020) 106 arXiv:2002.03066

23. **J. B. Dent**, **B. Dutta**, **D. Kim**, **S. Liao**, **R. Mahapatra**, **K. Sinha**, **A.T.**, "New Directions for Axion Searches via Scattering at Reactor Neutrino Experiments" *Phys. Rev. Lett.* **124** (2020) 21,211804 arXiv:1912.05733

24. **M. Abdullah**, **M. Dalchenko**, **T. Kamon**, **D. Rathjens**, **A.T.**, "A heavy neutral gauge boson near the Z boson mass pole via third generation fermions at the LHC" *Phys. Lett. B* **803** (2020) 135326 arXiv:1912.00102

CCM Collaboration

I led the analysis effort for the following papers authored by the Coherent CAPTAIN Mills (CCM) collaboration:

1. **CCM Collaboration**, "Testing Meson Portal Dark Sector Solutions to the MiniBooNE Anomaly at CCM". arXiv:2309.02599. *Phys. Rev. D* **109** 9, 095017. Led the theory and analysis effort.

2. **CCM Collaboration**, "Axion-Like Particles at Coherent CAPTAIN-Mills". *Phys. Rev. D* **107**, 095036 arXiv:2112.09979. Led the theory and analysis effort to search for axion-like particles.

Secondary Contributions

In these works I contributed in an advisory capacity or as an author not participating significantly in analysis work.

1. **B. Dutta**, **A. Karthikeyan**, **D. Kim**, **A.T.**, **R. G. Van de Water** "Photon Excess from Dark Matter and Neutrino Scattering at MiniBooNE and MicroBooNE" arXiv:2504.08071. In review for *PRL*.

2. **S. Sahoo**, **S. Verma**, **M. Mirzakhani**, **N. Mishra**, **A.T.**, **S. Maludze**, **R. Mahapatra**, **M. Platt** "Reactor-based Search for Axion-Like Particles using CsI(Tl) Detector" arXiv:2407.14704. In review.

3. **A. Kaur Kalsi**, **T. Kamon**, **S. Kim**, **J.S.H. Lee**, **D. Rathjens**, **Y. J. Roh**, **A.T.**, **I.J. Watson** "Probing bottom-associated production of a TeV scale scalar decaying to a top quark and dark matter at the LHC". *JHEP* **09** (2024) 203. arXiv:2404.14844

4. **M. Toups *et al***, "PIP2-BD: GeV Proton Beam Dump at Fermilab's PIP-II Linac". Contribution to 2022 Snowmass Summer Study. arXiv:2203.08079

5. **M.A. Acero *et al.***, "White Paper on Light Sterile Neutrino Searches and Related Phenomenology". NF02 Contribution to the 2022 Snowmass Summer Study. arXiv:2203.07323. Invited contribution.

6. **M. Abdullah**, **M. Dalchenko**, **B. Dutta**, **R. Eusebi**, **P. Huang**, **T. Kamon**, **D. Rathjens**, **A.T.**, "Bottom-quark Fusion Processes at the LHC for Probing Z' Models and B-meson Decay Anomalies" *Phys. Rev. D.* **97** (2018) 075035 arXiv:1707.07016

PhD Dissertation

1. **A.T.**, "On Coherence in Bragg-Primakoff Axion Photoconversion". For PhD candidacy, 2023. arXiv:2309.01767

Seminars and Presentations

2026

◇ "Kaon Factories and Vectors Coupled to Non-conserved Currents". **Mitchell Conference** on Collider, Dark Matter, and Neutrino Physics, May 30, 2026.

◇ "Kaon factories and searches for new physics". **PAECRS** student/postdoc talks given at Northwestern University. April 29, 2026.

◇ "Kaon Decay Constraints on Vector Bosons Coupled to Non-Conserved Currents", **The X17 particle, status, and new ideas** at the ECT*, Trento, Italy. March 25, 2026.

2025

◇ "Electroweak Precision with Muon Collider Neutrinos". **CETUP*** in Lead, SD, July 10, 2025.

◇ "The Muon Collider as a Neutrino Lighthouse". **Aspen Center for Physics**: Summer Workshop, *Collider Physics at the LHC and Beyond.* Invited blackboard talk. June 24, 2025.

◇ "Electroweak Observables in Neutrino-Electron Scattering from a Muon Storage Ring". **CIPANP**, UW Madison. Invited seminar. June 11, 2025.

◇ "The Terrestrial Neutrino Lighthouse". **LAWPHYSICS** (Latin American Webinars in Physics), virtual invited seminar. June 4, 2025. Link: https://youtu.be/_fd6w7oqbGc

◇ "Resolving Electromagnetic Signatures of Long-lived Particles at DUNE ND-LAr". **NEAT**: Neutrino Experiment and Theory workshop, Colorado State University. Invited seminar. May 30, 2025.

◇ "What Neutron Stars can tell us about Baryon Number Violation, GeV Dark Matter, and Baryogenesis". **University of Melbourne** invited virtual seminar. May 20, 2025.

◇ "Electroweak Observables in Neutrino-Electron Scattering from a Muon Storage Ring". Invited seminar at the **Mitchell Conference** on Collider, Dark Matter, and Neutrino Physics, Texas A&M, May 16, 2025.

◇ *"Binary Pulsars, Baryogenesis, and Majorana GeV Dark Matter".* **SNSF-INT** Joint Workshop: Baryon Number Violation: From Nuclear Matrix Elements to BSM Physics 2025. University of Washington, January 17, 2025.

2024

◇ *"Insights into Dark Matter and Baryogenesis from Binary Pulsar Data".* **PAECRS** meeting, Northwestern University, October 16, 2024.

◇ *"Neutrino NSI from Ultralight Scalars".* **NuFact** 2024 at Argonne Natl. Lab, September 23, 2024.

◇ *"The Multi-messenger Phase Space of Primordial Black Holes and Gravitational Waves".* **Fermilab**, September 12, 2024.

◇ *"Baryogenesis Relics from Binary Pulsars to Terrestrial Experiments".* **TeVPA 2024**: TeV Particle Astrophysics, University of Chicago, August 29, 2024.

◇ *"Constraints on Baryon Number Violation from Neutron Stars to the Lab".* **Mitchell Conference** on Collider, Dark Matter, and Neutrino Physics, Texas A&M, May 25, 2024.

◇ *"Axion-like Particles at the DUNE Near Detector".* **DUNE Collaboration Meeting**, *virtual*, May 20, 2024.

◇ *"Baryon Number Violation in Neutron Stars and the Lab".* **DPF-Pheno 2024**, Pittsburg, PA., May 14, 2024.

◇ *"Parsing the Nature of Cosmological Phase Transitions with Gravitational Waves and Primordial Black Holes".* **Northwestern University Theory Seminar**, Evanston, IL, April 8, 2024.

◇ *"A Bird's-Eye View of New Physics and the MiniBooNE Anomaly".* **2nd SBN Experiment-Theory Workshop**, Santa Fe, NM, April 2, 2024.

2023

◇ *"New Understanding of Coherence in Bragg-Primakoff Axion Detection".* **CETUP 2023**, Lead, SD, June 27, 2023.

◇ *"On Coherence in Bragg-Primakoff Axion Photoconversion".* Thesis Defense. Texas A&M University, June 6, 2023.

◇ *"Searches for Physics Beyond the Standard Model with Coherent CAPTAIN Mills".* **Fermilab Wine and Cheese Seminar**, Fermilab, June 16, 2023.

◇ *"MeV-scale BSM Physics at Stopped-Pion Facilities".* **Magnificent CEνNS** Münich, DE, March 24, 2023.

2022

◇ *"The MiniBooNE Anomaly and Dark Sectors".* **PITT-PACC Workshop**: Nu-Tools for BSM at Neutrino Beam Facilities, University of Pittsburgh, PA. December 15, 2022.

◇ *"Opportunities for Axion Searches at Beam Dumps and Stopped-Pion Facilities".* **Dark Interactions**: **New Perspectives from Theory and Experiment**, workshop at BNL, November 16, 2022. *Virtual.*

◇ *"New Physics in Meson Decays at Beam Dump and Stopped Pion Facilities".* **Particle Physics on the Plains**, University of Kansas, Lawrence, KS, October 22, 2022.

◇ *Midterm Project Review* for the BSM theory work done in collaboration between Texas A&M and Los Alamos National Laboratory. Faculty Engagement and Student Showcase Event, October 13-14, 2022.

◇ *"Absorption Effects in Coherent Crystal Photoconversion of Solar Axions".* **TACOS** (Theoretical Astroparticle and Cosmology Symposium) 2022 at SMU, Dallas, TX. October 10, 2022.

◇ *"Neutrino, DM, and Axion Physics with IsoDAR @ Yemilab".* **ICHEP** 2022, Bologna, Italy. By invitation on behalf of the IsoDAR collaboration. July 7, 2022.

◇ *"Solutions to the MiniBooNE Anomaly from New Physics in Charged Meson Decays".* **Mitchell Conference** on Collider, Dark Matter, and Neutrino Physics, May 24, 2022.

◇ *"Search for New Bosonic Neutrino Fluxes at IsoDAR".* Internal presentation for the **IsoDAR** collaboration, January 21, 2022.

◇ Gave an additional 2 internal talks for the **CCM** collaboration.

2021

◇ *"Solutions to the MiniBooNE Anomaly from New Physics in Charged Meson Decays".* Internal presentation for the CCM Collaboration, October 24, 2021.

◇ *"Long-lived Scalars at the Neutrino Frontier"* **Magnificent CEνNS Workshop**, October 7, 2021. *Virtual.*

◇ *"ALP Searches at Neutrino and Dark Matter Frontier Experiments"* **Pheno Symposium**, May 24, 2021. *Virtual.*

◇ Gave an additional 3 internal talks for the **DUNE** collaboration and 4 internal talks for the **CCM** collaboration.

2020

◇ *"Neutrino NSI Global Analyses & Atmospheric CEνNS at LXe Experiments"* **Snowmass** 2021: NF04 Topical Workshop, November 23, 2020. *Virtual.*

◇ *"Neutrino NSI and Global Analyses / Axion-like Particles in the Laboratory"* **Magnificent CEνNS** Workshop, November 18, 2020. *Virtual.*

◇ *"Axion-like Particles in the Laboratory"* **Texas Section APS**, Fall Meeting 2020. *Virtual.*

◇ *"Constraints on Non-Standard Neutrino Interactions Utilizing Copulas"* **Snowmass** 2021, Neutrino Frontier BSM topical group, September 17, 2020. *Virtual.*

◇ *"New Directions for Axion-like Particle Searches"* By invitation for the **SuperCDMS** collaboration, *Virtual*, June 2020.

◇ *"New Searches for Axion-like Particles in the Laboratory"* By invitation for **DUNE Physics Week**: BSM/Pheno, *Virtual*, June 2020.

◇ *"New Directions for Axion Searches via Scattering at Reactor Neutrino Experiments"* **Pheno** Symposium 2020, May 2020.

2019

◇ *"Bayesian Priors, Copulas, and Large-Dimensional Likelihoods"* Dark Matter and Neutrino Computation Explored (**DANCE**), Rice University, October 2019.

◇ *"Copulas and their Applications to Bayesian Analysis in Physics"* Applied Mathematics Undergraduate SEminar (**AMUSE**), Texas A&M University, October 2019.

2018

◇ *"CMS Muon Detectors: Run 2 experience"* International Workshop on Future Linear Colliders (**LCWS**), University of Texas at Arlington, October 2018.

◇ *"Bottom-quark Fusion Processes at the LHC for Probing Z′ Models and B-meson Decay Anomalies"* The **Mitchell Conference** on Collider, Dark Matter, and Neutrino Physics, Texas A&M University, May 21, 2018.

◇ *"Track-based Alignment of the CMS Muon System"* **APS Q2C** Meeting, Columbus OH, April 2018.

References

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Other references can be provided upon request.