Curriculum Vitae

Noah Everett

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Additional Information

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Research Summary

As an undergraduate, I have done research in theoretical and experimental particle physics and optical physics, pure mathematics, and machine learning at South Dakota Mines, SLAC National Accelerator Laboratory, and Fermi National Accelerator Laboratory. I have been fortunate to work with truly amazing people and either directly or indirectly with experiments such as ANNIE, LUX-ZEPLIN, nEXO, SciBooNE, and SuperCDMS.

Education

2020–2024 South Dakota School of Mines and Technology
B.S. Physics and Mathematics
Minors: Computer Science and Computational Statistics
GPA: 3.93/4.00

Research Appointments

Aug 2023–Present Undergraduate Research Assistant, South Dakota Mines
PI: Dr. Randy Hoover, Computer Science Department
Contributions:

- Investigating the use of convolutional deep learning methods for dynamic graph forecasting (additional information)

Jun 2023–Aug 2023 DOE SULI Intern, Fermi National Accelerator Laboratory
PI: Dr. Patrick Fox, Theory Department
Contributions:

- Investigated the feasibility of using SciBooNE to search for dark photons through visible decay channels (additional information)
- Unofficially attended the International Symposium on Lattice Field Theory (Lattice 2023) and the 14th International Neutrino Summer School 2023

Aug 2022–Present Undergraduate Research Assistant, South Dakota Mines
PI: Dr. Patrick Fleming, Mathematics Department
Contributions:

- Found isomorphisms that map between the extended $\mathbb{R}^2$ plane, (hemi)sphere, and $\mathbb{R}^3$ vector space constructions of the real projective plane (additional information)
- Presented findings at Mathematical Association of America (MAA) Rocky Mountain Section 2023 meeting and a math department colloquium

Jun 2022–Aug 2022 DOE SULI Intern, SLAC National Accelerator Laboratory
PI: Dr. Brian Mong, Fundamental Physics Directorate
Contributions:

- Created a Monte Carlo simulation of electrostatic chamber radon assay systems
- Developed an analysis method to determine the initial populations of long-lived radioactive isotopes in assayed materials with complete decay history fitting (additional information)
- Helped assemble a new electrostatic chamber radon assay system
- Presented results at the Stanford Physics, Identity, and Equity Workshop (SPIEW) and the America Physical Society (APS) Prairie Section 2022 meeting

Dec 2021–Present Undergraduate Research Assistant, South Dakota Mines
PI: Dr. Jingbo Wang, Physics Department
Contributions:

- Developing a new likelihood-based reconstruction method for ANNIE (additional information)
- Conducting a simulation-based feasibility study for a neutrino-argon measurement in ANNIE (additional information)
- Restored ANNIE's simulation softwares including GENIE, WCSim (GEANT4-based detector simulation), and ANNIEDirt (GEANT4-based fast particle propagator) after their ∼5 year hiatus
- Miscellaneous work on ANNIE software including creating Docker images, bash scripts, documentation, and maintaining and contributing to ANNIE's simulation and analysis softwares
- Presented results at the 2023 APS April meeting and multiple student research symposiums and ANNIE collaboration meetings

Jan 2021–Dec 2021 Undergraduate Research Assistant, South Dakota Mines
PI: Dr. Richard Schnee, Physics Department
Contributions:

- Developed an environmental monitoring system for the ultra-low radon cleanroom at South Dakota Mines (additional information)
- Assisted with material assays for SuperCDMS and LUX-ZEPLIN
- Assisted in assembling the cleanroom tent for the new cold emanation system and started the commissioning of the system

Honors and Awards

Aug 2023	Member of the ANNIE Collaboration *Context:* First and only undergraduate collaboration member
Apr 2023	APS Division of Particles and Fields Travel Grant for April Meeting *Context:* Gave a talk in the Neutrinos IV (non-undergraduate) session
Mar 2023	Outstanding Physics Junior *Context:* Awarded to 1-2 physics juniors chosen by the physics department faculty each year
Mar 2023	Leadership Award – Society of Physics Students (SPS)
Nov 2022	Private Dinner with Dr. Nigel Lockyer and Gov. Mike Rounds *Context:* I was 1 of 2 students (and the only undergraduate) (invited by the physics department head) that attended a private dinner with Dr. Nigel Lockyer (former director of Fermilab and TRIUMF), Gov. Mike Rounds (former Governor and Senator of South Dakota), and other prominent community members
Apr 2022	Sigma Pi Sigma Honor Society
2020–2023	Deans List (all semesters)

Scientific Collaborations

2023–Present	Accelerator Neutrino Neutron Interaction Experiment (ANNIE) *Member:* ANNIE is a 26-ton gadolinium-doped water Cherenkov detector on the Booster Neutrino Beam (BNB) at Fermilab. The primary physics goal of ANNIE is to make precision measurements of the number of final state neutrons from neutrino interactions in water to improve the systematic uncertainties of next-generation long-baseline neutrino experiments. In addition, ANNIE is also doing detector R&D on new Large Area Picosecond PhotoDetectors (LAPPDs) and Water-based Liquid Scintillator (WbLS) detector medium. The ANNIE collaboration consists of more than 40 collaborators from 19 institutions and 2 national labs in 5 countries.

Grants

To Do: Will add information about grants applications and renuels I have helped with

Professional Service and Leadership

May 2023–Present	Physics Departmental Action Team *Member:* Implement change to support department improvement. This consists of diversity, equity, and inclusion efforts, implementation of active learning, and other departmental issues. I am one of three undergraduate members selected by the physics department to be on the team.

Apr 2023–Present — Society of Physics Students (SPS) and Sigma Pi Sigma (National Council)

Assistant Zone Councilor (AZC): I am AZC for Zone 11 (which includes MN, SD, ND, NE, and IA). I was awarded this position as a result of winning an election in which each chapter in zone 11 voted. I manage correspondence and outreach between the SPS national branch and chapters in zone 11.

Co-Chair of the Burnout Committee: The burnout committee is tasked with discussing and implementing aid at a national level for students experiencing burnout which, according to a 2022 pole, was a one of the two most important issues facing SPS chapters for 41% of participants.

Apr 2022–Aug 2023 — South Dakota Mines' Society of Physics Students (SPS) Chapter

Vice President: Generally support the chapter by finding outreach events, club activities, assist in management, lead meetings, etc.

Feb 2022–Present — Health and Fitness Club

Founder, President (Feb 2022–Apr 2023), and Vice President (Apr 2023–Present): The Health and Fitness Club is a student community focused on promoting physical and mental well-being through activities, advice, and support in various areas of health and fitness. To this end, I founded and was the club president until April 2023 when I stepped down as president to give the club younger leadership.

Apr 2022–Present — Peer Mentor

Physics and Mathematics Peer Mentor: Served as a peer mentor in the First Year Peer Mentoring Program at South Dakota Mines, guiding first-year students in acclimating to campus life, offering academic support, and fostering a sense of community through workshops and events.

Research References

Jingbo Wang, Ph.D	Assistant Professor of Physics, South Dakota Mines Research Supervisor and Course Instructor Jingbo.Wang@sdsmt.edu ‖ (605) 394-5206
Patrick Fox, Ph.D	Senior Scientist and Deputy Head, Theory Division, Fermilab Research Supervisor PJFox@fnal.gov ‖ (831) 359-7998
Brian Mong, Ph.D	Associate Scientist, SLAC National Accelerator Laboratory Research Supervisor bung@slac.stanford.edu ‖ (650) 926-5540
Patrick Fleming, Ph.D	Assistant Professor of Mathematics, South Dakota Mines Supervisor and Course Instructor Patrick.Fleming@sdsmt.edu ‖ (605) 394-2471
Richard Schnee, Ph.D	Professor and Head, Physics Department, South Dakota Mines Member of the Particle Physics Projects Prioritization Panel (P5) Research Supervisor Richard.Schnee@sdsmt.edu ‖ (605) 394-5206

Research Projects

Additional information about each project can be found at
Noah-Everett.github.io/Research

Aug 2023–Present

Using Convolutional Deep Learning Methods for Dynamic Graph Forecasting
Advisor: Randy Hoover, South Dakota Mines, Electrical Engineering and Computer Science Department
Contributions:

Jun 2023–Present

Using Direction Sensitive Photosenors for Detailed Track Reconstruction in Unsegmented Scintillation Detectors
Advisor: None (Independent Project)
Contributions:

- Created a detector simulation using Geant4 and NEST to predict performance for a fully configurable detector
- Created a analytical ray tracer for geometric lenses to design a preliminary lens system for the detector's direction sensitive photodetectors
- Developing traditional (likeihood-based) and deep learning event reconstruction methods to determine the optimal detector configurations along with the efficacy of the general detector design

Jun 2023–Aug 2023

Search for Dark Photon Decay Via $A' \to \ell^+\ell^-$ in SciBooNE and ANNIE
Advisor: Patrick Fox, Fermilab, Theory Department
Contributions:

- Calculated the expected number of events in SciBooNE's SciBar and ANNIE's water tank as a function of the kinetic mixing strength and mass
- Proposed reconstruction methods to tag dark photon decays in SciBooNE and ANNIE

May 2023–Present

Analytical Meridional, Non-Paraxial Ray Tracing
Advisor: None (Independent Project)
Contributions:

- Presented a method for meridional (2-dimensional), non-paraxial (non-small angle approximation) ray tracing
- Provided a Python simulation framework for sensitivity analysis of optical systems, reward function for reinforcement-based lens design, etc.

Aug 2022–Present

Likelihood-based Track Reconstruction for ANNIE
Advisor: Jingbo Wang, South Dakota Mines, Physics Department
Contributions:

- Developed a Geant4 simulation to produce data needed to predict detector response, including photon emission, stopping power (dE/dx), and photon transmission distance
- Developing charged lepton PMT and LAPPD detector response prediction for ANNIE

Dec 2021–Present

Feasibility Study For Neutrino-Argon Interaction Measurement in ANNIE
Advisor: Jingbo Wang, South Dakota Mines, Physics Department
Contributions:

- Restored ANNIE's simulation softwares including GENIE, WCSim (GEANT4-based detector simulation), and ANNIEDirt (GEANT4-based fast particle propagator) after their ∼5 year hiatus
- ANNIE software work including creating Docker images, bash scripts, documentation, and maintaining and contributing to ANNIE's simulation and analysis softwares
- Modified ANNIE's simulation softwares to accurately simulation proposed detector modifications
- Produced the entirety of the simulation results used for the study

Aug 2022–Present

Isomorphisms for Real Projective Plane Constructions
Advisor: Patrick Fleming, South Dakota Mines, Mathematics Department
Contributions:

- Found isomorphisms that map between the extended $\mathbb{R}^2$ plane, (hemi)sphere, and $\mathbb{R}^3$ vector space projective plane constructions
- Investigated the similarity of projective plane constructions to an idealized type of photosensor

Jun 2022–Aug 2022

Improving Radon Assay Data Analysis With Complete Decay History Fitting
Advisor: Brian Mong, SLAC Fundamental Physics Directorate
Contributions:

- Created a Monte Carlo simulation of electrostatic chamber radon assay systems
- Developed an analysis method to determine the initial populations of long-lived radioactive isotopes in assayed materials
- Helped assemble a new electrostatic chamber radon assay system

Jan 2021–Dec 2021

Environmental Monitoring System for Cleanrooms
Advisor: Richard Schnee, South Dakota Mines, Physics Department
Contributions:

- Developed an environmental monitoring system for the ultra-low radon cleanroom at South Dakota Mines (illustration here)
- Assisted with material assays for SuperCDMS and LUX-ZEPLIN
- Assisted in assembling the cleanroom tent for the new cold emanation system and started the commissioning of the system

Presentations and Publications
(Oral and Poster Presentations; Published and Unpublished Papers)

Oral Presentations

Apr 2023 **Everett, N.**, "Projective Planes and Exploring Their Application in Physics," George F. Duck Math Colloquium, Rapid City, SD

Apr 2023 **Everett, N.**, "Projective Planes and Exploring Their Application in Physics," MAA Rocky Mountain Section Meeting, Spearfish, SD

Apr 2023 **Everett, N.**, "Likelihood-Based Reconstruction Techniques in ANNIE," APS April Meeting, Neutrinos IV, Minneapolis, MN

Apr 2023 **Everett, N.**, "Likelihood-Based Reconstruction Techniques in ANNIE," South Dakota Mines' Student Research Symposium, Rapid City, SD

Feb 2023 **Everett, N.**, "Detector Response Prediction and Likelihood-Based Charged Lepton Reconstruction," ANNIE Collaboration Meeting, Batavia, IL

Feb 2023 Wang, J., **Everett, N.**, "Possibility of Measuring Neutrons from Neutrino-Argon Interactions in ANNIE," ANNIE Collaboration Meeting, Batavia, IL

Dec 2022 **Everett, N.**, "Finding Projective Plane Isomorphisms and Exploring Their Applications in Particle Physics Detectors," Fall 2022 Math Research Symposium, Rapid City

Dec 2022 **Everett, N.**, "Likelihood Based Secondary Lepton Reconstruction for ANNIE," Fall 2022 Physics Experimental Design Research Symposium, Rapid City, SD

Aug 2022 **Everett, N.**, "Radon Assay for nEXO," SLAC SULI Presentation Seminar, Menlo Park, CA

Poster Presentations

Aug 2023 **Everett, N.**, Fox, P., "Search For Dark Photons Via $A' \to \ell^+\ell^-$ in SciBooNE and ANNIE," 2023 Fermilab SULI Poster Session, Batavia IL

Oct 2022 **Everett, N.**, Mong, B., "Improving Radon Assays for Ultra Sensitive Experiments," 2022 APS Prairie Section Meeting, Sioux Falls, SD

Oct 2022 **Everett, N.**, Wang, J., "Feasibility Study of ν-Ar Interaction Measurement in ANNIE," 2022 Physics Congress, Washington, DC

Jul 2022 **Everett, N.**, Mong, B., "Radon Emanation for nEXO," Stanford Physics, Identity, and Equity Workshop (SPIEW), Stanford, CA

Apr 2022 **Everett, N.**, Wang, J., "Feasibility Study For Neutrino-Argon Interaction Measurement in ANNIE," South Dakota Mines' Student Research Symposium, Rapid City, SD

Unpublished Notes

1. **Everett, N.**, P. Fox, "Illuminating Excluded Dark Photon Parameter Space With SciBooNE," 2023 Aug 11
2. **Everett, N.**, "Analytical Meridional, Non-Paraxial Ray Tracing," Aug 2023
3. **Everett N.**, "Likelihood-Based Charged Lepton Reconstruction for ANNIE," 2023 Jan 20
4. **Everett N.**, "Improving Radon Assay Data Analysis With Complete Decay History Fitting," 2022 Aug 26

Published Papers

1. **Everett, N.**, "Using Direction Sensitive Photosenors for Detailed Topological Reconstruction in Unsegmented Scintillation Detectors Without Drift Field," Oct 2023 (tentative)

2. **Everett, N.**, Wang, J., Lemmons, F., "Feasibility Study of Neutrino-Argon Measurement in ANNIE," Oct 2023 (tentative)

3. **Everett, N.**, Fleming, P., "On Real Projective Plane Constructions and Their Isomorphisms," Sep 2023 (tentative)