

*Curriculum Vitae*  
NOAH EVERETT  
September 2023

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TABLE OF CONTENTS

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ADDITIONAL INFORMATION

Research Summary .....	1	NoahEverett898@gmail.com ✉
Education .....	1	(507) 215-3209 ☎
Research Appointments .....	1	
Honors and Awards .....	2	<a href="https://linkedin.com/in/Noah-Everett">https://linkedin.com/in/Noah-Everett</a> in
Scientific Collaborations .....	4	<a href="https://github.com/Noah-Everett">https://github.com/Noah-Everett</a> GitHub
Grants .....	4	<a href="https://Noah-Everett.github.io">https://Noah-Everett.github.io</a> 🌐
Professional Service and Leadership .....	4	
Research References .....	5	
Research Projects .....	6	
Presentations and Publications .....	8	

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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.

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EDUCATION

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

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Aug 2023–Present	Undergraduate Research Assistant, South Dakota Mines <i>PI:</i> Dr. Randy Hoover, Computer Science Department <i>Contributions:</i> <ul style="list-style-type: none"><li>• (additional information)</li></ul>
Jun 2023–Aug 2023	DOE SULI Intern, Fermi National Accelerator Laboratory <i>PI:</i> Dr. Patrick Fox, Theory Department <i>Contributions:</i> <ul style="list-style-type: none"><li>• Investigated the feasibility of using SciBooNE to search for dark photons through visible decay channels (additional information)</li><li>• Unofficially attended the International Symposium on Lattice Field Theory (Lattice 2023) and the 14th International Neutrino Summer School 2023</li></ul>

- 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 construction, (hemi)sphere, and  $\mathbb{R}^3$  vector space (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  $\sim 5$  year hiatus
  - ANNIE software work 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

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Aug 2023	Member of the ANNIE Collaboration <i>Context:</i> First and only undergraduate collaboration member
Apr 2023	APS Division of Particles and Fields Travel Grant for April Meeting <i>Context:</i> Gave a talk in the Neutrinos IV (non-undergraduate) session
Mar 2023	Outstanding Physics Junior <i>Context:</i> 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 <i>Context:</i> 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

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2023–Present	Accelerator Neutrino Neutron Interaction Experiment (ANNIE) <i>Member:</i> 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.
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## GRANTS

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## PROFESSIONAL SERVICE AND LEADERSHIP

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May 2023–Present	Physics Departmental Action Team <i>Member:</i> One of three undergraduate members selected by the physics department.
Apr 2023–Present	Society of Physics Students (SPS) National Council <i>Assistant Zone Councilor (AZC):</i> I am the zone 11 (which includes MN, SD, ND, NE, and IA) AZC which 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.
Apr 2022–Aug 2023	South Dakota Mines' Society of Physics Students Chapter <i>Vice President</i>
Feb 2022–Present	Health and Fitness Club <i>Founder, President (Feb 2022–Apr 2023), and Vice President (Apr 2023–Present):</i> 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.
Apr 2022–Present	Peer Mentor <i>Physics and Mathematics Peer Mentor:</i> 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

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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

More information about each project can be found at [Noah-Everett.github.io/Research](https://Noah-Everett.github.io/Research)

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Aug 2023–Present	Machine Learning-based Tensor Time Series Forecasting <i>Advisor:</i> Randy Hoover, South Dakota Mines, Electrical Engineering and Computer Science Department <i>Contributions:</i>
Jun 2023–Present	Using Direction Sensitive Photosensors for Detailed Track Reconstruction in Unsegmented Scintillation Detectors <i>Contributions:</i> <ul style="list-style-type: none"><li>• Created a detector simulation using GEANT4 and NEST to predict performance for <math>\sim 4</math> tonne liquid xenon detector</li><li>• Created an analytical ray tracer for geometric lenses to design a preliminary lens system for the detector</li></ul>
Jun 2023–Aug 2023	Search for Dark Photon Decay Via $A' \rightarrow \ell^+ \ell^-$ in SciBooNE and ANNIE <i>Advisor:</i> Patrick Fox, Fermilab, Theory Department <i>Contributions:</i> <ul style="list-style-type: none"><li>• 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</li><li>• Proposed reconstruction methods to tag <math>A'</math> decays in SciBooNE and ANNIE</li></ul>
May 2023–Present	Analytical Meridional, Non-Paraxial Ray Tracing <i>Contributions:</i> <ul style="list-style-type: none"><li>• Presented a method for meridional (2-dimensional), non-paraxial (non-small angle approximation) ray tracing</li><li>• Provided a Python simulation framework for sensitivity analysis of optical systems, reward function for reinforcement-based lens design, etc.</li></ul>
Aug 2022–Present	Likelihood-based Track Reconstruction for ANNIE <i>Advisor:</i> Jingbo Wang, South Dakota Mines, Physics Department <i>Contributions:</i> <ul style="list-style-type: none"><li>• Developed a GEANT4 simulation to produce data needed to predict detector response, including photon emission, stopping power (<math>dE/dx</math>), and photon transmission distance</li><li>• Developing charged lepton PMT and LAPPD detector response prediction for ANNIE</li></ul>
Dec 2021–Present	Feasibility Study For Neutrino-Argon Interaction Measurement in ANNIE <i>Advisor:</i> Jingbo Wang, South Dakota Mines, Physics Department <i>Contributions:</i> <ul style="list-style-type: none"><li>• Restored ANNIE’s simulation softwares including GENIE, WCSim (GEANT4-based detector simulation), and ANNIEDirt (GEANT4-based fast particle propagator) after their <math>\sim 5</math> year hiatus</li><li>• ANNIE software work including creating Docker images, bash scripts, documentation, and maintaining and contributing to ANNIE’s simulation and analysis softwares</li><li>• Modified ANNIE’s simulation softwares to accurately simulate proposed detector modifications</li><li>• Produced the entirety of the simulation results used for the study</li></ul>

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- 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 construction, (hemi)sphere, and  $\mathbb{R}^3$  vector space
- 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

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- 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

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- Aug 2023 **Everett, N.**, Fox, P., “Search For Dark Photons Via  $A' \rightarrow \ell^+ \ell^-$  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  $\nu$ -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

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1. **Everett N.**, “Likelihood-Based Charged Lepton Reconstruction for ANNIE,” 2023 Jan 20
2. **Everett N.**, “Improving Radon Assay Data Analysis With Complete Decay History Fitting,” 2022 Aug 26



## PUBLISHED PAPERS

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1. **Everett, N.**, “Using Direction Sensitive Photosensors for Detailed Topological Reconstruction in Unsegmented Scintillation Detectors Without Drift Field,” Oct 2023
2. **Everett, N.**, Wang, J., Lemmons, F., “Feasibility Study of Neutrino-Argon Measurement in ANNIE,” Oct 2023
3. **Everett, N.**, Fleming, P., “On Real Projective Plane Constructions and Their Isomorphisms,” Sep 2023
4. **Everett, N.**, P. Fox, “Illuminating Excluded Dark Photon Parameter Space With Sci-BooNE,” 2023 Aug 11
5. **Everett, N.**, “Analytical Meridional, Non-Paraxial Ray Tracing,” Aug 2023