

*Curriculum Vitae*  
NOAH EVERETT  
October 2024

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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 Mines (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> 3.91/4.00
2024–Present	Harvard University <i>Ph.D.</i> Physics

RESEARCH APPOINTMENTS

(Additional information on individual projects can be found in the Research Projects Section and is hyperlinked by each project)

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>• Attended the International Symposium on Lattice Field Theory (Lattice 2023) and the 14<sup>th</sup> International Neutrino Summer School 2023</li></ul>
Aug 2022–Mar 2024	Undergraduate Research Assistant, South Dakota Mines <i>PI:</i> Dr. Patrick Fleming, Mathematics Department <i>Contributions:</i> <ul style="list-style-type: none"><li>• Found isomorphisms that map between the extended <math>\mathbb{R}^2</math> plane, (hemi)sphere, and <math>\mathbb{R}^3</math> vector space constructions of the real projective plane (additional information)</li><li>• Presented findings at Mathematical Association of America (MAA) Rocky Mountain Section 2023 meeting and a math department colloquium</li></ul>

- 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 American Physical Society (APS) Prairie Section 2022 meeting
- Dec 2021–Aug 2024 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 symposia 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 a new cold emanation system and started the commissioning of the system

## HONORS AND AWARDS

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- Apr 2024 National Science Foundation Graduate Research Fellowship Program  
*Context:* Proposed using ANNIE to study neutrino-argon interactions, specifically neutron multiplicity
- Mar 2024 Outstanding Physics Senior, South Dakota Mines  
*Context:* Awarded to 1-2 physics seniors chosen by the physics department faculty each year for outstanding academics and research.
- Feb 2024 Represented South Dakota Mines at the 2024 South Dakota Student Research Poster Session  
*Context:* Only student from South Dakota Mines to give a poster presentation at the South Dakota capitol to state legislatures. Each South Dakota university was able to have 1-2 students present research. There were 10 total presenters. I was nominated by the Physics Department.
- Nov 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, South Dakota Mines  
*Context:* Awarded to 1-2 physics juniors chosen by the physics department faculty each year for outstanding academics and research.
- Mar 2023 Leadership Award for The Society of Physics Students (SPS), South Dakota Board of Regents  
*Context:* Awarded to the South Dakota Mines' Society of Physics Students chapter for outstanding leadership and outreach during my vice presidency.
- Nov 2022 Private Dinner with Dr. Nigel Lockyer and Gov. Mike Rounds  
*Context:* I was 1 of 2 students (and the only undergraduate) that attended a private dinner with Dr. Nigel Lockyer (former director of Fermilab and TRIUMF), Gov. Mike Rounds (former Governor and current Senator of South Dakota), and other prominent community members. Students were invited by the physics associate department head.
- Apr 2022 Sigma Pi Sigma Honor Society  
*Context:* Nominated for induction by upper class Sigma Pi Sigma members.
- 2020–2024 Dean's List (all semesters)  
*Context:* Greater than 3.5 GPA each semester.

## SCIENTIFIC COLLABORATIONS

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Nov 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.

## PROFESSIONAL SERVICE AND LEADERSHIP

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May 2023–May 2024 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 1 of 3 undergraduate members selected by the physics department to be on the team.

Oct 2023–May 2024 APS Inclusion, Diversity, and Equity Alliance (APS-IDEA)  
*Member:* The APS Inclusion, Diversity, and Equity Alliance (APS-IDEA) is an APS Innovation Fund initiative with a mission of empowering the physics community to enact strategies for improving equity, diversity, and inclusion.

Apr 2023–May 2024 Society of Physics Students (SPS) and Sigma Pi Sigma (National Council) Associate Zone Councilor (AZC): I am AZC for Zone 11 (which spans MN, SD, ND, NE, and IA). I was elected to this position as a result of a Zone wide election. I manage correspondence between the SPS national branch and chapters in Zone 11, along with events and outreach activities across Zone 11.  
*Co-Chair of the Burnout Committee:* The burnout committee is tasked with discussing and implementing aid at the national level for students experiencing burnout which, according to a 2022 poll, was one of the most important issues facing physics students.

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, and lead meetings.

Feb 2022–May 2024 Health and Fitness Club  
*Founder, President (Feb 2022–Apr 2023), and Vice President (Apr 2023–May 2024):* 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 support the next generation of leadership.

Apr 2022–May 2024 Peer Mentor

*Physics and Mathematics Peer Mentor:* I serve 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 PROJECTS

(This section contains information about each of my research projects as opposed to research appointments as in the Research Appointments Section. Additional information about each project can be found at [Noah-Everett.github.io/Research.](https://Noah-Everett.github.io/Research/))

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|-------------------|--|
| Jun 2023–Present  | Feasibility Study for Using Direction Sensitive Photosensors for Detailed Track Reconstruction in Unsegmented Scintillation Detectors No Electric Drift Field<br><i>Advisor:</i> None (Independent Project)<br><i>Contributions:</i> <ul style="list-style-type: none"><li>• Created a fully configurable detector simulation using GEANT4 and NEST to predict detector performance</li><li>• Created an analytical ray tracer for geometric lenses to design a preliminary lens system for the detector’s direction sensitive photosensors</li><li>• Developed analysis methods to determine optimal detector configuration and sensitivity</li></ul> |
| Jun 2023–Aug 2023 | Search for Dark Photon Decay Via $A' \rightarrow \ell^+ \ell^-$ in SciBooNE and ANNIE<br><i>Advisor:</i> Patrick Fox, Fermilab, Theory Department<br><i>Contributions:</i> <ul style="list-style-type: none"><li>• Used Neutrino Simulations of the Booster Neutrino Beam to find the expected number of <math>A'</math> decays 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 dark photon decays in SciBooNE and ANNIE</li></ul>  |
| May 2023–Aug 2023 | Analytical Meridional, Non-Paraxial Ray Tracing<br><i>Advisor:</i> None (Independent Project)<br><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>• Developed a Python simulation framework for sensitivity analysis of optical systems, reward function for reinforcement-based lens design, and other uses</li></ul>  |
| Aug 2022–Aug 2024 | Likelihood-based Track Reconstruction for ANNIE<br><i>Advisor:</i> Jingbo Wang, South Dakota Mines, Physics Department<br><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, the first of its kind for LAPPDs</li></ul>   |
| Aug 2022–Mar 2024 | Isomorphisms for Real Projective Plane Constructions<br><i>Advisor:</i> Patrick Fleming, South Dakota Mines, Mathematics Department<br><i>Contributions:</i> <ul style="list-style-type: none"><li>• Found isomorphisms that map between the extended <math>\mathbb{R}^2</math> plane, (hemi)sphere, and <math>\mathbb{R}^3</math> vector space projective plane constructions</li><li>• Investigated the similarity of projective plane constructions to an idealized type of photosensor</li></ul>   |

- 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
- Dec 2021–Aug 2024 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 simulate proposed detector modifications
  - Produced the entirety of the simulation results used for the study
- 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; Papers and Unpublished Notes)

## PAPERS

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- 2024 ANNIE Collaboration, “Analysis Techniques for the Accelerator Neutrino Neutron Interaction Experiment”
- 2024 **Everett, N.**, Wang, J., Gardiner, S., et al., “Feasibility Study of Neutrino-Argon Measurement in ANNIE”
- Nov 2024 **Everett, N.**, “Using Direction Sensitive Photosensors for Detailed Topological Reconstruction in Unsegmented Scintillation Detectors Without Drift Field” (draft upon request)
- Mar 2024 **Everett, N.**, Fleming, P., “On Real Projective Plane Constructions and Their Isomorphisms”
- Oct 2023 **Everett, N.**, “Analytical Meridional, Non-Paraxial Ray Tracing”
- Aug 2023 **Everett, N.**, P. Fox, “Illuminating Excluded Dark Photon Parameter Space With SciBooNE”

## POSTER PRESENTATIONS

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- Feb 2024 **Everett, N.**, “Improving DUNE’s Results By Studying Neutrino-Argon Events With ANNIE,” 2024 South Dakota Student Research Poster Session, Pierre, SD
- 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



## ORAL PRESENTATIONS

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- Feb 2024 **Everett, N.**, “Using Direction-Sensitive Photosensors In Unsegmented Scintillation Detectors,” George A. Gamow Physics Colloquium Series, Rapid City, SD  
*(Invited)*
- Dec 2023 **Everett, N.**, “Using Direction Sensitive Photosensors for Detailed Track Reconstruction in Unsegmented Scintillation Detectors With No Electric Drift Field,” Fall 2023 Physics Advanced Design Research Symposium, Rapid City, SD
- Oct 2023 Wang, J., **Everett, N.**, “ANNIE Phase 3: Possible Argon Target Deployment,” ANNIE Collaboration Meeting, Batavia, IL
- Apr 2023 **Everett, N.**, “Finding Projective Plane Isomorphisms And Exploring Their Applications in Particle Physics Detectors,” George F. Duck Math Colloquium, Rapid City, SD
- Apr 2023 **Everett, N.**, “Finding Projective Plane Isomorphisms And Exploring Their Applications in Particle Physics Detectors,” 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, SD
- 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

## UNPUBLISHED NOTES

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