

# Christopher R. Barnes

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<b>Education</b>	<b>University of Michigan</b> Doctor of Philosophy, Physics Concentration: Neutrino Physics Advisor: Prof. Joshua Spitz Thesis Title: "First Muon Neutrino on Argon Cross Section Measurements with an Off-Axis Beam"	Ann Arbor, MI August 2021 GPA: 3.17/4.0
	<b>University of Notre Dame</b> Bachelor of Science Major: Physics Concentration: Advanced Physics Graduation Honors: Cum Laude	Notre Dame, IN May 2015 GPA: 3.72/4.0 Distinction: Honors
	<b>University College Dublin</b> Study Abroad Program	Dublin, Ireland Spring 2014 GPA: 3.93/4.0

## Work Experience

### **Accenture Federal Services (AFS) Center for Medicare and Medicaid Services (CMS) Account – Arlington, VA**

*Analytics Associate Manager*: February 2024 – Present

Supervisor: Kerianne Bertolino

- Currently serve as technical lead on project to build a retrieval augmented generation (RAG) system for medical plan management information, incorporating a chat completion tool, deep reasoning, and a recommendation system into the final product.
- Served as technical lead on project to predict adoption outcomes for medicines and medical services and summarize the application paperwork, incorporating LLMs for both tasks.
- Direct and validate the modeling work of team members.
- Lead project-wide effort to teach non-technical coworkers about current developments in artificial intelligence.

### **MITRE – McLean, VA**

*Senior Data Scientist*: August 2021 – February 2024

Supervisor: Dr. Lixia Song

- Constructed the data analysis framework for a lithium-ion battery design intended to operate in cold climates, focusing on the timing required to charge and discharge the teststand.
- Generated synthetic data for studying rare aviation events using transformer-based models.
- Built a discretized route network for using graph theory to study impacts of high traffic across National Airspace System at short timescales.
- Developed a NLP-based analysis for identifying delays from voice transcriptions of pilot and controller communications.
- Performed a historical data analysis to explore the impacts of airspace redesign on traffic capacity.

## Skills

- Python (Expert)
- Pandas (Expert)

- PySpark (Intermediate)
- TensorFlow (Intermediate)
- PyTorch (Intermediate)
- Machine Learning (Advanced)
- Data Visualization (Intermediate)
- Azure (Intermediate)
- AWS (Beginner)
- Git (Expert)
- C++ (Expert)
- SQL (Beginner)
- Project Management (Intermediate)

## Research Experience

### **Neutrino Analysis & Time Projection Chamber Studies – Ann Arbor, MI and Batavia, IL**

*Graduate Student:* February 2016 – July 2021

*Advisor:* Professor Joshua Spitz, Norman M. Leff Assistant Professor

- Analyzed a dataset of muon neutrino events for a differential cross section using personally developed calibration & reconstruction tools for thesis measurement.
- Performed studies on the differential cross section of a kaon-decay-at-rest (KDAR) muon neutrino for thesis measurement before analysis proved to be impractical.
- Built the data acquisition system (DAQ) for one of the photon detection systems of the Short Baseline Near Detector (SBND), a planned neutrino experiment at Fermilab.
- Carried out a novel study on the detection of Cherenkov light in an above-ground Liquid Argon Time Projection Chamber (LArTPC).
- Assisted in the technical development of a simulated sample that included data features.
- Calibrated the MicroBooNE LArTPC for the space charge effect, a sizeable systematic in every physics analysis on the experiment.
- Performed novel LArTPC studies on (1) using an external cosmic ray tagger (CRT) to reject cosmic ray backgrounds to neutrino interactions and (2) measuring the effects of Cherenkov light on optical reconstruction in MicroBooNE.
- Developed a new reconstruction technique for the tracking of cosmic ray muons passing through the MicroBooNE LArTPC that enabled multiple calibrations and cross-checks on the experiment.
- Performed cut-optimization studies for the selection of through-going cosmic ray muon tracks for studies of induced electric charge on the three TPC wire planes.
- Produced a reconstruction technique for the drift coordinate of a specific sample of through-going cosmic ray muons for the MicroBooNE collaboration.
- Configured and ran analysis of an argon sample from MicroBooNE using a universal gas analyzer in search of an unexpected element scintillating light in the LArTPC.

### **Visible Light Adaptive Optics Simulation Development – Notre Dame, IN**

*Research Assistant:* Fall 2014 – Spring 2015

*Advisor:* Professor Justin Crepp, Freimann Assistant Professor of Physics

- Reconstructed one-step and two-step propagation imaging from algorithms detailed in J.D. Schmidt, [Numerical Simulation of Optical Wave Propagation](#).
- Developed a mathematical method to accurately predict the phase shift of a refracted wave at a mirror according to earlier amplitude measurements of the wave.

### **Phase 2 Upgrade Simulations for the Compact Muon Solenoid – West Lafayette, IN**

*National Science Foundation Research Experience for Undergraduates Fellow:* Summer 2014

*Advisor:* Dr. Matthew Jones, Purdue University Department of Physics and Astronomy

- Built the correct release of the CMS software environment to run simulation using detector geometries that may be implemented during the Phase 2

Upgrades.

- Ran a collection of simulated particle events from an online repository within this configuration.
- Analyzed particle properties by generating histograms using ROOT and presented these findings in a final talk.

### **Compact Muon Solenoid Track Trigger Development – Notre Dame, IN**

*Research Assistant:* Fall 2012 – Spring 2013

*Undergraduate Leader:* Fall 2013

Advisors: Professor Kevin Lannon and Professor Michael Hildreth, University of Notre Dame Department of Physics

- Generated histograms measuring the tracker's performance to learn the structure of the algorithm and the intricacies of ROOT and Unix in Fall 2012.
- Rewrote the algorithm's functions that are responsible for matching the expected track of a particle, generally a muon, to the actual path of a simulated particle in Spring 2013.
- Assisted two newcomers to the project in learning how to use the enabling software for the algorithm while developing new methods of assigning tracks to a particle's trajectory based on its angle of incidence with one of the detector's layers in Fall 2013.

### **The Installation and Configuration of SHERPA – Waco, TX**

*National Science Foundation Research Experience for Undergraduates Fellow:* Summer 2013

Advisors: Dr. Jay Dittmann and Dr. Kenichi Hatakeyama, Baylor University Department of Physics

- Prepared a Monte Carlo event generator, Simulation of High-Energy Reactions of PArticles (SHERPA), to collect data for research and for use within further applications by the Baylor University Physics Department
- Created a histogram from SHERPA not before published that showed the rate of change of the cross section of jets with respect to missing transverse momentum for the  $Z + 3$  jets interaction
- Generated results that agreed well with histograms published by the creators of SHERPA, most notably with respect to the same quantities mentioned in the previous bullet for the  $Z + 2$  jets interaction

## **Academic Awards**

- Department of Energy Office of Science Graduate Research Fellow, Fall 2017 – Fall 2018
- University of Notre Dame Sigma Pi Sigma Physics Honors Society, Inducted Spring 2015
- University of Notre Dame Dean's List, Fall 2011, Fall 2013, Spring 2014
- National Merit Finalist, Spring 2011
- Dwight F. Davis Memorial Scholarship Winner, Spring 2011
- USTA Serves Scholarship Award Winner, Spring 2011
- Elks Merit Scholarship Award Winner, Spring 2011
- University of Notre Dame Club of Detroit Scholarship Recipient, Spring 2011

## **Publications**

- "First Muon Neutrino on Argon Cross Section Measurements With An Off-Axis Beam", Christopher Barnes, University of Michigan DeepBlue Document Database, Summer 2021.
- "Measurement of Space Charge Effects in the MicroBooNE LArTPC Using Cosmic Muons", P. Abratenko et al. [MicroBooNE Collaboration], *JINST* **15** P12037 (2020).
- "Ionization Electron Signal Processing in Single Phase LArTPCs II. Data/Simulation Comparison and Performance in MicroBooNE",

- C. Adams et al. [MicroBooNE Collaboration], *JINST* **13** P07007 (2018).
- “Predicting the Invisible Z Background in All-Hadronic Supersymmetry Searches Using SHERPA”, Christopher Barnes, University of Notre Dame Scientia Journal of Undergraduate Research, Volume 5, Spring 2014.

## Research Presentations

- MicroBooNE Experiment: *Collaboration Meeting, Spring 2021 (Oral Presentation)*: “NuMI NuMuCCInclusive Analysis: Results”
- MicroBooNE Experiment: *Collaboration Meeting, Fall 2020 (Oral Presentation)*: “NuMI NuMuCCInclusive Analysis”
- MicroBooNE Experiment: *Collaboration Meeting, Spring 2020 (Oral Presentation)*: “Selecting KDAR Muon Neutrino Events in NuMI Data”
- University of Michigan: *Physics Graduate Student Symposium, Summer 2019 (Oral Presentation)*: “The MicroBooNE Neutrino Experiment”
- University of Alberta: *Lake Louise Winter Institute, Winter 2019 (Oral Presentation)*: “Studying Single-Phase LArTPC Detectors With MicroBooNE”
- Fermilab Student and Postdoc Association: *New Perspectives Conference, Spring 2018 (Oral Presentation)*: “Studying Track Distortions From the Space Charge Effect At MicroBooNE”
- University of California, Berkeley: *Conference on the Intersections of Particle and Nuclear Physics, Spring 2018 (Oral Presentation)*: “Characterizing Single-Phase LArTPC Detector Performance With MicroBooNE”
- American Physical Society: *April Meeting, Spring 2018 (Oral Presentation)*: “Studying Track Distortions From the Space Charge Effect At MicroBooNE”
- MicroBooNE Experiment: *Collaboration Meeting, Fall 2017 (Oral Presentation)*: “Space Charge Measurements With Cosmic Data”
- MicroBooNE Experiment: *Deep Learning Internal Review, Fall 2017 (Oral Presentation)*: “Cosmic Ray Tagger: Improvement & Implementation of Flash Matching Module”
- MicroBooNE Experiment: *Collaboration Meeting, Summer 2017 (Oral Presentation)*: “Cosmic Space Charge Effect Calibration: Comparisons and New Calibration Results”
- MicroBooNE Experiment: *Deep Learning Internal Review, Summer 2017 (Oral Presentation)*: “Deep Learning Cosmic Ray Tagger: Progress and Updates”
- American Physical Society: *April Meeting, Winter 2017 (Oral Presentation)*: “Establishing a Pure Sample of Side-Piercing Through-Going Cosmic Ray Muons for LArTPC Calibration with MicroBooNE”
- MicroBooNE Experiment: *Collaboration Meeting, Summer 2016 (Oral Presentation)*: “Identifying Through-Going Cosmic Ray Muons in the MicroBooNE Time Projection Chamber”
- University of Notre Dame: *Talk Science Innovation Series, Spring 2015 (Oral Presentation)*: “Simulation Development for Equipment Upgrades and New Physics

Searches on CMS”

- Purdue University: *Research Experience for Undergraduates Final Presentations, Summer 2014* **(Oral Presentation)**: “Triggering on Higgs- $\rightarrow\tau\tau$  Events for the Phase 2 Upgrade to the Compact Muon Solenoid”
- University of Notre Dame: *Dublin Study Abroad Program Presentation, Spring 2014* **(Oral Presentation)**: “Have We Harnessed the Higgs? Physics of the Standard Model and Beyond”
- University of Nebraska - Lincoln: *Conference for Undergraduate Women in Physical Sciences, Fall 2013* **(Poster Presentation)**: “Predicting the Invisible Z Background in All-Hadronic Supersymmetry Searches Using SHERPA”
- University of Notre Dame: *Fall Undergraduate Research Fair, Fall 2013* **(Poster Presentation)**: “Predicting the Invisible Z Background in All-Hadronic Supersymmetry Searches Using SHERPA”
- Wayne State University: *WSU Physics Undergraduate Research Conference, Fall 2013* **(Poster Presentation)**: “Predicting the Invisible Z Background in All-Hadronic Supersymmetry Searches Using SHERPA”
- Baylor University: *CASPER Research Experience for Undergraduates Final Presentations, Summer 2013* **(Oral Presentation)**: “Predicting the Invisible Z Background in All-Hadronic Supersymmetry Searches Using SHERPA”
- University of Notre Dame: *College of Science – Joint Annual Meeting, Spring 2013* **(Poster Presentation)**: “Analyzing Potential Tracking Algorithms for the Track Trigger Upgrade to the Silicon Tracker of the Compact Muon Solenoid”

## Collaboration Positions Held

- MicroBooNE Young Coordinator, April 2020 – August 2020
- MicroBooNE Young Deputy Coordinator, February 2020 – April 2020
- MicroBooNE Software Release Manager, August 2017 – August 2019
- MicroBooNE Slow Monitoring Expert, January 2018 – Present

## Research Presentation Awards

- Best Poster Award: Conference for Undergraduate Women in Physical Sciences, University of Nebraska - Lincoln, Fall 2013
- 2<sup>nd</sup> Place, Best Poster Award: WSU Physics Undergraduate Research Conference, Wayne State University, Fall 2013

## Additional Activities

### University of Michigan Physics Graduate Council

*Entering Cohort of 2015 Member*: January 2016 – January 2017

- Assisted with the planning of social events for graduate students and faculty in the physics department.

- Work to enact measures to improve life for physics graduate students at Michigan.

### **University of Michigan Physics Graduate Student Symposium**

*Student Organizer:* May 2016 – August 2016

- Organized this lecture series, which serves the audience lunch beforehand and offers graduate students in physics and related fields the opportunity to present their research in a low-pressure environment, with four other graduate students.

### **Pure Michigan Talent Connect**

*University of Notre Dame Campus Liason:* Spring 2013 – Fall 2014

- Attempted to establish a chapter of this networking club, which promotes job opportunities and recreational activities in Michigan and the city of Detroit in particular, as Vice President.
- Attended a workshop to teach campus liasons how to introduce other students to the possibilities available to them in Michigan.

## **Teaching/Tutoring Experience**

### **Physics 236: Physics for the Life Sciences Laboratory II – Ann Arbor, MI**

*Instructor:* Winter 2021 – Spring 2021

*Course Director:* Dr. Dante Amidei

- Taught two sections of Electricity and Magnetism Lab to primarily College of Literature, Science, and the Arts students in the Winter 2021 and Spring 2021 Semesters.
- Held office hours to assist undergraduates in physics courses in learning basic concepts.

### **Hesed House – Aurora, IL**

*Volunteer:* Winter 2018 – Winter 2020 Supervisor: Hugo Saltijeral

- Volunteered once every two weeks to assist residents of this homeless shelter with daily activities.
- Unlocked residents' belongings, provided them with toiletries, and attended to the facility entrance.

### **Physics 241: Elementary Lab II – Ann Arbor,**

**MI** *Instructor:* Fall 2015 – Spring 2016

*Course Director:* Dr. Andrew Tomasch

- Taught two sections of Electricity and Magnetism Lab to primarily College of Engineering students in the Fall 2015 and Spring 2016 Semesters.
- Held office hours to assist undergraduates in physics courses in learning basic concepts.

### **Physics 20435: Physics C: Electricity and Magnetism – Notre Dame, IN**

*Tutor:* Fall 2013

*Instructor:* Professor Philippe Collon

- Met with students in this course one night a week to help them complete their homework.
- Assisted students in reviewing for their midterm and final examinations.

### **Separated Children Education Service – Dublin, Ireland**

*Volunteer Tutor:* Spring 2014 Supervisor:

Andrew Sexton

- Helped refugees seeking asylum in Ireland, high school and college students, sharpen their mathematics, English, and biology skills one night each week.

### **Greater Holy Temple Church of God in Christ – South Bend,**

**IN** *Volunteer Supervisor & Tutor:* Fall 2014 – Spring 2015

*Supervisor:* Starla Ross

- Tutored students aged 7-17 in all subjects weekly, but mainly science and math.
- Provided academic and personal guidance.
- Played sports with the students.

**Gesu Catholic Elementary School – Detroit, MI**

*Volunteer Supervisor & Tutor:* Fall 2010 – Spring 2011, Summer 2012

- Tutored sixth graders in all subjects weekly during my senior year of high school, Fall 2010 - Spring 2011.
- Supervised summer daycamp weekly by playing games and sports with preschool and Elementary school students the summer after my freshman year of college, Summer 2012

**Self-Employed – Royal Oak, MI**

*Tutor:* Summer 2011 and Summer 2012

- Provided middle school and younger high school students with help in algebra and geometry.
- Drilled older high school students on material present on the ACT and the SAT.

## Other Service Activities

**N Street Village**, Washington, DC, Fall 2024 - Present

**For Love of Children Afterschool Tutoring**, Washington, DC, Spring 2023

**Hesed House Homeless Shelter**, Aurora, IL, Winter 2018 – Winter 2020

**Appalachia Service Trip**, Charleston, WV, Fall 2012

**U of D Jesuit High School Service Trip**, Guatemala City, Guatemala, Summer 2010

References available upon request