Philip Velie

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Google Scholar

EDUCATION

Pennsylvania State University — State College, Pennsylvania
Ph.D. in Physics — Fall 2024-Present
Advisor: Jake Bourjaily

Heidelberg University — Heidelberg, Germany
Fulbright Study/Research Fellowship — 2023-2024 academic year

- Representation of Classical Groups — Spring 2024
- String Theory (In Math & Physics departments) — Fall 2023
- Transformers and Language Models for Physics Seminar — Fall 2023
- Machine Learning for Physicists — Fall 2023
- Twisted String Theory Seminar — Fall 2023

University of Virginia — Charlottesville, Virginia
Bachelor of Science degree in Physics with High Honors — Graduated in May 2023

- Topics in Mathematical Physics: Quantum Field Theory — Spring 2023
- Quantum Field Theory Methods in Condensed Matter Theory — Spring 2023
- Graduate Statistical Mechanics — Spring 2023
- Graduate Nuclear Theory — Spring 2022
- Graduate Quantum Field Theory I, II — Fall 2021-Spring 2022
- Graduate General Relativity I, II — Spring 2021 - Fall 2021
- Graduate Quantum Mechanics I, II — Fall 2020-Spring 2021
- Introduction to Differential Geometry — Fall 2020

North Carolina School of Science and Mathematics — Durham, North Carolina
High School Degree — Graduated in May 2019

PAPERS PUBLISHED AND IN PROGRESS

- **Deep Reinforcement Learning for Scattering Amplitudes**
  - Used deep reinforcement learning methods such as curriculum learning to analyze the structures of scattering amplitudes for N=4 Super Yang-Mills theory, to find more efficient means of conducting perturbation expansions in Quantum Field Theories
  - To be submitted for publication: Spring 2025
- **Jet Calibration with Uncertainty-Aware Precision Networks**
  - Application of deep neural networks for the use of calibrating the topological cell clusters in the ATLAS calorimeters. The goal of improve the calibration of the cluster energy to the true energy at low energies.
  - arXiv:2412.04370, To be published in Physical Review.
- **A Bijection for Tuples of Commuting Permutations and a Log-Concavity Conjecture**
  - We provide a new proof of an explicit formula for A(p, n, k) which is essentially due to Bryan and Fulman, in their work on orbifold higher equivariant Euler characteristics.
  - arXiv:2309.09407, Published in Research in Number Theory: https://doi.org/10.1007/s40993-024-00531-8
- **Parameterization of Quark and Gluon Generalized Parton Distributions in a Dynamical Framework**
  - Presented a parametrization of the chiral even generalized parton distributions, H, E, $\tilde{H}$, $\tilde{E}$, for the quark, antiquark, and gluon, in the perturbative QCD-parton framework.
  - arXiv:2101.01826, Published in Physical Review D: Phys. Rev. D 105, 056022

RESEARCH EXPERIENCE

INSTITUTE FOR GRAVITATIONAL AND THE COSMOS, PENNSLYVANIA STATE UNIVERSITY State College, PA
Graduate, Research Assistant: August 2024-Present
Professor Jacob Bourjaily

- Conducted research on the mathematical structures of scattering amplitudes in Quantum Field Theories. Used representation theory to help find better bases for solving Feynman integrals in arbitrary dimensions and for field theories with arbitrary symmetry groups. Applied both theoretical and machine learning techniques to study these phenomena from multiple perspectives.

INSTITUTE FOR THEORETICAL PHYSICS, UNIVERSITÄT HEIDELBERG Heidelberg, Germany
Graduate, Research Assistant: August 2023-July 2024
Professor Tilman Plehn

- Addressed the challenge of multi-dimensional correlated calibration of topological calorimeter-cell clusters (topo-clusters). Our Bayesian neural network (BNN) approach not only yields a continuous, unbinned calibration function that improves performance relative to the standard calibration but also provides single-cluster uncertainties. A boosted training of the BNN further improves the uncertainty estimate and the network precision in critical phase-space regions.

MANI L. BHAUMIK INSTITUTE, UNIVERSITY OF CALIFORNIA, LOS ANGELES Los Angeles, California
Undergraduate, Research Assistant: May 2022-April 2023
Professor Zhongbo Kang

- Used Color Glass Condensate Effective Theory to perform calculations on various processes including Double Photon Emission. Analytically calculated cross-sections of processes related to the future EIC. Used numerical methods to complete the Color Glass Condensate calculations. Used additional Effective Field Theory techniques including Non-Relativistic Quantum Chromodynamics to calculate quarkonium production with gluon emission at next-to-leading order.

CENTER FOR NUCLEAR FEMTOGRAPHY, UNIVERSITY OF VIRGINIA Charlottesville, Virginia
Undergraduate, Research Assistant: April 2019-May 2023
Professor Simonetta Liuti

- Performed research in the distribution of quarks inside of nucleons using Wigner Distributions and Machine Learning. Developed methods to parametrize Generalized Parton Distributions (GPDs) for both valence quarks and gluons inside protons. Used Fast Fourier Transform techniques to create spatial distributions from GPDs. Developed multilinear-interpolation methods to analyze and extrapolate large amounts of data. Performed analysis on GPD integrals to prove the finite limit of the $\tilde{E}$ as ζ approaches 0. Used various programming languages including C/C++ and Mathematica to perform numerical analysis on GPDs to extract relevant kinematics and GPD coefficients.

CONFERENCES, SEMINARS, AND INVITED TALKS

- **Transformers, Large Language Models and Physics Seminar** Oral Presentation, January 19, 2024
  - Applications of Transformers to Experimental and Theoretical Particle Physics
- **Workshop on Machine Learning and High Energy Physics** Oral Presentation, December 13-15, 2023
  - Jet Calibration with Uncertainty-Aware Precision Networks
- **Twisted String Theory Seminar** Oral Presentation, December 12, 2023
  - Nilpotent Varieties
- **Sigma Pi Sigma Research Symposium 2022** Oral Presentation, November 4, 2022
  - Using Color Glass Condensate to Calculate J/Psi Cross Sections
- **APS DNP 2022** Oral Presentation, October 27–30, 2022
  - Polarization observables for DVCS and TCS experiments
- **Physics Congress 2022** Poster Presentation, October 6-8, 2022
  - Polarization observables for DVCS and TCS experiments
- **Sigma Pi Sigma Research Symposium 2021** Poster Presentation, November 5, 2021

- Optimized Extraction of Generalized Parton Distributions from Deeply Virtual Compton Scattering
- **APS DNP 2021** Oral Presentation, October 11-14, 2021
  - Optimized Extraction of Generalized Parton Distributions from Deeply Virtual Compton Scattering
- **APS SESAPS 2021** Oral Presentation, November 18-20, 2021
  - Parameterization of Chiral Even Quark and Gluon Generalized Parton Distributions
- **Sigma Pi Sigma Research Symposium 2020** Poster Presentation, November 13, 2020
  - Parameterization of Chiral Even Quark and Gluon Generalized Parton Distributions
- **APS SESAPS 2020** Oral Presentation, November 5-6, 2020
  - Imaging the Nuclear Glue and Sea
- **APS DNP 2020** Oral Presentation, October 29–November 1, 2020
  - Imaging the Nuclear Glue and Sea
- **Sigma Pi Sigma Research Symposium 2019** Poster Presentation, November 8th, 2019
  - A Flexible Parametrization to Compute Chiral-Even Generalized Parton Distributions

AWARDS

Fulbright Study/Research Fellowship Universität Heidelberg, 2023-2024
Nationally competitive fellowship that funds travel and living expenses to perform research using novel machine learning techniques for particle physics at the Universität Heidelberg for the 2023-2024 academic year

Stephen Thornton Award in Physics Undergraduate Research University of Virginia, 2023
The annual award recognizes the most outstanding research project(s) completed by an undergraduate physics major at the University of Virginia.

Amplitude Summer School CERN, 2023
Physics summer school for graduate and postdoctoral students conducting research into the formal scattering amplitudes and their techniques.

Runner Up for National Outstanding Undergraduate Research Award 2022
Recognized as Runner-Up in the National Society of Physics Students Outstanding Undergraduate Research Award

TMD Winter School Acceptance Los Alamos National Laboratory, 2022
Physics school for graduate and postdoctoral students conducting research in QCD, collider physics, and hadron structure. I was the only undergraduate at the 2022 TMD Winter School

Peter Page Grant from the Serpentine Society University of Virginia, 2021
Demonstrated academic achievement, financial need, and commitment to bettering the LGBTQ+ community at UVA and Beyond

Mitchell Summer Grant University of Virginia, 2021-2022
The grant from the University of Virginia Physics Department to conduct physics research over the summer. Received twice, for Summer 2021 and Summer 2022

Sigma Pi Sigma Membership University of Virginia, 2020
Inducted into the National Honor Society for physics students

Access UVA Scholarship University of Virginia, 2020
Scholarship provided to high-achieving, low-income students to lower the financial barrier of attending the University of Virginia

QuestBridge Fellowship University of Virginia, 2019
Recognized as a National QuestBridge Scholar for the University of Virginia for being a high-achieving, low-income student

JOB EXPERIENCE

Pennsylvania State University **2024-2025 Academic Year**
- **Research Assistant**

- Worked with Professor Jacob Bourjaily on the mathematical structures of scattering amplitudes in Quantum Field Theories.
- **Teaching Assistant for PHYS212**
  - Worked as a teaching assistant for Introduction to Electrodynamics for the 2024-2025 academic year. Held recitation, oversaw laboratories, proctored laboratories, and graded homework for over 100 students.

Heidelberg University

- **Fulbright Research Assistant** **2023-2024 Academic Year**
  - Worked as a research assistant full-time for the 2023-2024 academic year. Performed research on Bayesian neural networks with direct application to ATLAS experimental data and future theoretical applications.

University of Virginia

- **PHYS8710 Graduate Nuclear Physics I Teaching Assistant** **Spring Semester 2023**
  - Taught several classes while the professor was absent. Lead a weekly journal club in tandem with the graduate students enrolled in the course. Assisted the professor in carrying out the course by grading all assignments on time. Held office hours to supplement the student's learning
- **PHYS2620 Modern Physics Teaching Assistant** **Spring Semester 2023**
  - Assisted the professor in carrying out the course by grading all assignments on time. Held office hours to supplement the student's learning
- **PHYS5720 Graduate Nuclear and Particle Physics Teaching Assistant** **Fall Semester 2022**
  - Assisted the professor in carrying out the course by grading all assignments promptly. Held office hours to supplement the student's learning
- **PHYS2660 Fundamentals of Scientific Computing Teaching Assistant** **Fall Semester 2022**
  - Assisted in the laboratory section by answering questions and guiding students through assignments. Graded student assignments on time
- **PHYS3660 Quantum Physics II Teacher Assistant** **Spring Semester 2022**
  - Assisted the professor in carrying out the course by grading all assignments on time. Held office hours to supplement the student's learning
- **PHYS7610 Quantum Theory I (Graduate Quantum Mechanics) Teaching Assistant** **Fall Semester 2021**
  - Assisted the professor in carrying out the course by grading all assignments promptly. Held office hours to supplement the student's learning

WORKSHOP ORGANIZING

QCD Evolution Workshop 2022 University of Virginia, 2022

- Assisted the organizing of the QCD Evolution Workshop 2022. Gathered the merchandise to be handed out to all of the attendees. Assisted with setting up and maintaining the presentation room.

LEADERSHIP

Society of Physics Students (SPS) University of Virginia

President *2022-2023*

Served as the head of the body of SPS presiding over all SPS gatherings. Planned, scheduled, and ran organizational meetings with the other SPS officers. Ensure that each Officer is performing their duties as per the description in the Constitution. Oversaw the support and inclusion of diversity-focused club start-ups such as the UVA NSBP chapter.

Vice President *2021-2022*

Planned and carried out weekly meetings including holding weekly colloquiums designed for undergraduate students. Assist the President of SPS and help create physics demonstrations.

Treasurer *2020- 2021*

Planned for the financial stability of SPS with the long-term goal of becoming able to help low-income students afford to take the GRE and/or the Physics GRE. Helped with physics demonstrations and weekly meetings.

Outreach Chair *2020-2021*

Helped develop videos of physics demonstrations to be used by Charlottesville High Schools as additional teaching material during the COVID-19 pandemic.

Out in STEM (OSTEM) University of Virginia

Financial Chair *2020-2022*

Plan for the financial stability of OSTEM in addition to reaching out to LGBTQ+-friendly companies for intellectual improvement. Plan for the financial aspect of activism events to improve the overall climate of the STEM fields.

COMMUNITY SERVICE

Physics Graduate Student Association (PGSA) +2 hours

Assisted with the coordination of events for the physics graduate students and the broader department at Pennsylvania State University.

PAW+ +2 hours

Assisted with the preparation and delivery of physics demonstrations aimed at primary students at local public schools in the surrounding State College area. Helped encourage the general interest in STEM subjects in primary students.

Meet Us through the Fulbright Commission +8 hours

Offered a personal look at social, historical, or cultural aspects of the United States and the interests and aspirations of Americans to a regional high school in Germany. The main goal is to generate an open and direct dialogue to better the connection between school students in Germany and America.

Society of Physics Students (SPS) at the University of Virginia +200 hours

Through my time at UVA, I coordinated, oversaw, and executed numerous physics demonstrations for multiple types of audiences including undergraduates and the general public. Notable events included UVA Physics Demo Day and the Charlottesville Discover Day.

Oakland Presbyterian Church and Scouts of America *+520 hours*

Carried out community service through various methods including serving as a busboy during monthly dinners and sound technician. Volunteered at local day camps and food pantries through the Scouts of America.