Garrett W. Merz

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Use-inspired AI/ML research driven by applications in physics & mathematics

Education

Ph.D., Physics | University of Michigan 2021

Thesis: *Precision Measurements of Higgs Boson Couplings in the Diphoton Decay Channel with Run-2 of the ATLAS Detector*
Advisor: Thomas Schwarz

M.S., Physics | University of Michigan 2018

B.S., Physics | The Ohio State University 2016

Thesis: *Novel Applications of Image-Processing Techniques to Particle Physics*
Advisor: Richard Hughes

B.S., Mathematics | The Ohio State University 2016

Experience

Postdoctoral Research Associate 2023-Present

University of Wisconsin-Madison Data Science Institute
Supervisor: Kyle Cranmer
AI for physics; physics for AI

- Small, domain-specific Transformer models for discrete symbolic problems in theoretical physics (Scattering amplitudes, Conformal Field Theory)
- Foundation Models for Science (self-supervised learning for hadronic jet physics, information-theoretic studies of transfer learning)

Machine Learning Scientist 2021-2023

Intelinair, Inc.
Computer vision research for sustainable agriculture

- Self-supervised hierarchical pretrained Vision Transformer for hyperspectral gigapixel remote-sensing imagery
- Crop growth state classification with noisy and missing labels. Transfer learning across optical sensor domains (satellite, aerial RGBN), synthetic data for seasonal domain shift mitigation

Graduate Research Assistant 2016-2021

University of Michigan, ATLAS experiment at CERN
Higgs boson and top quark physics at CERN's Large Hadron Collider

- First observation of rare top-associated Higgs production process (ttH)
- Measurement of degree of CP-violation in top-quark/Higgs coupling
- Searches for exotic beyond-standard model particles (leptoquarks, vector-like quarks)

Selected Publications

Cao, H., G. W. Merz, K. Cranmer, and G. Shiu (2026). "Reconstructing conformal field theoretical compositions with Transformers". In: **Machine Learning: Science and Technology (under review)**. arXiv: 2605.01072.

Cai, T., F. Charton, K. Cranmer, L. J. Dixon, G. W. Merz, and M. Wilhelm (Apr. 2025). "Recurrent features of amplitudes in planar N=4 super Yang-Mills theory". In: **Journal of High Energy Physics** 2025.4, p. 143. ISSN: 1029-8479. DOI: 10.1007/JHEP04(2025)143.

Hashmani, R. K., G. W. Merz, H. Qu, M. Pettee, and K. Cranmer (2025). **Multimodal Datasets with Controllable Mutual Information**. arXiv: 2510.21686. URL: https://arxiv.org/abs/2510.21686.

Rieck, P., K. Cranmer, E. Dreyer, E. Gross, N. Kakati, D. Kobylianskii, G. W. Merz, and N. Soybelman (Oct. 2025). "Self-supervised learning strategies for jet physics". In: **Machine Learning: Science and Technology** 6.4, p. 045015. DOI: 10.1088/2632-2153/ae1100.

Cai, T., G. W. Merz, F. Charton, N. Nolte, M. Wilhelm, K. Cranmer, and L. J. Dixon (Sept. 2024). "Transforming the bootstrap: using transformers to compute scattering amplitudes in planar super Yang–Mills theory". In: **Machine Learning: Science and Technology** 5.3, p. 035073. ISSN: 2632-2153. DOI: 10.1088/2632-2153/ad743e.

ATLAS Collaboration (July 2023a). "Measurement of the properties of Higgs boson production at $\sqrt{s} = 13TeV$ in the $H \to \gamma\gamma$ channel using $139fb^{-1}$ of pp collision data with the ATLAS experiment". In: **Journal of High Energy Physics** 2023.7. ISSN: 1029-8479. DOI: 10.1007/jhep07(2023)088.

— (Feb. 2023b). "Probing the CP nature of the top–Higgs Yukawa coupling in ttH and tH events with $H \to \gamma\gamma$ decays using the ATLAS detector at the LHC". In: **Physics Letters B** 849, p. 138469. ISSN: 0370-2693. DOI: 10.1016/j.physletb.2024.138469.

— (Aug. 2020a). "CP Properties of Higgs Boson Interactions with Top Quarks in the $t\bar{t}H$ and tH Processes Using $H \to \gamma\gamma$ with the ATLAS Detector". In: **Phys. Rev. Lett.** 125 (6), p. 061802. DOI: 10.1103/PhysRevLett.125.061802.

— (2020b). **Measurement of the properties of Higgs boson production at $\sqrt{s} = 13TeV$ in the $H \to \gamma\gamma$ channel using 139 fb^1 of pp collision data with the ATLAS experiment**. Tech. rep. Geneva: CERN. URL: https://cds.cern.ch/record/2725727.

— (June 2019). "Searches for third-generation scalar leptoquarks in $\sqrt{s} = 13TeVpp$ collisions with the ATLAS detector". In: **Journal of High Energy Physics** 2019.6. ISSN: 1029-8479. DOI: 10.1007/jhep06(2019)144.

— (Nov. 2018a). "Combination of the Searches for Pair-Produced Vectorlike Partners of the Third-Generation Quarks at $\sqrt{s} = 13TeV$ with the ATLAS Detector". In: **Physical Review Letters** 121.21. ISSN: 1079-7114. DOI: 10.1103/physrevlett.121.211801.

— (Sept. 2018b). "Measurements of Higgs boson properties in the diphoton decay channel with $36fb^1$ of pp collision data at $13TeV$ with the ATLAS detector". In: **Physical Review D** 98.5. ISSN: 2470-0029. DOI: 10.1103/physrevd.98.052005.

— (Sept. 2018c). "Observation of Higgs boson production in association with a top quark pair at the LHC with the ATLAS detector". In: **Physics Letters B** 784, pp. 173–191. ISSN: 0370-2693. DOI: 10.1016/j.physletb.2018.07.035.

— (Nov. 2018d). "Search for pair production of heavy vectorlike quarks decaying into hadronic final states in pp collisions at $\sqrt{(}s) = 13TeV$ with the ATLAS detector". In: **Physical Review D** 98.9. ISSN: 2470-0029. DOI: 10.1103/physrevd.98.092005.

Selected Publications, Continued

Hashmani, R. K., G. W. Merz, H. Qu, M. Pettee, and K. Cranmer (2026). "Multimodal Datasets with Controllable Mutual Information". In: **ICLR 2026 Workshop on Foundation Models for Science. Rio de Janeiro, Brazil**.

Cao, H., G. W. Merz, G. Shiu, and K. Cranmer (2025). "Reconstructing Conformal Field Theoretical Composition with Transformers". In: **NeurIPS 2025 Workshop on Machine Learning in the Physical Sciences. San Diego, California**.

— (2024). "Learning Conformal Field Theory With Symbolic Regression: Recovering the Energy Spectrum". In: **NeurIPS 2024 Workshop on Machine Learning in the Physical Sciences. Vancouver, Canada.**

Jablonka, K. M. et al. (2023). "14 examples of how LLMs can transform materials science and chemistry: a reflection on a large language model hackathon". In: **Digital Discovery** 2.5, pp. 1233–1250. ISSN: 2635-098X. DOI: 10.1039/d3dd00113j.

Merz, G. W., T. Cai, F. Charton, N. Nolte, M. Wilhelm, K. Cranmer, and L. J. Dixon (2023). "Transformers for Scattering Amplitudes". In: **NeurIPS 2023 Workshop on Machine Learning in the Physical Sciences. New Orleans, LA.**

Awards & Honors

2018 National Science Foundation Graduate Research Fellowship

2017 Norman Barnett Award

2015 Staninovski Mathematics Scholarship

2013 Hellen Cowan Book Award

2012 Valentino Physics Scholarship

2012 Honors Medalist Scholarship

Service & Leadership

2025, 2026 Organizing Committee, NeurIPS Machine Learning for the Physical Sciences Workshop

2025 Area Chair, NeurIPS Machine Learning for the Physical Sciences Workshop

2025-Present American Physical Society Group on Data Science (APS-GDS): Industry Advisory Board

2023-2026 American Physical Society Group on Data Science: Executive Committee, Early-Career Member at Large

August 2025 32nd International Symposium on Lepton Photon Interactions at High Energies: Computing AI/ML Session Co-Chair

Ongoing Reviews for:

- Journal of High-Energy Physics (JHEP)
- Machine Learning: Science and Technology (MLST)
- Conference on Physics and AI (PAI)
- Physica Scripta
- Journal of Open Source Software (JOSS)
- NeurIPS Machine Learning for the Physical Sciences Workshop
- CVPR Agriculture-Vision Workshop

Teaching & Science Communication

2025,2026 Precollege Enrichment Opportunity Program for Learning Excellence (PEOPLE): AI + Physics Section Lead

2016-2021 University of Michigan Center for Academic Innovation VR/XR Grant Pilot Program

2018 University of Michigan Museum of Natural History Science Communication Fellow

2016-2017 Graduate Student Instructor, University of Michigan Dept. of Physics

Physics 136 Life Sciences Lab I (Autumn 2016, Spring 2016, Autumn 2017)

Talks & Posters

Invited talks are indicated in **bold**.

Self-Supervised Learning, Mutual Information, and Massively Multimodal Models. SLAC Theory Group Seminar. 19 Jan 2026.

Self-Supervised Learning Strategies for High-energy Physics. 32nd International Symposium on Lepton Photon Interactions at High Energies. 28 Aug 2025. Talk.

Transformers for Scattering Amplitudes. IAIFI Summer Workshop 2024. 14 Aug 2024. Poster.

Transformers for Scattering Amplitudes. SLAC AI Seminar. 1 February 2024 (Virtual)

Transforming the Bootstrap: Transformers for Scattering Amplitudes. ORIGINS Data Science Lab Seminar. 19 April 2024. Munich, Germany (Virtual).

Rieck, Patrick; Dreyer, Etienne; Kakati, Nilotpal; Kobylianskii, Dmitrii; Merz, Garrett; Soybelman, Nathalie; Cranmer, Kyle; Gross, Eilam. Generic Representations of Jets at Detector-Level with Self-Supervised Learning. European AI for Fundamental Physics Conference 2024. Amsterdam, NL. 30 April to 3 May 2024.

Rieck, Patrick; Dreyer, Etienne; Kakati, Nilotpal; Kobylianskii, Dmitrii; Merz, Garrett; Soybelman, Nathalie; Cranmer, Kyle; Gross, Eilam. Generic Representations of Jets at Detector-Level with Self-Supervised Learning. 22nd International Workshop on Advanced Computing and Analysis Techniques in Physics Research. 11 March-15 March 2024.

Transformers for Scattering Amplitudes. Hammers and Nails, Ascona, Switzerland. https://indico.cern.ch/event/1202995/. 1 November 2023.

Transformers for Scattering Amplitudes. University of Wisconsin-Madison Postdoctoral Research Symposium. 20 September 2023.

Full Run-2 H→ Couplings Measurement. 2020 Higgs Workshop Plenary Meeting. 19 November 2020. CERN (Virtual).

Measuring the CP Properties of a Neutral Higgs with ttH→ in in pp Collisions at s= 13 TeV with the ATLAS Detector. ATLAS HTOP 2020 Workshop. 25 March 2020. CERN (Virtual).

Measuring the CP Properties of a Neutral Higgs with ttH→ in in pp Collisions at s= 13 TeV with the ATLAS Detector. 2019 USATLAS Collaboration Meeting. Aug 6, 2019- Aug 11, 2019. Amherst, MA.

Saturday Morning Physics: Update on Physics from the LHC. University of Michigan Department of Physics, 30 March 2019.

Students Mentored

Raheem Hashmani: Graduate student at University of Wisconsin-Madison.

- With Kyle Cranmer and Mariel Pettee, study Foundation Models through an information-theoretic lens using flow-matching generative models

Chris (Haotian) Cao: Graduate student at University of Wisconsin-Madison

- With Kyle Cranmer and Gary Shiu, explore symbolic regression methods for calculating high-energy limiting behavior of conformal field theories (CFTs)

Noah Zipper: Undergraduate student at University of Michigan. Currently a PhD student at CU boulder in the CMS group.

- Adapt Kinematic Likelihood Fitter (KLFitter) framework for use in ATLAS $H \to \gamma\gamma$ analyses

Sabrina Corsetti: Undergraduate student at University of Michigan. Currently a PhD student at MIT in the Notaros Group.

- Develop gradient boosted decision trees in XGBoost for ATLAS ttH CP measurement

Thomas Sandell: Undergraduate student at University of Michigan. Currently a Software Engineer at Patreon.

- Develop ATLASRift VR software for UMich VR/XR project