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Marietta Blau Institute for Particle Physics (MBI Vienna, fka: Institute of High-Energy Physics (HEPHY)), Austrian Academy of Sciences (ÖAW), Dominikanerbastei 16, 1010 Vienna, Austria

Research Interests

I am interested in fundamental questions about nature—such as the underlying mechanism of electroweak symmetry breaking, the observed baryon-antibaryon asymmetry, and the possible unification of forces. I develop machine learning methods to advance high-energy physics and address these questions. Recent work includes generative models for more efficient simulations (e.g. in the MadNIS framework or as organizer of the CaloChallenge), model-independent searches for new physics (e.g. the anomaly detection algorithm CATHODE), and simulation-based inference to maximize the information gain from experimental data (e.g. by winning the FAIR Universe Higgs Uncertaingy Challenge).

Research Experience and Academic Positions

10/2023 – · · · ·	**Group Leader (tenure track),** Marietta Blau Institute for Particle Physics (MBI Vienna), Austrian Academy of Sciences (ÖAW), Vienna, Austria.
10/2022 – 9/2023	**ITP Fellow (Senior Postdoc),** Institute for Theoretical Physics, University of Heidelberg, Heidelberg, Germany.
10/2020 – 9/2022	**Postdoctoral Associate,** Department of Physics and Astronomy, Rutgers University, Piscataway, USA.
3/2018 – 9/2020	**Feodor Lynen Research Fellow of the Alexander von Humboldt Foundation,** Theory Department, Fermi National Accelerator Laboratory (Fermilab), Chicago, USA.
11/2016 – 2/2018	**Postdoctoral Researcher,** Instituto de Física Corpuscular (IFIC), Valencia, Spain.
9/2013 – 10/2016	**Scientific Assistant / Doctoral Student,** (50%) Arnold Sommerfeld Center, Ludwig Maximilian University, Munich, Germany.

Education

September 15, 2016	**Dr.rer.nat in Physics, Ludwig Maximilian University Munich**. Thesis title: *Higgs Effective Field Theories — Systematics & Applications*. Supervisor: Prof. Dr. G. Buchalla. Grade: magna cum laude
Summer 2013	**M.Sc. Physics, Ludwig Maximilian University, Munich**. Thesis title: *An effective field theory for electroweak symmetry breaking including a light Higgs*. Supervisor: Prof. Dr. G. Buchalla. Grade: 1,0
Summer 2010	**B.Sc. Physics, Brandenburg Technical University, Cottbus**. Thesis title: *The impact of different Monte Carlo models on the cross section measurement of top-pair production at 7-TeV proton-proton collisions*. Supervisor: Prof. Dr. W. Lohmann. Grade: 1,1

Research Publications

Peer-reviewed Journal Articles

1. L. Benato, C. Giordano, **C. Krause**, A. Li, R. Schöfbeck, D. Schwarz, M. Shooshtari, and D. Wang, "Unbinned inclusive cross-section measurements with machine-learned systematic uncertainties," *Phys. Rev. D*, vol. 112, no. 5, p. 052 006, 2025. DOI: 10.1103/zwzt-1rrw. arXiv: 2505.05544 [hep-ph].

2 H. Du, **C. Krause**, V. Mikuni, B. Nachman, I. Pang, and D. Shih, "Unifying simulation and inference with normalizing flows," *Phys. Rev. D*, vol. 111, no. 7, p. 076 004, 2025. DOI: 10.1103/PhysRevD.111.076004. arXiv: 2404.18992 [hep-ph].

3 F. Ernst, L. Favaro, **C. Krause**, T. Plehn, and D. Shih, "Normalizing Flows for High-Dimensional Detector Simulations," *SciPost Phys.*, vol. 18, p. 081, 2025. DOI: 10.21468/SciPostPhys.18.3.081. arXiv: 2312.09290 [hep-ph].

4 **C. Krause** *et al.*, "CaloChallenge 2022: A Community Challenge for Fast Calorimeter Simulation," *Rept. Prog. Phys.*, vol. 88, no. 11, **C. Krause**, M. Faucci Giannelli, G. Kasieczka, B. Nachman, D. Salamani, D. Shih, and A. Zaborowska, Eds., p. 116 201, 2025. DOI: 10.1088/1361-6633/ae1304. arXiv: 2410.21611 [physics.ins-det].

5 L. Benato *et al.*, "FAIR Universe HiggsML Uncertainty Dataset and Competition," in *Conference on Neural Information Processing*, Oct. 2024. arXiv: 2410.02867 [hep-ph].

6 G. Bickendorf, M. Drees, G. Kasieczka, **C. Krause**, and D. Shih, "Combining resonant and tail-based anomaly detection," *Phys. Rev. D*, vol. 109, no. 9, p. 096 031, 2024. DOI: 10.1103/PhysRevD.109.096031. arXiv: 2309.12918 [hep-ph].

7 M. R. Buckley, **C. Krause**, I. Pang, and D. Shih, "Inductive simulation of calorimeter showers with normalizing flows," *Phys. Rev. D*, vol. 109, no. 3, p. 033 006, 2024. DOI: 10.1103/PhysRevD.109.033006. arXiv: 2305.11934 [physics.ins-det].

8 T. Buss, F. Gaede, G. Kasieczka, **C. Krause**, and D. Shih, "Convolutional L2LFlows: generating accurate showers in highly granular calorimeters using convolutional normalizing flows," *JINST*, vol. 19, no. 09, P09003, 2024. DOI: 10.1088/1748-0221/19/09/P09003. arXiv: 2405.20407 [physics.ins-det].

9 R. Das, L. Favaro, T. Heimel, **C. Krause**, T. Plehn, and D. Shih, "How to understand limitations of generative networks," *SciPost Phys.*, vol. 16, no. 1, p. 031, 2024. DOI: 10.21468/SciPostPhys.16.1.031. arXiv: 2305.16774 [hep-ph].

10 T. Golling, G. Kasieczka, **C. Krause**, R. Mastandrea, B. Nachman, J. A. Raine, D. Sengupta, D. Shih, and M. Sommerhalder, "The interplay of machine learning-based resonant anomaly detection methods," *Eur. Phys. J. C*, vol. 84, no. 3, p. 241, 2024. DOI: 10.1140/epjc/s10052-024-12607-x. arXiv: 2307.11157 [hep-ph].

11 B. Hashemi and **C. Krause**, "Deep generative models for detector signature simulation: A taxonomic review," *Rev. Phys.*, vol. 12, p. 100 092, 2024. DOI: 10.1016/j.revip.2024.100092. arXiv: 2312.09597 [physics.ins-det].

12 **C. Krause**, B. Nachman, I. Pang, D. Shih, and Y. Zhu, "Anomaly detection with flow-based fast calorimeter simulators," *Phys. Rev. D*, vol. 110, no. 3, p. 035 036, 2024. DOI: 10.1103/PhysRevD.110.035036. arXiv: 2312.11618 [hep-ph].

13 **C. Krause**, I. Pang, and D. Shih, "CaloFlow for CaloChallenge dataset 1," *SciPost Phys.*, vol. 16, no. 5, p. 126, 2024. DOI: 10.21468/SciPostPhys.16.5.126. arXiv: 2210.14245 [physics.ins-det].

14 S. Diefenbacher, E. Eren, F. Gaede, G. Kasieczka, **C. Krause**, I. Shekhzadeh, and D. Shih, "L2LFlows: generating high-fidelity 3D calorimeter images," *JINST*, vol. 18, no. 10, P10017, 2023. DOI: 10.1088/1748-0221/18/10/P10017. arXiv: 2302.11594 [physics.ins-det].

15 T. Heimel, R. Winterhalder, A. Butter, J. Isaacson, **C. Krause**, F. Maltoni, O. Mattelaer, and T. Plehn, "MadNIS - Neural multi-channel importance sampling," *SciPost Phys.*, vol. 15, no. 4, p. 141, 2023. DOI: 10.21468/SciPostPhys.15.4.141. arXiv: 2212.06172 [hep-ph].

16 **C. Krause** and D. Shih, "Accelerating accurate simulations of calorimeter showers with normalizing flows and probability density distillation," *Phys. Rev. D*, vol. 107, no. 11, p. 113 004, 2023. DOI: 10.1103/PhysRevD.107.113004. arXiv: 2110.11377 [physics.ins-det].

17 **C. Krause** and D. Shih, "Fast and accurate simulations of calorimeter showers with normalizing flows," *Phys. Rev. D*, vol. 107, no. 11, p. 113 003, 2023. DOI: 10.1103/PhysRevD.107.113003. arXiv: 2106.05285 [physics.ins-det].

18 A. Hallin, J. Isaacson, G. Kasieczka, **C. Krause**, B. Nachman, T. Quadfasel, M. Schlaffer, D. Shih, and M. Sommerhalder, "Classifying anomalies through outer density estimation," *Phys. Rev. D*, vol. 106, no. 5, p. 055 006, 2022. DOI: 10.1103/PhysRevD.106.055006. arXiv: 2109.00546 [hep-ph].

19 G. Buchalla, O. Catà, A. Celis, M. Knecht, and **C. Krause**, "Higgs-electroweak chiral Lagrangian: One-loop renormalization group equations," *Phys. Rev. D*, vol. 104, no. 7, p. 076 005, 2021. DOI: 10.1103/PhysRevD.104.076005. arXiv: 2004.11348 [hep-ph].

20 M. Carena, **C. Krause**, Z. Liu, and Y. Wang, "New approach to electroweak symmetry nonrestoration," *Phys. Rev. D*, vol. 104, no. 5, p. 055 016, 2021. DOI: 10.1103/PhysRevD.104.055016. arXiv: 2104.00638 [hep-ph].

21 C. Gao, S. Höche, J. Isaacson, **C. Krause**, and H. Schulz, "Event Generation with Normalizing Flows," *Phys. Rev. D*, vol. 101, no. 7, p. 076 002, 2020. DOI: 10.1103/PhysRevD.101.076002. arXiv: 2001.10028 [hep-ph].

22 C. Gao, J. Isaacson, and **C. Krause**, "i-flow: High-dimensional Integration and Sampling with Normalizing Flows," *Mach. Learn. Sci. Tech.*, vol. 1, no. 4, p. 045 023, 2020. DOI: 10.1088/2632-2153/abab62. arXiv: 2001.05486 [physics.comp-ph].

23 **C. Krause**, A. Pich, I. Rosell, J. Santos, and J. J. Sanz-Cillero, "Colorful Imprints of Heavy States in the Electroweak Effective Theory," *JHEP*, vol. 05, p. 092, 2019. DOI: 10.1007/JHEP05(2019)092. arXiv: 1810.10544 [hep-ph].

24 J. de Blas, O. Eberhardt, and **C. Krause**, "Current and Future Constraints on Higgs Couplings in the Nonlinear Effective Theory," *JHEP*, vol. 07, p. 048, 2018. DOI: 10.1007/JHEP07(2018)048. arXiv: 1803.00939 [hep-ph].

25 G. Buchalla, O. Cata, A. Celis, M. Knecht, and **C. Krause**, "Complete One-Loop Renormalization of the Higgs-Electroweak Chiral Lagrangian," *Nucl. Phys. B*, vol. 928, pp. 93–106, 2018. DOI: 10.1016/j.nuclphysb.2018.01.009. arXiv: 1710.06412 [hep-ph].

26 M. Chala, **C. Krause**, and G. Nardini, "Signals of the electroweak phase transition at colliders and gravitational wave observatories," *JHEP*, vol. 07, p. 062, 2018. DOI: 10.1007/JHEP07(2018)062. arXiv: 1802.02168 [hep-ph].

27 G. Buchalla, O. Cata, A. Celis, and **C. Krause**, "Standard Model Extended by a Heavy Singlet: Linear vs. Nonlinear EFT," *Nucl. Phys. B*, vol. 917, pp. 209–233, 2017. DOI: 10.1016/j.nuclphysb.2017.02.006. arXiv: 1608.03564 [hep-ph].

28 G. Buchalla, O. Cata, A. Celis, and **C. Krause**, "Fitting Higgs Data with Nonlinear Effective Theory," *Eur. Phys. J. C*, vol. 76, no. 5, p. 233, 2016. DOI: 10.1140/epjc/s10052-016-4086-9. arXiv: 1511.00988 [hep-ph].

29 G. Buchalla, O. Cata, A. Celis, and **C. Krause**, "Note on Anomalous Higgs-Boson Couplings in Effective Field Theory," *Phys. Lett. B*, vol. 750, pp. 298–301, 2015. DOI: 10.1016/j.physletb.2015.09.027. arXiv: 1504.01707 [hep-ph].

30 G. Buchalla, O. Cata, and **C. Krause**, "A Systematic Approach to the SILH Lagrangian," *Nucl. Phys. B*, vol. 894, pp. 602–620, 2015. DOI: 10.1016/j.nuclphysb.2015.03.024. arXiv: 1412.6356 [hep-ph].

31 G. Buchalla, O. Catá, and **C. Krause**, "On the Power Counting in Effective Field Theories," *Phys. Lett. B*, vol. 731, pp. 80–86, 2014. DOI: 10.1016/j.physletb.2014.02.015. arXiv: 1312.5624 [hep-ph].

32 G. Buchalla, O. Catà, and **C. Krause**, "Complete Electroweak Chiral Lagrangian with a Light Higgs at NLO," *Nucl. Phys. B*, vol. 880, pp. 552–573, 2014, [Erratum: Nucl.Phys.B 913, 475–478 (2016)]. DOI: 10.1016/j.nuclphysb.2014.01.018. arXiv: 1307.5017 [hep-ph].

Preprints

1. L. Favaro, A. Giammanco, and **C. Krause**, "A universal vision transformer for fast calorimeter simulations," Jan. 2026, Submitted to ML:ST. arXiv: 2601.05289 [hep-ph].
2. A. Hallin, D. Shih, **C. Krause**, and M. R. Buckley, "Via Machinae 3.0: A search for stellar streams in Gaia with the CATHODE algorithm," Sep. 2025. arXiv: 2509.08064 [astro-ph.GA].
3. M. He, **C. Krause**, and D. Wang, "Higgs Signal Strength Estimation with Machine Learning under Systematic Uncertainties," Aug. 2025, Submitted to SciPost Physics. arXiv: 2509.00672 [hep-ph].
4. **C. Krause**, D. Wang, and R. Winterhalder, "BitHEP – The Limits of Low-Precision ML in HEP," Apr. 2025, Accepted in SciPost Physics on 7.1.2026. arXiv: 2504.03387 [hep-ph].
5. G. Buchalla, A. Celis, **C. Krause**, and J.-N. Toelstede, "Master Formula for One-Loop Renormalization of Bosonic SMEFT Operators," Apr. 2019. arXiv: 1904.07840 [hep-ph].
6. G. Buchalla, O. Cata, A. Celis, and **C. Krause**, "Comment on "Analysis of General Power Counting Rules in Effective Field Theory"," Mar. 2016. arXiv: 1603.03062 [hep-ph].

Doctoral Thesis

1. **C. G. Krause**, "Higgs Effective Field Theories - Systematics and Applications," Ph.D. dissertation, Munich U., 2016. DOI: 10.5282/edoc.19873. arXiv: 1610.08537 [hep-ph].

Community Projects

1. **C. Krause** *et al.*, "CaloChallenge 2022: A Community Challenge for Fast Calorimeter Simulation," *Rept. Prog. Phys.*, vol. 88, no. 11, **C. Krause**, M. Faucci Giannelli, G. Kasieczka, B. Nachman, D. Salamani, D. Shih, and A. Zaborowska, Eds., p. 116 201, 2025. DOI: 10.1088/1361-6633/ae1304. arXiv: 2410.21611 [physics.ins-det].
2. J. M. Campbell *et al.*, "Event generators for high-energy physics experiments," *SciPost Phys.*, vol. 16, no. 5, p. 130, 2024. DOI: 10.21468/SciPostPhys.16.5.130. arXiv: 2203.11110 [hep-ph].
3. S. Badger *et al.*, "Machine learning and LHC event generation," *SciPost Phys.*, vol. 14, no. 4, A. Butter, T. Plehn, and S. Schumann, Eds., p. 079, 2023. DOI: 10.21468/SciPostPhys.14.4.079. arXiv: 2203.07460 [hep-ph].
4. T. Dorigo *et al.*, "Toward the end-to-end optimization of particle physics instruments with differentiable programming," *Rev. Phys.*, vol. 10, p. 100 085, 2023. DOI: 10.1016/j.revip.2023.100085. arXiv: 2203.13818 [physics.ins-det].
5. A. Adelmann *et al.*, "New directions for surrogate models and differentiable programming for High Energy Physics detector simulation," in *Snowmass 2021*, Mar. 2022. arXiv: 2203.08806 [hep-ph].
6. T. Plehn, A. Butter, B. Dillon, T. Heimel, **C. Krause**, and R. Winterhalder, "Modern Machine Learning for LHC Physicists," Nov. 2022, Lecture Notes. arXiv: 2211.01421 [hep-ph].
7. P. Shanahan *et al.*, "Snowmass 2021 Computational Frontier CompFo3 Topical Group Report: Machine Learning," Sep. 2022. arXiv: 2209.07559 [physics.comp-ph].
8. M. Cepeda *et al.*, "Report from Working Group 2: Higgs Physics at the HL-LHC and HE-LHC," *CERN Yellow Rep. Monogr.*, vol. 7, A. Dainese, M. Mangano, A. B. Meyer, A. Nisati, G. Salam, and M. A. Vesterinen, Eds., pp. 221–584, 2019. DOI: 10.23731/CYRM-2019-007.221. arXiv: 1902.00134 [hep-ph].
9. D. de Florian *et al.*, "Handbook of LHC Higgs Cross Sections: 4. Deciphering the Nature of the Higgs Sector," *CERN Yellow Rep. Monogr.*, vol. 2, pp. 1–869, 2017. DOI: 10.23731/CYRM-2017-002. arXiv: 1610.07922 [hep-ph].

Conference Proceedings

1. L. Favaro, A. Giammanco, and **C. Krause**, "Fast, accurate, and precise detector simulation with vision transformers," in *2nd European AI for Fundamental Physics Conference*, Sep. 2025. arXiv: 2509.25169 [hep-ph].
2. I. Rosell, **C. Krause**, A. Pich, and J. J. Sanz-Cillero, "Effective Theories and Resonances in Strongly-Coupled Electroweak Symmetry Breaking Scenarios," *PoS*, vol. EPS-HEP2019, p. 643, 2020. DOI: 10.22323/1.364.0643. arXiv: 1910.01839 [hep-ph].
3. **C. Krause**, G. Buchalla, O. Cata, A. Celis, and M. Knecht, "Complete One-Loop Renormalization of the Higgs-Electroweak Chiral Lagrangian," *PoS*, vol. CD2018, p. 072, 2019. DOI: 10.22323/1.317.0072. arXiv: 1907.07605 [hep-ph].
4. I. Rosell, **C. Krause**, A. Pich, J. Santos, and J. J. Sanz-Cillero, "Heavy resonances and the electroweak effective theory," *PoS*, vol. ICHEP2018, p. 316, 2019. DOI: 10.22323/1.340.0316. arXiv: 1811.10233 [hep-ph].
5. I. Rosell, **C. Krause**, A. Pich, J. Santos, and J. J. Sanz-Cillero, "Tracks of resonances in electroweak effective Lagrangians," *PoS*, vol. EPS-HEP2017, P. Checchia *et al.*, Eds., p. 334, 2018. DOI: 10.22323/1.314.0334. arXiv: 1710.06622 [hep-ph].

Teaching and Supervision

Teaching

2025	**Machine Learning for Physics**, full lecture (180min per week) with tutorials at University of Vienna in winter term 2025/26.
2024	**3× 45min lecture**, CRC TRR 257 Summer School "Particle Physics Phenomenology after the Higgs Discovery".
2023	**5× 90min lecture and tutorial**, MITP School Machine Learning in Particle Theory.
	8× 90min lecture and tutorial, 50th Heidelberg Graduate Days at the University of Heidelberg.
	4× 90min lecture and tutorial, KSETA doctoral program of Karlsruhe Institute of Technology (KIT).
2022	**90min lecture**, "Advanced Deep Learning", Doctoral School, ErUM-Data-Hub.
	3× 45min Lecture and tutorial, 3rd Terascale School of Machine Learning, Doctoral School at DESY Hamburg.
2023	**2 stand-in lectures** for Prof. Tilman Plehn at Heidelberg University
2021	**1 stand-in lecture** for Prof. David Shih at Rutgers University
2015	**2 stand-in lectures** for Prof. Gerhard Buchalla at Ludwig Maximilian University Munich
2008 – 2016	**Teaching assistant** for in total 15 courses at bachelors and masters level at Brandenburg Technical University Cottbus and Ludwig Maximilian University Munich

Teaching and Supervision (continued)

Supervision

2024 – · · · · **Supervision** of 1 bachelor student and 1 master student

2018 – · · · · **Co-supervision** of 1 bachelors, 3 masters, and 3 Ph.D. students

Miscellanea

Awards and Achievements

5/2025 **First place ex aequo**, FAIR Universe Higgs Uncertainty Challenge.

3/2018 – 9/2020 **Feodor Lynen Research Fellowship of the Alexander von Humboldt Foundation**, Fermi National Accelerator Laboratory (Fermilab), Chicago, USA.

1/2018 **Universe PhD Award 2017**, Cluster of Excellence Universe, Munich, category Theory, award for the best theoretical doctoral thesis in 2016/2017.

Service

4/2024 – · · · · **Editorial Fellow of SciPost Physics**.

1/2024 – · · · · **Co-Leader** of the Machine Learning Thematic Platform MLA^{2}S at the ÖAW.

10/2023 – · · · · **Co-Leader** of Working Group 2 (Technological innovation in data analysis) of COST action COMETA.

2018 – · · · · **Journal Referee in Peer Review** for more than 30 publications, including for journals: Journal of High-Energy Physics (JHEP), European Physical Journal C (EPJ C), Physical Review D, SciPost Physics, and Nature Communications.