# JOHANN **BREHMER**

Machine learner and physicist

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## RESEARCH INTERESTS

- Geometry + ML: Equivariance, scalability of strong priors, diffusion models, normalizing flows
- Causality + interactivity + ML: Non-iid situations, offline reinforcement learning, skill learning
- Scientific simulators + ML: Simulation-based / likelihood-free inference, AI for science

## EXPERIENCE

**Qualcomm AI Research Amsterdam**, Netherlands
Research scientist (Senior Staff Engineer) 11/2023 – now
Research scientist (Staff Engineer) 01/2021 – 11/2023

- Topics: Geometric deep learning, diffusion models, causality, offline RL, skill learning
- Roles: Researcher, supervisor, team lead (3 team members), manager (2 reports)
- Key collaborators: Taco Cohen, Pim de Haan

**New York University**, USA
Moore-Sloan postdoctoral researcher 09/2017 – 12/2020

- Topics: Simulation-based inference, normalizing flows, machine learning for physics
- Roles: Researcher, supervisor
- Key collaborators: Kyle Cranmer, Gilles Louppe, Siddharth Mishra-Sharma

**Heidelberg University**, Germany
PhD candidate 07/2014 – 08/2017

- Topics: Statistics for particle physics, effective field theories, Higgs boson measurements
- Roles: Researcher, co-supervisor, (head) teaching assistant
- PhD advisor: Tilman Plehn

**CERN**, Geneva
Summer student 06/2012 – 09/2012

- Topic: Machine learning for particle physics
- Supervisor: Johannes Albrecht

## EDUCATION

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|---|---|---|---|
| **PhD in Physics** | Heidelberg University | summa cum laude* | 07/2014 – 08/2017 |
| MSc in Physics | Heidelberg University | 1.0* | 02/2012 – 06/2014 |
| BSc in Physics | Heidelberg University | 1.0* | 09/2008 – 02/2012 |
| Visiting student | Imperial College, London, UK | 1.0* | 09/2010 – 07/2011 |
| Abitur | Heidelberg University | 1.0* | 06/2007 |

*German grading scale: from 1.0 (best) to 6.0 (worst); PhD grades: from summa cum laude (best) to rite (worst)

## PUBLICATION OVERVIEW

- **45** publications with **4198** citations, h-index of **21** (Google Scholar as of December 30, 2023)
- **17** first-author papers accepted in top venues including PRL, PNAS, NeurIPS

## SELECTED PUBLICATIONS

**GEOMETRY + ML**

| | | |
|---|---|---|
| Geometric algebra transformer | **Brehmer**, de Haan, Behrends, Cohen | NeurIPS 23 |
| Equivariant diffusion for planning w/ embodied agents | **Brehmer**, Bose, de Haan, Cohen | NeurIPS 23 |
| Euclidean, projective, conformal: … | de Haan, Cohen, **Brehmer** | Workshop 23 |
| Flows for simult. manifold learning & density estimation | **Brehmer**, Cranmer | NeurIPS 20 |
| Neural message passing for jet physics | Henrion, **Brehmer**, Bruna, Cho, … | Workshop 17 |

**CAUSALITY + INTERACTIVITY + ML**

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|---|---|---|
| Weakly supervised causal representation learning | **Brehmer**, de Haan, Lippe, Cohen | NeurIPS 22 |
| Deconfounded imitation learning | Vuorio, de Haan, **Brehmer**, …, Cohen | Workshop 22 |
| Hierarchical clustering in particle physics through RL | **Brehmer**, Macaluso, …, Cranmer | Workshop 20 |

**SCIENTIFIC SIMULATORS + ML**

| | | |
|---|---|---|
| Simulation-based inference for particle physics | **Brehmer**, Cranmer | Book chapter 22 |
| Stronger symbolic summary statistics for the LHC | Soybelman, Butter, Plehn, **Brehmer** | Workshop 22 |
| The frontier of simulation-based inference | Cranmer, **Brehmer**, Louppe | PNAS 20 |
| MadMiner: ML–based inference for particle physics | **Brehmer**, Kling, Espejo, Cranmer | CSBS 20 |
| Mining implicit models for likelihood-free inference | **Brehmer**, Louppe, Pavez, Cranmer | PNAS 20 |
| Inferring subhalo population properties with ML | **Brehmer**, Mishra-Sharma, …, Cranmer | AstrJ 19 |
| Constraining effective field theories with ML | **Brehmer**, Cranmer, Louppe, Pavez | PRL 18 |
| Guide to constraining EFTs with ML | **Brehmer**, Cranmer, Louppe, Pavez | PRD 18 |
| Better Higgs-CP tests w/ information geometry | **Brehmer**, Kling, Plehn, Tait | PRD 18 |
| Better Higgs measurements w/ information geometry | **Brehmer**, Cranmer, Kling, Plehn | PRD 17 |

**OTHER**

| | | |
|---|---|---|
| Instance-adaptive video compression | van Rozendaal, **Brehmer**, …, Cohen | TMLR 23 |
| Pushing Higgs Effective Theory to its limits | **Brehmer**, Freitas, Lopez-Val, Plehn | PRD 16 |

## ACCOMPLISHMENTS

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|---|---|
| Speaker: | **26** invited talks (**42** total) at international conferences / seminars<br>Keynote speaker at ACAT 2019 |
| Open source: | Lead developer of the MadMiner library |
| Organizer: | Seminars, workshops, conferences with up to 150 participants, including CLeaR 2023 |
| Member: | ELLIS |
| Awards: | PRL Editor's Suggestion<br>1 oral + 1 spotlight at workshops<br>Top Reviewer at NeurIPS 2023<br>Otto Haxel prize for best MSc thesis (out of 150)<br>Prestigious German Studienstiftung scholarship (top 0.5% of all German students) |
| Press coverage: | TWIML podcast, Physics, phys.org, Frankfurter Allgemeine Zeitung |

## SKILLS

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| Technical: | Python, PyTorch, git, Docker, SLURM |
| Leadership: | Team leadership, people management, project management, conference organization, hiring pipeline design, hiring, grassroots diversity initiative |
| Communication: | Technical writing, LaTeX, data visualization, presentations to experts and non-experts, teaching |
| Languages: | German (native), English (fluent), Dutch (advanced) |