# Mathias Driesse

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## Education

**PhD in Physics** Oct. 2023 – present

*Humboldt University of Berlin, Supervisor: Prof. Dr. Jan Plefka*

- **Research Topic:** High Precision Gravitational Wave Physics from a Worldline Quantum Field Theory
- Applied graph neural networks and reinforcement learning to speed up solving of symbolic equation systems
- Mastered state-of-the-art techniques for solving high-loop Feynman integrals
- Authored four papers on high-precision gravitational wave physics
- Main author on successful 20 million core-hour proposal at the supercomputer NHR@ZIB; also orchestrated efficient use of supercomputing time

**MPhys (Hons) Theoretical Physics with First Class Honours** Sept. 2019 – July 2023

*University of Edinburgh*

- **Master's Project:** deriving the Reissner-Nordström metric from scattering amplitudes in quantum field theory
- **Awards:** Certificate of Merit for excellent performance, Edinburgh Award for Representing Students

**Exchange Student (GPA: 4.0)** Sept. 2021 – June 2022

*California Institute of Technology*

## Publications

Y. Fabian Bautista, **M. Driesse** *et al.* Gravitational Wave Scattering in Spinless WQFT. arXiv: 2602.06125. Submitted to the *Journal of Higher Energy Physics.*

**M. Driesse** *et al.* Conservative black hole scattering at fifth post-Minkowksian and second self-force order. arXiv: 2601.16256. Submitted to *Phys. Rev. Lett.*

**M. Driesse** *et al.* Emergence of Calabi-Yau manifolds in high-precision black hole scattering. *Nature* **641** 603–607 (2025). *Cover article.*

**M. Driesse** *et al.* Conservative black hole scattering at fifth post-Minkowskian and first self-force order. *Phys. Rev. Lett.* **132**, 241402 (2024). *Editor's Suggestion.*

H. Ning, O. Mehio, X. Li, ... **M. Driesse**, ... D. Hsieh. A coherent phonon-induced hidden quadrupolar ordered state in $Ca_2RuO_4$, *Nat. Comm.* **14**, 8258 (2023).

## Talks

Invited seminar, University of Edinburgh, 27.01.2026, "The Gravitational Compton Amplitude"

Invited seminar, Queen Mary University of London, 22.01.2026, "The Gravitational Compton Amplitude"

Lost in Translation 2026, online conference, 19.01.2026, "Conservative Black Hole Scattering at Fifth Post-Minkowskian and Second Self-Force Orders"

Loop-the-Loop 2025, online conference, 11.11.2025, "Post-Minkowskian Integrals at Four Loops"

## Professional and Research Experience

**Summer Undergraduate Research Fellow** June 2022 – August 2022

*California Institute of Technology*

- Performed THz pump-probe time-domain spectroscopy on Mott insulators, handling lasers and vacuum devices and analyzing data
- Designed and constructed new THz time-domain spectroscopy equipment
- Simulated effects of Floquet engineering Kitaev material candidate $\alpha$-$RuCl_3$ using density functional theory
- Transfered tools developed for $\alpha$-$RuCl_3$ to analyze phonon eigenmodes and their effects in Mott insulators, in agreement with experimental results
- Evaluated feasibility of performing metamaterial-enhanced Floquet engineering

**Summer Student** June 2021 – August 2021
*CERN*

- Remote internship with ALPHA collaboration
- Researched existing literature for methods on simulating low-energy positron beams
- Developed simulations of longitudinal beam dynamics of positrons, extending existing models
- Investigated beam bunching (focusing) and simulated practical implementations thereof, leading to a potential 10× improvement in positron transfer capabilities
- Summarized research progress in final report: Longitudinal Dynamics of Positron Beams in the ALPHA Antihydrogen Experiment http://cds.cern.ch/record/2779405

## Volunteering and Extracurricular Activities

**Outreach Team Leader** Jul. 2024 – Present
*Non-Standard Models*

- Conducted, edited, and produced multiple episodes & interviews on outreach YouTube channel

**AI Competition Finalist** April 2022
*ClimateHack & Open Climate Fix*

- Designed, implemented, and tested CNN models for cloud coverage nowcasting
- Mastered frameworks such as Pytorch, Tensorflow, Pytorch Lightning, Keras

**Simulations Team Engineer** Sept. 2020 – May 2021
*HYPED – University of Edinburgh Hyperloop Society*

- Collaborated with fellow students and industry professionals to create COMSOL Multiphysics simulations of various components of the Hyperloop pod
- Developed a genetic algorithm to create and evaluate the optimal shell shape
- Applied Solidworks, Matlab and Comsol Livelink for Matlab to automate changes in the structure to speed up the algorithm

## Media coverage

- Nature News & Views: Black hole fly-by modelled with landmark precision
- Scientific American: Deep Math from String Theory Appears in Clashing Black Holes
- Der Standard: Was bei einer Beinahekollision Schwarzer Löcher geschieht
- Spektrum der Wissenschaft: Gravitationswellen erzeugen hochdimensionale Donuts (*Gravitational waves generate high-dimensional donuts*)
- Space.com: Black hole dance illuminates hidden math of the universe
- IFLScience: Better Solutions To Black Hole Collisions Thanks To 6-Dimensional Donuts
- Le Monde: Les ondes gravitationnelles lorsque deux trous noirs dansent le tango (*Gravitational waves when two black holes dance the tango*)
- El País: El sueño de Einstein, más cerca (*Einstein's dream, closer*)

## Professional Skills

**Languages:** English (native), French (native), German (fluent)

**Programming languages:** Python (numpy, scipy, pandas, PyTorch, matplotlib), Mathematica

**Software:** Photoshop, Premiere Pro, After Effects, Illustrator, VS Code, ParaView

**Various computer skills:** Remote working, data science, MS Office, VS Code, Linux, LaTeX, WSL2, Docker, bash, git, HPC

References: Jan Plefka, jan.plefka@physik.hu-berlin.de, Donal O'Connell, donal.o'connell@ed.ac.uk; David Hsieh, dhsieh@caltech.edu