

Dr. Christoph Berke

THEORETICAL AND COMPUTATIONAL PHYSICIST · SCIENCE COMMUNICATOR

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About Me

I am a theoretical and computational physicist with a Ph.D. in physics from the university of Cologne and expertise in quantum computation and condensed matter physics. In my research, I use a mix of analytic and numerical methods to advance the understanding of quantum materials and technology. Recently, my work has centered on transmon-based quantum computers, exploring how multi-qubit processors behave and uncovering potential many-body effects that could compromise the functionality of quantum hardware. Understanding these challenges is key to scaling quantum systems and ensuring their reliability for practical use.

In addition to my research, I am passionate about science communication and public outreach. I have led workshops, delivered public talks, and participated in various events aimed at explaining the mysteries of quantum physics and quantum computation.

Experience

Computational Condensed Matter Physics group, University of Cologne

Cologne, Germany

RESEARCH SCIENTIST

02/2023 - 06/2024

I focused my research on transmon-based quantum computers. Alongside this, I took on supplementary responsibilities as a postdoctoral researcher:

- Took technical responsibility for and co-authored the research proposal for [Collaborative Research Center 183](#).
- Supervised a Ph.D. student and conceptualized research projects for undergraduate students.
- Covered lectures on a substitute basis, developed video tutorials, designed and delivered interactive and innovative teaching formats.

Computational Condensed Matter Physics group, University of Cologne

Cologne, Germany

DOCTORAL RESEARCH ASSISTANT

10/2017 - 02/2023

My primary role involved conducting research both independently and collaboratively. I utilized analytical methods and developed and implemented numerical approaches. I worked in two distinct areas: frustrated magnets and the transmon platform for quantum computing. My contributions in both fields have resulted in several publications, collectively cited over 150 times. In addition to research, my work encompassed the following responsibilities:

- Visualizing research results, presenting at conferences, and publishing in scientific journals.
- Running simulations on high-performance clusters, utilizing more than 15 million CPU hours on [JUWELS](#) (Germany's most powerful supercomputer at the time), managing and analyzing raw data (>15 TB).
- Fulfilling teaching obligations, including preparing and teaching exercise sessions, designing new exercises, and overseeing the organization and operation of exercises for various lectures.
- Supervising Bachelor's and Master's thesis projects.
- Co-authoring research and computing time proposals.

Theory of Condensed Matter group, TUD Dresden Technical University

Dresden, Germany

RESEARCH ASSISTANT

10/2016 - 06/2017

Collaborating with Prof. Carsten [Timm](#), I completed the research project for my Master's thesis and authored a publication based on the findings.

TUD Dresden Technical University

Dresden, Germany

TEACHING ASSISTANT

10/2012 - 07/2016

Starting in the final year of my undergraduate studies, I taught exercise groups and developed self-designed tutorials for various courses, supporting first- to third-year students of physics and engineering at the Institute for Analysis and the Institute for Theoretical Physics.

SKM Köln, Department for addiction support

Köln, Germany

CIVILIAN SERVICE AND VOLUNTARY WORK

08/2009 - 07/2010

Civilian service at a contact center and emergency shelter, a low-threshold service for hard-to-reach, homeless individuals struggling with drug addiction. My responsibilities included providing basic care to clients and handling administrative tasks. Following the nine-month service, I volunteered for an additional three months to continue supporting the organization.

Education

University of Cologne

Cologne, Germany

PH.D. IN PHYSICS

FINAL GRADE: 0.7, SEHR GUT PLUS (MAGNA CUM LAUDE)

10/2017 - 02/2023

Thesis title: *Transmon-based quantum computers from a many-body perspective*, Supervisor: Prof. Dr. Simon [Trebst](#).

My work spanned a wide range of physical fields, including classical and quantum chaos, quantum information and computation, quantum engineering, and more. To address these research challenges, I employed diverse methods, ranging from analytical pen-and-paper calculations to large-scale numerical simulations.

TUD Dresden University of Technology

M.Sc. IN PHYSICS | FINAL GRADE: 1.0 (TOP 3 OF THE YEAR)

Dresden, Germany

10/2013 – 09/2016

I specialised in theoretical physics, focusing on condensed matter physics, while also taking courses in quantum information and computation, as well as mathematics and philosophy. I spent six months (09/2014–02/2015) at the Université Joseph Fourier in Grenoble, France. For my master thesis, I worked with Prof. Carsten [Timm](#). I graduated with the best achievable grade, earning a nomination for the [Lohrmann Medal](#).

TUD Dresden University of Technology

B.Sc. IN PHYSICS | FINAL GRADE: 1.5

Dresden, Germany

10/2010 – 09/2013

Freiherr-vom-Stein-Schule Gymnasium

ABITUR | FINAL GRADE: 1.0 (BEST ACHIEVABLE GRADE, BEST IN CLASS)

Rösrath, Germany

06/2009

Skills

During my Ph.D at the University of Cologne, I primarily used the Julia programming language. Prior to that, I gained experience with C++ and Python. While I personally prefer Ubuntu and similar operating systems, I am also proficient in MacOS and Windows.

Programming Julia (> 7 years), C++ (> 2 years), Python (> 2 years)

Other IT Skills / Software Windows, MacOS, Linux, SLURM, Git, Mathematica, \LaTeX , bash/zsh, MS Office/Libre Office

Languages German (native speaker), English (fluent), French (proficient)

Selected Publications

A comprehensive overview of all my publications is available on my [Orcid](#) profile or [homepage](#). Most of my publications are open access via [arXiv.com](#). Below is a selection of particularly recommended publications for which I am the first author (or equivalent).

1. [Christoph Berke](#), Evangelis Varvelis, Simon Trebst, Alexander Altland, and David DiVincenzo

“*Transmon platform for quantum computing challenged by chaotic fluctuations*”, *Nature Communications* 13, 2495 (2022)

This article is the first to fuse the disparate fields of quantum engineering and many-body physics. We analyze state-of-the-art transmon quantum computers in exact diagonalization studies and demonstrate that some of the prevalent design schemes operate close to a region of uncontrollable quantum chaos. Our research helps pave the way for more reliable quantum computers by showing how quantum chaos theory can be applied to understand the behavior of transmon chips. As quantum technology continues to develop, managing chaos could be the key to unlocking its full potential. Our paper was selected as an [Editors' Highlight \(May 2022\)](#), was featured in an [invited comment](#) and has been cited over 85 times.

2. Simon-Dominik Börner, [Christoph Berke](#), David P. DiVincenzo, Simon Trebst, Alexander Altland

“*Classical chaos in quantum computers*”, *Physical Review Research* 6, 033128 (2024)

Continuing our work on quantum chip instabilities, we show that the simulation of classical limits can be a potent diagnostic tool for the resilience of quantum hardware. Classical simulations can be pushed to large systems (>1,000 qubits). We find that larger layouts require additional efforts in information protection. Our research provides transmon engineers with another tool to diagnose and improve (large-scale) quantum chips.

Extracurricular activities and voluntary work

Friends of Children e.V.

MEMBER & HONORARY TEACHER

Cologne, Germany

11/2017 – present

- Dedicated several hours per week to providing individual and long-term tutoring support for school students across various subjects.
- Helped two students successfully achieve their secondary school leaving certificate (Mittlere Reife) and supported one student in passing their university entrance qualification (Abitur).
- Taught German to children from families entitled to protection, helping them improve their language skills as non-native speakers.

Science Communication and Public Outreach

SPEAKER & WORKSHOP LEADER

various locations, Germany

2017 – present

- Delivered public lectures, primarily on topics related to quantum computing.
- Organized and led workshops for children and young people to inspire enthusiasm for physics and programming.
- Participated in events such as the Long Night of Science (Dresden), Pint of Science, “Türen auf mit der Maus”, zdi-Schüler:innenlabore and the Night of Technologies (Cologne). Additional details and materials are available on [my homepage](#).