Volker Karle

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Education

Institute of Science and Technology Austria (ISTA) — Klosterneuburg (near Vienna), Austria
Ph.D in Physics, Supervisor: Prof. Mikhail Lemeshko *2019 – 2024*

- Main thesis project: Theory of non-abelian topological phases in molecules that are periodically driven by strong, ultrashort laser pulses [1]. Published in PRL [4] and submitted to arXiV [3].
- Formulated an effective theory for the time-evolution operator of linear molecules under the influence of intense, ultrashort infrared and few-cycle laser pulses. Published in PRA [2].
- Rotation project with Prof. Maksym Serbyn on many-body systems using tensor network techniques and exact diagonalization to explore new area-law eigenstates. Published in PRL [5].

Heidelberg University — Heidelberg, Germany
M.Sc in Physics, Supervisor: Prof. Tilman Enss *2016 – 2018*

- In my thesis, I examined a two-component Bose gas in 2D, revealing that interspecies interactions modify the BKT transition and induce break-down of superfluid phases. Published in PRA [7].
- Academic focus on the intersection of condensed matter theory and ultracold atom experiments.

University of Insubria — Como, Italy
Erasmus Exchange Year, Supervisor: Prof. Italo Guarneri *2013 – 2014*
Project focused on examining transport behaviors in classical kicked rotors numerically, revealing classical dynamical localization traditionally attributed to quantum chaos. Published in PRL [9].

University of Freiburg — Freiburg im Breisgau, Germany
B.Sc in Physics, Supervisor: Prof. Andreas Buchleitner *2011 – 2015*
In my thesis, I explored Bose-Einstein condensation in non-Hermitian, driven-dissipative systems, uncovering parameter-dependent fragmented condensation. Available online [8].

Awards & Fellowships

Institute of Science and Technology
ISTA Outstanding PhD Thesis Award *2025*

German Academic Scholarship Foundation (Studienstiftung des Deutschen Volkes)
Full scholarship *2012 – 2018*

Erasmus Exchange Program
Full scholarship *2013 – 2014*

Youth Research Competition (Jugend Forscht)
Special prize in the National level competition *2011*

Work experience

Institute of Science and Technology Austria (ISTA) — Klosterneuburg (near Vienna), Austria
Postdoctoral researcher *2025 – present*
Focus in topological and non-equilibrium aspects of strongly-driven atomic and molecular systems.

Solandeo — Berlin, Germany
Internship as Data Scientist (4 months) *2019*
Internship in the predictive analytics team. Analysis of solar, wind, and biogas energy data using deep learning to enhance next-day production forecasts.

Potsdam Institute of Climate Impact Research (PIK) — Potsdam, Germany
Academic internship (6 months), Supervisor: Dr. Jonathan Donges *2016*
Interdisciplinary project using bifurcation theory to analyze key climate tipping elements, including the Amazon rainforest and Greenland ice sheet. Explored their potential for triggering cascading tipping events; led to a publication [6].

Bosch Rexroth — Lohr, Germany

Internship as Software Engineer (4 months) — *2015*

Internship in the cybersecurity team. End-to-end encryption and authentication schemes with Bayesian detection systems for flagging suspicious activities based on network protocols.

Center for Nonlinear and Complex Systems Como — Como, Italy

Academic internship (10 months), Supervisor: Prof. Italo Guarneri — *2013 – 2014*

Internship in the group of Prof. Italo Guarneri during my Erasmus Exchange Year in Italy which lead to a publication of the project, see above in section Education [9].

Please refer to my Linkedin profile for the complete list of work experiences.

Recent Conferences and Invited talks

- APS Global Physics Summit 2025 (talk) — March 2025, Anaheim, USA
- Future of Ultracold and Ultrafast Dynamics (invited talk) — October 2024, Dresden, Germany
- Cold and Controlled Molecules & Ions (Hot topic talk) — September 2024, Klosterneuburg, Austria
- Topological phases and strong correlations, ITAMP workshop — November 2023, Boston, USA
- ITAMP seminar, JuliaCon (invited talks) — July 2023, Boston, USA
- APS March meeting 2023 (talk) — March 2023, Las Vegas, USA
- Quantum seminar, University of Freiburg (invited talk) — November 2022, Freiburg, Germany
- International School of Solid State Physics (talk) — August 2022, Erice, Italy
- APS March meeting 2022 (talk) — March 2022, Chicago, USA
- Many Body Physics in Open Quantum Systems — January 2021, Princeton (Online), USA

Miscellaneous

Programming skills: Proficient scientific programming with Julia, Python, and C++ and cluster usage with SLURM. Exact diagonalization techniques, tensor networks (DMRG), non-linear optimization.

Natural languages: German (*mother tongue*), English (*full professional proficiency*), Italian (*limited working proficiency*), French (*elementary proficiency*) and Spanish (*beginner*).

Publications

[1] **Volker Karle**. "Non-equilibrium topological phases of periodically driven molecules and quantum rotors". PhD thesis. Institute of Science and Technology Austria, 2025, p. 192. DOI: 10.15479/AT-ISTA-19393.

[2] **Volker Karle** and Mikhail Lemeshko. "Modeling laser pulses as δ kicks: Reevaluating the impulsive limit in molecular rotational dynamics". In: *Phys. Rev. A* 109 (2 Feb. 2024), p. 023101. DOI: 10.1103/PhysRevA.109.023101.

[3] **Volker Karle**, Mikhail Lemeshko, Adrien Bouhon, Robert-Jan Slager, and F. Nur Ünal. "Anomalous multi-gap topological phases in periodically driven quantum rotors". In: *arXiV preprint* (*submitted*) (Sept. 2024). DOI: https://doi.org/10.48550/arXiv.2408.16848.

[4] **Volker Karle**, Areg Ghazaryan, and Mikhail Lemeshko. "Topological Charges of Periodically Kicked Molecules". In: *Phys. Rev. Lett.* 130 (10 Mar. 2023), p. 103202. DOI: 10.1103/PhysRevLett.130.103202.

[5] **Volker Karle**, Maksym Serbyn, and Alexios A. Michailidis. "Area-Law Entangled Eigenstates from Nullspaces of Local Hamiltonians". In: *Phys. Rev. Lett.* 127 (6 Aug. 2021), p. 060602. DOI: 10.1103/PhysRevLett.127.060602.

[6] Ann Kristin Klose, **Volker Karle**, Ricarda Winkelmann, and Jonathan F Donges. "Emergence of cascading dynamics in interacting tipping elements of ecology and climate". In: *Royal Society open science* 7.6 (2020), p. 200599. DOI: 10.1098/rsos.200599.

[7] **Volker Karle**, Nicolò Defenu, and Tilman Enss. "Coupled superfluidity of binary Bose mixtures in two dimensions". In: *Phys. Rev. A* 99 (6 June 2019), p. 063627. DOI: 10.1103/PhysRevA.99.063627.

[8] **Volker Karle**. "Driven-dissipative Bose-Einstein condensation". B.Sc. Thesis. University of Freiburg, 2015. URL: https://freidok.uni-freiburg.de/data/10329.

[9] Italo Guarneri, Giulio Casati, and **Volker Karle**. "Classical Dynamical Localization". In: *Phys. Rev. Lett.* 113 (17 Oct. 2014), p. 174101. DOI: 10.1103/PhysRevLett.113.174101.