Sebastian Diehl

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Research interests:	Driven open quantum matter is characterized by an interplay of coherent quantum dynamics with external driving, dissipation, and quantum measurement. This scenario emerges in platforms ranging from ultracold atomic gases over light-driven quantum materials to the first quantum computing architectures. What are the universal principles and phenomena governing such systems? We construct novel theoretical frameworks to understand this question, bringing together concepts from quantum optics, solid state- and quantum field theory.

Qualifications and Career

1999 - 2003	Physics studies at Heidelberg University (with distinction)
2003 - 2006	PhD with Prof. Christof Wetterich, Heidelberg University (summa cum laude)
2006 - 2011	Postdoc at the Institute for Quantum Optics and Quantum Information, Innsbruck University
2011 - 2014	Independent junior research group leader (START grant), Innsbruck University
2014	Habilitation in theoretical physics at Innsbruck University
2014 - 2015	Full professor (W3), Technical University Dresden
2015 -	Full professor (W3), University of Cologne

Professional Activities

2016 -	Project leader in CRC1238 (Control and Dynamics of Quantum Materials) and CRC183 (Entangled States of Matter)
2019 -	Project leader in the cluster of excellence ML4Q
2020 -	Member of the selection committee of the Humboldt foundation (Feodor Lynen stipends)
2019 - 2023	Project leader in DFG Priority Program 1929 (Gigantic Interactions in Rydberg Systems)
2022 - 2023	Head of the department of physics, University of Cologne

Academic Distinctions

1999 - 2006	Student/PhD scholarship of Studienstiftung des Deutschen Volkes (German National Academic Foundation)
2003	Otto-Haxel-Prize, Physics Department, Heidelberg University
2011	START prize of the Austrian Science Fund
2015	Consolidator grant of the European Research Council

Selected publications

1. M. Buchhold, Y. Minoguchi, A. Altland, S. Diehl, *Effective theory for the measurement-induced phase transition of Dirac fermions*, Phys. Rev. X **11**, 041004 (2021), arxiv:2102.08381
   An analytical replica field theory approach is constructed to capture measurement induced phase transitions in monitored fermion systems.
2. A. Chiocchetta, D. Kiese, F. Piazza, S. Diehl, *Cavity-induced quantum spin liquids*, Nature Communications **12**, 5901 (2021), arxiv:2009.11856
   The coupling of magnetic systems, such as ordinary Heisenberg magnets, to the quantized light of a cavity generates frustration and results in robust spin liquid phases.
3. A. Altland, M. Fleischhauer, S. Diehl, *Symmetry classes of open fermionic quantum matter*, Phys. Rev. X **11**, 021037 (2021), arxiv:2007.10448
   A first-principles classification for open fermion systems in terms of discrete symmetries is developed, revealing a fine structure of equilibrium vs. non-equilibrium evolutions.
4. O. Alberton, M. Buchhold, S. Diehl, *Entanglement transition in a monitored free-fermion chain: from extended criticality to area law*, Phys. Rev. Lett. **126**, 170602 (2021), arxiv:2005.09722
   New scaling behaviors of entanglement of fermions subject to measurement are discovered.
5. L. M. Sieberer, A. Chiocchetta, A. Gambassi, U. C. Täuber, S. Diehl, *Thermodynamic equilibrium as a symmetry of the Schwinger-Keldysh action*, Phys. Rev. B **92**,134307 (2015), arXiv:1505.00912
   A sharp distinction between systems residing in- or out of thermal equilibrium is constructed in a functional integral framework for quantum systems.
6. J. Marino, S. Diehl, *Driven Markovian quantum criticality*, Phys. Rev. Lett. **116**, 070407 (2016), arxiv:1508.02723
   An analog of quantum criticality is established in driven open quantum systems, constituting a new non-equilibrium universality class.
7. L. M. Sieberer, M. Buchhold, S. Diehl, *Keldysh field theory for driven open quantum systems*, Rep. Prog. Phys. **79**, 096001 (2016), arxiv:1512.00637
   The Lindblad-Keldysh field theory approach to driven open many-body systems is reviewed and further developed.
8. L. Sieberer, S. Huber, E. Altman, S. Diehl, *Dynamical critical phenomena in driven-dissipative systems*, Phys. Rev. Lett. **110**, 195301 (2013), arxiv:1301.5854
   New universality induced due to the breaking of equilibrium conditions is revealed.
9. S. Diehl, E. Rico Ortega, M. Baranov, P. Zoller, *Topology by dissipation in atomic quantum wires*, Nature Physics **7,** 971 (2011), arxiv:1105.5947
   Topological states in fermion systems can be reached by engineered dissipation.
10. S. Diehl, A. Micheli, A. Kantian, B. Kraus, H. Büchler, P. Zoller, *Quantum states and phases in driven open quantum systems with cold atoms*, Nature Physics **4,** 878 (2008), arxiv:0803.1482
    The concept of dissipation engineering in many-body systems is introduced.