

FABIAN RENNECKE

Curriculum Vitae

(Updated: April 20, 2026)

Institute for Theoretical Physics
Justus Liebig University Giessen
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Research Interests

- ▶ **Phase structure of Quantum Chromodynamics**
QCD at high density – moat regime and pattern formation – confinement and chiral symmetry breaking – thermodynamics and transport phenomena
- ▶ **Phenomenology of heavy-ion collisions**
particle correlations – signatures of novel phases at high density – dilepton spectra
- ▶ **Topological aspects of strongly interacting matter**
axial anomaly – higher topological charge effects – axion dark matter – novel anomalous quark correlations
- ▶ **Nonperturbative methods in quantum field theory**
functional renormalization group techniques – effective field theories – semi-classical path integral methods – large- N and mean-field approximations
- ▶ **Critical phenomena**
Yang-Lee edge singularities – critical physics of QCD and QCD-like theories

Research Experience

- | | |
|-------------------|---|
| since 09/2021 | Habilitation Position (6+2 years, non-tenured)
Institute for Theoretical Physics, University of Giessen, Germany |
| 10/2017 – 08/2021 | Research Associate
Physics Department, Brookhaven National Laboratory, USA
Group: Nuclear Theory Group
Until 9/2019: <i>Research Fellow of the German Research Foundation (DFG)</i>
Host: Robert D. Pisarski |
| 9/2016 – 9/2017 | Postdoctoral Researcher
Institute for Theoretical Physics, Heidelberg University, Germany
Groups: Jan M. Pawłowski and Stefan Floerchinger |
| 8/2015 – 8/2016 | Postdoctoral Researcher
Institute for Theoretical Physics, University of Giessen, Germany
Group: Bernd-Jochen Schaefer |
| 6/2014 – 9/2014 | Visiting Researcher
Physics Department, Brookhaven National Laboratory, USA
Host: Robert D. Pisarski |

Education

- 2012 – 2015 **Dr. rer. nat. (Ph.D.) in Physics**, Heidelberg University, Germany
Thesis: *The Chiral Phase Transition of QCD*
Advisor: Jan M. Pawłowski
- 2006 – 2012 **Diplom (M.Sc.) in Physics**, Heidelberg University, Germany
Thesis: *Renormalization Group Study of the Chiral Phase Transition in QCD*
Advisor: Jan M. Pawłowski

Funding and Grants

- 1/2026 – 6/2029 **Project leader**
Collaborative Research Center TransRegio CRC-TR 211 "Strong-interaction matter under extreme conditions" [\[Link\]](#)
Project: *Inhomogeneous phases at high density (A03)*
- 10/2017 – 9/2019 **Research Fellowship** ("Forschungsstipendium")
German Research Foundation (DFG)
Project: *Signatures of the QCD Phase Diagram* [\[Link\]](#)
- 5/2014 – 8/2014 **Research Grant** "HGS-HiRe Abroad"
Helmholtz Graduate School for Hadron and Ion Research (HGS-HiRe)
- 2/2012 – 7/2015 **Ph.D. Scholarship**
Helmholtz Graduate School for Hadron and Ion Research (HGS-HiRe)

Publications

43 publications, 2365 citations, h-index: 26 (as of April 20, 2026; source: [\[INSPIRE\]](#))

Selected publications:

- ▶ *Dilepton production from moaton quasiparticles*
Z. Nussinov, M. C. Ogilvie, L. Pannullo, R. D. Pisarski, **F. Rennecke**,
S. T. Schindler and M. Winstel
Phys. Rev. Letters 135, 101904, [arXiv:2410.22418](#) (2024)
- ▶ *Conjectures about the Chiral Phase Transition in QCD
from Anomalous Multi-Instanton Interactions*
R. D. Pisarski and **F. Rennecke**
Phys. Rev. Letters 132, 251903, [arXiv:2401.06130](#) (2024)
- ▶ *Particle Interferometry in a Moat Regime*
F. Rennecke, R. D. Pisarski and D. H. Rischke
Phys. Rev. D 107, 116011, [arXiv:2301.11484](#) (2023)
- ▶ *Signatures of Moat Regimes in Heavy-Ion Collisions*
R. D. Pisarski and **F. Rennecke**
Phys. Rev. Letters 127, 152302, [arXiv:2103.06890](#) (2021)
- ▶ *Universal location of the Yang-Lee edge singularity in $O(N)$ theories*
A. Connelly, G. Johnson, **F. Rennecke** and V. Skokov
Phys. Rev. Letters 125, 191602, [arXiv:2006.12541](#) (2020)

- ▶ *Higher Topological Charge and the QCD Vacuum*
F. Rennecke
Phys. Rev. Research, 2, 033359, [arXiv:2003.13876](https://arxiv.org/abs/2003.13876) (2020)
- ▶ *Multi-Instanton Contributions to Anomalous Quark Interactions*
R. D. Pisarski and **F. Rennecke**
Phys. Rev. D 101, 114019, [arXiv:1910.14052](https://arxiv.org/abs/1910.14052) (2019)
- ▶ *The QCD Phase Structure at Finite Temperature and Density*
W.-j. Fu, J. M. Pawłowski and **F. Rennecke**
Phys. Rev. D 101, 054032, [arXiv:1909.02991](https://arxiv.org/abs/1909.02991) (2019)
- ▶ *Strangeness Neutrality and Baryon-Strangeness Correlations*
W.-j. Fu, J. M. Pawłowski and **F. Rennecke**
Phys. Rev. D 100, 111501(R), [arXiv:1809.01594](https://arxiv.org/abs/1809.01594) (2018)
- ▶ *In-Medium Spectral Functions of Vector- and Axial-Vector Mesons*
C. Jung, **F. Rennecke**, R.-A. Tripolt, L. von Smekal and J. Wambach
Phys. Rev. D 95, 036020, [arXiv:1610.08754](https://arxiv.org/abs/1610.08754) (2016)
- ▶ *Vacuum Structure of Vector Mesons in QCD*
F. Rennecke
Phys. Rev. D 92, 076012, [arXiv:1504.03585](https://arxiv.org/abs/1504.03585) (2015)
- ▶ *From Quarks and Gluons to Hadrons: Chiral Symmetry Breaking in Dynamical QCD*
J. Braun, L. Fister, J. M. Pawłowski and **F. Rennecke**
Phys. Rev. D 94, 034016, [arXiv:1412.1045](https://arxiv.org/abs/1412.1045) (2014)

A complete list of publications can be found under:

<http://inspirehep.net/author/profile/Fabian.Rennecke.1>

Talks and Seminars

65 talks in total, 23 invited/plenary talks at conferences and workshops, 15 invited seminar talks and colloquia

Invited/plenary talks at workshops and conferences (since 2020):

- 19/09/2025 *Hot and dense QCD from functional methods*
International School of Nuclear Physics
Erice, Italy
- 09/09/2025 *Universality of the Yang-Lee edge singularity and its applications*
Analytic structure of QCD and Yang-Lee edge singularity
ECT* Trento, Italy
- 11/04/2025 *QCD phase diagram & equation of state: a functional perspective*
XXXI International Conference on Ultra-relativistic Nucleus-Nucleus Collisions (Quark Matter 2025)
Frankfurt, Germany
- 14/03/2025 *New insights into the QCD phase diagram*
Spring Meeting of the German Physical Society (DPG)
Cologne, Germany
- 16/08/2024 *The QCD phase structure and its signatures from functional approaches*
Strong and Electro-Weak Matter 2024 (SEWM 2024)
Frankfurt, Germany

- 19/08/2024 *The QCD phase structure and its signatures from functional approaches*
The XVIth Quark Confinement and the Hadron Spectrum Conference (QCHSC 2024)
Cairns, Australia
- 17/07/2024 *Mixing, moats and modulations in dense QCD matter*
The 20th International Conference on QCD in Extreme Conditions (XQCD 2024)
Lanzhou, China
- 15/07/2024 *Mixing, moats and modulations in dense QCD matter*
2nd Symposium on Intermediate-energy Heavy Ion Collisions (iHIC 2024)
Tsinghua University, Beijing, China
- 30/05/2024 *Topological Effects & their Phenomenology*
Non-Perturbative and Topological Aspects of QCD
CERN, Switzerland
- 24/04/2024 *Mixing, Moats and Modulations in Dense QCD Matter*
ELEMENTS Annual Conference 2024
Frankfurt, Germany
- 21/02/2024 *Nuclear Matter Properties at High μ_B*
Probing Dense Baryonic Matter with Hadrons II: FAIR Phase-0
GSI, Darmstadt, Germany
- 22/05/2023 *Correlations in a Moat Regime*
From First-Principles QCD to Experiments
ECT* Trento, Italy
- 08/11/2021 *Moat Regimes & their Signatures in Heavy-Ion Collisions*
XXXIII International Workshop on High Energy Physics
Kurchatov Institute, Protvino, Russia (online)
- 09/09/2021 *Higher Topological Charge Effects in QCD and Beyond*
Topological Aspects of Strong Correlations and Gauge Theories
International Centre for Theoretical Sciences, Bengaluru, India (online)
- 16/11/2020 *The Functional RG: Universality and Emergence*
Renormalization Group Approaches to the Many-Body Problem,
Institute for Nuclear Theory, Seattle, USA (online)
- 03/11/2020 *QCD from an FRG Perspective*
10th International Conference on the Exact Renormalization Group (ERG 2020)
Kyoto University, Japan (online)

Supervision and Teaching

Supervision of students:

- 2/2026 – present Master's thesis supervision of **Domenico Artese**,
University of Giessen, Germany,
Thesis (preliminary title): *Real time properties of the moat regime*
- 3/2025 – present Master's thesis supervision of **Simon Schute**,
University of Giessen, Germany,
Thesis (preliminary title): *Universal features of matrix models*

- 3/2025 – present Master's thesis co-supervision (with C. Höhne) of **Johanna Scharf**,
University of Giessen, Germany,
Thesis (preliminary title): *The moat regime in heavy-ion collisions*
- 6/2020 – 6/2023 Ph.D. co-supervision (with V. Skokov) of **Gregory Johnson**,
North Carolina State University, USA,
Thesis: *The Universal Location of The Yang Lee Edge Singularity for $O(N)$ Universality Classes*
- 3/2023 – 4/2023 Research internship supervision of **Timothy Herl**,
University of Giessen, Germany
Topic: *Yang-Lee edge singularities and the Columbia plot*
- 3/2022 – 9/2022 Bachelor's thesis supervision of **Maximilian Hänsch**,
University of Giessen, Germany,
Thesis: *Analytic Structure of Effective Low-Energy Models of QCD*
- 8/2015 – 7/2016 Master's thesis co-supervision (with B.-J. Schaefer) of **Simon Resch**,
University of Giessen, Germany,
Thesis: *Mass Sensitivity of the QCD Phase Structure*

Postdocs:

- 4/2024 – 6/2026 **Shi Yin**, Humboldt Research Fellow

Lectures:

- Summer term 2026 *Quantum Field Theory*,
University of Giessen, Germany
- Winter term 25/26 *Advanced Quantum Mechanics*,
University of Giessen, Germany
- Summer term 2025 *Quantum Field Theory*,
University of Giessen, Germany
- Winter term 24/25 *Advanced Quantum Mechanics*,
University of Giessen, Germany
- Winter term 23/24 *Advanced Quantum Field Theory*,
University of Giessen, Germany
- 10/2023 *The Functional Renormalization Group, Critical Phenomena & QCD*,
Joint CRC-TR 211 & HGS-HIRe Lecture Week (invited lecture),
Rauischholzhausen, Germany
- 09/2023 *The Functional Renormalization Group and Critical Phenomena*,
CRC 1225 IsoQuant YRC Retreat (invited lecture), Baiersbronn, Germany
- 04/2022 *Dense Strongly Interacting Matter*,
HGSFP Graduate Days (invited lecture), Heidelberg University, Germany
- Summer term 2016 *The Theory of Electrodynamics and Thermodynamics* (substitute),
University of Giessen, Germany
- Winter term 15/16 *The Theory of Thermodynamics* (substitute),
University of Giessen, Germany

Collaborations

since 09/2021

Member and project leader (since 01/2026)

Collaborative Research Center TransRegio CRC-TR 211 "Strong-interaction matter under extreme conditions" [\[Link\]](#),
German Research Foundation (DFG)

since 2016

Co-founder and board member

Functional QCD Collaboration (fQCD) [\[Link\]](#),

Academic Service

- ▶ **Organizer:** *12th International Conference on the Exact Renormalization Group (ERG2024)*, Conference in Les Diablerets, Switzerland (~130 participants), co-organized with L. Classen, N. Defenu and L. Zambelli (22 – 27/09/2024)
- ▶ **Organizer:** *Functional Methods in Strongly Correlated Systems (FunSCS)*, Workshop in Hirschegg, Austria (38 participants), co-organized with M. Buballa and N. Wink (22 – 26/05/2023)
- ▶ **Organizer:** *FunQCD*, Hybrid Workshop in Valencia, Spain (97 participants), co-organized with C. Aguilar, D. Ibanez, J. Papavassiliou, J. M. Pawłowski and R. D. Pisarski (13– 17/04/2022)
- ▶ **Organizer:** Weekly seminar *Lunch Club*, Institute for Theoretical Physics, University of Giessen, Germany (09/2021 – present)
- ▶ **Organizer:** *FunQCD: from first principles to effective theories*, Online Workshop (156 participants), co-organized with C. Aguilar, J. Papavassiliou, J. M. Pawłowski and R. D. Pisarski (29/03 – 01/04/2021)
- ▶ **Organizer:** Weekly seminar *Cold Quantum Coffee*, Institute for Theoretical Physics, Heidelberg University, Germany (2012 – 2014)
- ▶ **Peer review:** Referee for Phys. Rev. Letters, Phys. Rev. C, Phys. Rev. D and Phys. Lett. B