Millikelvin Confocal Microscopy of Electrostatic Exciton Traps and Filter-Function Description of Noisy Quantum Dynamics

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Colophon
This document was typeset with the help of KOMA-Script and LaTeX using the kaobook class.
The source code of this thesis is available at: https://github.com/thangleiter/phd_thesis

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Summary

Zusammenfassung

Acknowledgements

Tobias Hangleiter
Aachen, September 2025

Preface

It's been a journey.

Tobias Hangleiter
Aachen, September 2025

How to read this thesis

Contents

Publications

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Software

The following open-source software packages were developed (at least partially) during the work on this thesis.

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Part I

A Flexible Python Tool For Fourier-Transform Noise Spectroscopy

Part II

Characterization and Improvements of a Millikelvin Confocal Microscope

Part III

Optical Measurements of Electrostatic Exciton Traps in Semiconductor Membranes

Part IV

A Filter-Function Formalism For Unital Quantum Operations

Appendix

Glossary

Numbers
2DEG two-dimensional electron gas. xiv

P
PL photoluminescence. xiv
PLE photoluminescence excitation. xiv

T
TMM transfer-matrix method. xiv

Figure source files and parameters

Declaration of Authorship

I, Tobias Hangleiter, declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

I do solemnly swear that:

1. This work was done wholly or mainly while in candidature for the doctoral degree at this faculty and university;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this university or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others or myself, this is always clearly attributed;
4. Where I have quoted from the work of others or myself, the source is always given. This thesis is entirely my own work, with the exception of such quotations;
5. I have acknowledged all major sources of assistance;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. Parts of this work have been published before as:

[1] Pascal Cerfontaine, Tobias Hangleiter, and Hendrik Bluhm. "Filter Functions for Quantum Processes under Correlated Noise." In: *Physical Review Letters* 127.17 (Oct. 18, 2021), p. 170403. DOI: 10.1103/PhysRevLett.127.170403.

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