Tobias **Haas**

PostDoc · Quantum Information · Quantum Fields · Analog Gravity

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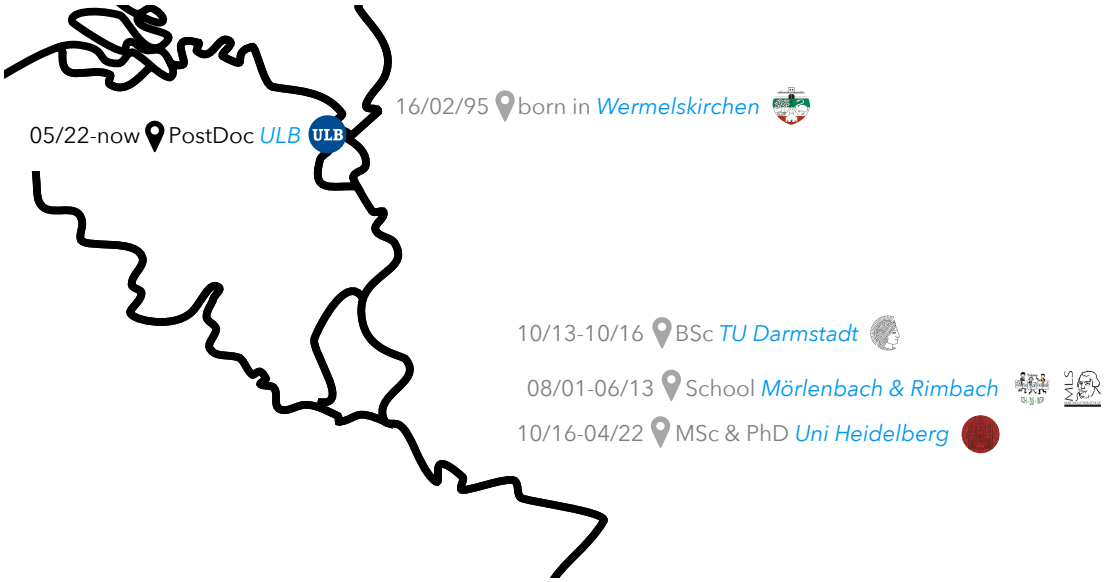
Summary

I'm a PostDoc in theoretical physics as part of the Centre for Quantum Information and Communication led by Nicolas Cerf. My main research interests lie in the interplay of quantum information theory, quantum field theory and general relativity with a special focus on entanglement, entropic uncertainty and analog gravity models.

Personal Information & Education

Citizenship *German* **Gender** *Male* **Family Status** *Married since 07/20*



22	**Ph. D. Thesis**, An Entropic Perspective on Equilibrium, Entanglement and Uncertainty	*Advisor: Stefan Floerchinger*
18	**M. Sc. Thesis**, Higher derivative quantum gravity in different approximations	*Advisor: Jan Pawlowski*
16	**B. Sc. Thesis**, Top-down causation in the quantum mechanicle measurement process	*Advisor: Barbara Drossel*

Honors & Awards

20	**Teaching Award**, for outstanding engagement in education during the winter term 2019/2020	*Heidelberg University*
16	**Gerhard-Herzberg-Gesellschaft Award**, for outstanding engagement in education during 2016	*TU Darmstadt*
13	**Grading Awards**, of the Deutsche Physikalische Gesellschaft (DPG) and the Deutsche Mathematiker-Vereinigung (DMV)	*MLS Rimbach*
12-13	**Academic studies during secondary school**, physics and mathematics	*TU Darmstadt*
07	**Skipped 7th Grade**, during secondary school	*MLS Rimbach*

Teaching Activities

Tutorials & Seminars

Information Theory and Quantum Physics — *Heidelberg University*
Co-organizer for a master seminar — *10/20 - 03/21*

Theoretical Physics III — *Heidelberg University*
Tutor for an exercise class — *10/19 - 03/20*

Theoretical Physics II — *Heidelberg University*
Tutor for an exercise class — *04/19 - 09/19*

Theoretical Physics II — *Heidelberg University*
Tutor for an exercise class — *04/18 - 09/18*

Theoretical Physics I — *Heidelberg University*
Tutor for an exercise class — *10/16 - 03/17*

Experimental Physics II & Calculus for physicists — *TU Darmstadt*
Tutor for an exercise class — *04/16 - 09/16*

Theoretical Physics I & Physics for Engineers — *TU Darmstadt*
Tutor for an exercise class — *10/15 - 03/16*

Experimental Physics I — *TU Darmstadt*
Tutor for an exercise class — *04/15 - 09/15*

Co-supervised students

Bachelor students

Johannes Schmidt (08/21 - 04/22), Salome Schwark (08/21 - 02/22), Sara Ditsch (04/21 - 06/21), Henrik Müller-Groeling (04/20 - 08/20) and Ben Höber (10/19 - 02/20)

Master students

Benoît Dubus (09/22 - now), Kobe Vergaerde (09/22 - now), Mireia Tolosa-Simeón (10/20 - 10/21), Álvaro Parra-López (10/20 - 10/21) and Neil Dowling (10/19 - 09/20)

Service

19-20 **Founder of Dedda**, a former student group helping students with mental problems — *Heidelberg University*
22-now **Referee**, for PLR

Referees

Prof. Dr. Nicolas Cerf
Professor at the Center for Quantum Information & Communication
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Prof. Dr. Markus Oberthaler
Professor at the Kirchhoff Institute for Physics, Heidelberg
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Priv.-Doz. Dr. Martin Gärttner
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Preprints & Publications

Preprints

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Publications

9. Quantum field simulator for dynamics in curved spacetime

Nature 611, 260–264

Celia Viermann, Marius Sparn, Nikolas Liebster, Maurus Hans, Elinor Kath, Álvaro Parra-López, Mireia Tolosa-Simeón, Natalia Sánchez-Kuntz, **Tobias Haas**, Helmut Strobel, Stefan Floerchinger and Markus K. Oberthaler

11/22

Experimental implementation of analogs of spatially curved FLRW universe in a Bose-Einstein condensate showing the effect of cosmological particle production in the lab.

8. Curved and expanding spacetime geometries in Bose-Einstein condensates

PRA 106, 033313

Mireia Tolosa-Simeón, Álvaro Parra-López, Natalia Sánchez-Kuntz, **Tobias Haas**, Celia Viermann, Marius Sparn, Nikolas Liebster, Maurus Hans, Elinor Kath, Helmut Strobel, Markus K. Oberthaler and Stefan Floerchinger

09/22

A one-to-one correspondence between phonons in a Bose-Einstein condensate and a free scalar field in a time-dependent FLRW universe allowing to study cosmological particle production is established.

7. Scalar quantum fields in cosmologies with 2+1 spacetime dimensions

PRD 105, 105020

Natalia Sánchez-Kuntz, Álvaro Parra-López, Mireia Tolosa-Simeón, **Tobias Haas** and Stefan Floerchinger

05/22

Study of a scalar quantum field in spatially curved FLRW backgrounds in $d = 2 + 1$ dimensions.

6. Relative entropic uncertainty relation for scalar quantum fields

SciPost Phys. 12, 089

Stefan Floerchinger, **Tobias Haas** and Markus Schröfl

03/22

The first entropic uncertainty relation for a quantum field theory is formulated by using functional relative entropy.

5. Entropic entanglement criteria in phase space

PRA 105, 012409

Stefan Floerchinger, Martin Gärttner, **Tobias Haas** and Oliver R. Stockdale

01/22

A strong and experimentally accessible entropic entanglement witness in phase space is derived for an entropy of the Husimi Q-distribution.

4. Wehrl entropy, entropic uncertainty relations, and entanglement

PRA 103, 062222

Stefan Floerchinger, **Tobias Haas** and Henrik Müller-Groeling

06/21

A study of the Wehrl-Lieb inequality as an entropic uncertainty relation in phase space and of the Wehrl mutual information, which turns out to be a measurable perfect witness for pure state entanglement.

3. Relative entropic uncertainty relation

PRA 103, 062209

Stefan Floerchinger, **Tobias Haas** and Ben Hoeber

06/21

Common entropic uncertainty relations for discrete and continuous variables are reformulated and unified in terms of relative entropy.

2. Thermodynamics from relative entropy

PRE 102, 052117

Stefan Floerchinger and **Tobias Haas**

11/20

The maximum entropy principle is replaced by the minimum expected relative entropy principle, allowing for an information geometric interpretation of maximum entropy states and a formulation of thermodynamics in terms of thermal model states without the necessity of the actual states being thermal.

1. Second law of thermodynamics for relativistic fluids formulated with relative entropy

PRD 102, 105002

Neil Dowling, Stefan Floerchinger and **Tobias Haas**

11/20

Second law-like inequalities are obtained from the monotonicity property of quantum relative (entanglement) entropy, which is applied to open quantum systems in the context of local quantum field theory and relativistic fluids.

Conferences & Workshops

Conference: DPG Verhandlungen der Sektion Materie und Kosmos

Online

Title: Relative entropic uncertainty relation for scalar quantum fields

09/21

Contributed a talk.

Workshop: Entanglement in Quantum Fields

Heidelberg

Title: Entropic entanglement criteria in phase space

06/21

Contributed a talk.

Student Workshop: Entanglement *Schöntal*

Title: Entanglement and General Relativity: Black hole information paradox *09/20*

Co-organized the workshop and contributed a talk.

Student Workshop: Entropy *Schöntal*

Title: The role of entropy in statistical physics *09/19*

Contributed a talk.