

Elements of Quantum Information

Edited by

Wolfgang P. Schleich and Herbert Walther



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Herbert Walther*

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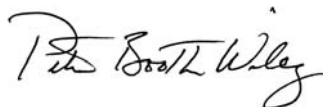
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The Editors

Prof. Dr. Wolfgang P. Schleich
Universität Ulm
Abteilung f. Quantenphysik
Albert-Einstein-Allee 11
89069 Ulm
Germany

Prof. Dr. Herbert Walther †
MPI für Quantenoptik
Hans-Kopfermann-Str. 1
85748 Garching
Germany

Cover Image

Segmented linear Paul trap, University of Ulm, Germany (2006) by S. Schulz and F. Schmidt-Kaler.

The trap is fabricated from gold coated ceramic wafers which are structured by fs-laser pulses. The large number of 12 segments in the 500 μm wide loading zone – at the right hand side of the slit – and 19 segments in the 250 μm wide processor zone of this trapping device allow to scale-up quantum computing with trapped ions.

The article *Optimization of Segmented Linear Paul Traps and Transport of Stored Particles* by S. Schulz, U. Poschinger, K. Singer, and F. Schmidt-Kaler explains how to transport ions in this device fast but without any heating effects.

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Preface to the Book Edition

Elements of Quantum Information is based on a collection of articles previously published in a special issue of *Fortschritte der Physik/Progress of Physics*. It summarizes the results obtained in a collaboration of scientists from Bavaria and Baden-Württemberg working in the field of quantum information processing. This research effort was coordinated by H. Walther and W.P. Schleich. Despite his illness H. Walther was part of the project until his un-timely death on July 22, 2006, at which time all manuscripts were already in press. Unfortunately, he never saw the special issue nor the present book in their final forms.

Ulm, November 2006

W.P. Schleich

Preface to the Journal Edition

Quantum information processing has come a long way – from the early ideas of a quantum computer, put forward by Richard Feynman and David Deutsch in the early eighties, via the factorization algorithm of Peter Shor, to the present day quantum optical realisations of quantum gates. This newly emerging branch of quantum physics has united many disciplines by encompassing computer science, physics, mathematics as well as engineering. The potential gain in using the resources of quantum mechanics is enormous.

The governments of Baden-Württemberg and Bavaria have recognized the importance of quantum information and have dedicated substantial support to its development. Four years ago 12 groups from Baden-Württemberg and 6 groups from Bavaria joined forces to collaborate on this topic. Since all groups were located (more or less) along the highway A8 the descriptive title *Quantum Information Highway A8* was chosen for this project. We are also very proud that our colleague and collaborator in the *Quantum Information Highway A8*, Prof. Dr. Theodor Hänsch, Munich, was awarded the Nobel Prize 2005.

The present special issue represents a state of the art summary of the various projects of the *Quantum Information Highway A8*. The contribution by Reichle et al. is a slight exception to this program. It summarizes the approach taken by the Wineland group in Boulder (Colorado) and, therefore, lies outside of the *Quantum Information Highway A8*. Since the theme of this work complements that of the article by Schulz et al. and the paper was prepared in Ulm with the assistance of the *Quantum Information Highway A8* we have decided to include it in this issue. Moreover, it demonstrates clearly one of the many international connections of this collaboration.

We take this opportunity to express our sincere thanks to our sponsors and the enthusiastic support of Dr. Heribert Knorr from the Ministerium für Wissenschaft, Forschung und Kunst Baden-Württemberg and the late Dr. Christian Schubert and his successor Felix Köhl from the Bayerisches Staatsministerium für Wissenschaft, Forschung und Kunst, without them the idea of a quantum information highway would have never materialized. We are most grateful for the financial support provided by the Landesstiftung Baden-

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Wolfgang P. Schleich and Herbert Walther

List of Contributors

Thomas Amthor

Physikalisches Institut
Universität Freiburg
Hermann-Herder-Str. 3
79104 Freiburg
Germany
t.amthor@physik.uni-freiburg.de

Ulrik L. Andersen

Building 309
Danmarks Tekniske Universitet
(DTU)
2800 Lyngby
Denmark
ulrik.andersen@fysik.dtu.dk

Ilya Sh. Averbukh

Department of Chemical Physics
Weizmann Institute of Science
Rehovot 76100
Israel
ilya.averbukh@weizmann.ac.il

Dmitry A. Bagrets

Institut für Nanotechnologie
Forschungszentrum Karlsruhe
Postfach 3640
76021 Karlsruhe
Germany
dmitry.bagrets@int.fzk.de

Brad Rodney Blakestad

Time and Frequency Division
National Institute of Standards and
Technology
325 Broadway
Boulder, CO 80305
USA
brad.blakestad@nist.gov

Immanuel Bloch

Max-Planck-Institut für Physik
Johannes-Gutenberg-Universität
Staudingerweg 7
55099 Mainz
Germany
bloch@uni-mainz.de

Mohamed Bourennane

Physics Department
Stockholm University
10691 Stockholm
Sweden
boure@physto.se

Karl-Heinz Brenner

Lehrstuhl für Optoelektronik
Universität Mannheim
B 6, 27–29
68131 Mannheim
Germany
brenner@rumms.uni-mannheim.de

Joe Britton

Time and Frequency Division
National Institute of Standards and
Technology
325 Broadway
Boulder, CO 80305
USA
britton@nist.gov

Thorsten Bschorr

Institut für Quantenphysik
Universität Ulm
89069 Ulm
Germany

Giovanni Cennini

Philips Research
High Tech Campus 37
5656AE Eindhoven
The Netherlands
giovanni.cennini@philips.com

Ignacio Cirac

Max-Planck-Institut für
Quantenoptik
Hans-Kopfermann-Str. 1
85748 Garching
Germany
ignacio.cirac@mpq.mpg.de

Yves Colombe

Laboratoire Kastler Brossel de
l'E.N.S.
24 Rue Lhomond
75231 Paris Cedex 05
France
yves.colombe@lkb.ens.fr

Philippe Courteille

Physikalisches Institut
Universität Tübingen
Auf der Morgenstelle 14
72076 Tübingen
Germany
courteille@pit.physik.uni-
tuebingen.de

André Luiz de Oliveira

UDESC – Universidade do Estado
de Santa Catarina
Departamento de Física
Joinville, SC 89223-100
Brazil
andre@joinville.udesc.br

Thomas Decker

Institut für Algorithmen und
Kognitive Systeme (IAKS)
Fakultät für Informatik
Universität Karlsruhe (TH)
Postfach 6980
76128 Karlsruhe
Germany
decker@ira.uka.de

Johannes Deiglmayr

Physikalisches Institut
Universität Freiburg
Hermann-Herder-Str. 3
79104 Freiburg
Germany
j.deiglmayr@physik.uni-freiburg.de

Thomas Fernholz

Van der Waals-Zeeman Instituut
Universiteit van Amsterdam
1018 XE Amsterdam
The Netherlands
tfernhol@science.uva.nl

Matthias Freyberger

Institut für Quantenphysik
 Universität Ulm
 89069 Ulm
 Germany
 matthias.freyberger@uni-ulm.de

Sascha Gaertner

Ludwig-Maximilians-Universität
 80799 Munich
 and
 Max-Planck-Institut für
 Quantenoptik
 Hans-Kopfermann-Str. 1
 85748 Garching
 Germany
 s.gaertner@mpq.mpg.de

Carsten Geckeler

Physikalisches Institut
 Universität Tübingen
 Auf der Morgenstelle 14
 72076 Tübingen
 Germany
 geckeler@pit.physik.uni-
 tuebingen.de

Bertrand Girard

Laboratoire Collisions, Agrégats,
 Réactivité
 CNRS UMR 5589 – IRSAMC
 Université Paul Sabatier
 118 route de Narbonne
 31062 Toulouse Cedex 04
 France
 bertrand.girard@irsamc.ups-tlse.fr

Oliver Glöckl

Institut für Optik, Information und
 Photonik
 Max-Planck-Forschungsgruppe
 Universität Erlangen-Nürnberg
 Günther-Scharowsky-Str. 1
 91058 Erlangen
 Germany

Dmitri S. Golubev

Institut für Nanotechnologie
 Forschungszentrum Karlsruhe
 Postfach 3640
 76021 Karlsruhe
 Germany
 dmitri.golubev@int.fzk.de

Axel Grabowski

Physik Instrumente (PI) GmbH &
 Co. KG
 Auf der Römerstraße 1
 76228 Karlsruhe
 Germany

Markus Grassl

Institut für Algorithmen und
 Kognitive Systeme (IAKS)
 Fakultät für Informatik
 Universität Karlsruhe (TH)
 Postfach 6980
 76128 Karlsruhe
 Germany
 grassl@ira.uka.de

Markus Greiner

Department of Physics
 Harvard University
 17 Oxford Street
 Cambridge, MA 02138
 USA
 greiner@physics.harvard.edu

Sönke Groth

Physikalisches Institut
Universität Heidelberg
Philosophenweg 12
69120 Heidelberg
Germany
groth@physi.uni-heidelberg.de

Albrecht Haase

ICFO – Institut de Ciències
Fotòniques
Parc Mediterrani de la Tecnologia
Av. del Canal Olímpic s/n
08860 Castelldefels, (Barcelona)
Spain
albrecht.haase@icfo.es

Daniel Haase

Institut für Zahlentheorie und
Wahrscheinlichkeitstheorie
Universität Ulm
Helmholtzstraße 18
89069 Ulm
Germany
daniel.haase@uni-ulm.de

Peter Hänggi

Institut für Physik
Universität Augsburg
Universitätsstraße 1
86135 Augsburg
Germany
peter.hanggi@physik.uni-
augsburg.de

Theodor W. Hänsch

Max-Planck Institut für
Quantenoptik und
Sektion Physik der Ludwig-
Maximilians-Universität
Schellingstr. 4
80799 München
Germany
t.w.haensch@physik.lmu.de

Andreas Heidebrecht

2. Physikalisches Institut
Universität Stuttgart
Pfaffenwaldring 57
70569 Stuttgart
Germany
a.heidebrecht@physik.uni-
stuttgart.de

Rolf Heidemann

5. Physikalisches Institut
Universität Stuttgart
Pfaffenwaldring 57
70569 Stuttgart
Germany
R.Heidemann@physik.uni-
stuttgart.de

Dennis Heine

Physikalisches Institut
Universität Heidelberg
Philosophenweg 12
69120 Heidelberg
Germany
heine@physi.uni-heidelberg.de

Björn Hessmo

Atomic Institute of the Austrian
Universities
Vienna University of Technology
Stadionallee 2
1020 Vienna
Austria
hessmo@atomchip.org

Peter Hommelhoff

Varian Physics Building
382 Via Pueblo Mall
Stanford University
Stanford, CA 94305
USA
hommelhoff@stanford.edu

Dominik Janzing

Institut für Algorithmen und
Kognitive Systeme
Fakultät für Informatik
Universität Karlsruhe (TH)
Am Fasanengarten 5
76131 Karlsruhe
Germany
janzing@ira.uka.de

John D. Jost

Time and Frequency Division
National Institute of Standards and
Technology
325 Broadway
Boulder, Colorado 80305
USA
john.jost@nist.gov

Emanuel (Manny) Knill

Mathematical and Computational
Sciences Division
National Institute of Standards and
Technology
325 Broadway
Boulder, Colorado 80305
USA
knill@boulder.nist.gov

Markus Kohler

Physikalisches Institut
Universität Tübingen
Auf der Morgenstelle 14
72076 Tübingen
Germany
kohler@pit.physik.uni-tuebingen.de

Sigmund Kohler

Institut für Physik
Universität Augsburg
Universitätsstraße 1
86135 Augsburg
Germany
sigmund.kohler@physik.uni-
augsburg.de

Christian Kurtsiefer

Department of Physics
National University of Singapore
Singapore 117 542
Singapore
phyck@nus.edu.sg

Chris Langer

Time and Frequency Division
National Institute of Standards and
Technology
325 Broadway
Boulder, Colorado 80305
USA
chris.langer@nist.gov

Dietrich Leibfried

Time and Frequency Division
National Institute of Standards and
Technology
325 Broadway
Boulder, Colorado 80305
USA
dil@boulder.nist.gov

Gerd Leuchs

Institut für Optik, Information und
Photonik
Max-Planck-Forschungsgruppe
Universität Erlangen-Nürnberg
Günther-Scharowsky-Strasse 1
91058 Erlangen
Germany
leuchs@physik.uni-erlangen.de

Benjamin Lev

Department of Physics
UCB/JILA
Boulder, CO 80309-0440
USA
benlev@jila.colorado.edu

Xiyuan Liu

Lehrstuhl für Optoelektronik
Universität Mannheim
B 6, 27-29
68131 Mannheim
Germany
xiyuanl@rumms.uni-mannheim.de

Robert Löw

5. Physikalisches Institut
Universität Stuttgart
Pfaffenwaldring 57
70550 Stuttgart
Germany
r.loew@physik.uni-stuttgart.de

Günter Mahler

1. Institut für Theoretische Physik
Universität Stuttgart
Pfaffenwaldring 57
70550 Stuttgart
Germany
guenter.mahler@itp1.uni-
stuttgart.de

Helmut Maier

Institut für Zahlentheorie und
Wahrscheinlichkeitstheorie
Universität Ulm
Helmholtzstraße 18
89069 Ulm
Germany
hamaier@mathematik.uni-ulm.de

Olaf Mandel

Varian Physics Building
Stanford University
382 Via Pueblo Mall
Stanford, CA 94305
USA
mandel@stanford.edu

Luis Gustavo Marcassa

USP – Universidade de São Paulo
Istituto de Física
São Carlos, SP 13560-970
Brazil
marcassa@if.sc.usp.br

Michael Mehring

2. Physikalisches Institut
Universität Stuttgart
Pfaffenwaldring 57
70569 Stuttgart
Germany
m.mehring@physik.uni-stuttgart.de

Jens Mende

Institut für Technische Physik
 Deutsches Zentrum für Luft- und
 Raumfahrt e.V.
 Pfaffenwaldring 38-40
 70569 Stuttgart
 Germany
 jens.mende@dlr.de

Wolfgang Merkel

Institut für Quantenphysik
 Albert-Einstein-Allee 11
 89081 Ulm
 Germany
 wolfgang.merkel@uni-ulm.de

Roe Ozeri

Time and Frequency Division
 National Institute of Standards and
 Technology
 325 Broadway
 Boulder, Colorado 80305
 USA
 roee.ozeri@nist.gov

Gerhard G. Paulus

Department of Physics
 Texas A&M University
 College Station, TX 77843
 USA
 ggpaulus@tamu.edu

Tilman Pfau

5. Physikalisches Institut
 Universität Stuttgart
 Pfaffenwaldring 57
 70550 Stuttgart
 Germany
 t.pfau@physik.uni-stuttgart.de

Markus Popp

Max-Planck-Institut für
 Quantenoptik
 Hans-Kopfermann-Str. 1
 85748 Garching
 Germany
 markus.popp@mpq.mpg.de

Ulrich Poschinger

Abteilung Quanten-
 Informationsverarbeitung
 Universität Ulm
 Albert-Einstein-Allee 11
 86069 Ulm
 Germany
 ulrich.poschinger@uni-ulm.de

Stefan Probst-Schendzielorz

Institut für Quantenphysik
 Universität Ulm
 89069 Ulm
 Germany
 Stefan.probst@uni-ulm.de

Markus Reetz-Lamour

Universität Freiburg
 Physikalisches Institut
 Hermann-Herder-Str. 3
 79104 Freiburg
 Germany
 m.rlamour@physik.uni-freiburg.de

Nadja Regner

Department für Physik
 Ludwig-Maximilians-Universität
 München
 Oettingenstr. 67
 80538 Munich
 Germany
 nadja.regner@physik.uni-
 muenchen.de

Jakob Reichel

Laboratoire Kastler Brossel de
l'E.N.S
24 Rue Lhomond
75231 Paris Cedex 05
France
jakob.reichel@ens.fr

Rainer Reichle

Abteilung Quanten-
Informationsverarbeitung
Universität Ulm
Albert Einstein Allee 11
89069 Ulm
Germany
rainer.reichle@uni-ulm.de

Gunnar Ritt

Forschungsinstitut für Optronik und
Mustererkennung
Gutleuthausstr. 1
76275 Ettlingen
Germany
ritt@fom.fgan.de

Tim Rom

Institut für Physik
Johannes-Gutenberg-Universität
Staudingerweg 7
55099 Mainz
Germany
rom@uni-mainz.de

Tobias Salger

Institut für Angewandte Physik
Universität Bonn
Wegelerstr. 8
53115 Bonn
Germany
Salger@iap.uni-bonn.de

Wolfgang P. Schleich

Institut für Quantenphysik
Universität Ulm
Albert-Einstein-Allee 11
89081 Ulm
Germany
wolfgang.schleich@uni-ulm.de

Christian Schmid

Ludwig-Maximilians-Universität
80799 Munich
and
Max-Planck-Institut für
Quantenoptik
Hans-Kopfermann-Straße 1
85748 Garching
Germany
christian.schmid@mpq.mpg.de

Ferdinand Schmidt-Kaler

Abteilung Quanten-
Informationsverarbeitung
Universität Ulm
Albert-Einstein-Allee 11
89069 Ulm
Germany
ferdinand.schmidt-kaler@uni-
ulm.de

Jörg Schmiedmayer

Atomic Institute of the Austrian
Universities
Vienna University of Technology
Stadionallee 2
1020 Vienna
Austria
schmiedmayer@atomchip.org