

Dr. Andreas Ruschhaupt

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Overview

Scientific publications in international, refereed journals:	67
Scientific book chapters:	3
Scientific Books (as editor):	1
Total number of citations (Web of Science):	2715
h-Index (Web of Science):	21

One of the **founder of the research field of quantum control via “Shortcuts to Adiabaticity” (STA)** (Phys. Rev. Lett. 104 (2010) 063002, more than 300 citations), an internationally strongly growing field with the goal of developing new schemes for controlling quantum systems for quantum technologies; author of two review papers on STA (Adv. At. Mol. Opt. Phys. 62, 117 (2013), more than 300 citations, and Rev. Mod. Phys. 91, 045001 (2019))

Invited MC Member for Ireland of the COST Action CA17113: “Trapped Ions: Progress in classical and quantum applications” and the COST Action CA16221: AtomQT, “Quantum Technologies with Ultra-Cold Atoms”

Invited member of the EU “Quantum Flagship: Strategic Research Agenda Working Group”, selected as one of approx. 50 international experts to design the future strategy of the € 1 Billion European Quantum Flagship

Total number of taught lecture courses (including course developments): **46**
(Broad spectrum of specialised courses, fundamental courses, service teaching with up to 300 students, always excellent evaluations from the students)

Education

17/11/2009	“Habilitation” in Theoretical Physics (Quantum Optics), Technical University of Braunschweig (Germany)
20/12/2001	Doctor of natural sciences/Physics (Mathematical Physics), University of Bielefeld (Germany) Doctoral grade: ausgezeichnet (“with distinction”, best possible grade) Supervisor: Prof. Dr. Ph. Blanchard
31/03/1998:	Diploma in Physics , University of Bielefeld (Germany) Diploma grade: ausgezeichnet (“with distinction”, best possible grade) Supervisor: Prof. Dr. Ph. Blanchard

Employment

- Since 09/2012 **Lecturer in Physics** (Permanent position) with own research group working on “Quantum Control via Shortcuts to Adiabaticity”, University College Cork, Cork (Ireland)
- 11/2005 – 08/2012 **Junior Professor** at the Technical University of Braunschweig (Germany) and at the Leibniz University of Hanover (Germany) in the quantum information group of Prof. Dr. R. F. Werner. Main achievements during this period were:
- Founder of the research field of “Shortcuts to Adiabaticity”
 - Important improvements in the theory of “Quantum Mechanics of Time” and their applications in the tomography of single-photons
- 05/2003 - 09/2005 **Postdoctoral position** at the University of the Basque Country (Bilbao, Spain) in the quantum optics group of Prof. Dr. J. G. Muga. Main achievements during this time were:
- Invention of the atom diode
 - First proposal of a physical realization of Parity-Time (PT) symmetric potentials
- 04/2002 - 03/2003 **Postdoctoral position** at the University of Bielefeld (Germany) in the mathematical physics group of Prof. Dr. Ph. Blanchard
- 04/1998 - 12/2001 **Doctoral study** at the University of Bielefeld (Germany) in the mathematical physics group of Prof. Dr. Ph. Blanchard

Research Grants (Selection)

- Since 2020 **SFI Frontiers of the Future Project “Shortcut-Enhanced Quantum Thermodynamics” as principal investigator (€ 599,073 total grant, € 338,185 direct costs for A. Ruschhaupt)**
- Since 2018 Invited MC Member for Ireland of the COST Action CA17113: „Trapped Ions: Progress in classical and quantum applications“ (€ **2000** travel costs until now)
Invited MC Member for Ireland of the COST Action CA16221: AtomQT, „Quantum Technologies with Ultra-Cold Atoms“ (€ **2000** travel costs until now)
- Since 2017 Supervisor of Irish Research Council Postgraduate Grant for a PhD student (€ **95,000**)
- Since 2015 Supervisor of Irish Research Council Postgraduate Grant for a PhD student (€ **95,000**)
- 2014 - 2015 Science Foundation Ireland (SFI) ISCA Japan Grant: travel grant for collaboration with Japan (€ **2000**)
- 2009 - 2013 EPHQUAM Network Grant (Germans Ministry): development of tomography of single-photon sources (€ **142,000**, A. Ruschhaupt allocation)
- 2008 - 2010 German Research Foundation (DFG) project: new applications for the atom diode (€ **57,000**)

Most-cited publication

E. Torrontegui, S. Ibáñez, S. Martínez-Garaot, M. Modugno, A. del Campo, D. Guéry-Odelin, A. Ruschhaupt, X. Chen and J. G. Muga, “Shortcuts to Adiabaticity”, *Advances In Atomic, Molecular, And Optical Physics*, 62, 117 (2013) **(358 citations)**

A. Ruschhaupt, F. Delgado and J. G. Muga, “Physical realization of PT-symmetric potential scattering in a planar slab waveguide”, *Journal of Physics A* 38, L171-L176 (2005) **(318 citations)**

X. Chen, A. Ruschhaupt, S. Schmidt, A. del Campo, D. Guéry-Odelin and J. G. Muga, “Fast Optimal Frictionless Atom Cooling in Harmonic Traps: Shortcut to Adiabaticity”, *Physical Review Letters* 104, 063002 (2010) **(303 citations)**

X. Chen, I. Lizuain, A. Ruschhaupt, D. Guéry-Odelin and J. G. Muga, “Shortcut to Adiabatic Passage in Two- and Three-Level Atoms”, *Physical Review Letters* 105, 123003 (2010) **(276 citations)**

A. Ruschhaupt, X. Chen, D. Alonso and J.G. Muga, “Optimally robust shortcuts to population inversion in two-level quantum systems”, *New Journal of Physics* 14, 093040 (2012) **(159 citations)**

Impact of Own Research

- **One of the founder of the research field “Shortcuts to Adiabaticity” (STA)** in 2010 (*Phys. Rev. Lett* 104, 063002 (2010, more than 300 citations); currently many international groups are working in this field (see also the two review paper on STA (*Adv. At. Mol. Opt. Phys.* 62, 117 (2013), 358 citations, und *Rev. Mod. Phys.* 91, 045001 (2019)); development of new methods for the optimisation of the stability of STA (*New J. Phys.* 14, 093040 (2012)). My reserach group is continuing to develop new precise, fast and stable STA schemes for quantum systems, to overcome one of the main roadblocks for future quantum technology, namely decoherence.
- My work on the simulation of chemical reactions with cold atoms (*Phys. Rev. A* 83 (2011) 013415) has been selected as one of the three references to represent the field of „Simulations“ in the **White House Report „Advancing Quantum Information Science: National Challenges and Opportunities (July 2016)“**
- Invention of the atom diode together with J. G. Muga (*Phys. Rev. A* 70, 061604 (2004)), This atom diode was also used, in collaboration with M. G. Raizen, for proposing an optical realisation of Maxwell's demon.
- My proposal to realise **PT (parity-time) symmetry in optical devices** (*J. Phys. A* 38 (2005) L171, 318 citations) has already opened an entire new field and is considered, e.g., in **Nat. Phys. 11 (2015) 799**, among **one of the top ten Physics discoveries of the last ten years**.

Supervision

PhD Theses: **1** (current, since Oct. 2017) / **1** (starting in 2021) / **3** (completed)

Master/Diploma Theses: **2** (current) / **5** (project completed)

Post-doctoral student: **1** (project completed) / **1** (starting in 2021)

Bachelor/4th year projects: **20** (completed)

(Three of my 4th year project students have started as a PhD student in my research group, two of the projects have resulted in scientific papers)

Summer Research projects: **10** (completed)

(8 weeks each for physics students)

Lectures

Total number of independently taught modules: 46

Lectures in English (Selection):

Quantum Mechanics, Advanced Quantum Mechanics, Nuclear and Particle Physics, Quantum Optics, Introduction to Computational Physics, Environmental Physics (service teaching), Physics for biology (Service teaching with approx. 300 students)

Lectures in German (Selection):

Statistische Physik, Theoretische Physik für Lehramtsstudierende, Numerische Modellierung, Quantentheorie, Quantenoptik, Mathematik-Vorkurs für Physiker

Leadership

Since 2019	Chair for the development and implementation of the new BSc degree programme "Theoretical Physics" in University College Cork
Since 2019	Chair for the development and implementation of the new annual summer school for US students in University College Cork
Since 2019	Invited member of the EU "Quantum Flagship: Strategic Research Agenda Working Group", selected as one of approx. 50 international experts to design the future strategy of the € 1 Billion European Quantum Flagship
2017	Chair of the sub-committee "Quantum Optics and Quantum Technology" at "Photonics Ireland 2017" (Galway, Ireland)
2016	Organizer of the summer school "Shortcuts to Adiabaticity 2016" in Cork
2015	Chair of the sub-committee "Quantum Optics and Quantum Technology" at "Photonics Ireland 2015" (Cork, Ireland)
2014	Invited Organizer of the international workshop "Shortcuts to Adiabaticity 2014" in Shanghai (China)
2012	Invited Organizer of the international workshop "Shortcuts to Adiabaticity 2012" in Bilbao (Spain) (20 invited speakers, 55 participants from 16 different states)
2007 - 2009	Responsible for the development and implementation of a new master degree in physics at the TU Braunschweig

Guest editor / Book (as editor)

Guest editor of the journal “Entropy”, special Issue on “Shortcuts to Adiabaticity” (2019/20)

Guest editor of the journal “Mathematics”, special issue on “Time and Time Dependence in Quantum Mechanics” (2018/19)

“Time in Quantum Mechanics - Vol. 2”, Lecture Notes in Physics, Vol. 789 (Springer, 2009)

J. G. Muga, A. Ruschhaupt und A. del Campo (editors)

Publications in international, refereed journals

A. Ruschhaupt, A. Kiely, M. A. Simon and J. G. Muga, “Quantum-optical implementation of non-Hermitian potentials for asymmetric scattering”, Phys. Rev. A (2020), in print

C. Whitty, A. Kiely and A. Ruschhaupt, “Quantum control via enhanced shortcuts to adiabaticity”, Physical Review Research 2, 023660 (2020)

D. Guéry-Odelin, A. Ruschhaupt, A. Kiely, E. Torrontegui, S. Martínez-Garaot and J. G. Muga, “Shortcuts to adiabaticity: Concepts, methods, and applications”, Rev. Mod. Phys. 91, 045001 (2019)

A. Kiely, J. G. Muga and A. Ruschhaupt, “Selective population of a large angular momentum state in an optical lattice”, Physical Review A 98, 053616 (2018)

X.-J. Lu, A. Ruschhaupt and J. G. Muga, “Fast shuttling of a particle under weak spring-constant noise of the moving trap”, Physical Review A 97, 053402 (2018)

T. Dowdall and A. Ruschhaupt, “Trapping and cooling particles using a moving atom diode and an atomic mirror”, Physical Review A 97, 013412 (2018)

M. Pons, Y. Y. Cui, A. Ruschhaupt, M. A. Simón and J. G. Muga, “Local rectification of heat flux”, EPL 119, 64001 (2017)

T. Dowdall, A. Benseny, Th. Busch and A. Ruschhaupt, “Fast and robust quantum control based on Pauli blocking”, Physical Review A 96, 043601 (2017)

E. Torrontegui, I. Lizuain, S. González-Resines, A. Tobalina, A. Ruschhaupt, R. Kosloff and J. G. Muga, “Energy consumption for shortcuts to adiabaticity”, Physical Review A 96, 022133 (2017)

A. Benseny, A. Kiely, Y. Zhang, T. Busch and A. Ruschhaupt, “Spatial non-adiabatic passage using geometric phases”, EPJ Quantum Technology 4, 3 (2017)

A. Kiely, J. G. Muga and A. Ruschhaupt, “Effect of Poisson noise on adiabatic quantum control”, Physical Review A 95, 012115 (2017)

A. Kiely, A. Benseny, Th. Busch and A. Ruschhaupt, “Shaken, not stirred: Creating exotic angular momentum states by shaking an optical lattice”, Journal of Physics B 49, 215003 (2016)

M. Palmero, S. Martinez-Garaot, U. G. Poschinger, A. Ruschhaupt and J. G. Muga, “Fast separation of two trapped ions”, New Journal of Physics 17, 093031 (2015)

S. Martínez-Garaot, A. Ruschhaupt, J. Gillet, Th. Busch and J. G. Muga, “Fast quasiadiabatic dynamics”, Physical Review A 92, 043406 (2015)

M. Ndong, G. Djotyan, A. Ruschhaupt and S. Guerin, “Robust coherent superposition of states by single-shot shaped pulse”, Journal of Physics B 48, 174007 (2015)

X.-J. Lu, M. Palmero, A. Ruschhaupt, Xi Chen and J. G. Muga, “Optimal transport of two ions under slow spring-constant drifts”, Physica Scripta 90, 074038 (2015)

A. Kiely, J. P. L. McGuinness, J. G. Muga and A. Ruschhaupt, “Fast and stable manipulation of a charged particle in a Penning trap”, Journal of Physics B 48, 07550 (2015)

X-L Lu, J.G. Muga, X. Chen, U. G. Poschinger, F. Schmidt-Kaler and A. Ruschhaupt, „Fast shuttling of a trapped ion in the presence of noise“, *Physical Review A* 89, 063414 (2014)

A. Kiely and A. Ruschhaupt, „Inhibiting unwanted transitions in population transfer in two- and three-level quantum systems“, *Journal of Physics B* 47, 115501 (2014)

E. Torrontegui, S. Ibáñez, S. Martínez-Garaot, M. Modugno, A. del Campo, D. Guéry-Odelin, A. Ruschhaupt, X. Chen and J. G. Muga, “Shortcuts to Adiabaticity”, *Advances In Atomic, Molecular, And Optical Physics*, 62, 117 (2013) (358 citations)

D. Daems, A. Ruschhaupt, D. Sugny and S. Guérin, “Robust Quantum Control by a Single-Shot Shaped Pulse”, *Physical Review Letters* 111, 050404 (2013) (80 citations)

A. Ruschhaupt and J.G. Muga, „Shortcuts to adiabaticity in two-level systems: control and optimization“, *Journal of Modern Optics* DOI:10.1080/09500340.2013.846431 (2013)

X-L Lu, X. Chen, A. Ruschhaupt, D. Alonso, S. Guérin and J.G. Muga, „Fast and robust population transfer in two-level quantum systems with dephasing noise and/or systematic frequency errors“, *Physical Review A* 88 , 033406 (2013)

J. Kiukas, A. Ruschhaupt and R.F. Werner, „Full counting statistics of stationary particle beams“, *Journal of Mathematical Physics* 54, 042109 (2013)

A. Ruschhaupt, X. Chen, D. Alonso and J.G. Muga, “Optimally robust shortcuts to population inversion in two-level quantum systems”, *New Journal of Physics* 14, 093040 (2012) (159 citations)

S. Ibáñez, X. Chen, E. Torrontegui, J. G. Muga and A. Ruschhaupt, “Multiple Schrödinger Pictures and Dynamics in Shortcuts to Adiabaticity”, *Physical Review Letters* 109, 100403 (2012) (121 citations)

V.P. Singh and A. Ruschhaupt, „Optimizing the catching of atoms or molecules in two-dimensional traps“, *Physical Review A* 86, 043834 (2012)

E. Torrontegui, S. Martinez-Garaot, A. Ruschhaupt, and J. G. Muga, „Shortcuts to adiabaticity: Fast-forward approach“, *Physical Review A* 86, 013601 (2012)

J. Kiukas, A. Ruschhaupt, P. O. Schmidt and R. F. Werner, „Exact Energy-Time Uncertainty Relation for Arrival Time by Absorption“, *Journal of Physics A* 45, 185301 (2012)

W. Schmunk, M. Gramegna, G. Brida, I. P. Degiovanni, M. Genovese, H. Hofer, S. Kück, L. Lolli, M. G. A. Paris, S. Peters, M. Rajteri, A. M. Racu, A. Ruschhaupt, E. Taralli and P. Traina, „Photon Number Statistics of NV Centre Emission“, *Metrologia* 49, S156 (2012)

E. Torrontegui, X. Chen, M. Modugno, S. Schmidt, A. Ruschhaupt , D. Guéry-Odelin and J. G. Muga, „Transitionless expansion of cold atoms in optical Gaussian beam traps“, *Physical Review A* 85, 033605 (2012)

E. Torrontegui, X. Chen, M. Modugno, S. Schmidt, A. Ruschhaupt and J. G. Muga, „Fast transport of Bose-Einstein condensates“, *New Journal of Physics*, 14, 013031 (2012)

E. Torrontegui, S. Ibáñez, X. Chen, A. Ruschhaupt, D. Guéry-Odelin and J. G. Muga, “Fast atomic transport without vibrational heating”, *Physical Review A* 83, 013415 (2011) (131 citations)

E. Torrontegui, A. Ruschhaupt, D. Guéry-Odelin and J. G. Muga, „Simulation of quantum collinear chemical reactions with ultracold atoms“, *Journal of Physics B: At. Mol. Opt. Phys.* 44, 195302 (2011)

J. G. Muga, X. Chen, E. Torrontegui, S. Ibáñez, I. Lizuain and A. Ruschhaupt, „Shortcuts to quantum adiabatic processes“, *Journal of Physics: Conference Series* 306, 012022 (2011)

I. Lizuain, J. Echanobe, A. Ruschhaupt, J. G. Muga and D. A. Steck, „Structural and dynamical aspects of avoided-crossing resonances in a 3-level Λ system“, *Physical Review A* 82, 065602 (2010)

E. Torrontegui, J. Echanobe, A. Ruschhaupt, D. Guéry-Odelin and J. G. Muga, „Cold-atom dynamics in crossed-laser-beam waveguides“, *Physical Review A* 82, 043420 (2010)

E. Ya. Sherman, J. G. Muga, V. K. Dugaev and A. Ruschhaupt, „Strong electron spin-Hall effect by a coherent optical potential“, *Semiconductor Science and Technology* 25, 0905004 (2010)

J. G. Muga, X. Chen, S. Ibáñez, I. Lizuain and A. Ruschhaupt, „Transitionless quantum drivings for the harmonic oscillator“, Journal of Physics B 43, 085509 (2010)

X. Chen, A. Ruschhaupt, S. Schmidt, S. Ibáñez and J. G. Muga, „Review: Shortcut to adiabaticity in harmonic traps“, Journal of Atomic and Molecular Sciences 1, 1 (2010)

X. Chen, I. Lizuain, A. Ruschhaupt, D. Guéry-Odelin and J. G. Muga, “Shortcut to Adiabatic Passage in Two- and Three-Level Atoms”, Physical Review Letters 105, 123003 (2010) (276 citations)

X. Chen, A. Ruschhaupt, S. Schmidt, A. del Campo, D. Guéry-Odelin and J. G. Muga, “Fast Optimal Frictionless Atom Cooling in Harmonic Traps: Shortcut to Adiabaticity”, Physical Review Letters 104, 063002 (2010) (303 citations)

J. G. Muga, Xi Chen, A. Ruschhaupt and D. Guéry-Odelin, “Frictionless dynamics of Bose-Einstein condensates under fast trap variations”, Journal of Physics B: At. Mol. Opt. Phys. 42, 241001 (2009) (105 citations)

Xi Chen, J. G. Muga, A. del Campo and A. Ruschhaupt, „Atom cooling by nonadiabatic expansion“, Physical Review A 80, 063421 (2009)

S. Schmidt, J. G. Muga and A. Ruschhaupt, „Stopping particles of arbitrary velocities with an accelerated wall“, Physical Review A 80, 023406 (2009)

J. Kiukas, A. Ruschhaupt and R. F. Werner, „Tunneling Times with Covariant Measurements“, Foundation of Physics 39, 829-846 (2009)

A. Ruschhaupt, A. del Campo and J. G. Muga, „Momentum-space interferometry with trapped ultracold atoms“, Physical Review A 79, 023616 (2009)

A. Ruschhaupt and J. G. Muga, „Control of atomic motion with an atom-optical diode on a ring“, Journal of Physics B: At. Mol. Opt. Phys. 41, 205503 (2008)

A. Ruschhaupt and J. G. Muga, „The atom diode - A one-way laser barrier for cooling atoms“, European Physical Journal Special Topics 159, 127–134 (2008)

A. Ruschhaupt and J. G. Muga, „Three-dimensional effects in atom diodes: Atom-optical devices for one-way motion“, Physical Review A 76, 013619 (2007)

A. Ruschhaupt, A. del Campo and J. G. Muga, „Momentum interferences of a freely expanding Bose-Einstein condensate due to interatomic interaction change“, European Physical Journal D 40, 399-403 (2006)

F. Delgado, J. G. Muga and A. Ruschhaupt, „Preparation of ultralow atomic velocities by transforming bound states into tunneling resonances“, Physical Review A 74, 063618 (2006)

I. Lizuain, J. G. Muga and A. Ruschhaupt, „Laser excitation of transverse modes in an atomic waveguide“, Physical Review A 74, 053608 (2006)

A. Ruschhaupt, J. G. Muga and M. G. Raizen, „One-photon atomic cooling with an optical Maxwell's demon valve“, Journal of Physics B 39, 3833 (2006)

A. Ruschhaupt, J. G. Muga and M. G. Raizen, „Improvement by laser quenching of an ‘atom diode’: a one-way barrier for ultra-cold atoms“, Journal of Physics B 39, L133-L138 (2006)

A. Ruschhaupt and J. G. Muga, „Adiabatic interpretation of a two-level atom diode, a laser device for unidirectional transmission of ground-state atoms“, Physical Review A 73, 013608 (2006)

A. Ruschhaupt, F. Delgado and J. G. Muga, “Physical realization of PT-symmetric potential scattering in a planar slab waveguide”, Journal of Physics A 38, L171-L176 (2005) (318 citations)

A. Ruschhaupt, F. Delgado and J. G. Muga, „Velocity selection of ultra-cold atoms with Fabry-Perot laser devices: improvements and limits“, Journal of Physics B 38, 2665-2674 (2005)

Ph. Blanchard, T. Krueger and A. Ruschhaupt, „Small world graphs by iterated local edge formation“, Physical Review E 71, 046139 (2005)

A. Ruschhaupt and J. G. Muga, “Atom diode: a laser device for a unidirectional transmission of ground-state atoms”, *Physical Review A* 70, 061604(R) (2004) (62 citations)

A. Ruschhaupt and J. G. Muga, “Simultaneous Arrival of Information in Absorbing Waveguides”, *Physical Review Letters* 93, 020403 (2004)

A. Ruschhaupt, B. Navarro and J. G. Muga, „Perfect detection of ultra-cold atoms by laser-induced ionization“, *Journal of Physics B* 37, L313-319 (2004)

A. Ruschhaupt, J. A. Damborenea, B. Navarro, J. G. Muga and G. C. Hegerfeldt, „Exact and approximate complex potentials for modelling time observables“, *Europhysics Letters* 67, 1-7 (2004)

F. Delgado, J. G. Muga and A. Ruschhaupt, „Ultrafast propagation of Schrödinger waves in absorbing media“, *Physical Review A* 69, 022106 (2004)

F. Delgado, J. G. Muga, A. Ruschhaupt, G. Garcia-Calderon and J. Villavicencio, „Tunneling dynamics in relativistic and nonrelativistic wave equations“, *Physical Review A* 68, 032101 (2003)

I. L. Egusquiza, J. G. Muga, B. Navarro and A. Ruschhaupt, „Comment on: On the standard quantum-mechanical approach to times of arrival“, *Physics Letters A* 313, 498-501 (2003)

A. Ruschhaupt, „Relativistic time of arrival and traversal time“, *Journal of Physics A* 35, 10429-10443 (2002)

A. Ruschhaupt, „A relativistic extension of event enhanced quantum theory“, *Journal of Physics A* 35, 9227-9243 (2002)

Ph. Blanchard, A. Jadczyk and A. Ruschhaupt, „How events come into being: EEQT, particle tracks, quantum chaos and tunnelling time“, *Journal of Modern Optics* 47, 2247-2263 (2000)

A. Ruschhaupt, „Simulations of barrier traversal and reflection times based on event enhanced quantum theory“, *Physics Letters A* 250, 249-256 (1998)

Book Chapters

A. Ruschhaupt and R. F. Werner, “Quantum Mechanics of Time” in “The Message of Quantum Science” (Ph. Blanchard, J. Fröhlich, editors, Springer, 2015)

A. Ruschhaupt, J. G. Muga and G. C. Hegerfeldt, “Detector models for the quantum time of arrival”, in “Time in Quantum Mechanics - Vol. 2” (Lecture Notes in Physics, Vol. 789, 2009), J. G. Muga, A. Ruschhaupt and A. del Campo (editors)

A. Ruschhaupt, “An Application of EEQT: Tunneling Times” in Ph. Blanchard et. al. (editors) “Decoherence: Theoretical, Experimental, and Conceptual Problems” (LNP 538, Springer, 2000)