Andreas Winter – Curriculum Vitae (5 February 2024)

Personal details

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Organisation:	ICREA—Institució Catalana de Recerca i Estudis Avançats and Universitat Autònoma de Barcelona
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Present and previous appointments

since 10/2012	ICREA Research Professor, affiliated with Universitat Autònoma de Barcelona.
10/2006-9/2012	Professor of the Physics of Information, Department of Mathematics, University of Bristol, U.K. (2008-2012 in addition Visiting Research Professor with the Centre for Quantum Technologies, National University of Singapore.)
9/2003-9/2006	Lecturer in Mathematics, Department of Mathematics, University of Bristol, U.K.
4/2001-8/2003	Research Associate with Prof. Richard Jozsa, Department of Computer Science, University of Bristol, U.K.
7/1999-3/2001	Research Associate with Prof. Rudolf Ahlswede, Department of Mathematics, University of Bielefeld, Germany.

Academic qualifications

1/7/1999	PhD (Dr. math.) from University of Bielefeld, Germany. Thesis: *Coding Theorems of Quantum Information Theory.* Advisor: Prof. Rudolf Ahlswede.
8/1997	Diploma (Dipl. math.) from Freie Universität Berlin, Germany.
4/1994-8/1997	Undergraduate studies of mathematics at Freie Universität Berlin, Germany.
10/1991-3/1994	Undergraduate studies of mathematics at Universität Konstanz, Germany.

Teaching and mentoring

At UAB, my position is defined as a research appointment, but I do contribute to advanced courses on different levels: every year I cover a couple of lectures in the undergraduate course on *Quantum Information Theory*, delivered by our group; since 2019/20 I contribute to a course on *Quantum Information* offered

by the Physics department in the context of a Data Science degree in Mathematics; since 2021/22 I contribute to the new Barcelona Master in Quantum Science and Technology with a course *Advanced Quantum Information Theory* and graduate theses. Furthermore, I supervise on average one final-year project (treball de fi de grau) per year in the Physics department.

In 2015 I taught a graduate course in *Information Theory* (jointly with Albert Guillén i Fabregas, UPF) at the Barcelona Graduate School of Mathematics.

In Bristol I taught *Advanced Optimisation* in 2003 and 2004. Furthermore, I designed a course *Information Theory* and delivered it from 2006, first fully, susequently in cooperation with other lecturers, till my departure 2012. I participated in the graduate Taught Course Centre in collaboration between the Universities of Bristol, Bath, Warwick, Oxford and Imperial College, by covering for several years part of a unit *Quantum Information and Computing*.

I have supervised or co-supervised 18 PhD students, 4 of whom are currently in progress. Furthermore, I have served as mentor to four Marie Curie fellows (Aram Harrow, Milan Mosonyi and Marcus Huber, all in Bristol; and Matteo Rosati in Barcelona), five Juan de la Cierva fellows (Marcus Huber, Michalis Skotiniotis, Philipp Strasberg, Matteo Rosati, and Marco Fanizza), one Beatriu de Pinós fellow (Joseph Schindler), and three DFG postdoctoral fellows (Janis Nötzel, Philipp Strasberg and Minglai Cai, all in Barcelona).

Grants and prizes

German Research Council Emmy Noether fellowship		(awarded but
Information and Quantum Physics	2001	not taken up)
University of Bristol Research Fellowship		
Transmission of partial quantum information	2005-2006	£10,000
U.K. EPSRC Advanced Research Fellowship		
Random and Nonrandom Coding for Quantum Information	2006-2011	£450,000
Royal Society International Joint Project		
Noise as a Resource in Cryptography	2006-2008	£8,000
Wolfson Research Merit Award		
Mathematical Studies in the Physics of Information	2007-2012	£100,000
ERC Advanced Grant "IRQUAT"		
Information and Randomness in Quantum Theory	2011-2017	€1,440,119
Co-PI in MINECO project FIS2016-86681-P		
Quantum Learning and Non-Classicality	2017-2020	€153,000
Research collaboration with Baidu Ltd.		
Learning of Quantum Hidden Markov Chains	2019-2021	€152,532
Participant in EC collaborative network "RESQ"		
Resources in Quantum Information Processing	2003-2006	€140,000
Participant in U.K. EPSRC "QIP IRC" (Large U.K.-wide		
collaboration; Bristol group with separate theory grant)	2004-2010	£525,000
Participant and node leader in EC integrated project "QAP"		
Qubit Applications	2006-2010	€150,000
Participant in EC integrated project "QESSENCE"		
Quantum Interfaces, Sensors and Communication based on Entanglement	2010-2013	€75,000
Participant in EC STREP project "QICS"		
Foundational Structures for Quantum Information and Computation	2007-2010	€150,000
Participant in EC STREP project "QCS"		
Quantum Computer Science	2010-2013	€150,000
Participant in Templeton Foundation project (Bristol)		
Why is Nature Not More Non-local?	2011-2013	£145,000
Participant in ARC Discovery project *Towards a quantum zero-error*		
information theory (Prof. Runyao Duan, UTS, Sydney)	2011-2013	–
Participant in EC STREP project "RAQUEL"		
Randomness and Quantum Entanglement	2013-2016	€200,000
Participant in MINECO project FIS2013-40627-P		
Recursos y Restricciones en el Procesado de Información Cuántica	2013-2016	€175,000
Participant in MINECO project PID2019-107609GB-100		
Dynamical Resources in Quantum Information	2020-2022	€112,125
Participant in EC Quantera project "ExTRaQT"		
Experiment and Theory of Resources in Quantum Technologies	2022-2025	€115,000
Philip Leverhulme Prize *Quantum Information*	2009	£70,000
Whitehead Prize of the London Mathematical Society	2012	£1,000
Paper Award of the Information Theory Society for *Ref. 128*	2017	US$400
Alexander von Humboldt Foundation Research Prize	2022	€65,000
TUM IAS Hans Fischer Senior Fellowship	2022	€320,000
QCMC International Quantum Award	2022	US$2,500

Other indicators of academic leadership

I am considered one of the internationally leading figures in mathematical/theoretical quantum information science, and my scientific advice is being sought consistently. I have been consulted regularly since 2005 by the U.K. EPSRC, the European Commission, and Austrian, Canadian, German and Japanese funding

bodies on future research directions and grant proposal evaluation. Despite not being a member, I have been also involved with the Information Theory Society, on whose committee for the Paper Award I have served four times, 2006, 2008, 2013 and 2014.

2008-2012 my role in shaping the then newly founded Centre for Quantum Technologies (CQT) in Singapore (`http://www.quantumlah.org`) was being honoured with a visiting research professorship there. As a principal investigator within CQT, I was responsible for a research budget of ca. S$ 2M, to manage a group of around five RAs, aided by a Senior RA.

Representing both Bristol and Singapore, I was involved in a "Collaborative Research Group" for *Mathematics of Quantum Information* of the Pacific Institute for Mathematical Sciences (PIMS), led by Barry Sanders (Calgary).

Invited lectures at international conferences

From the beginning of my career I have been invited to international conferences to speak about my work. Every year I accept around 6 such invitations, from specialist workshops to major international events. In the following I list only the most visible such invitations.

- Invited speaker at the 2nd "ESF Quantum Information Theory Conference", Gdańsk, 2001.
- Invited speaker at "Quantum Information Processing" 2002, IBM, Yorktown Heights, NY; 2003, MSRI, Berkeley; 2004, Perimeter Institute, Waterloo; 2005, MIT, Cambridge MA; 2007, University of Queensland, Brisbane; 2014, Barcelona, Spain.
- Invited speaker at the "Von Neumann centennial conference", Alfred Rényi Institute, Budapest, 2003.
- Invited speaker at "Asian Quantum Information Science" 2005, Tokyo; 2011, Busan (Korea); tutorial speaker at AQIS 2013, IMSc Chennai (India).
- Plenary speaker at "13th International Congress of Mathematical Physics", Rio de Janeiro, 2006.
- Invited speaker at "Phenomena in High Dimension", Sevilla, 2008.
- Invited speaker at "5th European Congress of Mathematics", Amsterdam, 2008.
- Invited speaker at a topical symposium of the 2014 Spring meeting of the German Physical Society (DPG), Berlin; and 2018, Erlangen.
- Hearne Eminent Lecture at LSU, Baton Rouge, March 2017.
- Plenary speaker at the 2017 International Symposium on Information Theory (ISIT), Aachen, Germany, 2017.
- Plenary speaker at "Rényi centennial conference", Hungarian Academy of Sciences, Budapest, 2021 (moved to 2022).
- Invited participant at extended topical programmes on quantum information: MSRI (Berkeley), Isaac Newton Institute (Cambridge), Institut Henri Poincaré (Paris), Fields Institute (Toronto), Centro de Ciencias "Pedro Pascual" (Benasque) and KITP (Santa Barbara).

Organisation of conferences

- Member of the Steering Committee of the "Quantum Information Processing" conference series, 2007-2012. `http://qipworkshop.org/`
- Member of the Steering Committee of the "Central European Quantum Information Processing" conference series, since 2011. `http://ceqip.eu/`

- Member of the Steering Committee of the "Asian Quantum Information Science" conference series, 2012-2014.
- Member of technical programme committee of the "Theory of Quantum Computing" conference 2011.
- Member of technical programme committee of the "Quantum Information Processing" conference 2006, 2007, 2015 and 2018.
- Member of technical programme committee of the "Asian Quantum Information Science" conference 2005, 2006, 2008, 2009, 2010, 2012, 2013 and 2017; chair of the programme committee 2014.
- Member of technical programme committee of the "International Symposium on Information Theory", 2013, 2014, 2016, 2017, 2019 and 2021.
- Co-chair (with Emina Soljanin) of the technical programme committee of the Information Theory Workshop of the Information Theory Society, Porto, 5-9 May 2008. `http://www.dcc.fc.up.pt/itw08/`
- Co-organiser (with Matthias Christandl and Heinz Siedentopp) of a topical semester "Complex Quantum Systems" at the Institute for Mathematical Sciences, National University of Singapore, 15 February-27 March 2010. `http://www.ims.nus.edu.sg/Programs/010quantum/`
- Co-organiser (with Alexander S. Holevo, Mary-Beth Ruskai, Erling Størmer and Michael M. Wolf) of the topical semester "Quantum Information Theory" at Institut Mittag-Leffler, Stockholm, 1 September-15 December 2010. `http://www.mittag-leffler.se/?q=1011f`
- Local organiser of the 14th "Quantum Information Processing" conference, 10-14 January 2011, Singapore. `http://qip2011.quantumlah.org/`
- Co-organiser (with Richard Jozsa, Noah Linden and Peter Shor) of the topical semester "Mathematical Challenges of Quantum Information" at the Isaac Newton Institute, Cambridge, 27 August-20 December 2013. `http://www.newton.ac.uk/programmes/MQI/`
- Co-organiser (with Stefano Mancini and Maciej Lewenstein) of the conference "Noise Information and Complexity at Quantum Scale", Ettore Majorana Centre for Scientific Culture, Erice (TP), Italy, 6-11 October 2013.
- Co-organiser (with Stefano Mancini) of of the workshop "New Frontiers in Quantum Information Theory", Ascoli Piceno (AP), Italy, Palazzo dei Capitani del Popolo, 7-11 July 2014.
- Co-organiser (with Nilanjana Datta, Renato Renner and Mark Wilde) of the workshop "Beyond IID in Information Theory 3", Banff (AB), Canada, 5-10 July 2015. `https://sites.google.com/site/beyondiid4/`
- Co-organiser (with Holger Boche, Albert Guillén i Fabregas, Alfonso Martinez and Mark Wilde) of the workshop "Beyond IID in Information Theory 4", Barcelona, Spain, Institut d'Estudis Catalans, 18-22 July 2016. `https://www.birs.ca/events/2015/5-day-workshops/15w5120`
- Co-organiser (with Nilanjana Datta and Jossy Sayir) of the workshop "Beyond IID in Information Theory 6", Isaac Newton Institute, Cambridge, U.K., 23-27 July 2018. `https://www.newton.ac.uk/event/mqiw05`
- Co-organiser (with Dominic Verdon) of the focused research group "Non-commutative mathematics and quantum information", Heilbronn Institute for Mathematical Research, Bristol, U.K., 8-10 August 2019.
- Co-organiser (with Ivan G. Todorov, Monique Laurent and Simone Severini) of the workshop "Analytical and combinatorial aspects of quantum information theory", International Centre for Mathematical Sciences, Edinburgh, U.K., 9-13 September 2019.

- Co-organiser (with Ivan G. Todorov, Gemma De las Cuevas and Hamza Fawzi) of the workshop "Analytical and combinatorial methods in quantum information theory", International Centre for Mathematical Sciences, Edinburgh, U.K., 24-28 July 2023.
- Co-organiser (with Ángela Capel, Nilanjana Datta and Ludovico Lami) of the BIRS workshop "Towards infinite dimension and beyond in quantum information", IMAG, Granada, Spain, 5-10 May 2024.

Editorial activity

- Associate editor for Quantum Information with IEEE Transactions on Information Theory, 2005-2008.
- Editorial board member of Communications in Mathematical Physics, 12/2012-3/2020.
- Steering board member of Quantum, since its foundation 6/2016.
- Editorial board member of Journal of Mathematical Physics, since 4/2011.
- Senior editor of Journal on Selected Areas of Information Theory, since 7/2019.
- Area (Executive) Editor for Quantum topics with IEEE Transactions on Information Theory, since 7/2021.

Research statement

Quantum Shannon theory asks about the ultimate building blocks and physical limitations of information processing; it is concerned with operational questions of the type "how to communicate most efficiently through a noisy channel?", and abstractions thereof. I have contributed fundamentally to this field, by focusing on the mathematical structures behind these information coding problems, and I am especially fascinated by probabilistic and geometric methods applied to information. Indeed, the development of mathematical techniques is becoming of paramount importance to quantum information science, and my own work contributes to this development in three ways. First, through the creation of new mathematical tools and concepts to approach information theory problems; in the past, this has ranged from combinatorial ideas, to new large deviation bounds for operator valued random variables, and to new inequalities for the quantum entropy, including entropic uncertainty relations. Secondly, by importing tools from other disciplines – an example is the extremely fruitful use of probabilistic-geometric measure concentration in quantum coding and in the construction of exotic quantum states, or most prominently of quantum channels violating certain so-called additivity conjectures (papers by me and by Hayden, culminating in the recent counterexample by Hastings). Thirdly, by applying the new techniques to other areas, for example in work with Linden, Popescu and Short on the foundations of statistical mechanics. In the last few years I and several collaborators have started developing quantum zero-error information theory, which relates to quantum non-locality and quantum error correcting codes.

Most significant scientific contributions

1. **Partial quantum information.** In my work on negative quantum information [with M. Horodecki and J. Oppenheim, *Nature* **436**:673-676 (2005) and *Commun. Math. Phys.* **269**:107-136 (2007)], the fundamental new concept of quantum state merging is introduced, giving operational meaning to the sometimes negative values of the quantum conditional entropy. It profoundly changed the community's view of the subjects of quantum error correction, channel coding and capacities. In particular, we showed a deep duality between quantum (distributed) data compression and channel coding, known in different form in classical information theory. This new viewpoint has resulted in a whole series of papers re-organising the foundations of quantum Shannon theory, spearheaded by my work with A. Abeyesinghe, I. Devetak and P. Hayden [*Proc. Roy. Soc. London A* **465**:2537-2563 (2009)].

2. **Information Causality.** With M. Pawłowski *et al.* [*Nature* **461**:1101-1104 (2009)], we put forward the new concept of "information causality" and showed that this principle could explain the quantum limitations on non-local correlations which separate them from the "no-signalling" ones (i.e. the constraints due to Einstein locality). This paper already had significant impact, prompting several other groups to elaborate on the information theory of non-local correlations.
3. **Statistical mechanics.** Together with N. Linden, S. Popescu and A. J. Short, we are attempting to establish the foundations of statistical mechanics on quantum theoretical grounds. Our initial paper on this subject [with S. Popescu and A. J. Short, *Nature Physics* **2**:754-758 (2006)] showed that the equilibrium state consistent with the postulate of equal probabilities can be generically explained by a pure state of system and bath, in the most general of physical situations. It is continued in [N. Linden *et al.*, *Phys. Rev. E* **79**:061103 (2009) and arXiv:0907.1267], and we are still engaged in carrying out the ambitious "roadmap" laid out in the PRE paper. In recent work with N. Yunger Halpern, Ph. Faist and J. Oppenheim [*Nature Comm.* **7**:12051 (2016)] we used information theoretic ideas to justify grand canonical equilibrium states as the unique "completely passive" states for work extraction, under arbitrary extensive conserved quantities, even if they do not commute; the crucial concept we developed here is that of an "approximately microcanonical subspace" in the composition of many copies of the system.
4. **Zero-error quantum information.** In collaboration with R. Duan and S. Severini [*IEEE Trans. Inf. Theory* **59**(2):1164-1174 (2013)], we have not only introduced a quantum generalisation of Lovász' famous ϑ function [IEEE Trans. Inf. Theory **25**(1):1-7 (1979)], and proved that it bounds the zero-error capacity of a quantum channel, but have shown that much of graph theory can be recast in the algebraic language of Hilbert modules and operator systems, motivating the generalisation to *non-commutative graphs*, a theory that is ideally adapted to reason about error-free information transmission via channels, and which we expect to have many further applications, in quantum Shannon theory and combinatorics. With R. Duan [*IEEE Trans. Inf. Theory* **62**(2):891-914 (2016)] we showed subsequently that the Lovász number of a graph is actually equal to the no-signalling assisted capacity of classical-quantum channels, the first such information theoretic interpretation of $\vartheta(G)$.
5. **Additivity conjectures.** I initiated much of the conceptual and mathematical progress on the "additivity problem" of quantum communication theory. In work with K. Matsumoto and T. Shimono [*Commun. Math. Phys.* **246**:427-442 (2004)] we provided the first link of the additivity of the so-called Holevo capacity to other additivity conjectures; this was subsequently developed into a full equivalence of several additivity conjectures by Shor [*Commun. Math. Phys.* **246**:453-472 (2004)]. The equivalences were the basis for my recent work [with P. Hayden, *Commun. Math. Phys.* **284**:263-280 (2008); and with T. S. Cubitt *et al.*, *Commun. Math. Phys.* **284**:281-290 (2008)] on counterexamples to a set of stronger additivity properties; the ideas of these papers were essential to Hastings' subsequent disproof of the original additivity conjectures [*Nature Physics* **5**:255-258 (2009)]. With J. Chen [arXiv:1206.1307], we have shown, using information theoretic and numerical methods, that another correlation measure, the entanglement of purification, is not additive.
6. **Operator-valued random variables.** My paper with R. Ahlswede [*IEEE Trans. Inf. Theory* **48**(3):569-579 (2002)] contains the elements of an original theory of operator valued random variables and their large deviations, developed to solve a specific problem in quantum identification theory. The theory is so beautiful and versatile, that it started having further applications instantly, at first in quantum Shannon theory, then further afield, e.g. a new, shorter and more efficient proof of the Alon-Roichman theorem on random Cayley graphs being expanders [Z. Landau and A. Russell, *Electr. J. Comb.* **11**:62 (2004); D. Christofides and K. Markström, *Rand. Struct. Alg.* **32**(1):88-100 (2007); A. Wigderson and D. Xiao, Proc. FOCS 2005 & 2009], and recently a much simplified approach to matrix completion [E. J. Candes and T. Tao, arXiv:0903.1476; D. Gross *et al.*, arXiv:0909.3304 and arXiv:0910.1879].
7. **Random states.** My paper on generic entanglement [with P. Hayden and D. Leung, *Commun. Math. Phys.* **265**(1):95-117 (2006)], was the very first exploration of a fully quantum version of the probabilistic method, yielding not examples but the existence of states and quantum channels with exotic or even paradoxical properties. Among later applications of this are the above-mentioned

ground-breaking results concerning statistical mechanics and the additivity conjectures.

8. **Applications of non-standard entropies.** In the paper with P. Hayden [*Phys. Rev. A* **67**:012326 (2003)], Rényi entropies, and more importantly *smoothed* Rényi entropies, are used for the first time in quantum information to solve the problem of reversibility in the theory of pure state entanglement. R. Renner [PhD thesis, ETH Zürich 2005] and his followers have systematically developed this tool as a foundation of information theory, putting at the centre of the theory smoothed (conditional) min-entropies. In work with C. Morgan [*IEEE Trans. Inf. Theory* **60**(1):317-333 (2014)], this formalism was used to show a "pretty strong" converse for the quantum capacity of certain channels. Finally, in a preprint with M. M. Wilde and D. Yang [*Commun. Math. Phys.* **331**(2):593-622 (2014)] a new, "sandwiched", Rényi relative entropy was defined and shown to be useful for proving strong converses for the classical capacity of entanglement-breaking and Hadamard channels; the latter papers have sparked immediate interest in the new functional an its properties.
9. **Entropy inequalities.** Finally, inequalities relating quantum entropies are among the fundamental tools in information theory. In my work with N. Linden [*Commun. Math. Phys.* **259**:129-138 (2005)], we provided the first evidence of a new inequality for the von Neumann entropy in more than 30 years since the proof of strong subadditivity [E. H. Lieb, M.-B. Ruskai, *J. Math. Phys.* **44**(12):1938-1941 (1973)], by building on my own work regarding the equality conditions of the latter [with P. Hayden, R. Jozsa and D. Petz, *Commun. Math. Phys.* **246**:359-374 (2004)], and bringing to bear information theoretic ideas. More such inequalities were found in work with J. Cadney and N. Linden [*IEEE Trans. Inf. Theory* **58**(6):3657-3663, 2012]. With N. Linden and M. Mosonyi [*Proc. Roy. Soc. London A* **469**(2158):20120737 (2013)], we showed that Rényi entropies in contrast cannot obey any nontrivial inequalities. The exception is the limiting case of $\alpha \to 0$, which corresponds to the rank of the density matrix: with J. Cadney, M. Huber and N. Linden [*Lin. Algebra Appl.* **452**:153-171, 2014] we showed that there is an interesting structure of inequalities constraining the ranks of reduced states. Finally, in recent work [with K. Li, *Found. Phys.* **48**(8):910-924 (2018)], we conjectured a strengthening of strong subadditivity and the monotonicity of the quantum relative entropy by introducing a new term in the inequality, relating to approximate recoverability (aka sufficiency), and with applications throughout quantum information theory. It was subsequently proved by Fawzi and Renner in a breakthrough paper, and with M. Junge, R. Renner, D. Sutter and M. M. Wilde [*Ann. Henri Poincaré* **19**(10):2955-2978 (2018)], we were able to give an explicit form of the recovery map.
10. **Distrustful cryptography.** In cryptography, my work with A. C. A. Nascimento and H. Imai [*Proc. 9th IMA Intl. Conference on Cryptography and Coding*, LNCS 2898, Springer Verlag, Berlin 2003, pp. 35-51] has shown that every noisy channel can be used to implement the cryptographic primitive, bit commitment, and indeed we found a simple formula for the precise capacity of committing to a long string. This is the first result of its kind in distrustful cryptography; subsequently we managed to extend this work to a capacity theorem for the more powerful task of oblivious transfer [with A. C. A. Nascimento, *IEEE Trans. Inf. Theory* **54**(6):2572-2581 (2008)].

Publications

During the twenty-odd years of my research career in quantum information science, I have written more than 250 papers as preprints or in refereed journals and proceedings, in part as the sole author, but many in collaboration: to-date I have more than 150 collaborators on papers, including C. H. Bennett, K., M. and P. Horodecki, R. Jozsa, M. Lewenstein, R. Renner, P. W. Shor, V. Vedral, F. Verstraete, M. M. Wilde, etc, but also many younger colleagues, the interaction with whom remains extremely important to me.

1. "Coding theorem and strong converse for quantum channels", IEEE Trans. Inf. Theory **45**(7):2481-2485, 1999; doi:10.1109/18.796385; e-print arXiv[quant-ph]:1409.2536.
2. "Another algebraic proof of Bondy's theorem on induced subsets", J. Combin. Theory Ser. A **89**(1):145-147, 2000; doi:10.1006/jcta.1999.3013.
3. (with H. Barnum, P. Hayden and R. Jozsa) "On the reversible extraction of classical information from a quantum source", Proc. Roy. Soc. Lond. A: Math. Phys. Eng. Sci. **457**(2012):2019-2039, 2001; doi:10.1098/rspa.2001.0816; e-print `arXiv/quant-ph:0011072`.

4. (with S. Massar) "Compression of quantum-measurement operations", Phys. Rev. A **63**:012311, 2001; doi:10.1103/PhysRevA.64.012311; e-print `arXiv:quant-ph/0012128`.
5. "On the fidelity of two pure states", J. Phys. A: Math. Gen. **34**(35):7095-7101, 2001; doi:10.1088/0305-4470/34/35/333; e-print `arXiv:quant-ph/0011053`.
6. "The capacity of the quantum multiple-access channel", IEEE Trans. Inf. Theory **47**(7):3059-3065, 2001; doi:10.1109/18.959287; e-print `arXiv:quant-ph/9807019`.
7. (with R. Freivalds) "Quantum Finite State Transducers", in Proc. of SOFSEM 2001, Piešťany, Slovakia, 24 November-1 December 2001, LNCS 2234, pp. 233-242, Springer Verlag, Berlin 2001. Full version: e-print `arXiv:quant-ph/0011052`.
8. (with R. Ahlswede) "Strong converse for identification via quantum channels", IEEE Trans. Inf. Theory **48**(3):569-579, 2002; doi:10.1109/18.985947; e-print `arXiv:quant-ph/0012127`. Addendum: IEEE Trans. Inf. Theory **49**(1):346, 2003.
9. "Scalable programmable quantum gates and a new aspect of the additivity problem for the classical capacity of quantum channels", J. Math. Phys. **43**(9):4341-4352, e-print `arXiv:quant-ph/0108066`.
10. (with P. Hayden and R. Jozsa) "Trading quantum for classical resources in quantum data compression", J. Math. Phys. **43**(9):4404-4444, 2002; e-print `arXiv:quant-ph/0204038`
11. "The Reverse Shannon Theorem in Classical and Quantum Information Theory: a New Unifying Principle", Proc. ICSF 2002, Waseda University, Tokyo, Japan, 27-28 March 2002, pp. S6.12-17.
12. "Scalable programmable quantum gates and a new aspect of the additivity problem for the classical capacity of quantum channels", in Proc. ISIT, Lausanne, Switzerland, 1-5 July 2002, p. 70.
13. "Compression of sources of probability distributions and density operators", e-print `arXiv:quant-ph/0208131`, 2002.
14. (with P. Hayden) "Communication cost of entanglement transformations", Phys. Rev. A **67**:012326, 2003; e-print `arXiv:quant-ph/0204092`.
15. (with M. Hayashi, M. Koashi, K. Matsumoto and F. Morikoshi) "Error exponents for entanglement concentration", J. Phys. A: Math. Gen. **36**(2):527-553, 2003; e-print `arXiv:quant-ph/0206097`.
16. (with I. Devetak) "Classical data compression with quantum side information", Phys. Rev. A **68**:042301, 2003; e-print `arXiv:quant-ph/0209029`.
17. (with R. Jozsa, M. Koashi, N. Linden, S. Popescu, S. Presnell and D. Shepherd) "Entanglement cost of generalised measurements", Quantum Inf. Comput. **3**(5):405-422, 2003; doi:10.26421/QIC3.5-2; e-print `arXiv:quant- ph/0303167`.
18. (with I. Devetak) "Distilling common randomness from bipartite quantum states", in Proc. ISIT, Yokohama, Japan, 29 June-4 July 2003, p. 403.
19. (with A. C. A. Nascimento and H. Imai) "Commitment Capacity of Noisy Channels", in Proc. 9th IMA Intl. Conference on Cryptography and Coding, Cirencester, U.K., 16-18 December 2003, LNCS 2898, Springer Verlag, Berlin 2003, pp. 35-51. Full version e-print `arXiv:cs.CR/0304014`.
20. "'Extrinsic' and 'intrinsic' data in quantum measurements: asymptotic convex decomposition of positive operator valued measures", Commun. Math. Phys. **244**:157-185, 2004; e-print `arXiv:quant-ph/0109050`.
21. (with K. Matsumoto and T. Shimono) "Remarks on additivity of the Holevo channel capacity and of the entanglement of formation", Commun. Math. Phys. **246**:427-442, 2004; e-print `arXiv:quant-ph/0206148`.
22. "Quantum and Classical Message Identification via Quantum Channels", in *Quantum Information, Statistics, Probability* (festschrift on the occasion of A. S. Holevo's 60th birthday), (O. Hirota, ed.), pp. 172-189, Rinton Press, 2004. Reprinted in Quantum Inf. Comput. **4**(6&7):563-578, 2004; doi:10.26421/QIC4.6-7-14; e-print `arXiv:quant-ph/0401060`.
23. (with P. Hayden, R. Jozsa and D. Petz) "Structure of states satisfying strong subadditivity of quantum entropy with equality", Commun. Math. Phys. **246**:359-374, 2004; e-print `arXiv:quant-ph/0304007`.
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