# Salman Beigi

Full name: **Salman Abolfathe Beikidezfuli**
Full professor
School of Mathematics
Institute for Research in Fundamental Sciences (IPM)
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**Education**

- Massachusetts Institute of Technology (MIT)
  Ph.D, Mathematics, (2005-2009)
  Supervisor: Prof. Peter W. Shor
  Thesis: *Quantum Proof Systems and Entanglement Theory*

- Sharif University of Technology (SUT)
  B.Sc, Mathematics (2000-2004)
  Tehran, Iran

**Positions**

- Faculty member, School of Mathematics, Institute for Research in Fundamental Sciences (IPM), from February 2011

- Visitor, Centre for Quantum Technologies, National University of Singapore, March 2023-March 2024

- Lead researcher, QuOne Lab, Phanous Research & Innovation Centre, January 2020-November 2022

- Visitor, Department of Information Engineering, The Chinese University of Hong Kong (CUHK), June - December 2015

- Postdoc, Institute for Quantum Information, California Institute of Technology (Caltech), June 2009 - Dec 2010

**Awards**

- Saramadan prize, Vice-Presidency for Science and Technology, Iran, 2023

- Saramadan prize, Vice-Presidency for Science and Technology, Iran, 2020

- Abu Rayhan prize in Mathematics, The Academy of Sciences, Iran, 2019

- Sobouti-Khajehpour Prize in Computer Science, Institute for Advanced Studies in Basic Sciences, 2018

- Gold Medal, 41st International Mathematical Olympiad (IMO), Taejon, South Korea, 2000.

- First Prize, 8th International Mathematics Competition for University Students (IMC), Prague, Czech, 2001.

- First Prize, 9th International Mathematics Competition for University Students (IMC), Warsaw, Poland, 2002.

- First Prize, 11th International Mathematics Competition for University Students (IMC), Skopje, Macedonia, 2004.

- Four Gold Medals in national mathematics competitions for high school and university students, Tehran, Iran, 1999-2004.

**Publications**

- S. Beigi and S. Rahimi-Keshari, Quantum Maximal Correlation for Gaussian States, *Physical Review A* **108**, 062419 (2023).

- S. Beigi and M. M. Goodarzi, Operator-valued Schatten spaces and quantum entropies, *Letters in Mathematical Physics* **113**, 91 (2023).

- E. Abedi, S. Beigi and L. Taghavi, Quantum Lazy Training, *Quantum* **7**, 989 (2023).

- A. Hamed Moosavian, S. S. Kahani, S. Beigi, Limits of Short-Time Quantum Annealing, *Quantum* **6**, 744 (2022).

- S. Beigi, L. Taghavi, A. Tajdini, Time and Query Optimal Quantum Algorithms Based on Decision Trees, *ACM Transactions on Quantum Computing* **3**(4), 1-33 (2022).

- M.-O. Renou, S. Beigi, Nonlocality for Generic Networks, *Physical Review Letters* **128**, 060401 (2022).

- M.-O. Renou, S. Beigi, Network Nonlocality via Rigidity of Token-Counting and Color-Matching, *Physical Review A* **105**, 022408 (2022).

- S. Beigi, M.-O. Renou, Covariance Decomposition as a Universal Limit on Correlations in Networks, *IEEE Transactions on Information Theory* **68**(1), 384-394 (2022).

- S. Beigi, Improved Quantum Hypercontractivity Inequality for the Qubit Depolarizing Channel, *Journal of Mathematical Physics* **62**, 122201 (2021).

- S. Beigi, Separation of quantum, spatial quantum, and approximate quantum correlations, *Quantum* **5**, 389 (2021).

- S. Beigi, N. Datta and C. Rouzé, Quantum reverse hypercontractivity: its tensorization and application to strong converses, *Communications in Mathematical Physics* **376**, 753-794 (2020)

- S. Beigi and L. Taghavi, Quantum Speedup Based on Classical Decision Trees, *Quantum* **4**, 241 (2020).

- M. M. Mojahedian, S. Beigi, A. Gohari, M. H. Yassaee and M. R. Aref, A Correlation Measure Based on Vector-Valued $L_p$-Norms, *IEEE Transactions on Information Theory* **65**(12), 7985-8004 (2019).

- M.-O. Renou, E. Bäumer, S. Boreiri, N. Brunner, N. Gisin, S. Beigi, Genuine Quantum Nonlocality in the Triangle Network, *Physical Review Letters* **123**, 140401 (2019).
  *Selected as "Editor's Suggestion" and "Featured in Physics."*

- S. Beigi and L. Taghavi, Span Program for Non-binary Functions, *Quantum Information & Computation* **19**(9,10), 0760-0792 (2019).

- M.-O. Renou, Y. Wang, S. Boreiri, S. Beigi, N. Gisin, N. Brunner, Limits on Correlations in Networks for Quantum and No-Signaling Resources, *Physical Review Letters* **123**, 070403 (2019).

- S. Beigi and A. Gohari, Phi-Entropic Measures of Correlation, *IEEE Transactions on Information Theory* **64**(4), 2193-2211 (2018).

- F. Haddadpour, M. H. Yassaee, S. Beigi, A. Gohari and M. R. Aref, Simulation of a Channel with Another Channel, *IEEE Transactions on Information Theory* **63**(5), 2659-2677 (2017).

- S. Beigi, O. Etesami, and A. Gohari, Deterministic Randomness Extraction from Generalized and Distributed Santha-Vazirani Sources, *SIAM Journal on Computing* **46**(1), 1-36 (2017).

- S. Beigi, O. Etesami, and A. Gohari, The Value of Help Bits in Randomized and Average-Case Complexity, *Computational Complexity* **26**(1), 119-145 (2017).

- S. Beigi, N. Datta, and F. Leditzky, Decoding quantum information via the Petz recovery map, *Journal of Mathematical Physics* **57** 082203 (2016).

- S. Beigi and C. King, Hypercontractivity and the logarithmic Sobolev inequality for the completely bounded norm, *Journal of Mathematical Physics* **57**, 015206 (2016).

- S. Beigi and A. Gohari, Monotone Measures for Non-local Correlations, *IEEE Transactions on Information Theory* **9**, 5185-5208 (2015).

- S. Beigi and A. Gohari, Quantum Achievability Proof via Collision Relative Entropy, *IEEE Transactions on Information Theory* **60**, 7980-7986 (2014).

- P. Delgosha and S. Beigi, Impossibility of Local State Transformation via Hypercontractivity, *Communications in Mathematical Physics* **332**, 449-476 (2014).

- S. Beigi and A. Gohari, On Dimension Bounds for Auxiliary Quantum Systems, *IEEE Transactions on Information Theory* **60**, 368-387 (2014).

- S. Beigi, Sandwiched Rényi Divergence Satisfies Data Processing Inequality, *Journal of Mathematical Physics* **54**, 122202 (2013).

- S. Beigi, A New Quantum Data Processing Inequality, *Journal of Mathematical Physics* **54**, 082202 (2013).

- S. Beigi, Classification of the Phases of 1D Spin Chains with Commuting Hamiltonians, *Journal of Physics A: Mathemathical and Theoretical* **45**, 025306 (2012).

- S. Beigi, and R. Koenig, Simplified Instantaneous Non-local Quantum Computation with Applications to Position-Based Cryptography, *New Journal of Physics* **13**, 093036 (2011).

- S. Beigi, P. W. Shor, and D. Whalen, The Quantum Double Model with Boundary: Condensations and Symmetries, *Communications in Mathematical Physics* **306**, 663-694 (2011).

- S. Beigi, P. W. Shor, and J. Watrous, Quantum Interactive Proofs with Short Messages, *Theory of Computing* **7**, 101-117 (2011).

- S. Beigi, I. Chuang, M. Grassl, P. W. Shor, and B. Zeng, Graph Concatenation for Quantum Codes, *Journal of Mathematical Physics* **52**, 022201 (2011).

- S. Beigi, Entanglement-Assisted Zero-Error Capacity is Upper Bounded by the Lovász $\vartheta$ Function, *Physical Review A* **82**, 010303 (2010).

- S. Beigi, A Lower Bound on the Value of Entangled Binary Games, *Quantum Information & Computation* **10**, 0911-0924 (2010).

- H. Barnum, S. Beigi, S. Boixo, M. B. Elliott, and S. Wehner, Local Quantum Measurement and No-Signaling Imply Quantum Correlations, *Physical Review Letters* **104**, 140401 (2010).

- S. Beigi and P. W. Shor, Approximating the Set of Separable States Using the Positive Partial Transpose Test, *Journal of Mathematical Physics* **51**, 042202 (2010)

- S. Beigi, NP vs $\text{QMA}_{\log}(2)$, *Quantum Information & Computation* **10**, 141-151 (2010).

- S. Beigi and P. W. Shor, $\mathcal{C}_3$, Semi-Clifford and Generalized Semi-Clifford Operations, *Quantum Information & Computation* **10**, 41-59 (2010).

- S. Aaronson, S. Beigi, A. Drucker, B. Fefferman, and P. W. Shor, The Power of Unentanglement, *Theory of Computing* **5**, 1-42 (2009).

**Conference Proceedings**

- M. M. Mojahedian, S. Beigi, A. Gohari, M. H. Yassaee and M. R. Aref, A Correlation Measure Based on Vector-Valued $L_p$-Norms, 2019 IEEE International Symposium on Information Theory (ISIT)

- S. Beigi, A. Bogdanov, O. Etesami, S. Guo, Optimal Deterministic Extractors for Generalized Santha-Vazirani Sources, Approximation, Randomization, and Combinatorial Optimization. Algorithms and Techniques (APPROX/RANDOM 2018), 30:1–30:15.

- S. Beigi, S. Liu, C. Nair, and M. Yazdanpanah, Some results on the scalar Gaussian interference channel, 2016 IEEE International Symposium on Information Theory (ISIT), 2199-2203.

- S. Beigi and C. Nair, Equivalent characterization of reverse Brascamp-Lieb type inequalities using information measures, 2016 IEEE International Symposium on Information Theory (ISIT), 1038-1042.

- S. Beigi and A. Gohari, On the duality of additivity and tensorization, 2015 IEEE International Symposium on Information Theory (ISIT), 2381-2385.

- S. Beigi and A. Gohari, Two-way channel simulation, Communication and Information Theory (IWCIT), 2015 Iran Workshop on, 1-5.

- S. Beigi, Maximal entanglement - A new measure of entanglement, Communication and Information Theory (IWCIT), 2014 Iran Workshop on, 106.

- S. Beigi, J. Chen, M. Grassl, Z. Ji, Q. Wang, and B. Zeng, Symmetries of Codeword Stabilized Quantum Codes, 8th Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC 2013), LIPIcs 22, 192–206 (2013).

- S. Beigi, A. Gohari, On dimension bounds for quantum systems, Communication and Information Theory (IWCIT), 2013 Iran Workshop on, 1-6.

- S. Aaronson, S. Beigi, A. Drucker, B. Fefferman, and P. W. Shor, The Power of Unentanglement, Computational Complexity 2008 (CCC '08), 23rd Annual IEEE Conference on, 223-236.

**Preprints**

- S. Beigi and S. Rahimi-Keshari, A Meta Logarithmic-Sobolev Inequality for Phase-Covariant Gaussian Channels, arXiv:2311.09572 (2023).

- S. Beigi and H. Mehrabi, Towards Optimal Convergence Rates for the Quantum Central Limit Theorem, arXiv:2310.09812 (2023).

- S. Beigi and M. Tomamichel, Lower Bounds on Error Exponents via a New Quantum Decoder, arXiv:2310.09014 (2023).

- S. Beigi, Quantum Kernel Method in the Presence of Noise, arXiv:2210.08476 (2022).

- S. Beigi, A. Bogdanov, O. Etesami and S. Guo, Complete Classification of Generalized Santha-Vazirani Sources, arXiv:1709.03053 (2017).

- S. Beigi, On the Optimality of Time Division for Broadcast Channels, arXiv:1605.08874 (2016).

- S. Beigi and A. Gohari, Information Causality is a Special point in the Dual of the Gray-Wyner Region, arXiv:1111.3151 (2011).

- S. Beigi and P. W. Shor, On the Complexity of Computing Zero-Error and Holevo Capacity of Quantum Channels, arXiv:0709.2090 (2007).

- M. Bahramgiri and S. Beigi, Enumerating the Classes of Local Equivalency in Graphs, arXiv:math/0702267 (2007).

- M. Bahramgiri and S. Beigi, An Efficient Algorithm to Recognize Locally Equivalent Graphs in Non-Binary Case, arXiv:cs/0702057 (2007).

- M. Bahramgiri and S. Beigi, Graph States Under the Action of Local Clifford Group in Non-Binary Case, arXiv:quant-ph/0610267 (2006).

**Selected talks**

- Error exponents in quantum information theory, tutorial talk, IWCIT, Sharif University of Technology, May 1, 2024.

- Time and Query-Optimal Quantum Algorithms Based on Decision Trees, Quantum CS Day, CQT, Singapore, December 20, 2023.

- Optimal Convergence Rates in the Quantum Central Limit Theorem, Lyon-Singapore Quantum Information Meeting, CQT, Singapore, June 2023.

- Covariance Decomposition as a Universal Limit on Correlations in Networks, Network Nonlocality Workshop, in honor of 70th birthday of Nicolas Gisin, Les Diablerets, June 1, 2022.

- Algorithmic optimal transport in Euclidean spaces, Bernoulli-IMS 10th World Congress in Probability and Statistics, July 20, 2021.

- Correlation Measures with the Tensorization Property, 24th Annual Conference on Quantum Information Processing (QIP), Tutorial talk, January 31, 2021.

- Covariance decomposition in no-signaling theories, Workshop on Graph Theory and its Applications, IPM-Isfahan, January 2020.

- Limits of Short-Time Quantum Annealing, 2nd Iranian Conference on Microelectronics (ICM 2020), University of Tehran, Dec 24, 2020

- Nonlocal Correlations in Networks, Winter Seminar Series (WSS 2020), Sharif University of Technology, Tehran, Iran.

- Quantum Nonlocality in the Triangle Network, Mathematical Aspects in Current Quantum Information Theory 2019 (MAQIT 2019), Seoul National University, Korea.

- Quantum Reverse Hypercontractivity: Its Tensorization and Applications to the Hypothesis Testing Problem, Analysis Seminar, IPM, Tehran, Iran (November, 2018).

- Non-local correlations in the triangle causal structure beyond Bell's theorem, Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran (November, 2018).

- Non-local correlations in the triangle causal structure beyond Bell's theorem, Combinatorics Seminar, IPM, Tehran, Iran (October, 2018).

- Monotone measures for nonlocal correlations, GAP-Optique group, University of Geneva, Geneva, Switzerland (June 2018).

- An overview of quantum stabilizer codes, Combinatorics Seminar, IPM, Tehran, Iran (October, 2017).

- Phi-entropic measures of correlation, Workshop on Beyond I.I.D. in Information Theory, IMS, National University of Singapore, Singapore (July, 2017)

- Hypercontractivity and logarithmic Sobolev inequalities, Combinatorics Seminar, IPM, Tehran, Iran (April, 2016).

- Hypercontractivity and log Sobolev inequalities for completely bounded norms, NIMS, Daejeon, Korea (February 18, 2016).

- On the Duality of Additivity and Tensorization, ISIT 2015, Hong Kong (June 19, 2015).

- Measuring quantum correlation via completely bounded norms, Banff Centre, Canada (February 25, 2015).

- A Monotone Measure for Non-local Correlations, QIP 2015, Sydney, Australia (January 12, 2015).

- A Monotone Measure for Non-local Correlations, Combinatorics Seminar, IPM, Tehran, Iran (November 12, 2014).

- Quantum Achievability Proof via Collision Relative Entropy, IICQI 2014, Isfahan University of Technology, Isfahan, Iran (September 8, 2014).

- Quantum Achievability Proof via Collision Relative Entropy, Beyond I.I.d in Information Theory Conference 2014, Centre for Quantum Technologies (CQT), National University of Singapore, Singapore (May 19, 2014).

- Maximal Entanglement - A New Measure of Entanglement, Iran Workshop on Communication and Information Theory IWCIT 2014, Sharif University of Technology, Tehran, Iran (May 7, 2014).

- A Mathematical Treatment of Quantum Mechanics, Mathematics Colloquium, Shahid Beheshti University, Tehran, Iran (April 27, 2014).

- A Mathematical Treatment of Quantum Mechanics, Sharif University of Technology, Tehran, Iran (March 12, 2014).

- Classification of Phases of Non-interacting Fermions via K-theory, Hard Talk seminar, IPM, Tehran, Iran (January 2014).

- Local Transformation of Bipartite Quantum States, Mathematics Colloquium, Sharif University of Technology, Tehran, Iran (November 17, 2013)

- Non-commutative Probability Theory, Mathematics Colloquium, IPM, Tehran, Iran (August 2013).

- Information Theoretic Benefit of Entanglement in Classical Communication Settings, Perimeter Institute, Waterloo, Canada (May 2013).

- The Combinatorics of (Non-)Contextuality and Non-locality, Combinatorics Seminar, IPM, Tehran, Iran (February 2013).

- The quantum double model as a topologically ordered phase, Sharif University of Technology, Frontiers in Mathematical Sciences (A conference in honor of Siavash Shahshahani), Tehran, Iran (December 2012).

- Introduction to Quantum Computation, IPM Summer School on Theoretical Computer Science, Tehran, Iran (July 2012).

- Information Theoretic Benefit of Entanglement in Classical Communication Settings, Centre for Quantum Computation and Intelligent Systems, University of Technology Sydney, Sydney, Australia (September 2012).

- The Quantum Double Model with Boundary: Condensations and Symmetries, Condensed Matter Seminar, School of Physics, IPM, Tehran, Iran (January 2012).

- Information Causality is a Special Point in the Dual of the Gray-Wyner Region, Quantum Information Processing (QIP 2012), Centre de recherches mathématiques (CRM), Montreal, Canada (December 2011).

- Simplified instantaneous non-local quantum computation with applications to position-based cryptography, Quantum Information Processing (QIP 2012), Centre de recherches mathématiques (CRM), Montreal, Canada (December 2011).

- The Quantum Double Model with Boundary: Condensations and Symmetries, IBM T. J. Watson Research Center, Yorktown Heights, NY (August 2011).

- An Efficient Algorithm to Recognize Locally Equivalent Graphs, Workshop on Graphs and Algorithms, IPM, Tehran, Iran (June 2011).
- Entanglement-Assisted Zero-Error Capacity is Upper Bounded by the Lovász $\vartheta$ Function, Combinatorics Seminar, IPM, Tehran, Iran (May 2011).
- Simplified instantaneous non-local computation with applications to position-based cryptography, Quantum Information Science group, Department of Physics, Sharif University of Technology, Tehran, Iran (May 2011).
- A Lower Bound on the Value of Entangled Binary Games, Quantum computation group, University of California, Berkeley, CA (November 2010).
- Two-Message Quantum Interactive Proofs with Short Messages, CS Theory Seminar, Caltech, Pasadena, CA (July 2009).
- An Efficient Algorithm to Recognize Locally Equivalent Graphs, Combinatorics Seminar, MIT, Boston, MA (February 27, 2009).
- Quantum Multiple-Merlin-Arthur Games and Separability Problem, IQI, Caltech, Pasadena, CA (January 28, 2009).
- NP vs $\mathsf{QMA}_{\log}(2)$, CS Theory Seminar, Caltech, Pasadena (January 27, 2009).
- Quantum Multiple-Merlin Arthur Games, IBM T. J. Watson Research Center, Yorktown Heights, NY (December 2, 2008).

**Teaching Experiences**

- Mathematical Foundations of Quantum Mechanics, School of Mathematics, IPM, Spring 2019
- Mathematical aspects of quantum mechanics, Math department of Sharif University of Technology, Fall 2016
- Linear programming and semidefinite programming in combinatorics and computer sciences, A short course, IPM, Fall 2014
- Quantum information theory, EE department of Sharif University of Technology, Fall 2013
- Complexity theory, IPM, Spring 2013
- Quantum information theory, EE department of Sharif University of Technology, Fall 2012
- Theory of quantum computation, Math department of Sharif University of Technology, Spring 2012

**Professional Services**

1. Steering Committee member of Quantum Information Processing conference (since 2023)
2. Associate Editor of IEEE Transactions on Information Theory (2020-2023)
3. Member of the Editorial Advisory Board of Journal of Mathematical Physics (since 2016)
4. Program Committee co-chair of the 10th Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC 2015, Brussels, Belgium)
5. Program Committee member of
   - Asian Quantum Information Science Conference 2023 (AQIS 2023, Seoul, Korea)
   - Quantum Information Processing 2022 (QIP 2022, Pasadena, CA)
   - 2021 IEEE International Symposium on Information Theory (ISIT 2021, Melbourne, Victoria, Australia)

- Iran Workshop on Communication and Information Theory (IWCIT 2020, Tehran, Iran)

- The Third International Conference on Topics in Theoretical Computer Science (TTCS 2020, IPM, Tehran, Iran)

- 15th Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC 2020, University of Latvia, Riga, Latvia)

- 2020 IEEE International Symposium on Information Theory (ISIT 2020, Los Angeles, CA, USA)

- 2019 IEEE International Symposium on Information Theory (ISIT 2019, Paris, France)

- The 14th Conference on the Theory of Quantum Computation, Communication and Cryptograph (TQC 2019, University of Maryland College Park, MD, USA)

- Iran Workshop on Communication and Information Theory (IWCIT 2019, Tehran, Iran)

- 2018 IEEE International Symposium on Information Theory (ISIT 2018, Colorado, USA)

- Iran Workshop on Communication and Information Theory (IWCIT 2018, Tehran, Iran)

- Quantum Information Processing 2017 (QIP 2017, Seattle, WA)

- Iran Workshop on Communication and Information Theory (IWCIT 2017, Tehran, Iran)

- 16th Asian Quantum Information Science Conference (AQIS 2016, Taipei, Taiwan)

- Iran Workshop on Communication and Information Theory (IWCIT 2016, Tehran, Iran)

- The 1st conference on Topics in Theoretical Computer Science (TTCS 2015, Tehran, Iran)

- The 3rd Iran Workshop on Communication and Information Theory (IWCIT 2015, Tehran, Iran)

- The 2nd Iran Workshop on Communication and Information Theory (IWCIT 2014, Tehran, Iran)

- The 8th Conference on the Theory of Quantum Computation, Communication and Cryptograph (TQC 2013, Guelph, Canada)

- Quantum Information Processing 2013 (QIP 2013, Beijing, China)

6. Organizing Committee of

- Fundamental Limitations to Quantum Computation, Banff International Research Station, March 2024

- IPM Combinatorics and Computing Conference 2021 (IPMCCC 2021, Tehran, Iran)

- IPM Combinatorics and Computing Conference 2019 (IPMCCC 2019, Tehran, Iran)

- International Iran Conference on Quantum Information 2018 (IICQI 2018, Tehran, Iran)

- Frontiers in Mathematical Sciences 2017 (Tehran, Iran)

- IPM Combinatorics and Computing Conference 2017 (IPMCCC 2017, Tehran, Iran)
- IPM Combinatorics and Computing Conference 2015 (IPMCCC 2015, Tehran, Iran)

7. Reviewer of several high qualified journals including:

Communications in Mathematical Physics, Journal of Mathematical Physics (selected as an "outstanding referee" in 2013), IEEE Transactions on Information Theory, Theory of Computing, Journal of the ACM, Annales Henri Poincaré, SIAM Journal on Computing, Journal of Combinatorial Theory Series B, New Journal of Physics, Chicago Journal of Theoretical Computer Science, Quantum Information and Computation, Journal of Physics A: Mathematical and Theoretical, Proceedings of the Royal Society A , Quantum Information Processing, Entropy, Quantum, Nature Communications