SFB *BeyondC* publications
(as of July 2022)

Sub-project P02 | Briegel

1. *Entangling logical qubits with lattice surgery*, A. Erhard∗, H. Poulsen Nautrup∗, M. Meth, L. Postler, R. Stricker, M. Ringbauer, P. Schindler, H. J. Briegel, R. Blatt, N. Friis, T. Monz, **Nature** 589, 220-224 (2021). https://doi.org/10.1038/s41586-020-03079-6 (Gold OA)
2. *Optimizing quantum error correction codes with reinforcement learning*, H. Poulsen Nautrup, N. Delfosse, V. Dunjko, H. J. Briegel, N. Friis, **Quantum** 3, 215 (2019). https://doi.org/10.22331/q-2019-12-16-215 (Gold OA)
3. *Experimental quantum speed-up in reinforcement learning agents*, V. Saggio, B. E. Asenbeck, A. Hamann, T. Strömberg, P. Schiansky, V. Dunjko, N. Friis, N. C. Harris, M. Hochberg, D. Englund, S. Wölk, H. J. Briegel, P. Walther, **Nature** 591, 229 (2021). https://doi.org/10.1038/s41586-021-03242-7 (Gold OA)
4. *Parametrized quantum policies for reinforcement learning*, S. Jerbi, C. Gyurik, S. C. Marshall, H. J. Briegel, V. Dunjko, **NeurIPS** 34 (2021). https://proceedings.neurips.cc/paper/2021/file/eec96a7f788e88184c0e713456026f3f-Paper.pdf (Gold OA)
5. *On the convergence of projective-simulation–based reinforcement learning in Markov decision processes*, W. L. Boyajian, J. Clausen, L. M. Trenkwalder, V. Dunjko, H. J. Briegel, **Quantum Mach. Intell.** 2, 13 (2020). https://doi.org/10.1007/s42484-020-00023-9 (Gold OA)
6. *Machine learning for long-distance quantum communication*, J. Wallnöfer, A. A. Melnikov, W. Dür, H. J. Briegel, **PRX Quantum** 1, 010301 (2020). https://doi.org/10.1103/PRXQuantum.1.010301 (Gold OA)
7. *Quantum enhancements for deep reinforcement learning in large spaces,* S. Jerbi, L. M. Trenkwalder, H. Poulsen Nautrup, H. J. Briegel, V. Dunjko, **PRX Quantum** 2, 010328 (2021). https://doi.org/10.1103/PRXQuantum.2.010328 (Gold OA)
8. *Photonic architecture for reinforcement learning*, F. Flamini, A. Hamann, S. Jerbi, L. M. Trenkwalder, H. Poulsen Nautrup, H. J Briegel, **New J. Phys.** 22, 045002 (2020). https://doi.org/10.1088/1367-2630/ab783c (Gold OA)
9. *Reinforcement learning for optimization of variational quantum circuit architectures*, M. Ostaszewski, L. M. Trenkwalder, W. Masarczyk, E. Scerri, V. Dunjko, **NeurIPS** 34 (2021) https://proceedings.neurips.cc/paper/2021/file/9724412729185d53a2e3e7f889d9f057-Paper.pdf (Gold OA)
10. *Quantum-accessible reinforcement learning beyond strictly epochal environments*, A. Hamann, V. Dunjko, S. Wölk, **Quantum Mach. Intell.** 3, 22 (2021). https://doi.org/10.1007/s42484-021-00049-7 (Gold OA)

11. *Performance analysis of a hybrid agent for quantum-accessible reinforcement learning*, A. Hamann, S. Wölk, **New J. Phys.** 24, 033044 (2022). https://doi.org/10.1088/1367-2630/ac5b56 (Gold OA)
12. *Emergence of biased errors in imperfect optical circuits*, F. Flamini, **Phys. Rev. Applied** 16, 064038 (2021). https://doi.org/10.1103/PhysRevApplied.16.064038 (Gold OA)
13. *Development of swarm behavior in artificial learning agents that adapt to different foraging environments*, A. Lopez-Incera, K. Ried, T. Müller, H. J. Briegel, **PLoS ONE** 15(12), e0243628 (2020). https://doi.org/10.1371/journal.pone.0243628 (Gold OA)
14. *Honeybee communication during collective defence is shaped by predation,* A. López-Incera, M. Nouvian, K. Ried, T. Müller, H. J. Briegel, **BMC Biol** 19, 106 (2021). https://doi.org/10.1186/s12915-021-01028-x (Gold OA)
15. *General expressions for the quantum Fisher information matrix with applications to discrete quantum imaging,* L. J. Fiderer, T. Tufarelli, S. Piano, G. Adesso, **PRX Quantum** 2(2), 020308 (2021). https://doi.org/10.1103/PRXQuantum.2.020308 (Gold OA)
16. *Witnessing Bell violations through probabilistic negativity,* B. Morris, L. J. Fiderer, B. Lang, D. Goldwater, **Phys. Rev. A** 105, 032202 (2021). https://doi.org/10.1103/PhysRevA.105.032202 (Green OA)
17. *Operationally meaningful representations of physical systems in neural networks*, H. Poulsen Nautrup, T. Metger, R. Iten, S. Jerbi, L. M. Trenkwalder, H. Wilming, H. J. Briegel, R. Renner, preprint at arXiv:2001.00593v1. https://doi.org/10.48550/arXiv.2001.00593 (Green OA)
18. *TensorFlow Quantum: A Software Framework for Quantum Machine Learning*, M. Broughton et al. preprint at arXiv:2003.02989v2. https://doi.org/10.48550/arXiv.2003.02989 (Green OA)
19. *Quantum machine learning beyond kernel methods*, S. Jerbi, L. J. Fiderer, H. Poulsen Nautrup, J. M. Kübler, H. J. Briegel, V. Dunjko, preprint at arXiv:2110.13162v2. https://doi.org/10.48550/arXiv.2110.13162 (Green OA)
20. *Quantum agents in the Gym: a variational quantum algorithm for deep Q-learning*, A. Skolik, S. Jerbi, V. Dunjko, preprint at arXiv:2103.15084. https://doi.org/10.48550/arXiv.2103.15084 (Green OA)
21. Software library at www.github.com/HendrikPN/scigym. www.scigym.net (Other OA)

Sub-project P03 | Brukner

22. *Computational Advantage from a Quantum Superposition of Qubit Gate Orders,* M. J. Renner and Č. Brukner, **Phys. Rev. Lett.** 128, 230503 (2022). https://doi.org/10.1103/PhysRevLett.128.230503 (Green OA)
23. *Inferring work by quantum superposing forward and time-reversal evolutions*, G. Rubino, G. Manzano, L. A. Rozema, P. Walther, J. M. R. Parrondo, and Č. Brukner, **Phys. Rev. Research** 4, 013208 (2022). https://doi.org/10.1103/PhysRevResearch.4.013208 (Gold OA)
24. *Experimental entanglement of temporal order*, G. Rubino, L. A. Rozema, F. Massa, M. Araújo, M. Zych, Č. Brukner, and P. Walther, **Quantum** 6, 621 (2022). https://doi.org/10.22331/q-2022-01-11-621 (Gold OA)
25. *Noncausal Page-Wootters circuits,* V. Baumann, M. Krumm, P. A. Guérin, Č. Brukner, **Phys. Rev. Research** 4, 013180 (2022). https://doi.org/10.1103/PhysRevResearch.4.0130 (Gold OA)
26. *Quantum superposition of spacetimes obeys Einstein's equivalence principle*, F. Giacomini, Č. Brukner, **AVS Quantum Sci.** 4, 015601 (2022). https://doi.org/10.1116/5.0070018 (no OA)
27. *The Essence of Entanglement*, Č. Brukner, M. Żukowski, A. Zeilinger, 10. Okt. 2021, in Quantum Arrangements: Contributions in Honor of Michael Horne, Jaeger, G., Simon, D., Sergienko, A. V., Greenberger, D. & Zeilinger, A. (Hrsg.), **Springer Science and Business Media Deutschland GmbH**, Band 203. S. 117-138 22 S. (Fundamental Theories of Physics, Band 203). https://doi.org/10.1007/978-3-030-77367-0_6 (no OA)
28. *Transformation of spin in quantum reference frames*, M. Mikusch, L. C. Barbado, Č. Brukner, **Phys. Rev. Research** 3, 043138 (2021). https://doi.org/10.1103/PhysRevResearch.3.043138. (Gold OA)
29. *Quantum superposition of thermodynamic evolutions with opposing time's arrows*, G. Rubino, G. Manzano, Č. Brukner, **Communication Physics** 4, 251 (2021). https://doi.org/10.1038/s42005-021-00759-1 (Green OA)
30. *Reassessing the computational advantage of quantum-controlled ordering of gates*, M. J. Renner, Č. Brukner, **Phys. Rev. Research** 3, 043012 (2021). https://doi.org/10.1103/PhysRevResearch.3.043012 (Gold OA)
31. *Relativistic Bell Test within Quantum Reference Frames*, L. F. Streiter, F. Giacomini, Č. Brukner, **Phys. Rev. Lett.** 126, 230403 (2021) https://doi.org/10.1103/PhysRevLett.126.230403 (Green OA)
32. *Experimental quantum communication enhancement by superposing trajectories*, G. Rubino, L.A. Rozema, D. Ebler, H. Kristjánsson, S. Salek, P. A. Guérin, A. A. Abbott, C. Branciard,

Č. Brukner, G. Chiribella, P. Walther, **Phys. Rev. Research** 3, 013093 (2021). https://doi.org/10.1103/PhysRevResearch.3.013093 (Gold OA)

33. *Simulating indefinite causal order with Rindler observers*, A. Dimić, M. Milivojević, D. Gočanin, N. S. Móller, Č. Brukner, **Front. Phys**., 26 October (2020). https://doi.org/10.3389/fphy.2020.525333 (Gold OA)
34. *Quantum Temporal Superposition: The Case of Quantum Field Theory*, L. J. Henderson, A. Belenchia, E. Castro-Ruiz, C. Budroni, M. Zych, Č. Brukner, R. B. Mann, **Phys. Rev. Lett.** 125, 131602 (2020). https://doi.org/10.1103/PhysRevLett.125.131602 (no OA)
35. *Does violation of a Bell inequality always imply quantum advantage in a communication complexity problem?* A. Tavakoli, M. Żukowski, Č. Brukner, **Quantum** 4, 316 (2020). https://doi.org/10.22331/q-2020-09-07-316 (Gold OA)
36. *Unruh effect for detectors in superposition of accelerations*, L. C. Barbado, E. Castro-Ruiz, L. Apadula, Č. Brukner, **Phys. Rev. D** 102, 045002 (2020). https://doi.org/10.1103/PhysRevD.102.045002 (no OA)
37. *Quantum clocks and the temporal localisability of events in the presence of gravitating quantum systems*, E. Castro-Ruiz, F. Giacomini, A. Belenchia, Č. Brukner, **Nature Communications** 11, 2672 (2020). https://doi.org/10.1038/s41467-020-16013-1 (Gold OA)
38. *Relativistic Quantum Reference Frames: The Operational Meaning of Spin*, F. Giacomini, E. Castro-Ruiz, Č. Brukner**, Phys. Rev. Lett.** 123, 090404 (2019). https://doi.org/10.1103/PhysRevLett.123.090404 (Green OA)
39. *Bell's theorem for temporal order*, M. Zych, F. Costa, I. Pikovski, Č. Brukner, **Nature Communications** 10, 3772 (2019). https://doi.org/10.1038/s41467-019-11579-x (Green OA)
40. *Semi-device-independent certification of indefinite causal order*, J. Bavaresco, M. Araújo, Č. Brukner, M. Túlio Quintino, **Quantum** 3, 176 (2019). https://doi.org/10.22331/q-2019-08-19-176 (Gold OA)
41. *A spacetime area law bound on quantum correlations*, I. Kull, P. A. Guérin, Č. Brukner, **npj Quantum Information** 5, 48 (2019). https://doi.org/10.1038/s41534-019-0171-x (Gold OA)
42. *Communication through quantum-controlled noise*, P. A. Guérin, G. Rubino, Č. Brukner, **Phys. Rev. A** 99, 062317 (2019). https://doi.org/10.1103/PhysRevA.99.062317 (no OA)
43. *Information content of the gravitational field of a quantum superposition*, A. Belenchia, R. M. Wald, F. Giacomini, E. Castro-Ruiz, Č. Brukner, M. Aspelmeyer, **Int. J. Mod. Phys. D** 1943001 (2019). https://doi.org/10.1142/S0218271819430016. (no OA)
44. *Quantum mechanics and the covariance of physical laws in quantum reference frames*, F. Giacomini, E. Castro, and Č. Brukner, **Nature Communications** 10, 494 (2019), https://doi.org/10.1038/s41467-018-08155-0 (Green OA)

45. *Composition rules for quantum processes: a no-go theorem*, P. Allard Guérin, M. Krumm, C. Budroni, Č. Brukner, **New J. Phys.** 21, 012001 (2019). https://doi.org/10.1088/1367-2630/aafef7 (Gold OA)
46. *Equivalence of grandfather and information antinomy under intervention,* A. Baumeler, E. Tselentis, **Proceedings of the 17th International Conference on Quantum Physics and Logic, Electronic Proceedings in Theoretical Computer Science 340**, 1 (2021), https://doi.org/10.4204/EPTCS.340.1 (Green OA)
47. *Free energy of a general computation,* A. Baumeler, S. Wolf, **Physical Review D** 100, 052115 (2019), https://doi.org/10.1103/PhysRevE.100.052115 (Green OA)
48. *Experimental two-way communication with one photon,* F. Massa, A. Moqanaki, A. Baumeler, F. Del Santo, J. A. Kettlewell, B. Dakić, P. Walther, **Advanced Quantum Technologies** 2, 1900050 (2019). https://doi.org/10.1002/qute.201900050 (Gold OA)
49. *Reversible time travel with freedom of choice,* A. Baumeler, F. Costa, T. Ralph, S. Wolf, M. Zych, **Classical and Quantum Gravity** 36, 224002 (2019). https://doi.org/10.1088/1361-6382/ab4973 (Gold OA)
50. *Unlimited non-causal correlations and their relation to non-locality,* A. Baumeler, A. Shiraz Gilani, J. Rashid, **Quantum** 6:673 (2022), https://doi.org/10.22331/q-2022-03-29-673 (Gold OA)
51. *Equivalence of grandfather and information antinomy under intervention,* A. Baumeler, E. Tselentis, Proceedings of the 17th International Conference on Quantum Physics and Logic (QPL2020), **Electronic Proceedings in Theoretical Computer Science** 340, (2021), https://doi.org/10.4204/EPTCS.340.1 (Green OA)
52. *Temporal correlations in the simplest measurement sequences*, L. Vieira, C. Budroni, **Quantum** 6, 623, (2022), https://doi.org/10.22331/q-2022-01-18-623 (Gold OA)
53. *Ticking-clock performance enhanced by nonclassical temporal correlations*, C. Budroni, G. Vitagliano, M. P. Woods, **Phys. Rev. Research** 3, 033051 (2021), https://dx.doi.org/10.1103/PhysRevResearch.3.033051 (Gold OA)
54. *Device-independent quantification of measurement incompatibility*, S.-L. Chen, N. Miklin, C. Budroni, Y.-N. Chen, **Phys. Rev. Research** 3, 023143 (2021). https://dx.doi.org/10.1103/PhysRevResearch.3.023143 (Gold OA)
55. *Simulating extremal temporal correlations*, C. Spee, C. Budroni, O. Gühne, **New J. Phys.** 22, 103037 (2020), https://dx.doi.org/10.1088/1367-2630/abb899 (Gold OA)
56. *Memory cost of temporal correlations*, C. Budroni, G. Fagundes, M. Kleinmann, **New J. Phys**. 21, 093018 (2019), https://dx.doi.org/10.1088/1367-2630/ab3cb4 (Gold OA)

57. *Device-independent tests of structures of measurement incompatibility*, M. T. Quintino, C. Budroni, E. Woodhead, A. Cabello, D. Cavalcanti, **Phys. Rev. Lett**. 123, 180401 (2019), https://dx.doi.org/10.1103/PhysRevLett.123.180401
58. *Leggett-Garg macrorealism and the quantum nondisturbance conditions*, R. Uola, G. Vitagliano, C. Budroni, **Phys. Rev. A** 100, 042117 (2019), https://doi.org/10.1103/PhysRevA.100.042117
59. *Bell nonlocality with a single shot,* M. Araújo, F. Hirsch, M.T. Quintino, **Quantum** 4, 353 (2020), https://doi.org/10.22331/q-2020-10-28-353 (Green OA)
60. *Simple and maximally robust processes with no classical common-cause or direct cause explanation*, M. Nery, M. T. Quintino, P. A. Guérin, T. O. Maciel, R. O. Vianna, **Quantum** 5, 538 (2021). https://doi.org/10.22331/q-2021-09-09-538 (Gold OA)
61. *Certifying dimension of quantum systems by sequential projective measurements,* A. Sohbi, D. Markham, J. Kim, M.T. Quintino, **Quantum** 5, 472 (2021). https://doi.org/10.22331/q-2021-06-10-472 (Gold OA)
62. *Success-or-Draw: A Strategy Allowing Repeat-Until-Success in Quantum Computation*, Q. Dong, M.T. Quintino, A. Soeda, M. Murao, **Phys. Rev. Lett**. 126, 150504 (2021). https://doi.org/10.1103/PhysRevLett.126.150504 (Green OA)
63. *Strict Hierarchy between Parallel, Sequential, and Indefinite-Causal-Order Strategies for Channel Discrimination*, J. Bavaresco, M. Murao, M.T. Quintino, **Phys. Rev. Lett.** 127, 200504 (2021). https://doi.org/10.1103/PhysRevLett.127.200504 (Green OA)
64. *Deterministic transformations between unitary operations: Exponential advantage with adaptive quantum circuits and the power of indefinite causality*, M.T. Quintino, D. Ebler, **Quantum** 6, 679 (2022). https://doi.org/10.48550/arXiv.2109.08202 (Green OA)
65. *Unitary channel discrimination beyond group structures: Advantages of sequential and indefinite-causal-order strategies*, J. Bavaresco, M. Murao, M.T. Quintino, **J. Math. Phys.** 63, 042203 (2022). https://doi.org/10.1063/5.0075919 (Green OA)
66. *Detecting quantum non-breaking channels without entanglement*, H.-Y. Ku, J. Kadlec, A. Cernoch, M.T. Quintino, W. Zhou, K. Lemr, N. Lambert, A. Miranowicz, S.-L. Chen, F. Nori, Y-N. Chen, **PRX Quantum** 3, 020338 (2022). https://doi.org/10.48550/arXiv.2106.15784 (Green OA)
67. *Quantum teleportation of quantum causal structures*, M. Krumm, P. A. Guérin, T. Zauner, Č. Brukner, preprint at arXiv:2203.00433, https://doi.org/10.48550/arXiv.2203.00433 (Green OA)
68. *Einstein's Equivalence principle for superpositions of gravitational fields and quantum reference frames*, F. Giacomini, C. Brukner, preprint at arXiv:2012.13754 https://doi.org/10.48550/arXiv.2012.13754 (Green OA)

69. *Falling through masses in superposition: quantum reference frames for indefinite metrics,* A.-C. de la Hamette, V. Kabel, E. Castro-Ruiz, Č. Brukner, preprint at arXiv:2112.11473. https://doi.org/10.48550/arXiv.2112.11473 (Green OA)
70. *How quantum nonlocality without entanglement witnesses classical processes without causal order,* R. Kunjwal, A. Baumeler, preprint at arXiv:2110.05359 https://doi.org/10.48550/arXiv.2202.00440 (Green OA)
71. *Algebraic and geometric properties of local transformations,* D. Rosset, A. Baumeler, J.-D. Bancal, N. Gisin, A. Martin, M.-O. Renou, Elie Wolfe, preprint at arXiv:2004.09405. https://doi.org/10.48550/arXiv.2004.09405 (Green OA)
72. *Complete classification of steerability under local filters and its relation with measurement incompatibility*, H.-Y. Ku, C.-Y. Hsieh, S.-L. Chen, Y.-N. Chen, C. Budroni, preprint at arXiv:2201.07691. https://doi.org/10.48550/arXiv.2201.07691 (Green OA)
73. *Quantum Contextuality*, C. Budroni, A. Cabello, O. Gühne, M. Kleinmann, J.-Å. Larsson, preprint at arXiv:2102.13036 [quant-ph]. https://doi.org/10.48550/arXiv.2102.13036

Sub-project P04 | Cirac

74. *Unveiling quantum entanglement in many-body systems from partial information,* I. Frérot, F. Baccari, A. Acín, **PRX Quantum** 3, 010342 (2022). doi:10.1103/PRXQuantum.3.010342 (Gold OA)
75. *Enhancing generative models via quantum correlations,* X. Gao, E. R. Anschuetz, S.-T. Wang, J. I. Cirac, M. D. Lukin, **Phys. Rev. X** 12, 021037 (2022). https://doi.org/10.1103/PhysRevX.12.021037 (Gold OA)
76. *Symmetries and local transformations of translationally invariant Matrix Product States,* M. Hebenstreit, D. Sauerwein, A. Molnar, J. I. Cirac, B. Kraus, **Phys. Rev. A** 105, 032424 (2022). https://doi.org/10.1103/PhysRevA.105.032424 (Hybrid OA)
77. *Sequential generation of projected entangled-pair states,* Z.-Y. Wei, D. Malz, J. I. Cirac, **Phys. Rev. Lett.** 128, 010607 (2022). https://doi.org/10.1103/PhysRevLett.128.010607 (Hybrid OA)
78. *Entanglement marginal problems,* M. Navascues, F. Baccari, A. Acín, **Quantum** 5, 589 (2021). doi:10.22331/q-2021-11-25-589 (Gold OA)
79. *Locally accurate tensor networks for thermal states and time evolution,* Á. M. Alhambra, J. I. Cirac, **PRX Quantum** 2, 040331 (2021). doi:10.1103/PRXQuantum.2.040331 (Gold OA)
80. *Computable Rényi mutual information: Area laws and correlations,* S. O. Scalet, A. M. Alhambra, G. Styliaris, J. I. Cirac, **Quantum** 5, 541 (2021). doi:10.22331/q-2021-09-14-541 (Gold OA)
81. *Quantum algorithms for powering stable Hermitian matrices,* G. González, R. Trivedi, J. I. Cirac, **Phys. Rev. A** 103, 062420 (2021). doi:10.1103/PhysRevA.103.062420 (Hybrid OA)

82. *Modeling and mitigation of cross-talk effects in readout noise with applications to the Quantum Approximate Optimization Algorithm,* F. B. Maciejewski, F. Baccari, Z. Zimboras, M. Oszmaniec, **Quantum** 5, 464 (2021). doi:10.22331/q-2021-06-01-464 (Gold OA)
83. *Algorithms for quantum simulation at finite energies,* S.-R. Lu, M. C. Bañuls, J. I. Cirac, **PRX Quantum** 2, 020321 (2021). doi:10.1103/PRXQuantum.2.020321 (Gold OA)
84. *The quantum marginal problem for symmetric states: applications to variational optimization, nonlocality and self-testing,* A. Aloy, M. Fadel, J. Tura i Brugués, **New J. Phys.** 23, 033026 (2021). doi:10.1088/1367-2630/abe15e (Gold OA)
85. *Generation of Photonic Matrix Product States with Rydberg Atomic Arrays,* Z.-Y. Wei, D. Malz, A. González-Tudela, J. I. Cirac, **Phys. Rev. Research** 3, 023021 (2021). doi:10.1103/PhysRevResearch.3.023021 (Gold OA)
86. *Bounding the fidelity of quantum many-body states from partial information,* M. Fadel, A. Aloy, J. Tura i Brugués, **Phys. Rev. A** 102, 020401 (2020). doi:10.1103/PhysRevA.102.020401 (Hybrid OA)
87. *Ultrafast molecular dynamics in terahertz-STM experiments: Theoretical analysis using Anderson Holstein model,* T. Shi, J. Ignacio Cirac, E. Demler, **Phys. Rev. Research** 2, 033379 (2020). doi: 10.1103/PhysRevResearch.2.033379 (Gold OA)
88. *A variational approach for many-body systems at finite temperature,* T. Shi, E. Demler, J. I. Cirac, **Phys. Rev. Lett.** 125, 180602 (2020). doi:10.1103/PhysRevLett.125.180602 (Hybrid OA)
89. *Device-Independent Certification of Genuinely Entangled Subspaces,* F. Baccari, R. Augusiak, I. Supic, A. Acin, **Phys. Rev. Lett.** 125, 260507 (2020). doi:10.1103/PhysRevLett.125.260507 (Hybrid OA)
90. *Bounding sets of sequential quantum correlations and device-independent randomness certification,* J. Bowles, F. Baccari, A. Salavrakos, **Quantum** 4, 344 (2020). doi:10.22331/q-2020-10-19-344 (Gold OA)
91. *Matrix Product States: Entanglement, symmetries, and state transformations,* D. Sauerwein, A. Molnar, J. I. Cirac, B. Kraus, **Phys. Rev. Lett.** 123, 170504 (2019). doi: 10.1103/PhysRevLett.123.170504 (Hybrid OA)
92. *Gaussian matrix product states cannot efficiently describe critical systems,* Adrián Franco-Rubio, J. Ignacio Cirac, https://doi.org/10.48550/arXiv.2204.02478 (Other OA)
93. *Error propagation in NISQ devices for solving classical optimization problems,* Guillermo González-García, Rahul Trivedi, J. Ignacio Cirac, https://doi.org/10.48550/arXiv.2203.15632 (Other OA)
94. *Large-N limit of spontaneous superradiance,* Daniel Malz, Rahul Trivedi, Ignacio Cirac, https://doi.org/10.48550/arXiv.2202.05197 (Other OA)

95. *Preparation and verification of tensor network states,* E. Cruz-Rico, F. Baccari, J. Tura, N. Schuch, J. I. Cirac, https://doi.org/10.48550/arXiv.2105.06866 (Other OA) (accepted by Phys. Rev. Research on May 5, 2022)
96. *Adiabatic Spectroscopy and a Variational Quantum Adiabatic Algorithm,* B. Schiffer, J. Tura, J. I. Cirac, https://doi.org/10.48550/arXiv.2103.01226 (Other OA) (accepted by PRX Quantum on April 7, 2022)
97. *Certificates of quantum many-body properties assisted by machine learning,* Borja Requena, Gorka Muñoz-Gil, Maciej Lewenstein, Vedran Dunjko, Jordi Tura, https://doi.org/10.48550/arXiv.2103.03830 (Other OA)
98. *Convergence guarantees for discrete mode approximations to non-Markovian quantum baths,* Rahul Trivedi, Daniel Malz, J. Ignacio Cirac, https://doi.org/10.48550/arXiv.2107.07196 (Other OA)
99. *Simulatability of locally-interacting open quantum spin systems,* Rahul Trivedi, J. Ignacio Cirac, https://doi.org/10.48550/arXiv.2110.10638 (Other OA)
100. *Tensor networks and efficient descriptions of classical data,* Sirui Lu, Márton Kanász-Nagy, Ivan Kukuljan, J. Ignacio Cirac, https://doi.org/10.48550/arXiv.2103.06872 (Other OA)

Sub-project P05 | Fink

101. *Surpassing the resistance quantum with a geometric superinductor*, M. Peruzzo*, A. Trioni*, F. Hassani, M. Zemlicka, J. M. Fink, **Phys. Rev. Applied** 14, 044055 (2020). https://doi.org/10.1103/PhysRevApplied.14.044055 (Green OA)
102. *Geometric superinductance qubits: Controlling phase delocalization across a single Josephson junction*, Matilda Peruzzo, Farid Hassani, Gregory Szep, Andrea Trioni, Elena Redchenko, Martin Žemlička, Johannes Fink, **PRX Quantum** 2, 040341 (2021). https://doi.org/10.1103/PRXQuantum.2.040341 (Gold OA)
103. *Electro-optic entanglement source for microwave to telecom quantum state transfer*, Alfredo Rueda, William Hease, Shabir Barzanjeh, Johannes M. Fink, **npj Quantum Information** 5, 108 (2019). https://doi.org/10.1038/s41534-019-0220-5 (Gold OA)
104. *Microwave Quantum Illumination using a Digital Receiver*, S. Barzanjeh, S. Pirandola, D. Vitali and J. M. Fink, **Science Advances** 6 eabb0451 (2020) https://doi.org/10.1126/sciadv.abb0451 (Gold OA)
105. Efficient microwave frequency conversion mediated by the vibrational motion of a silicon nitride nanobeam oscillator, J. M. Fink, M. Kalaee, R. Norte, A. Pitanti, O. Painter, **Quantum Sci. Technol.** 5 034011 (2020) https://doi.org/10.1088/2058-9565/ab8dce (Gold OA)
106. *Converting microwave and telecom photons with a silicon photonic nanomechanical interface*, G. Arnold*, M. Wulf*, S. Barzanjeh, E. S. Redchenko, A. Rueda, W. J. Hease, F. Hassani,

J. M. Fink. **Nature Commun.** 11, 4460 (2020). https://doi.org/10.1038/s41467-020-18269-z (Gold OA)

107. *Bidirectional electro-optic wavelength conversion in the quantum ground state*, W. Hease*, A. Rueda*, R. Sahu, M. Wulf, G. Arnold, H. G. L. Schwefel, J. M. Fink, **PRX Quantum** 1, 020315 (2020). https://doi.org/10.1103/PRXQuantum.1.020315 (Gold OA)
108. *Quantum-enabled operation of a microwave-optical interface*, Rishabh Sahu, William Hease, Alfredo Rueda, Georg Arnold, Liu Qiu, Johannes Fink, **Nature Commun.** 13, 1276 (2022). https://doi.org/10.1038/s41467-022-28924-2 (Gold OA)
109. *A superconducting qubit with noise-insensitive plasmon levels and decay-protected fluxon states*, Farid Hassani, Matilda Peruzzo, Lucky N. Kapoor, Andrea Trioni, Martin Zemlicka, Johannes M. Fink, **arXiv**:2202.13917 (2022). https://doi.org/10.48550/arXiv.2202.13917 (Green OA)
110. *Compact vacuum gap transmon qubits: Selective and sensitive probes for superconductor surface losses*, M. Zemlicka, E. Redchenko, M. Peruzzo, F. Hassani, A. Trioni, S. Barzanjeh, and J. M. Fink, arXiv:2206.14104 (2022). https://doi.org/10.48550/arXiv.2206.14104 (Green OA)
111. *Tunable directional photon scattering from a pair of superconducting qubits*, Elena S. Redchenko, Alexander V. Poshakinskiy, Riya Sett, Martin Zemlicka, Alexander N. Poddubny, Johannes M. Fink, **arXiv**:2205.03293 (2022). https://doi.org/10.48550/arXiv.2205.03293 (Green OA)

Sub-project P06 | Kirchmair

112. *Collective bosonic effects in an array of transmon devices*, Tuure Orell, Maximilian Zanner, Mathieu L. Juan, Aleksei Sharafiev, Romain Albert, Stefan Oleschko, G. Kirchmair, Matti Silveri, **Phys. Rev. A** 105, 063701 (2022) https://doi.org/10.1103/PhysRevA.105.063701 (Green OA)
113. *Coherent control of a multi-qubit dark state in waveguide quantum electrodynamics*, M. Zanner, T. Orell, C. Schneider, R. Albert, S. Oleschko, M. L. Juan, M. Silveri, G. Kirchmair, **Nat. Phys**. 18, 538 (2022). https://doi.org/10.1038/s41567-022-01527-w (Green OA)
114. *Non-Markovian Effects of Two-Level Systems in a Niobium Coaxial Resonator with a Single-Photon Lifetime of 10 milliseconds*, P. Heidler, C. M. F. Schneider, K. Kustura, C. Gonzalez-Ballestero, O. Romero-Isart, G. Kirchmair, **Phys. Rev. Applied** 16, 34024 (2021). https://doi.org/10.1103/PhysRevApplied.16.034024 (Green OA)

Sub-project P07 | Kraus

115. *All Pure Fermionic Non-Gaussian States Are Magic States for Matchgate Computations,* M. Hebenstreit, R. Jozsa, B. Kraus, S. Strelchuk, M. Yoganathan, **Phys. Rev. Lett.** 123, 080503 (2019). https://doi.org/10.1103/PhysRevLett.123.080503 (Hybrid OA)
116. *Computational power of matchgates with supplementary resources,* M. Hebenstreit, R. Jozsa, B. Kraus, S. Strelchuk, **Phys. Rev. A** 102, 052604 (2020). https://doi.org/10.1103/PhysRevA.102.052604 (Hybrid OA)
117. *Theoretical and Experimental Perspectives of Quantum Verification,* J. Carrasco, A. Elben, C. Kokail, B. Kraus, and P. Zoller, **PRX Quantum** 2, 010102 (2021). https://doi.org/10.1103/PRXQuantum.2.010102 (Gold OA)
118. *Mixed-State Entanglement from Local Randomized Measurements,* A. Elben, R. Kueng, H.-Y. Huang, R. van Bijnen, C. Kokail, M. Dalmonte, P. Calabrese, B. Kraus, J. Preskill, P. Zoller, B. Vermersch, **Phys. Rev. Lett.** 125, 200501 (2020). https://doi.org/10.1103/PhysRevLett.125.200501 (Hybrid OA)
119. *Symmetry-resolved entanglement detection using partial transpose moments*, Neven, J. Carrasco, V. Vitale, C. Kokail, A. Elben, M. Dalmonte, P. Calabrese, P. Zoller, B. Vermersch, R. Kueng, B. Kraus, **npj Qauntum Information** 7, 152 (2021). https://doi.org/10.1038/s41534-021-00487-y (Gold OA)
120. *Symmetry-resolved dynamical purification in synthetic quantum matter,* V. Vitale, A. Elben, R. Kueng, A. Neven, J. Carrasco, B. Kraus, P. Zoller, P. Calabrese, B. Vermersch, M. Dalmonte, **SciPost Phys.** 12, 106 (2022). https://scipost.org/10.21468/SciPostPhys.12.3.106 (Gold OA)
121. *State transformations within entanglement classes containing permutation-symmetric states,* M. Hebenstreit, C. Spee, N. K. H. Li, B. Kraus, J. I. de Vicente, **Phys. Rev. A 105**, 032458 (2022). https://doi.org/10.1103/PhysRevA.105.032458 (Hybrid OA)
122. *Local Transformations of Multiple Multipartite States,* A. Neven, D. Gunn, M. Hebenstreit, B. Kraus, **SciPost Phys.** 11, 042 (2021). https://scipost.org/10.21468/SciPostPhys.11.2.042 (Gold OA)
123. *A link between symmetries of critical states and the structure of SLOCC classes in multipartite systems,* O. Słowik, M. Hebenstreit, B. Kraus, A. Sawicki, **Quantum** 4, 300 (2020). https://doi.org/10.22331/q-2020-07-20-300 (Gold OA)
124. *Measurement outcomes that do not occur and their role in entanglement transformations,* M. Hebenstreit, M. Englbrecht, C. Spee, J. I. de Vicente, B. Kraus, **New J. Phys. 23**, 033046 (2021). https://doi.org/10.1088/1367-2630/abe60c (Gold OA)
125. *Symmetries and entanglement of stabilizer states,* M. Englbrecht, B. Kraus, **Phys. Rev. A** 101, 062302 (2020). https://doi.org/10.1103/PhysRevA.101.062302 (Hybrid OA)

126. *Matrix Product States: Entanglement, Symmetries, and State Transformations,* D. Sauerwein, A. Molnar, J. I. Cirac, B. Kraus, **Phys. Rev. Lett.** 123, 170504 (2019). https://doi.org/10.1103/PhysRevLett.123.170504 (Hybrid OA)
127. *Symmetries and local transformations of translationally invariant matrix product states,* M. Hebenstreit, D. Sauerwein, A. Molnar, J. I. Cirac, B. Kraus, **Phys. Rev. A 105**, 032424 (2022). https://doi.org/10.1103/PhysRevA.105.032424 (Hybrid OA)
128. *Hardware efficient quantum simulation of non-abelian gauge theories with qudits on Rydberg platforms,* D. González-Cuadra, T. V. Zache, J. Carrasco, B. Kraus, P. Zoller. (2022) https://doi.org/10.48550/arXiv.2203.15541
129. *Towards experimental classical verification of quantum computation,* R. Stricker, J. Carrasco, M. Ringbauer, L. Postler, M. Meth, C. Edmunds, P. Schindler, R. Blatt, P. Zoller, B. Kraus, T. Monz (2022) https://doi.org/10.48550/arXiv.2203.07395
130. *Transformations of Stabilizer States in Quantum Networks,* M. Englbrecht, T. Kraft, B. Kraus, (2022) https://doi.org/10.48550/arXiv.2203.04202

Sub-project P08 | Lechner

131. *A quantum n-queens solver,* V. Torggler, P. Aumann, H. Ritsch, W. Lechner, **Quantum** 3, 149, (2019) https://doi.org/10.22331/q-2019-06-03-149 (Gold OA)
132. *Quantum phase transition with inhomogeneous driving in the Lechner-Hauke-Zoller model*, A. Hartmann, W. Lechner, **Review A** 100, 032110 (2019) https://doi.org/10.1103/PhysRevA.100.032110 (Hybrid OA)
133. *Quantum expectation-maximization algorithm*, H. Miyahara, K. Aihara, W. Lechner, **Physical Review A** 101, 012326 (2020) https://doi.org/10.1103/PhysRevA.101.012326 (Hybrid OA)
134. *Perspectives of quantum annealing: Methods and implementations*, P. Hauke, H. G. Katzgraber, W. Lechner, H. Nishimori, W. D. Oliver, **Reports on Progress in Physics** 83, 054401, (2020) https://doi.org/10.1088/1361-6633/ab85b8 (No OA)
135. *Many-body quantum heat engines with shortcuts to adiabaticity*, A. Hartmann, V. Mukherjee, W. Niedenzu, W. Lechner, **Physical Review Research** 2, 023145 (2020) https://doi.org/10.1103/PhysRevResearch.2.023145 (Gold OA)
136. *Quantum approximate optimization with parallelizable gates*, W. Lechner, **IEEE Transactions on Quantum Engineering** 1, 1-6 (2020) https://doi.org/10.48550/arXiv.1802.01157 (Gold OA)
137. *Multi-spin counter-diabatic driving in many-body quantum Otto refrigerators*, A. Hartmann, V. Mukherjee, G. B. Mbeng, W. Niedenzu, W. Lechner, **Quantum** 4, 377 (2020) https://doi.org/10.22331/q-2020-12-24-377 (Gold OA)

138. *Two-parameter counter-diabatic driving in quantum annealing*, L. Prielinger, A. Hartmann, Y. Yamashiro, K. Nishimura, W. Lechner, H. Nishimori, **Physical Review Research** 3, 013227 (2021) https://doi.org/10.1103/PhysRevResearch.3.013227 (Gold OA)
139. *Minimal constraints in the parity formulation of optimization problems,* M. Lanthaler, W. Lechner, **New Journal of Physics** 23, 083039 (2021) https://doi.org/10.1088/1367-2630/ac1897 (Gold OA)
140. *Embedding Overhead Scaling of Optimization Problems in Quantum Annealing,* M. S. Könz, W. Lechner, H. G. Katzgraber, M. Troyer, **PRX Quantum** 2, 040322 (2021) https://doi.org/10.1103/PRXQuantum.2.040322 (Gold OA)
141. *Qualifying quantum approaches for hard industrial optimization problems. A case study in the field of smart-charging of electric vehicles,* C. Dalyac, L. Henriet, E. Jeandel, W. Lechner, S. Perdrix, M. Porcheron, M. Veshchezerova, **EPJ Quantum Technology** 8, 12 (2021) https://doi.org/10.1140/epjqt/s40507-021-00100-3 (Gold OA)
142. *Polynomial scaling enhancement in the ground-state preparation of Ising spin models via counterdiabatic driving,* A. Hartmann, G. B. Mbeng, W. Lechner, **Physical Review A** 105, 022614 (2022) https://doi.org/10.1103/PhysRevA.105.022614 (Hybrid OA)
143. *Quantum optimization via four-body Rydberg gates*, Dlaska, C., Ender, K., Mbeng, G. B., Kruckenhauser, A., Lechner, W., & van Bijnen, R. (2022). **Physical Review Letters**, 128(12), 120503 (2022) https://doi.org/10.1103/PhysRevLett.128.120503 (Hybrid OA)
144. *Demonstration and modeling of time-bin entangled photons from a quantum dot in a nanowire*, Aumann, P., Prilmüller, M., Kappe, F., Ostermann, L., Dalacu, D., Poole, P. J., ... & Weihs, G., **AIP Advances** 12, 055115 (2022) https://doi.org/10.1063/5.0081874 (Gold OA)
145. *Two-Dimensional Z2 lattice gauge theory on a near-term quantum simulator: Variational quantum optimization, confinement, and topological order*, Lumia, L., Torta, P., Mbeng, G. B., Santoro, G. E., Ercolessi, E., Burrello, M., & Wauters, M. M., **PRX Quantum**, 3(2) (2022) https://doi.org/10.1103/PRXQuantum.3.020320 (Gold OA)
146. *Compact ion-trap quantum computing demonstrator*. I. Pogorelov, T. Feldker, Ch. D. Marciniak, L. Postler, G. Jacob, O. Krieglsteiner, V. Podlesnic, M. Meth, V. Negnevitsky, M. Stadler, B. Höfer, C. Wächter, K. Lakhmanskiy, R. Blatt, P. Schindler, and T. Monz, **PRX Quantum** 2. 2021: 020343. https://doi.org/10.1103/PRXQuantum.2.020343 (Gold OA)
147. *Parity Quantum Optimization: Compiler*, Ender, K., ter Hoeven, R., Niehoff, B. E., Drieb-Schön, M., & Lechner, W. (2021). https://doi.org/10.48550/arXiv.2105.06233
148. *Parity Quantum Optimization: Benchmarks*. Fellner, M., Ender, K., ter Hoeven, R., & Lechner, W. (2021). https://doi.org/10.48550/arXiv.2105.06240
149. *Parity Quantum Optimization: Encoding Constraints*. Drieb-Schön, M., Javanmard, Y., Ender, K., & Lechner, W. (2021). https://doi.org/10.48550/arXiv.2105.06235

150. *CircuitQ: An open-source toolbox for superconducting circuits*. Aumann, P., Menke, T., Oliver, W. D., & Lechner, W. (2021). https://doi.org/10.48550/arXiv.2106.05342
151. *Electron cloud design for Rydberg multi-qubit gates*. Khazali, M., & Lechner, W. (2021). https://doi.org/10.48550/arXiv.2111.01581
152. *Modular Parity Quantum Approximate Optimization*. Ender, K., Messinger, A., Fellner, M., Dlaska, C., & Lechner, W. (2022). https://doi.org/10.48550/arXiv.2203.04340
153. *Applications of Universal Parity Quantum Computation*. Fellner, M., Messinger, A., Ender, K., & Lechner, W. (2022). https://doi.org/10.48550/arXiv.2205.09517
154. *Universal Parity Quantum Computing*. Fellner, M., Messinger, A., Ender, K., & Lechner, W. (2022) https://doi.org/10.48550/arXiv.2205.09505

Sub-project P09 | Monz

155. *Optimal metrology with programmable quantum sensors*. Ch. D. Marciniak, T. Feldker, I. Pogorelov, R. Kaubruegger, D. V. Vasilyev, R. v. Bijnen, P. Schindler, P. Zoller, R. Blatt & T. Monz, **Nature** 603, 2022: 604-609. https://doi.org/10.1038/s41586-022-04435-4 (Green OA), arXiv:2107.01860
156. *Demonstration of fault-tolerant universal quantum gate operations*. L. Postler, S. Heußen, I. Pogorelov, M. Rispler, T. Feldker, M. Meth, Ch. D. Marciniak, R. Stricker, M. Ringbauer, R. Blatt, P. Schindler, M. Müller & T. Monz, **Nature** 605, 2022: 675-680. https://doi.org/10.1038/s41586-022-04721-1 (Green OA), arXiv:2111.12654
157. *Entangling logical qubits with lattice surgery*. A. Erhard, H. P. Nautrup, M. Meth, L. Postler, R. Stricker, M. Ringbauer, P. Schindler, H. J. Briegel, R. Blatt, N. Friis, T. Monz, **Nature** 589 (2021): 220-224. (Green OA), arXiv:2006.03071
158. *Cross-verification of independent quantum devices*. C. Greganti, T. F. Demarie, M. Ringbauer, J. A. Jones, V. Saggio, I. A. Calafell, L. A. Rozema, A. Erhard, M. Meth, L. Postler, R. Stricker, P. Schindler, R. Blatt, T. Monz, P. Walther, J. F. Fitzsimons, **Physical Review X** 11 (2021): 031049. https://journals.aps.org/prx/abstract/10.1103/PhysRevX.11.031049 (Gold OA)
159. *Relaxation times do not capture logical qubit dynamics*. Pal, A. K., Schindler, P., Erhard, A., Rivas, Á., Martin-Delgado, M. A., Blatt, R., ... & Müller, M., **Quantum** 6 (2022): 632. https://quantum-journal.org/papers/q-2022-01-24-632 (Gold OA)
160. *Experimental quantification of spatial correlations in quantum dynamics*, L. Postler, Á. Rivas, P. Schindler, A. Erhard, R. Stricker, D. Nigg, T. Monz, R. Blatt, M. Müller, **Quantum** 2, (2018), https://doi.org/10.22331/q-2018-09-03-90 (Gold OA)
161. *Characterizing large-scale quantum computers via cycle benchmarking,* A. Erhard, J. J. Wallman, L. Postler, M. Meth, R. Stricker, E. A. Martinez, P. Schindler, T. Monz,

J. Emerson, R. Blatt, **Nature Communications** 10, 5347 (2019), https://doi.org/10.1038/s41467-019-13068-7 (Gold OA)

162. *Coherent rotations of qubits within a multi-species ion-trap quantum computer,* M. W. van Mourik, E. A. Martinez, L. Gerster, P. Hrmo, T. Monz, P. Schindler, R. Blatt, **Physical Review A** 102, 022611 (2020), (Green OA), arXiv:2001.02440
163. *Experimental deterministic correction of qubit loss.* R. Stricker, D. Vodola, A. Erhard, L. Postler, M. Meth, M. Ringbauer, P. Schindler, T. Monz, M. Müller, R. Blatt, **Nature** 585, 2020:207-210, (Green OA), arXiv:2002.09532
164. *Scalable and Parallel Tweezer Gates for Quantum Computing with Long Ion Strings*. T. Olsacher, L. Postler, P. Schindler, T. Monz, P. Zoller, L. M. Sieberer, **PRX Quantum** 1, 2020, https://doi.org/10.1103/PRXQuantum.1.020316 (Gold OA)
165. *Quantum portfolio value forecasting*. C. Sanz-Fernandez, R. Hernandez, Ch. D. Marciniak, I. Pogorelov, T. Monz, F. Benfenati, S. Mugel, R. Orus, **arXiv preprint** *arXiv:2111.14970* (2021) (Green OA), arXiv:2111.14970
166. *A universal qudit quantum processor with trapped ions.* M. Ringbauer, M. Meth, L. Postler, R. Stricker, R. Blatt, P. Schindler, T. Monz, **arXiv preprint** *arXiv:2109.06903* (2021). (Green OA), arXiv:2109.06903
167. *Towards experimental classical verification of quantum computation.* R. Stricker, J. Carrasco, M. Ringbauer, L. Postler, M. Meth, C. Edmunds, P. Schindler, R. Blatt, P. Zoller, B. Kraus, T. Monz, **arXiv preprint** *arXiv:2203.07395* (2022). (Green OA), arXiv:2203.07395
168. *Practical randomness and privacy amplification.* C. Foreman, S. Wright, A. Edgington, M. Berta, F. J. Curchod, **arXiv preprint** *arXiv:2009.06551* (2020). (Green OA), arXiv:2009.06551
169. *Characterizing quantum instruments: from non-demolition measurements to quantum error correction.* R. Stricker, D. Vodola, A. Erhard, L. Postler, M. Meth, M. Ringbauer, P. Schindler, R. Blatt, M. Müller, T. Monz, **arXiv preprint** arXiv:2110.06954 (2021) (Green OA), arXiv:2110.06954
170. *Experimental Bayesian calibration of trapped ion entangling operations*. L. Gerster, F. Martínez-García, P. Hrmo, M. van Mourik, B. Wilhelm, D. Vodola, M. Müller, R. Blatt, P. Schindler, T. Monz, **arXiv preprint** arXiv:2112.01411 (2021) (Green OA), arXiv:2112.01411
171. *Analytical and experimental study of center line miscalibrations in Mølmer-Sørensen gates.* F. Martínez-García, L. Gerster, D. Vodola, P. Hrmo, T. Monz, P. Schindler, M. Müller, **arXiv preprint** arXiv:2112.05447 (2021) (Green OA), arXiv:2112.05447
172. *Versatile fidelity estimation with confidence.* A. Seshadri, M. Ringbauer, R. Blatt, T. Monz, S. Becker, **arXiv preprint** arXiv:2112.07925 (2021) (Green OA), arXiv:2112.07925

173. *Industrially Microfabricated Ion Trap with 1 eV Trap Depth.* S. Auchter, C. Axline, C. Decaroli, M. Valentini, L. Purwin, R. Oswald, R. Matt, E. Aschauer, Y. Colombe, P. Holz, T. Monz, R. Blatt, P. Schindler, C. Rössler, J. Home, **arXiv preprint** arXiv:2202.08244 (2022) (Green OA), arXiv:2202.08244
174. *Probing phases of quantum matter with an ion-trap tensor-network quantum eigensolver.* M. Meth, V. Kuzmin, R. van Bijnen, L. Postler, R. Stricker, R. Blatt, M. Ringbauer, T. Monz, P. Silvi, P. Schindler, **arXiv preprint** arXiv:2203.13271 (2022) (Green OA), arXiv:2203.13271
175. *Experimental single-setting quantum state tomography.* R. Stricker, M. Meth, L. Postler, C. Edmunds, C. Ferrie, R. Blatt, P. Schindler, T. Monz, R. Kueng, M. Ringbauer, **arXiv preprint** arXiv:2206.00019 (2022) (Green OA), arXiv:2206.00019
176. *Native qudit entanglement in a trapped ion quantum processor.* P. Hrmo, B. Wilhelm, L. Gerster, M. W. van Mourik, M. Huber, R. Blatt, P. Schindler, T. Monz, M. Ringbauer, **arXiv preprint** arXiv:2206.04104 (2022) (Green OA), arXiv:2206.04104

Sub-project P10 | Roos

177. *Observing emergent hydrodynamics in a long-range quantum magnet,* M. K. Joshi, F. Kranzl, A. Schuckert, I. Lovas, C. Maier, R. Blatt, K. Knap, C. F. Roos, **Science** 376, 720-724 (2022) https://doi.org/10.1126/science.abk2400 (Green OA)
178. *Controlling long ion strings for quantum simulation and precision measurements*, F. Kranzl, M.K. Joshi, C. Maier, T. Brydges, J. Franke, R. Blatt, C. F. Roos, **Phys. Rev. A** 105, 052426 (2022), https://doi.org/10.1103/PhysRevA.105.052426 (Green OA)
179. *Polarization-gradient cooling of 1D and 2D ion Coulomb crystals,* M. K. Joshi, A. Fabre, C. Maier, T. Brydges, D. Kiesenhofer, H. Hainzer, R. Blatt, C. F. Roos, **New J. Phys.** 22 103013 (2020), https://dx.doi.org/10.1088/1367-2630/abb912 (Gold OA)
180. *Quantum information scrambling in a trapped-ion quantum simulator with tunable range interactions*, M. Joshi, A. Elben, B. Vermersch, T. Brydges, C. Maier, P. Zoller, R. Blatt, C. F. Roos, **Phys. Rev. Lett.** 124, 240505 (2020) https://doi.org/10.1103/PhysRevLett.124.240505 (Green OA)
181. *Cross-Platform Verification of Intermediate Scale Quantum Devices*, A. Elben, B. Vermersch, R. van Bijnen, C. Kokail, T. Brydges, C. Maier, M. Joshi, R. Blatt, C. F. Roos, P. Zoller, **Phys. Rev. Lett.** 124, 010504 (2020) https://dx.doi.org/10.1103/PhysRevLett.124.010504 (Green OA)
182. *Correlation spectroscopy with multi-qubit-enhanced phase estimation*, H. Hainzer, D. Kiesenhofer, T. Ollikainen, M. Bock, F. Kranzl, M. K. Joshi, G. Yoeli, R. Blatt, T. Gefen, C. F. Roos, arXiv:2203.12656 (2022) https://doi.org/10.48550/arXiv.2203.12656

183. *Experimental observation of thermalisation with noncommuting charges*, F. Kranzl, A. Lasek, M. K. Joshi, A. Kalev, R. Blatt, C. F. Roos, N. Yunger Halpern, **arXiv**:2202.04652 (2022), https://doi.org/10.48550/arXiv.2202.04652

Sub-project P12 | Dakić

184. *Quantum enhancement to information speed acquisition*, S. Horvat, B. Dakić, **New J. Phys.** 23 033008, (2021), https://doi.org/10.1088/1367-2630/abe9d4 (Gold OA)
185. *Coherence Equality and Communication in Quantum Superposition,* F. Del Santo, B. Dakić, **Phys. Rev. Lett.** 124, 190501 (2020), https://doi.org/10.1103/PhysRevLett.124.190501 (Hybrid OA)
186. *Interference as an information-theoretic game,* S. Horvat B. Dakić, **Quantum** 5, 404 (2021), https://doi.org/10.22331/q-2021-03-08-404 (Gold OA)
187. *Higher-order interference between multiple quantum particles interacting nonlinearly*, L. A. Rozema, Z. Zhuo, T. Paterek, B. Dakić, **Phys. Rev. A** 103, 052204 (2021), https://doi.org/10.1103/PhysRevA.103.052204 (Hybrid OA)
188. *Macroscopically nonlocal quantum correlations*, M. Gallego, B. Dakić, **Phys. Rev. Lett**. 127, 120401 (2021), https://doi.org/10.1103/PhysRevLett.127.120401 (Hybrid OA)
189. *Bell's theorem for trajectories*, D. Gočanin, A. Dimić, F. Del Santo, B. Dakić, **Phys. Rev. A** 102, 020201 (2020), https://doi.org/10.1103/PhysRevA.102.020201 (Hybrid OA)
190. *Universal quantum computation via quantum controlled classical operations,* S. Horvat, X. G. Gao, B. Dakić, **J. Phys. A: Math. Theor.** 55 075301 (2022), https://doi.org/10.1088/1751-8121/ac4393 (Gold OA)
191. *Experimental few-copy multi-particle entanglement detection*, V. Saggio, A. Dimić, C. Greganti, P. Walther, B. Dakić, **Nature Physics** 15, 935 (2019), https://doi.org/10.1038/s41567-019-0550-4 (Hybrid OA)
192. *Sample-efficient device-independent quantum state verification and certification,* A. Gočanin, I. Šupić, B. Dakić, **PRX Quantum** 3, 010317 (2022),
193. *Quantum verification with few copies,* J. Morris, V. Saggio, A. Gočanin, B. Dakić, **Adv. Quantum Technol.** 2100118 (2022), https://doi.org/10.1002/qute.202100118 (Gold OA)
194. *Experimental photonic quantum memristor,* M. Spagnolo, J. Morris, S. Piacentini, M. Antesberger, F. Massa, A. Crespi, F. Ceccarelli, R. Osellame, P. Walther, **Nature Photonics** 16, 318–323 (2022). https://doi.org/10.1038/s41566-022-00973-5 (Gold OA)
195. *Experimental two-way communication with one photon,* F. Massa, A. Moqanaki, F. Del Santo, J. A. Kettlewell, B. Dakić, P. Walther, **Adv. Quantum Technol.** 2, 1900050 (2019), https://doi.org/10.1002/qute.201900050 (Gold OA)

196. *Fourier Transform of the Orbital Angular Momentum of a Single Photon,* J. Kysela, X. Gao, B. Dakić, **Phys. Rev. Applied** 14, 034036 (2020), https://doi.org/10.1103/PhysRevApplied.14.034036 (Gold OA)
197. *Accessing inaccessible information via quantum indistinguishability,* S. Horvat and B. Dakić, arXiv:2203.16592 [quant-ph], https://doi.org/10.48550/arXiv.2203.16592 (Other OA)
198. *Selective Quantum State Tomography,* J. Morris, B. Dakić, arXiv:1909.05880 [quant-ph] (2019), https://doi.org/10.48550/arXiv.1909.05880 (Other OA)
199. *Experimental Higher-Order Interference in a Nonlinear Triple Slit,* P. Namdar et al., https://doi.org/10.48550/arXiv.2112.06965 (Other OA)
200. *Verifying Multi-Partite Entanglement with a Few Detection Events,* L. A. Rozema, V. Saggio, A. Dimić, C. Greganti, P. Walther, B. Dakić, In Conference on Lasers and Electro-Optics 2019, OSA Technical Digest (Optical Society of America, 2019) paper FM2M.7, https://doi.org/10.1364/CLEO_QELS.2019.FM2M.7 (Hybrid OA)
201. *Verifying Multi-Particle Entanglement with a Few Detection Events,* V. Saggio, A. Dimić, C. Greganti, L. A. Rozema, P. Walther, B. Dakić, In Quantum Information and Measurement (QIM) V: Quantum Technologies, OSA Technical Digest (Optical Society of America, 2019) paper F5A.7, https://doi.org/10.1364/QIM.2019.F5A.7 (Hybrid OA)
202. *Comment on "Quantum principle of relativity",* F.D. Santo and S. Horvat, https://doi.org/10.48550/arXiv.2203.03661 (Other OA)

Sub-project P13 | Walther

203. *A perspective on few-copy entanglement detection in experiments*, V. Saggio, P. Walther, **Annalen der Physik** (in print), (2022) https://doi.org/10.1002/andp.202100597 (Gold OA)
204. *Inferring work by quantum superposing forward and time-reversal evolutions*, G. Rubino, G. Manzano, L. A. Rozema, P. Walther, J. M. R. Parrondo, C. Brukner, **Physical Review Research** 4, 013208 (2022). https://doi.org/10.1103/PhysRevResearch.4.013208 (Gold OA)
205. *Experimental photonic quantum memristor*, M. Spagnolo, J. Morris, S. Piacentini, M. Antesberger, F. Massa, A. Crespi, F. Ceccarelli, R. Osellame, P. Walther, **Nature Photonics** 16, 318–323 (2022). https://doi.org/10.1038/s41566-022-00973-5 (Gold OA)
206. *Experimental entanglement of temporal order*, G. Rubino, L. A. Rozema, F. Massa, M. Arauja, M. Zych, C. Brukner, P. Walther, **Quantum** 6, 621 (2022) https://doi.org/10.22331/q-2022-01-11-621 (Gold OA)
207. *Giant enhancement of third-harmonic generation in graphene–metal heterostructures*, I. Alonso Calafell, L.A. Rozema, D. Alcaraz Iranzo, A. Trenti, P.K. Jenke, J.D. Cox, A. Kumar, H. Bieliaiev, S. Nanot, C. Peng, D.K. Efetov, J.Y. Hong, J. Kong, D.R. Englund, F.J. García de

Abajo, F.H.L. Koppens, P. Walther, **Nature Nanotechnology** 16, 318–324 (2021) https://doi.org/10.1038/s41565-020-00808-w (Gold OA)

208. *Cross-Verification of Independent Quantum Devices*, C. Greganti, T. F. Demarie, M. Ringbauer, J. A. Jones, V. Saggio, I. Alonso Calafell, L. A. Rozema, A. Erhard, M. Meth, L. Postler, R. Stricker, P. Schindler, R. Blatt, T. Monz, P. Walther, J. F. Fitzsimons, **Physical Review X** 11, 031049 (2021) https://doi.org/10.1103/PhysRevX.11.031049 (Gold OA)
209. *Probabilistic one-time programs using quantum entanglement*, M.-C. Röhsner, J. A. Kettlewell, J. Fitzsimons, P. Walther, **npj Quantum Information** 7, 98 (2021) https://doi.org/10.1038/s41534-021-00435-w (Gold OA)
210. *Quantum cryptography with highly entangled photons from semiconductor quantum dots*, C. Schimpf, M. Reindl, D. Huber, B. Lehner, S.F. Covre Da Silva, S. Manna, M. Vyvlecka, P. Walther, A. Rastelli, **Science Advances** 7, 16 (2021) https://doi.org/10.1126/sciadv.abe8905 (Green OA)
211. *Experimental quantum speed-up in reinforcement learning agents*, V. Saggio, B. E. Asenbeck, A. Hamann, T. Strömberg, P. Schiansky, V. Dunjko, N. Friis, N.C. Harris, M. Hochberg, D. Englund, S. Wölk, H.J. Briegel, P. Walther, **Nature** 591, 229–233 (2021) https://doi.org/10.1038/s41586-021-03242-7 (Green OA)
212. *Experimental quantum homomorphic encryption*, J. Zeuner, I. Pitsios, S.-H. Tan, A. Sharma, J. Fitzsimons, R. Osellame, P. Walther, **npj Quantum Information** 7, 25 (2021) https://doi.org/10.1038/s41534-020-00340-8 (Gold OA)
213. *Experimental quantum communication enhancement by superposing trajectories*, G. Rubino, L.A. Rozema, D. Ebler, H. Kristjánsson, S. Salek, P. Allard Guérin, A.A. Abbott, C. Branciard, C. Brukner, G. Chiribella, P. Walther, Phys. Rev. Research 3, 013093 (2021) https://doi.org/10.1103/PhysRevResearch.3.013093 (Gold OA)
214. *Fiber-compatible photonic feed-forward with 99% fidelity*, G. L. Zanin, M. Jacquet, M. Spagnolo, P. Schiansky, I. Alonso Calafell, L.A. Rozema, P. Walther, **Optic Express** 29, 3425-3437 (2021) https://doi.org/10.1364/OE.409867 (Gold OA)
215. *Quantum superposition of thermodynamic evolutions with opposing time's arrows*, G. Rubino, G. Manzano, Č. Brukner, **Communication Physics** 4, 251 (2021). https://doi.org/10.1038/s42005-021-00759-1 (Green OA)
216. *Experimental Two-Way Communication with One Photon*, F. Massa, A. Moqanaki, Ä. Baumeler, F. Del Santo, J.A. Kettlewell, B. Dakic, P. Walther, **Advanced Quantum Technologies** 201900050 (2019) https://doi.org/10.1002/qute.201900050 (Gold OA)
217. *Trace-free counterfactual communication with a nanophotonic processor*, I. Alonso Calafell, T. Strömberg, D.R.M. Arvidsson-Shukur, L.A. Rozema, V. Saggio, C. Greganti, N.C. Harris, M. Prabhu, J. Carolan, M. Hochberg, T. Baehr-Jones, D. Englund,

C.H.W. Barnes, P. Walther, **npj Quantum Information** 5, 61 (2019) https://doi.org/10.1038/s41534-019-0179-2 (Gold OA)

218. *Experimental few-copy multi-particle entanglement detection*, V. Saggio, A. Dimić, Ch. Greganti, L.A. Rozema, P. Walther, B. Dakić, **Nature Physics** 15, 935–940 (2019) https://doi.org/10.1038/s41567-019-0550-4 (Green OA)
219. *Quantum Computing with Graphene Plasmons*, I. Alonso Calafell, J.D. Cox, M. Radonjic, J.R.M. Saavedra, F.J. Garca de Abajo, L.A. Rozema, P. Walther**, npj Quantum Information** 5, 37 (2019) https://doi.org/10.1038/s41534-019-0150-2 (Gold OA)
220. *Communication through quantum-controlled noise*, P. A. Guérin, G. Rubino, Č. Brukner, **Phys. Rev. A** 99, 062317 (2019). https://doi.org/10.1103/PhysRevA.99.062317 (no OA)
221. *Enhancing quantum cryptography with quantum dot single-photon sources*, M. Bozzio, M. Vyvlecka, M. Cosacchi, C. Nawrath, T. Seidelmann, J. C. Loredo, S. L. Portalupi, V. M. Axt, P. Michler, P. Walther, arXiv:2204.11734 [quant-ph] (2022).
222. *High-harmonic generation enhancement with graphene heterostructures*, I. A. Alonso, L. A. Rozema, A. Trenti, J. Bohn, E. J. C. Dias, P. K. Jenke, K. S. Menghrajani, D. Alcaraz Iranzo, F. J. Garcia de Abajo, F. H. L. Koppens, E. Hendry, P. Walther, arXiv:2203.14644v1 [con-mat.mes-hall] (2022).
223. *Measuring space-time curvature using maximally path-entangled quantum states*, T. Mieling, C. Hilweg, P. Walther, arXiv:2202.12562 [gr-qc] (2022).
224. *Experimental semi-device-independent certification of indefinite causal order*, H. Cao, J. Bavaresco, N.-N. Wang, L. A. Rozema, C. Zhang, Y.-F. Huang, B.-H. Liu, C.-F. Li, G.-C. Guo, P. Walther, arXiv:2202.05346 [quant-ph] (2022)
225. *Experimental Higher-Order Interference in a Nonlinear Triple Slit*, P. Namdar, P. K. Jenke, I. Alonso Calafell, A. Trenti, M. Radonjic, B. Dakic, P. Walther, L. A. Rozema, arXiv:2112.06965 [quant-ph] (2021) (2021).
226. *Enhanced Photonic Maxwell's Demon with Correlated Baths*, G. L. Zanin, M. Antesberger, M. J. Jacquet, P. H. Souto Ribeiro, L. A. Rozema, P. Walther, arXiv:2107.09686 [quant-ph] (2021).

Sub-project P14 | Weihs

227. *Demonstration and modeling of time-bin entangled photons from a quantum dot in a nanowire,* P. Aumann, M. Prilmüller, F. Kappe, L. Ostermann, D. Dalacu, P. J. Poole, H. Ritsch, W. Lechner, and G. Weihs, **AIP Advances** 12, 055115 (2022), https://doi.org/10.1063/5.0081874 (Gold OA)

228. *Difference-frequency generation in an AlGaAs Bragg-reflection waveguide using an on-chip electrically-pumped quantum dot laser,* A. Schlager, M. Götsch, R. J. Chapman, S. Frick, H. Thiel, H. Suchomel, M. Kamp, S. Höfling, C. Schneider, and G. Weihs, **Journal of Optics** 23, 085802 (2021), https://doi.org/10.1088/2040-8986/ac13ae (Gold OA)
229. *Symmetry Allows for Distinguishability in Totally Destructive Many-Particle Interference***,** J. Münzberg, C. Dittel, M. Lebugle, A. Buchleitner, A. Szameit, G. Weihs, and R. Keil, **PRX Quantum** 2, 020326 (2021), https://doi.org/10.1103/PRXQuantum.2.020326 (Gold OA)
230. *Towards probing for hypercomplex quantum mechanics in a waveguide interferometer,* S. Gstir, E. Chan, T. Eichelkraut, A. Szameit, R. Keil, and G. Weihs, **New J. Phys.** 23, 093038 (2021), https://doi.org/10.1088/1367-2630/ac2451 (Gold OA)
231. *Wave-Particle Duality of Many-Body Quantum States,* C. Dittel, G. Dufour, G. Weihs, and A. Buchleitner, **Phys. Rev. X** 11, 031041 (2021), https://doi.org/10.1103/PhysRevX.11.031041 (Gold OA)
232. *Understanding photoluminescence in semiconductor Bragg-reflection waveguides,* S. Auchter, A. Schlager, H. Thiel, K. Laiho, B. Pressl, H. Suchomel, M. Kamp, S. Höfling, C. Schneider, and G. Weihs, **Journal of Optics** 23 (2021), https://doi.org/10.1088/2040-8986/abd888 (Gold OA)
233. *Approaching the Tsirelson bound with a Sagnac source of polarization-entangled photons,* S. Meraner, R. Chapman, S. Frick, R. Keil, M. Prilmüller, and G. Weihs, **SciPost Physics** 10, 017 (2021), https://doi.org/10.21468/SciPostPhys.10.1.017 (Gold OA)
234. *Fast and efficient demultiplexing of single photons from a quantum dot with resonantly enhanced electro-optic modulators,* J. Münzberg, F. Draxl, S. Filipe Covre da Silva, Y. Karli, S. Manna, A. Rastelli, G. Weihs, and R. Keil, arXiv preprint arXiv:2203.08682 (2022), https://arxiv.org/abs/2203.08682 (Green OA)
235. *Complementarity Between One- and Two-Body Visibilities,* C. Dittel, and G. Weihs, in Quantum Arrangements, G. Jaeger, D. Simon, A. V. Sergienko, G. D., and Z. A., eds. (Springer, Cham, 2021), pp. 177, https://doi.org/10.1007/978-3-030-77367-0_9 https://arxiv.org/abs/2003.01563 (Green OA)