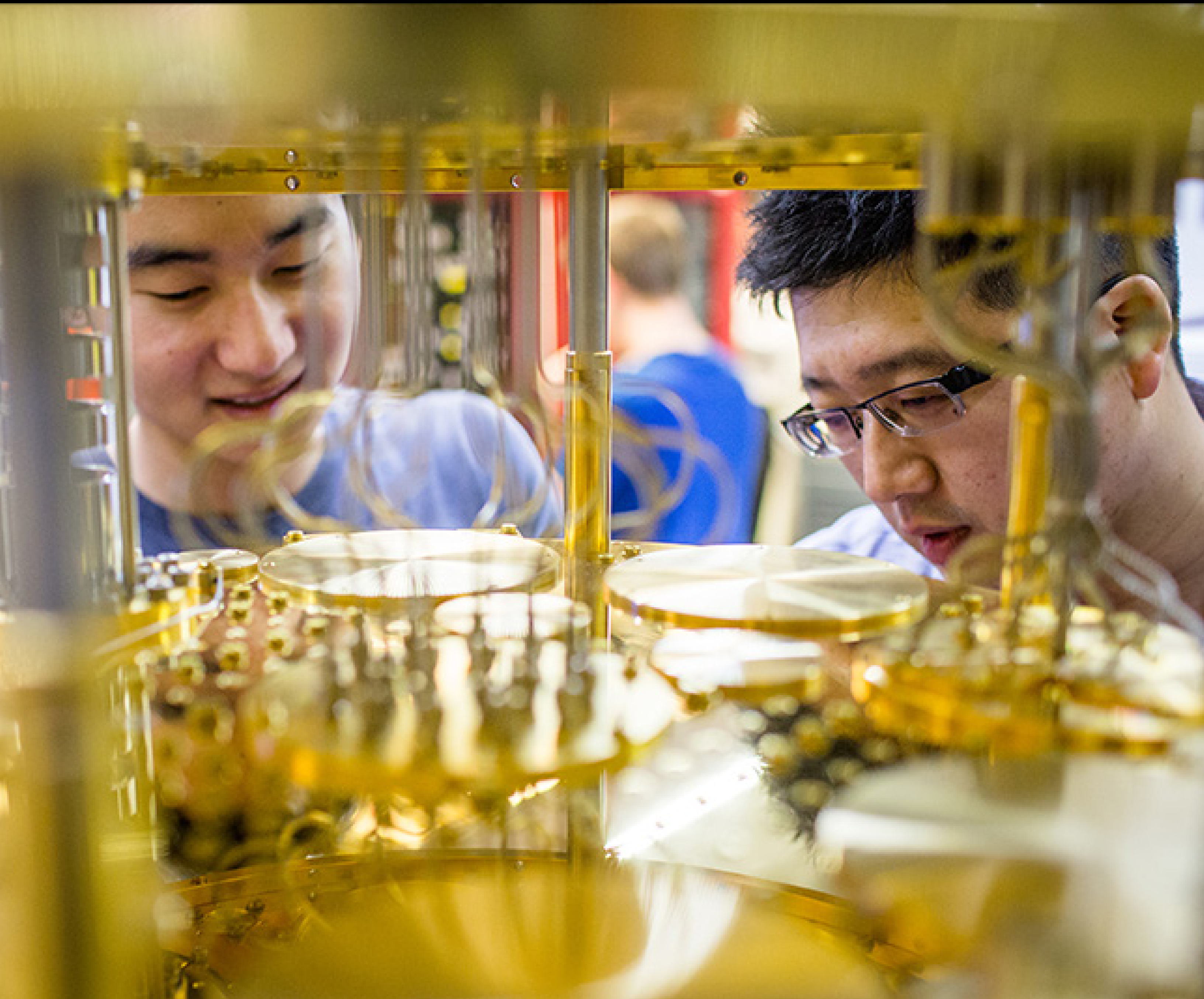
VOLUME 1

MIT Quantum Science and Engineering Consortium

QSEC Quarterly

Summer 2021



Contents

Celebrating 40 years of quantum. The 1981 Physics of Computation Conference held at the MIT Endicott House in Massachusetts was jointly organized by MIT and IBM. It was here when Richard Feynman proposed quantum computers for solving quantum physics problems: "It's not a Turing machine, but a machine of a different kind." QC40

MIT-CQE Mission

MIT's Center for Quantum Engineering is dedicated to the academic pursuit and practice of science and engineering to accelerate the practical application of quantum technologies for the betterment of humankind.

On behalf of the MIT Quantum Science and Engineering Consortium (QSEC), it is my pleasure to welcome you to the inaugural QSEC Quarterly.

The QSEC is an industry and government membership group within the MIT Center for Quantum Engineering (CQE). Our mission includes connecting professionals interested in quantum science and technology with the MIT students, researchers, and faculty across the Institute who are making it happen.

Every three months, the QSEC Quarterly will feature:

- A snapshot of the latest quantum science and engineering research around the Institute – MIT's main campus and MIT Lincoln Laboratory;
- A profile of a CQE PI and student, their research, and their broader interests;
- A roundup of select publications, politics, and pronouncements from beyond the Institute; and a listing of upcoming conferences.

You will find here information spanning basic quantum science through fundamental engineering, from both the School of Science and the School of Engineering. Indeed, "Quantum Engineering" is an emerging discipline that must leverage both quantum science and engineering to realize tomorrow's quantum technologies.

DIRECTOR
MIT Center for Quantum Engineering (CQE)

PROFESSOR
of Electrical Engineering and Computer Science and of Physics

LINCOLN LABORATORY FELLOW

Again, welcome to the QSEC Quarterly!

Best regards,

William D. Oliver
william.oliver@mit.edu

Holding on to single ions to enable quantum computing and sensing

Dr. John Chiaverini, a Senior Member of the Technical Staff at Lincoln Laboratory and a Principal Investigator in MIT's Center for Quantum Engineering (CQE), is developing technology to enable quantum computing and sensing based on some of the best qubits in the world.

The qubits he and his team use are each housed in a single atomic ion. A single ion of an element like strontium or calcium can be held electromagnetically, almost motionless in space, above the surface of specialized microchips in a vacuum chamber. The ion is thus isolated from many of the deleterious influences of the environment that limit the coherence of most other qubit types. Though ions themselves form naturally stable qubits, cajoling them into doing exactly what is needed for quantum computing and quantum-enhanced sensing requires applying control fields (typically laser beams, and in some cases radio-frequency or microwave signals), and this is where imperfections can be introduced, especially when considering independent control of multiple ions.

But Chiaverini is working to reduce those imperfections and make it possible to coordinate the control of arrays of individual ion qubits robustly and with low error. Doing so may lead

DR. JOHN CHIAVERINI
Senior Member of the Technical Staff at Lincoln Laboratory and a Principal Investigator in MIT's Center for Quantum Engineering (CQE)

to systems which can serve as highly sensitive probes of beyond-standard-model effects, such as is the search for ultra-light dark matter. Or they may be used to explore the fundamental behavior of multi-component entangled states, teasing apart the paradox of Schroedinger's simultaneously alive-and-dead cat. Or they can lay the foundation for practical quantum computers, processors that have the potential to speed up certain optimizations and accelerate the development of novel materials and the understanding of complex systems.

Growing up near Pittsburgh, Pennsylvania, a hilly area with hundreds of bridges over ravines and rivers, Chiaverini was first enticed by engineering; designing and building things that work became an enduring passion. Taking up experimental physics for his degrees was not a significant departure, since the fields depend on one another synergistically. Performing precision experiments to explore gravity at small length scales in graduate school at Stanford University required many disparate skills, including microfabrication, coherent optics, and cryogenics. Moving into quantum information science, Chiaverini applied these and related techniques to the development of trapped-ion quantum information processors as a postdoc at the National Institute of Science and Technology in Boulder, Colorado. Catching the quantum-computing bug, he never looked back. He hopes to continue to push the boundaries of the engineering of quantum systems.

The trapped-ion team at Lincoln Laboratory collaborates closely with campus groups, in particular those of Prof. Isaac Chuang and Prof. Rajeev Ram, through the CQE, to explore new technologies and techniques for high-fidelity ion-state manipulation. Along with these researchers, Chiaverini investigates integrated optical and electronic methods for more-precisely controlling ion qubits, as well as novel ion-state quantum encodings and the sensing algorithms that they may enable, among several related areas. New ideas can be flexibly pursued on the campus side of the joint Lincoln-MIT team; those that are viable can be adapted for integration into the multi-ion systems being engineered using Lincoln's microfabrication capabilities. In turn, advanced chip-scale ion traps with integrated control for collections of ions can be utilized on campus in the next wave of scientific inquiry, to allow more complex functionality with each step. MIT students working with Chiaverini, both on campus and at Lincoln, enable much of this foundational quantum engineering.

Chiaverini believes that advances in quantum science and engineering will bear fruit in many areas over the coming years, with applications to metrology and positioning in the near term, the realization of practical quantum computing more long term, and enabling technology for basic science being continually developed along the way. The field is just getting off the ground, and the ramifications are likely to be far-reaching, though it's not yet known exactly where the biggest impacts will be. In the meantime, the physicist in Chiaverini loves having the ability to manipulate quantum systems while trapping individual atoms, while the engineer in him will keep pushing to make them practically functional.

CQE STUDENT FEATURE

Quanta Group: Kyle DeBry

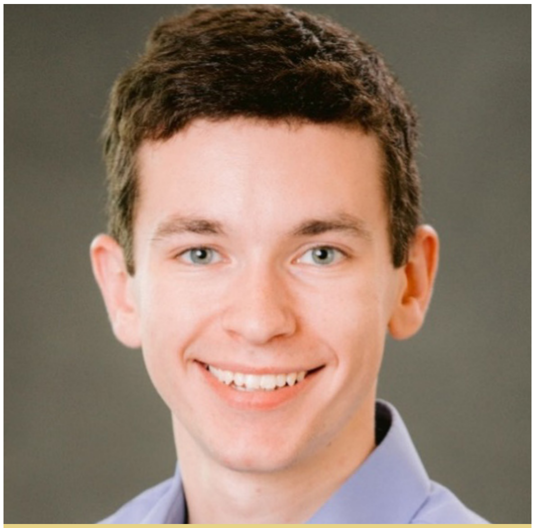
Research group name: Quanta

Research Advisors: Dr. Isaac Chuang, MIT Professor of EECS and Physics; Principal Investigator, MIT RLE Quanta Group; Member of the MIT Center for Quantum Engineering.

Dr. John Chiaverini, Senior Technical Staff and Principal Investigator, Quantum Information and Integrated Nanosystems Group, Lincoln Laboratory; Member of the MIT Center for Quantum Engineering.

Hometown, Country: Cincinnati, OH, USA

Academic History Prior to coming to MIT: B.S. Engineering Physics, The Ohio State University



KYLE DEBRY
CQE-LPS Doc Bedard Fellow. This three-year graduate fellowship is awarded through the MIT Center for Quantum Engineering. It is funded by the Laboratory of Physical Sciences and recognizes the achievements and technical leadership of Dr. Fernand (Doc) Bedard, a pioneer of cryogenic computing.

What brought you to MIT? I've known for a long time that I was excited by quantum computing, and that I wanted to pursue a PhD in it. During the open house, I realized that MIT was an amazing environment with lots of people thinking about this topic, plus there are exciting opportunities for collaboration. The research environment of MIT and Boston, especially in atomic physics with the Center for Ultracold Atoms, is unlike anywhere else. There's so much exciting research everywhere you look. Plus, I love exploring Boston.

What interests you most about your research? I work on experimental trapped ion quantum computing, and the most exciting part is how many open questions there are to explore, and the potential for collaboration in answering those questions. The field has been growing incredibly rapidly in recent years, but there is still a long way to go before we realize practical quantum computers, and nobody knows what the best approach will be. Maybe it's superconducting qubits, maybe it's trapped ions, maybe it's something else. And even within trapped ions, there are so many different strategies. In our group in particular, we are looking at using a radioactive isotope of barium that has an unusual internal structure, opening up a whole new set of choices for how we store and process the quantum bits contained in the ions. Whatever the eventual dominant technology turns out to be, though, it will surely require a lot of interdisciplinary expertise, which is why the collaborative environment here is so exciting.

Meet our MIT-CQE Principal Investigators

RAYMOND ASHOORI
Physics

MARC BALDO
EECS

JOHN BARRY
Lincoln Laboratory

KARL BERGGREN
EECS

RAFAEL GOMEZ-BOMBARELLI
DMSE

DON BORONSON
Lincoln Laboratory

DANIELLE BRAJE
Lincoln Laboratory

COLIN BRUZEWICZ
Lincoln Laboratory

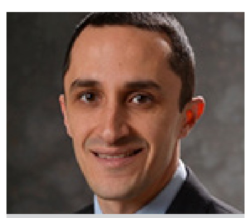
PAOLA CAPPELLARO
NSE

JOSEPH CHECKELSKY
Physics

JOHN CHIAVERINI
Lincoln Laboratory

ISAAC CHUANG
EECS, Physics

RICCARDO COMIN
Physics



ERIC DAULER
Lincoln Laboratory

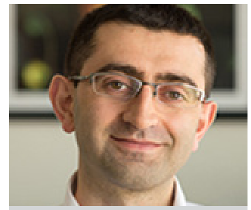
BENJAMIN DIXON
Lincoln Laboratory

DIRK ENGLUND
EECS

Meet our MIT-CQE Principal Investigators

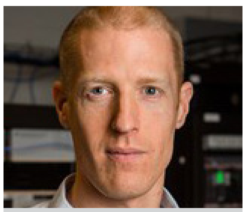
EDWARD FARHI
Physics

JOSEPH A. FORMAGGIO
Physics



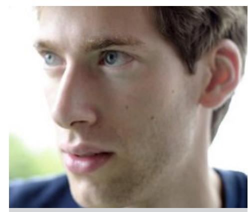
NUH GEDIK
Physics

MARK GOUKER
Lincoln Laboratory



SIMON GUSTAVSSON,
RLE

SCOTT HAMILTON,
Lincoln Laboratory



ARAM HARROW,
Physics

PABLO JARILLO-HERRERO,
Physics

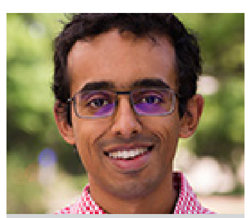
LONG JU,
Physics

WOLFGANG KETTERLE,
Physics

LUQIAO LIU,
EECS

SETH LLOYD,
ME, ES, Physics

ROBERT McCONNELL,
Lincoln Laboratory



ANAND NATARAJAN,
EECS

KEVIN P. O'BRIEN,
EECS

WILLIAM D. OLIVER,
EECS, Physics, Lincoln Laboratory

Meet our MIT-CQE Principal Investigators

TERRY ORLANDO, *EECS*

LINH PHAM, *Lincoln Laboratory*

RAJEEV RAM, *EECS*

DANNA ROSENBERG, *Lincoln Laboratory*

MOLLIE SCHWARTZ, *Lincoln Laboratory*

KYLE SERNIAK, *Lincoln Laboratory*

JEFFREY SHAPIRO, *EECS*

PETER SHOR, *Mathematics*

MICHAEL SIPSER, *Mathematics*

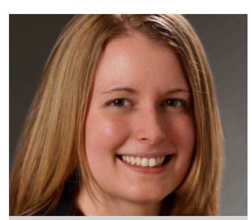
VIVISHEK SUDHIR, *ME*

TROY VAN VOORHIS, *Chemistry*

VLADAN VULETIC, *Physics*

LINDLEY WINSLOW, *Physics*

WAYNE WOODS, *Lincoln Laboratory*



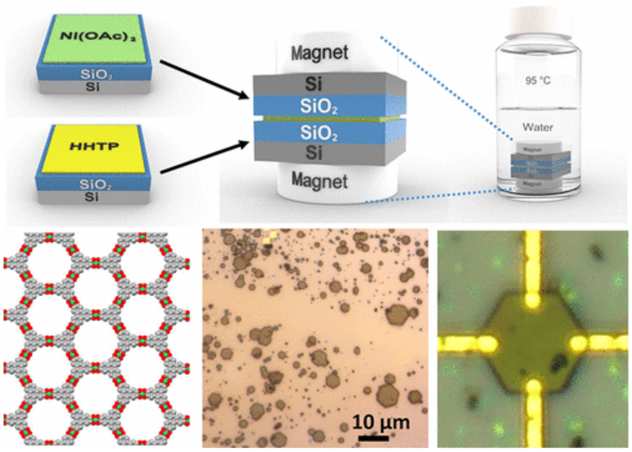
JONILYN YODER, *Lincoln Laboratory*

MARTIN ZWIERLEIN, *Physics*

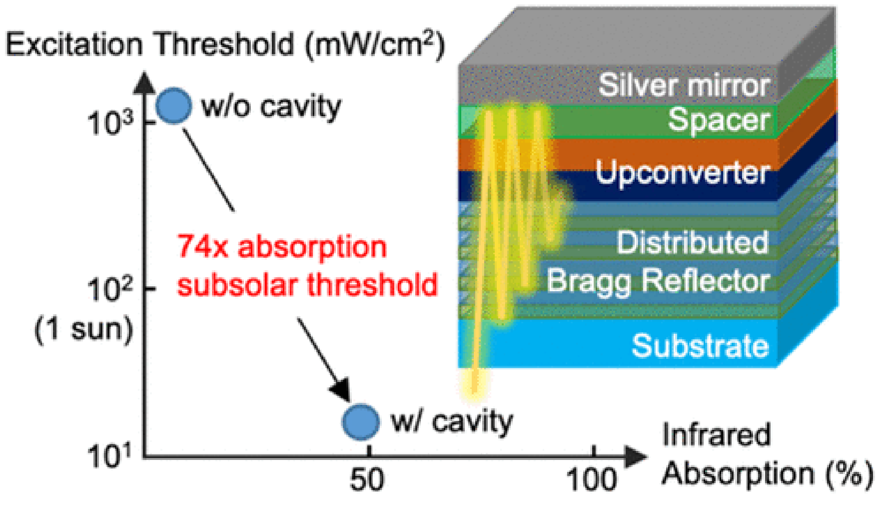
RAYMOND ASHOORI, *Physics*

"Strong interlayer charge transfer due to exciton condensation in an electrically-isolated GaAs quantum well bilayer"
J. Jang, H.-M. Yoo, L.N. Pfeiffer, K.W. West, K.W. Baldwin, R.C. Ashoori
arXiv:2103.06488 (2021)

MARC BALDO, *EECS*



"Large single crystals of two-dimensional π-conjugated metal–organic frameworks via biphasic solution-solid growth"
D. Ha, M. Rezaee, Y. Han, S. A. Siddiqui, R. W. Day, L. S. Xie, B. J. Modtland, D. A. Muller, J. Kong, P. Kim, M. Dincă, M. A. Baldo
ACS Cent. Sci. 2021, 7, 1, 104–109, (08/20/2020)



"Nanocrystal-Sensitized Infrared-to-Visible Upconversion in a Microcavity under Subsolar Flux"
M. Wu, T. Lin, J. O Tiepelt, V. Bulović, M. A. Baldo
Nano Lett. 2021, 21, 2, 1011–1016, (01/14/2021)

KARL BERGGREN, *EECS*

“Electrical Control of Surface Acoustic Waves”
L. Shao, D. Zhu, M. Colangelo, D. H. Lee, N. Sinclair, Y. Hu, P. T. Rakich, K. Lai, K. K. Berggren, M. Loncar
arXiv:2101.01626 (2021)

“Enhancing the performance of superconducting nanowire-based detectors with high-filling factor by using variable thickness”
Reza Baghdadi, Ekkehart Schmidt, Saman Jahani, Ilya Charaev, Michael G W Müller, Marco Colangelo, Di Zhu, Konstantin Ilin, Alexej D Semenov, Zubin Jacob, Michael Siegel and Karl K Berggren
Supercond. Sci. Technol. 34, 3 (2021) | arXiv: 2010.11938 (2020)

“Physical properties of amorphous molybdenum silicide films for single photon detectors”
Xiaofu Zhang, Ilya Charaev, Huanlong Liu, Tony X. Zhou, Dong Zhu, Karl K. Berggren, Andreas Schilling
arXiv:2104.06905 (April 2021)

“A scalable superconducting nanowire memory cell and preliminary array test”
Brenden A Butters, Reza Baghdadi, Murat Onen, Emily A Toomey, Owen Medeiros, Karl K Berggren
Superconductor Science and Technology 34, Number 3 (2021)

“Superconducting MoN thin films prepared by DC reactive magnetron sputtering for nanowire single-photon detectors”
Lily Hallett, Ilya Charaev, Akshay Agarwal, Andrew Dane, Marco Colangelo, Di Zhu, Karl K. Berggren
Supercond. Sci. Technol. 34, 3 (2021) arXiv: 2010.10634 (2020)

KARL BERGGREN, *EECS*

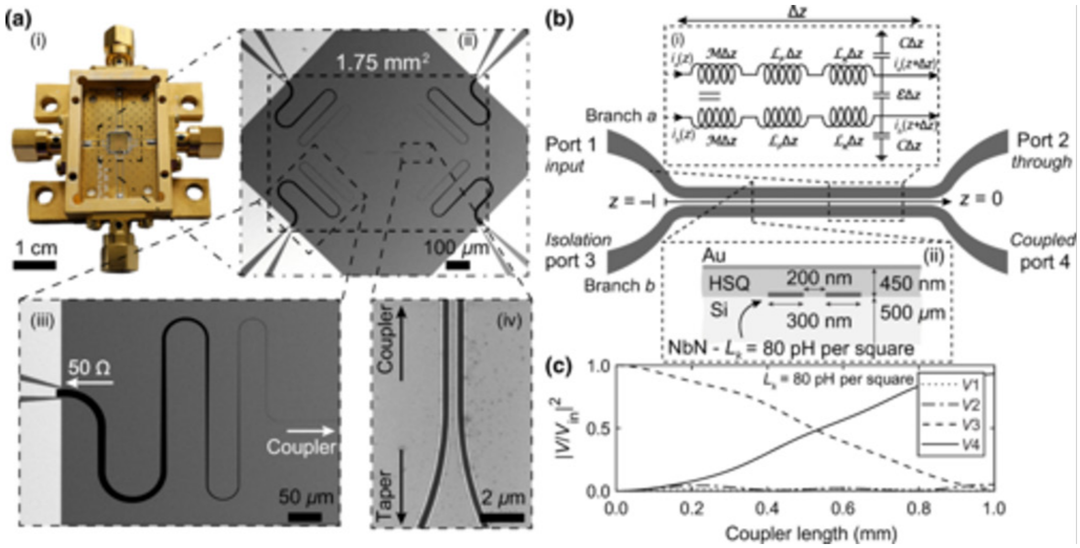
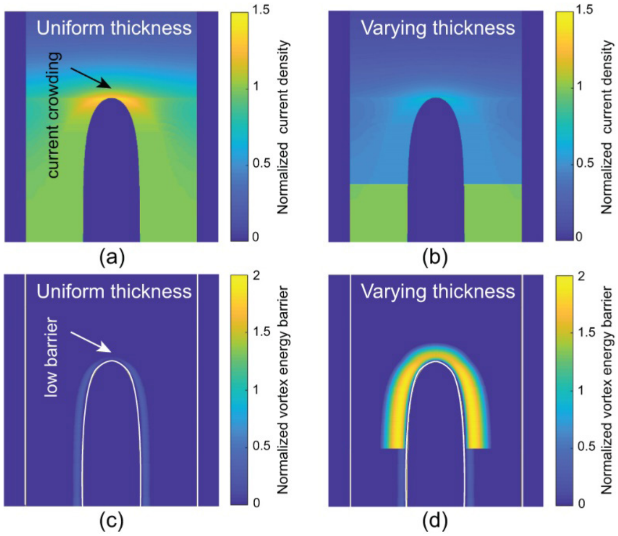


Figure 1: Superconducting-nanowire directional forward coupler: device and model. (a) Optical and scanning electron micrographs (SEMs) of the fabricated device: (i) device die mounted in the radio-frequency (rf) testing box; (ii) SEM showing the full four-port device before the fabrication of the dielectric spacer and the top ground; (iii) closeup SEM of the impedance-matching taper; (iv) closeup SEM of the coupled nanowire transmission lines. (b) Geometry, model, and implementation of coupler: two nanowire transmission lines brought together for a coupling length l. (i) Analytical model: coupled LC ladder, where we explicitly separated the geometric (Faraday) component of the total line inductance per unit length (p.u.l.), LF, from the kinetic inductance p.u.l. Lk; C is the capacitance p.u.l. of each line; E is the coupling capacitance p.u.l.; M is the mutual inductance p.u.l. (ii) Implementation as side-coupled striplines. In the analytical model, the gold layers (Au) have been treated as perfect electric conductors. (c) Simulation of the port voltages versus coupler length at 5GHz for 50:50 forward coupling (Lk=80pH per square).

“A compact and tunable forward coupler based on high-impedance superconducting nanowires”
Marco Colangelo, Di Zhu, Daniel F. Santavicca, Brenden A. Butters, Joshua C. Bienfang, Karl K. Berggren
Phys. Rev. Applied 15 (2021) | arXiv:2011.11406 (2020)

KARL BERGGREN, *EECS*



The bias current density in the bend normalized to the current density in the straight arm for (a) uniform and (b) variable thickness NbN SNSPDs. The width of the nanowire in the straight arm is 100 nm. The current-crowding occurs around the inner side of the curvature. Increasing the thickness near the bend reduces the current density. The vortex potential barrier normalized to the characteristic vortex energy, ε0, inside the full etched region for (c) uniform and (d) variable thickness SNSPDs are also shown. The bias current is in the straight section. The current-crowding weakens the vortex barrier in the uniform SNSPD. This causes a reduction in the vortex switching current and an increase in the dark-count rate. Increasing the thickness near the bend increases the self-energy of a vortex, and as a results, the switching current is enhanced to the switching current of the straight arm and the dark count rate is reduced.

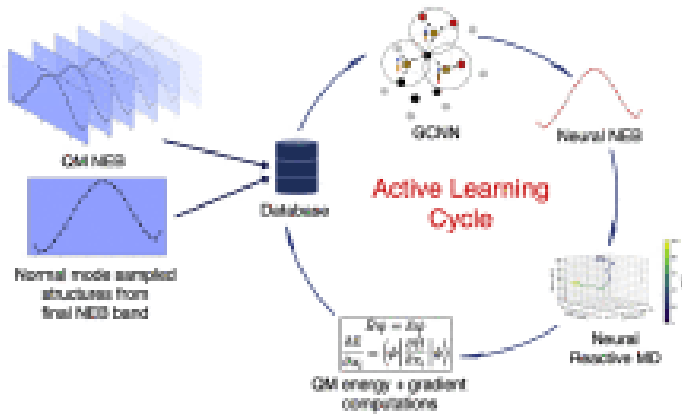
"Precise, Subnanosecond, and High-Voltage Switching of Complex Loads Enabled by Gallium Nitride Electronics"
John W. Simonaitis, Benjamin Slayton, Yugu Yang-Keathley, Phillip D. Keathley, and Karl K. Berggren
arXiv:2102.03271 (February 2021)

MIT researchers are developing a superconducting nanowire, which could enable more efficient superconducting electronics. Image: Christine Daniloff

"Self-Heating Hotspots in Superconducting Nanowires Cooled by Phonon Black-Body Radiation"
Andrew Dane, Jason Allmaras, Di Zhu, Murat Onen, Marco Colangelo, Reza Bahgdadi, Jean-Luc Tambasco, Yukimi Morimoto, Ignacio Estay Forno, Ilya Charaev, Qingyuan Zhao, Mikhail Skvortsov, Alexander Kozorezov, Karl Berggren
MIT News (2021) | arXiv:2104.04652: (2021)

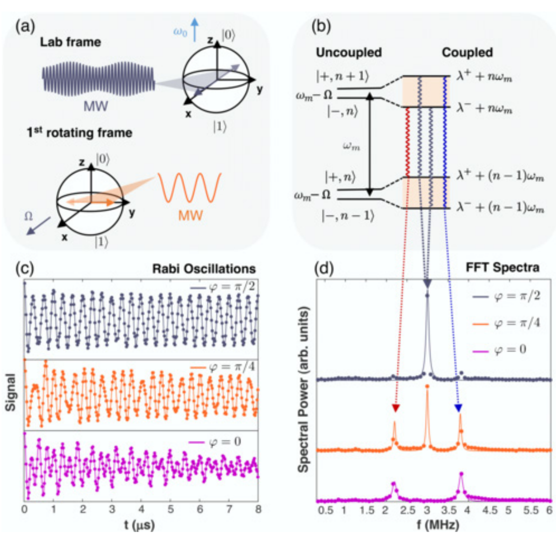
RAFAEL GOMEZ-BOMBARELLI, *DMSE*

"Differentiable sampling of molecular geometries with uncertainty-based adversarial attacks"
Daniel Schwalbe-Koda, Aik Rui Tan, Rafael Gómez-Bombarelli
arXiv: 2101.11588 (2021)



"Active learning accelerates ab initio molecular dynamics on reactive energy surfaces"
Shi JunAng, Wujie Wang, Daniel Schwalbe-Koda, Simon Axelrod, Rafael Gómez-Bombarelli
Science Direct (2021)

PAOLA CAPPELLARO, *NSE*



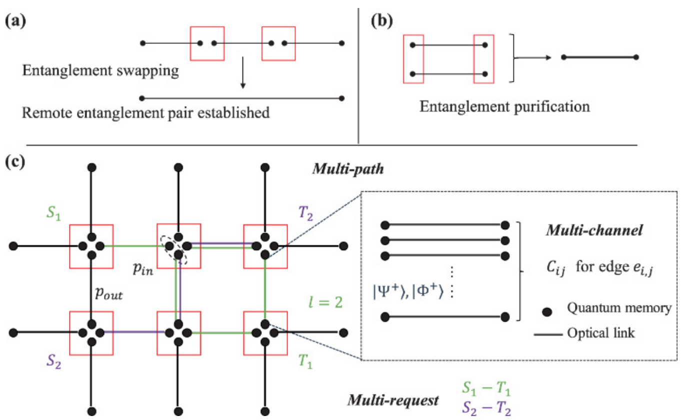
Observation of Mollow triplet with the CCD scheme. (a) Principle of amplitude-modulated CCD method. (b) Energy structure in the dressed atom picture explaining the origin of the Mollow triplet structure. (c) Measured Rabi oscillations under three modulation phases φ=π/2 (top), φ=π/4 (middle),and φ=0 (bottom). (d) Mollow triplet. Fourier spectra of the Rabi oscillations shown in (c). When φ=π/2, only the center band exists, which corresponds to spin locking. When φ=0, only the sidebands exist. For other angles we can observe the three frequency components comprising the triplet structure.

"Observation of the high-order Mollow triplet by quantum mode control with concatenated continuous driving"
G. Wang, Y.-X. Liu and P. Cappellaro
Phys. Rev. A 103, 022415 (2021)

PAOLA CAPPELLARO, *NSE*

[“Deep reinforcement learning for quantum Hamiltonian engineering”]
P. Peng, X. Huang, C. Yin, L. Joseph, C. Ramanathan and P. Cappellaro
arXiv:2102.13161 (2021)

“Nanoscale vector AC magnetometry with a single nitrogen-vacancy center in diamond”
G. Wang, Y.-X. Liu, Y. Zhu and P. Cappellaro
arxiv:2103.12044 (2021)



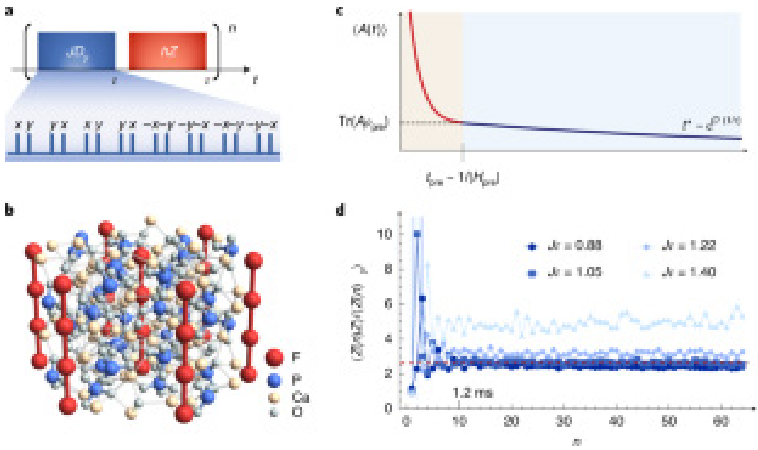
a Diagram of entanglement swapping. Two remote stations can be entangled with the assistance of intermediate nodes. Black dots (lines) represent quantum memories (optical links). b Diagram of entanglement purification. With local physical operations and communication through classical channels, an entangled pair with high fidelity can be distilled from two fresh pairs with lower fidelity. c Entanglement routing on a 2D square lattice network. Edge (i, j) consists of multiple entangled pairs (multi-channels) such as Bell states, whose capacity is denoted as Cij. Entanglement generation between S1(2) and T1(2) is requested and multiple paths are identified for each request. The probabilities of successfully building an entangled pair between adjacent nodes and performing local Bell state measurement are denoted as pout and pin, respectively.

“Effective routing design for remote entanglement generation on quantum networks”
C. Li, T. Li, Y.-X. Liu and P. Cappellaro
npj Q. Inf. 7, 10 (2021)

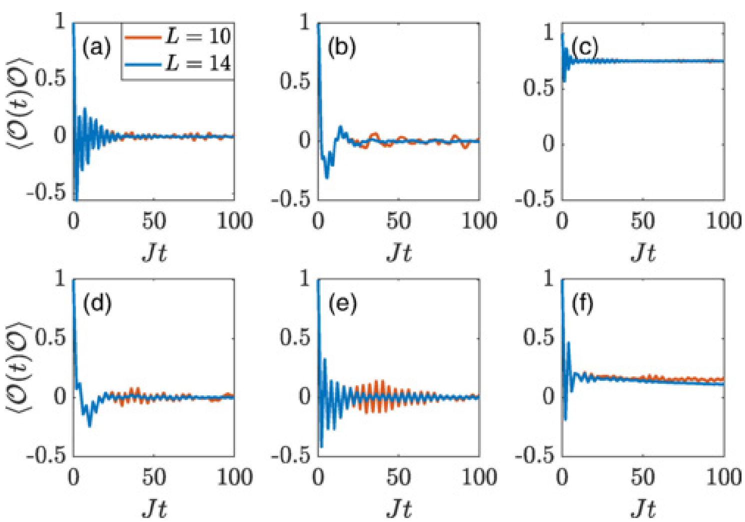
“Bias in error-corrected quantum sensing”
Rojkov, D. Layden, P. Cappellaro, J. Home and F. Reiter
arxiv:2101.05817 (2021)

“Experimental characterization of the 4D tensor monopole and topological nodal rings”
M. Chen, C. Li, G. Palumbo, Y.-Q. Zhu, N. Goldman and P. Cappellaro
arXiv:2008.00596 (2021)

PAOLA CAPPELLARO, *NSE*



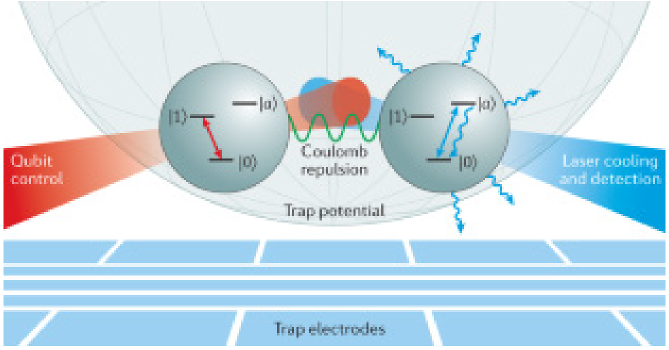
["Floquet prethermalization in dipolar spin chains"](#)
P. Peng, C. Yin, X. Huang, C. Ramanathan and P. Cappellaro
[Nat. Phys. , s41567](#) (2021)



Typical dynamics of ⟨O(t)O′⟩ in a Floquet spin chain. Here we choose KDM and O=O′. (a)–(c) Jτ=0.5; (d)–(f) Jτ=2. (a),(d) O=X; (b),(e) O=Y; (c),(f) O=Z. Different colors correspond to different system size L, as shown in the legend.

["Prethermal quasiconserved observables in Floquet quantum systems"](#)
C. Yin, P. Peng, X. Huang, C. Ramanathan and P. Cappellaro
[Phys. Rev. B 103, 054305](#) (2021)

JOHN CHIAVERINI, *Lincoln Laboratory*



"Materials challenges for trapped-ion quantum computers"
Kenneth R. Brown, John Chiaverini, Jeremy M. Sage & Hartmut Häffner
Nature Reviews Materials (2021), doi: 10.1038/s41578-021-00292-1,
arxiv:2009.00568

"Fast and robust particle shuttling for quantum science and technology"
Authors: Luke Qi, John Chiaverini, Hilario Espinos, Mikel Palmero, and Juan Gonzalo Muga
arXiv:2104.07362 (2021)

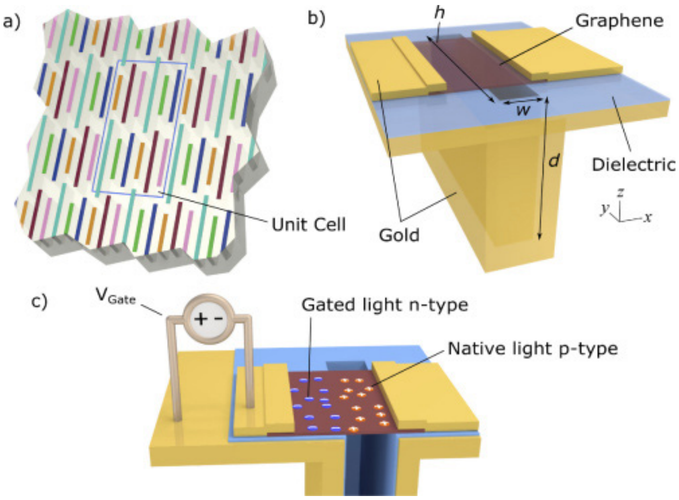
"Roadmap on Integrated Quantum Photonics"
Galan Moody, et. all with MIT-CQE faculty and staff: Paul W. Juodawlkis, William Loh, Cheryl Sorace-Agaskar, John Chiaverini
arxiv:2102.03323 (2021)

"Heating of a trapped ion induced by dielectric materials"
Markus Teller, Dario A. Fioretto, Philip C. Holz, Philipp Schindler, Viktor Messerer, Klemens Schüppert, Yueyang Zou, Rainer Blatt, John Chiaverini, Jeremy Sage, Tracy E. Northup
arXiv: 2103.13846 (2021)

ISAAC CHUANG, *EECS*

"Quantum Hypothesis Testing with Group Structure"
Z. M. Rossi, I. L. Chuang
arXiv:2102.02194 (2021)

DIRK ENGLUND, *EECS*



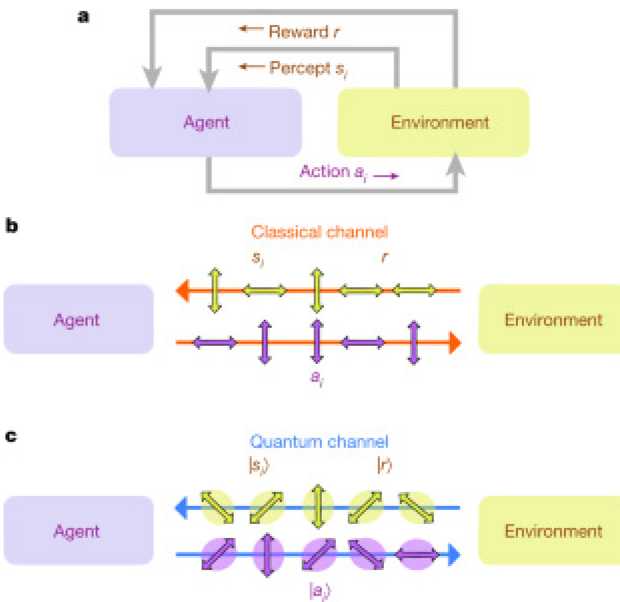
Development of Quantum InterConnects for Next-Generation Information Technologies"
David Awschalom, Karl K. Berggren, Hannes Bernien, Sunil Bhave, Lincoln D. Carr, Paul Davids,Sophia E. Economou, Dirk Englund, Andrei Faraon, Marty Fejer, Saikat Guha0, Martin V.Gustafsson, Evelyn Hu, Liang Jiang, Jungsang Kim, Boris Korzh, Prem Kumar, 0, Paul G.Kwiat, Marko Lončar, Mikhail D. Lukin, David A. B. Miller, Christopher Monroe , ,Sae Woo Nam, Prineha Narang, Jason S. Orcutt, Michael G. Raymer, Amir H. Safavi-Naeini, Maria Spiropulu, Kartik Srinivasan, Shuo Sun, Jelena Vučković, Edo Waks, Ronald Walsworth, Andrew M. Weiner, Zheshen Zhang
Physical Review X 2, 017001 (2021)

"Imaging Metasurfaces based on Graphene-Loaded Slot Antennas"
Jordan Goldstein, Dirk Englund
Optics Express Vol. 29, Issue 2, (2021)

"Scalable and High-Fidelity Quantum Random Access Memory in Spin-Photon Networks"
Kevin C. Chen, Wenhan Dai, Carlos Errando-Herranz, Seth Lloyd, Dirk Englund
ArXiv: 2103.07623 (2021)

"Investigation of the Stark Effect on a Centrosymmetric Quantum Emitter in Diamond"
Lorenzo De Santis, Matthew Trusheim, Kevin Chen, Dirk Englund
ArXiv:2102.01322 (2021)

DIRK ENGLUND, *EECS*



[“Experimental quantum speed-up in reinforcement learning agents”]

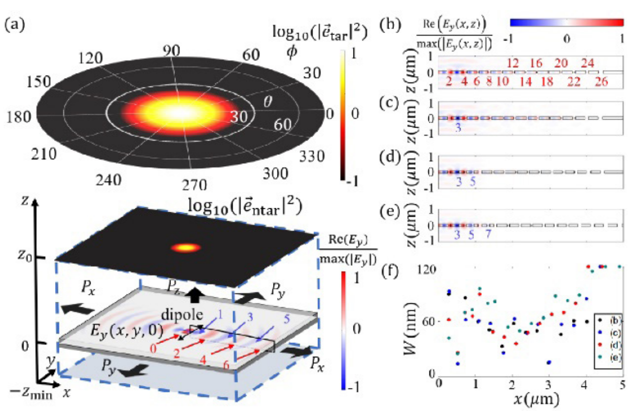
V. Saggio, B. Asenbeck, A. Hamann, T. Strömberg, P. Schiansky, V. Dunjko, N. Friis, N. C. Harris, M. Hochberg, D. Englund, S. Wölk, H. J. Briegel, and P. Walther
[Nature] (2021)

[“Hardware error correction for programmable photonics”]

Saumil Bandyopadhyay, Ryan Hamerly, Dirk Englund
[ArXiv: 2103.04993 (2021)]

[“Josephson-junction infrared single-photon detector”]

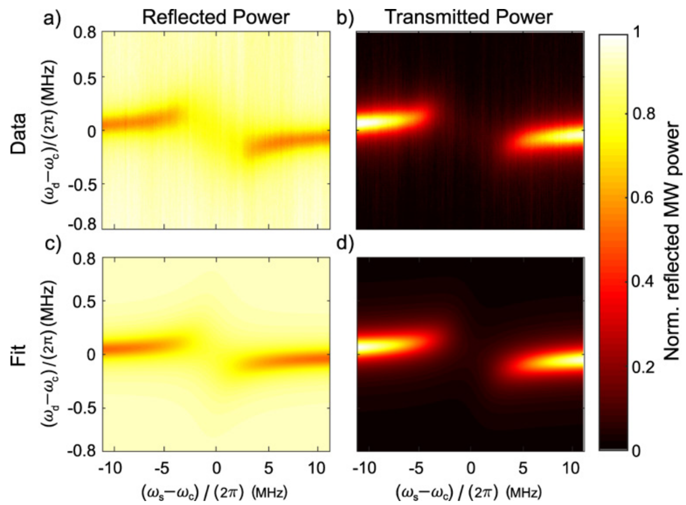
Evan D. Walsh, Woochan Jung, Gil-Ho Lee, Dmitri K. Efetov, Bae-Ian Wu, K.-F. Huang, Thomas A. Ohki, Takashi Taniguchi, Kenji Watanabe, Philip Kim, Dirk Englund, Kin Chung Fong
[Science (2021)]



[“Field-based Design of a Resonant Dielectric Antenna for Coherent Spin-Photon Interfaces”]

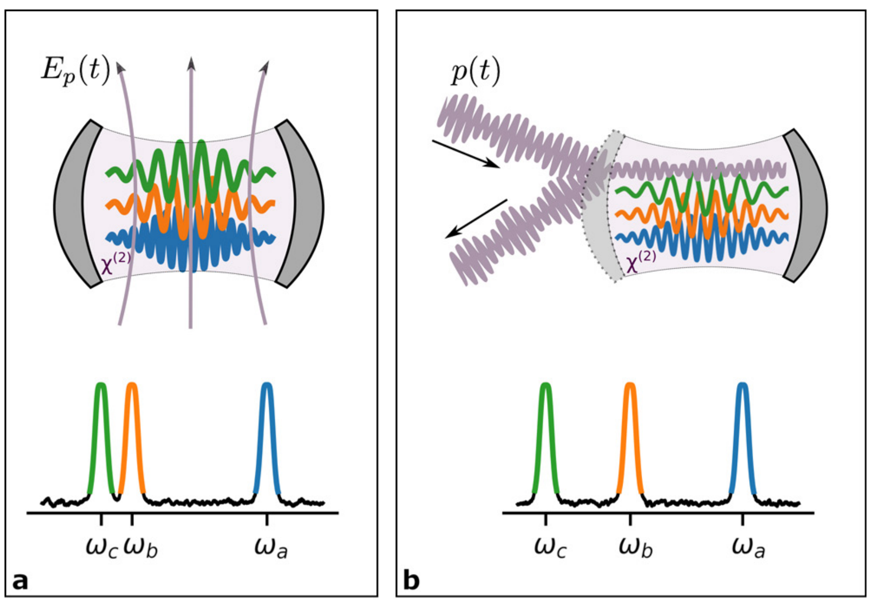
Linsen Li, Hyeongrak Choi, Mikkel Heuck, Dirk Englund
[arXiv:2101.02366] | [[physics.optics]] (2021)

DIRK ENGLUND, *EECS*



[“Cavity quantum electrodynamic readout of a solid-state spin sensor”]
Erik R. Eisenach, John F. Barry, Michael F. O’Keeffe, Jennifer M. Schloss, Matthew H. Steinecker, Dirk R. Englund, Danielle A. Braje
Nature Communications 12, Article number: 1357 (2021)

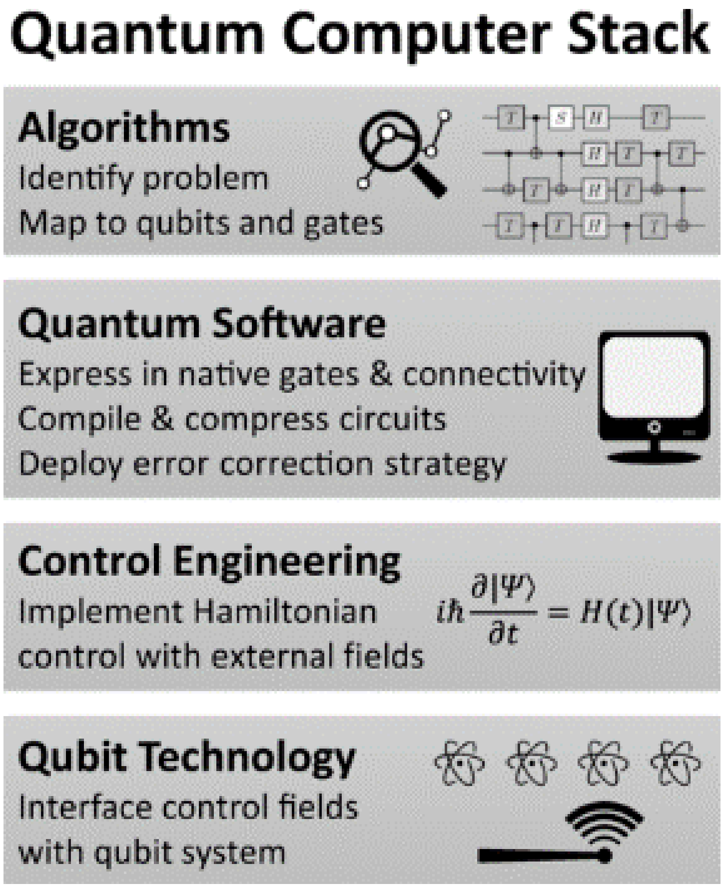
“Optically-Heralded Entanglement of Superconducting Systems in Quantum Networks”
Stefan Krastanov, Hamza Raniwala, Kurt Jacobs, Dirk R. Englund
arXiv:2012.13408 (2021)



Electrical Control Optical Control

“Room-Temperature Photonic Logical Qubits via Second-Order Nonlinearities”
Stefan Krastanov, Mikkel Heuck, Jeffrey H. Shapiro, Prineha Narang, Dirk R. Englund, Kurt Jacobs
Nature Communications 12, Article number: 191 (2021)

DIRK ENGLUND, *EECS*

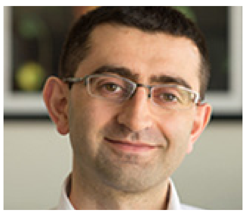


"Quantum Computer Systems for Scientific Discovery"
Yuri Alexeev, Dave Bacon, Kenneth R. Brown, Robert Calderbank, Lincoln D. Carr, Frederic T. Chong, Brian DeMarco, Dirk Englund, Edward Farhi, Bill Fefferman, Alexey V. Gorshkov, Andrew Houck, Jungsang Kim, Shelby Kimmel, Michael Lange, Seth Lloyd, Mikhail D. Lukin, Dmitri Maslov, Peter Maunz, Christopher Monroe, John Preskill, Martin Roetteler, Martin Savage, Jeff Thompson, Umesh Vazirani
PRX Quantum (2021)

JOSEPH A. FORMAGGIO, *Physics*

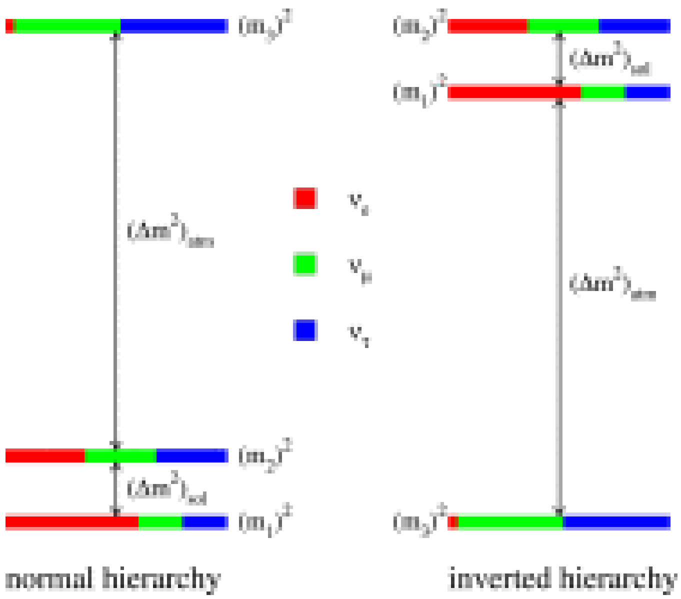
"The Design, Construction, and Commissioning of the KATRIN Experiment"
M. Aker, K. Altenmüller, J. F. Amsbaugh,..., J. A. Formaggio
arXiv:2103.04755 (2021)

"Bayesian Analysis of a Future Beta Decay Experiment's Sensitivity to Neutrino Mass Scale and Ordering"
A. Ashtari Esfahani, M. Betancourt, Z. Bogorad,..., J. A. Formaggio
arXiv: 2012.14341 (2020)



JOSEPH A. FORMAGGIO, *Physics*

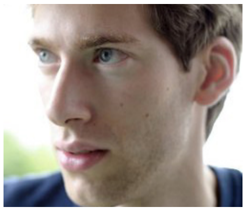
"Analysis methods for the first KATRIN neutrino-mass measurement"
M. Aker, K. Altenmüller, A. Beglarian,..., J. Formaggio (2021)
arXiv: 2101.05253 (2021)



"Direct Measurements of Neutrino Mass"
Joseph A. Formaggio, André Luiz C. de Gouvêa, R. G. Hamish Robertson-
Science Direct (2021) | arXiv: 2102.00594 (2021)

NUH GEDIK, *Physics*

"Phonoritons in a monolayer hBN optical cavity"
Simone Latini, Umberto De Giovannini, Edbert J. Sie, Nuh Gedik, Hannes Hübener, Angel Rubio
arXiv:2102.09472 (2021)



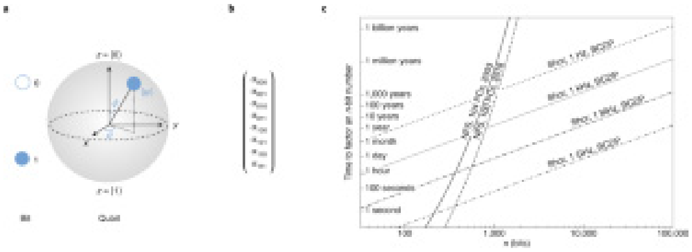
ARAM HARROW, *Physics*

“Low-depth gradient measurements can improve convergence in variational hybrid quantum-classical algorithms”
AW Harrow, JC Napp
Physical Review Letters 126 (14), 140502

“Rapid mixing of path integral Monte Carlo for 1D stoquastic Hamiltonians”
E Crosson, AW Harrow
Quantum 5, 395

“Using spectral graph theory to map qubits onto connectivity-limited devices”
JX Lin, ER Anschuetz, AW Harrow
ACM Transactions on Quantum Computing 2 (1), 1-30

“Nonlinear Bell inequality for macroscopic measurements”
AB Watts, NY Halpern, A Harrow
Physical Review A 103 (1), L010202

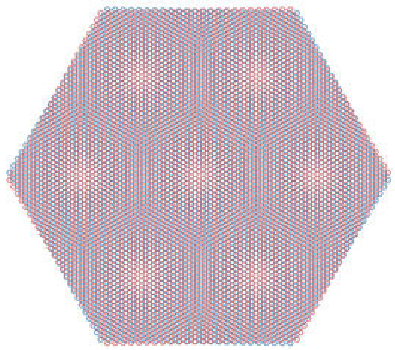


“Quantum computing at the frontiers of biological sciences”
Prashant S Emani, Jonathan Warrell, Alan Anticevic, Stefan Bekiranov, Michael Gandal, Michael J McConnell, Guillermo Sapiro, Alán Aspuru-Guzik, Justin T Baker, Matteo Bastiani, John D Murray, Stamatios N Sotiropoulos, Jacob Taylor, Geetha Senthil, Thomas Lehner, Mark B Gerstein, Aram W Harrow
Nature Methods, 1-9

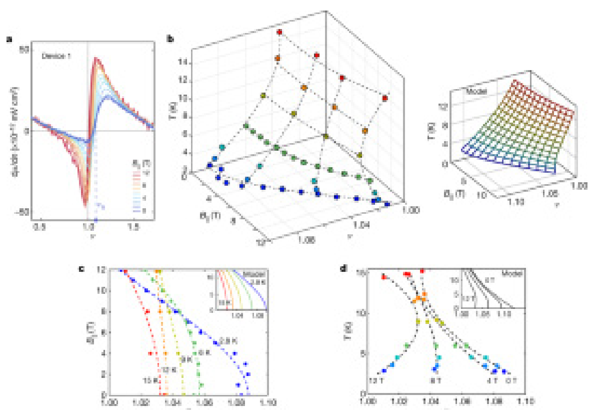
PABLO JARILLO-HERRERO, *Physics*

“Large Pauli Limit Violation and Reentrant Superconductivity in Magic-Angle Twisted Trilayer Graphene”
Yuan Cao*, Jeong Min Park*, Kenji Watanabe, Takashi Taniguchi, Pablo Jarillo-Herrero
arXiv:2103.12083

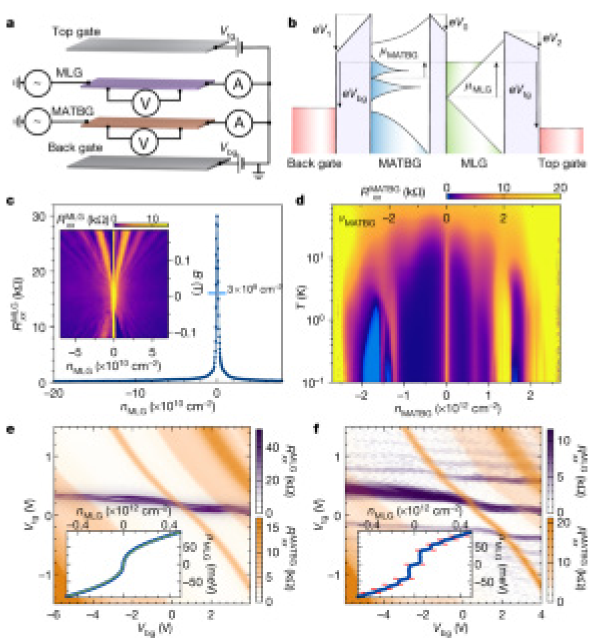
PABLO JARILLO-HERRERO, *Physics*



"Highly Tunable Junctions and Nonlocal Josephson Effect in Magic Angle Graphene Tunneling Devices"
Daniel Rodan-Legrain*, Yuan Cao*, Jeong Min Park*, Sergio C. de la Barrera, Mallika T. Randeria, Kenji Watanabe, Takashi Taniguchi, Pablo Jarillo-Herrero
arXiv:2011.02500, Nature Nanotechnology (2021) featured on Science "Latest News"

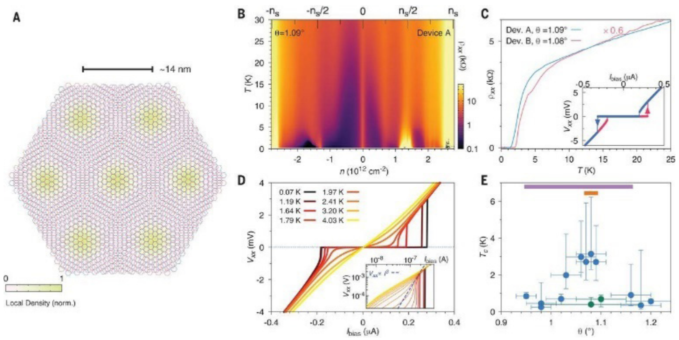


"Entropic evidence for a Pomeranchuk effect in magic-angle graphene"
Asaf Rozen*, Jeong Min Park*, Uri Zondiner*, Yuan Cao*, Daniel Rodan-Legrain, Takashi Taniguchi, Kenji Watanabe, Yuval Oreg, Ady Stern, Erez Berg+, Pablo Jarillo-Herrero+, Shahal Ilani+
Nature 592, 214–219 (2021)
arXiv:2009.01836 (2020)



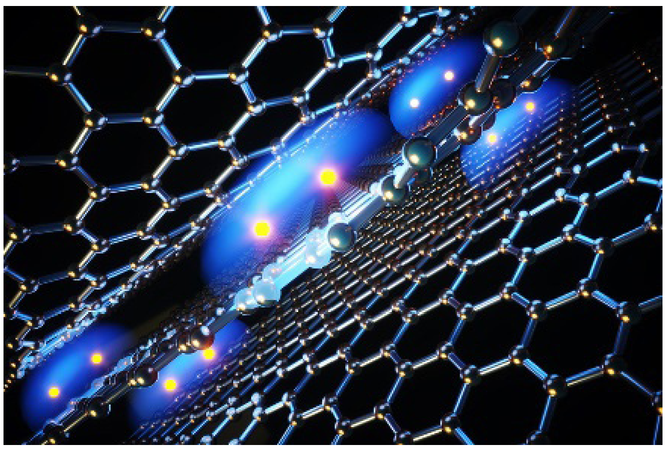
"Flavour Hund's coupling, Chern gaps and charge diffusivity in moiré graphene"
Jeong Min Park*, Yuan Cao*, Kenji Watanabe, Takashi Taniguchi, Pablo Jarillo-Herrero
Nature 592, 43–48 (2021) |
arXiv:2008.12296 (2020)

PABLO JARILLO-HERRERO, *Physics*



“Nematicity and Competing Orders in Superconducting Magic-Angle Graphene”
Yuan Cao, Daniel Rodan-Legrain, Jeong Min Park, Fanqi Noah Yuan, Kenji Watanabe, Takashi Taniguchi, Rafael M. Fernandes, Liang Fu, Pablo Jarillo-Herrero
Science | arXiv:2004.04148 (2021)

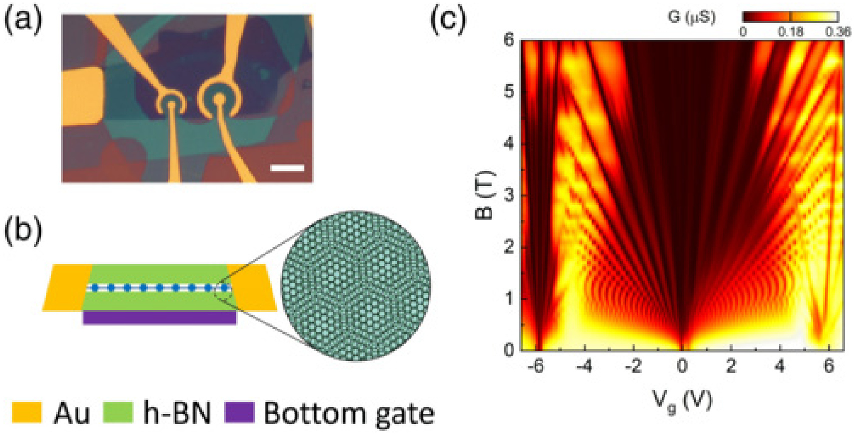
“Fizeau Drag in Graphene Plasmonics”
Y. Dong, L. Xiong, I.Y. Phinney, Z. Sun, R. Jing, A.S. McLeod, S. Zhang, S. Liu, F.L. Ruta, H. Gao, Z. Dong, R. Pan, J.H. Edgar, P. Jarillo-Herrero, L.S. Levitov, A.J. Millis, M.M. Fogler, D.A. Bandurin, D.N. Basov
arXiv:2103.10831 (2021).



This artist’s rendition shows magic-angle twisted trilayer graphene, composed of three honeycomb lattices. The tightly bound electronics (yellow spheres connected by blue halos) indicate the new structure’s strong coupled superconducting state. Image: Ella Maru Studio.

“Tunable strongly coupled superconductivity in magic-angle twisted trilayer graphene”
Jeong Min Park, Yuan Cao, Kenji Watanabe, Takashi Taniguchi, Pablo Jarillo-Herrero
Nature 590, 249-255 (2021) arXiv:2012.01434, featured on MIT news

LONG JU, *Physics*



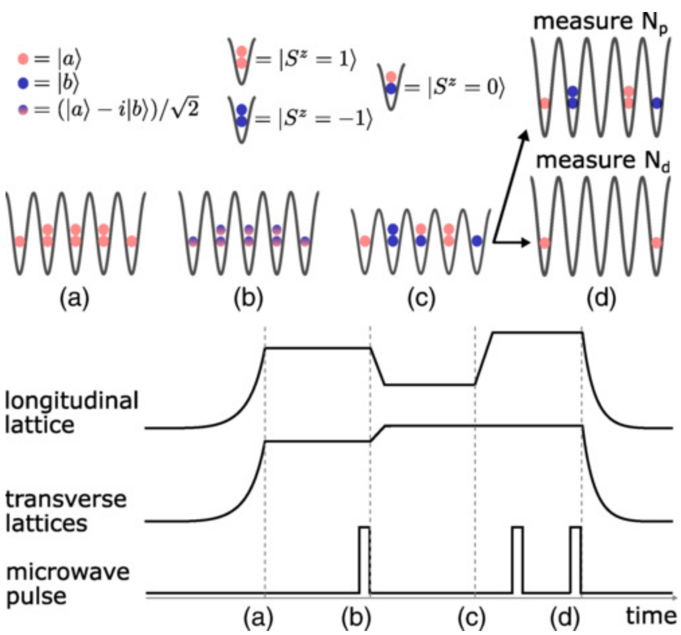
Device structure and transport characterization. (a) Optical image of a Corbino geometry device. Scale bar, 10 µm. (b) Schematic of the device structure: monolayer graphene sandwiched by h–BN, with either a SiO2/Si or graphite bottom gate. The moiré superlattice exists between monolayer graphene and either top or bottom h–BN flake. (c) Characteristic Landau fan diagram of the monolayer graphene Corbino device C with moiré potential. Satellite conductance dips emerge at around Vg=±6 V.

"Accurate Measurement of the Gap of Graphene/hBN Moiré Superlattice through Photocurrent Spectroscopy"
Tianyi Han, Jixiang Yang, Qihang Zhang, Lei Wang, Kenji Watanabe, Takashi Taniguchi, Paul L. McEuen, Long Ju
Physical. Review Letters 126, 146402 (2021) | arXiv: 2103.08120 (2021)

WOLFGANG KETTERLE, *Physics*

“Observation of Microwave Shielding of Ultracold Molecules”
Loïc Anderegg, Sean Burchesky, Yicheng Bao, Scarlett S. Yu, Tijs Karman, Eunmi Chae, Kang-Kuen Ni, Wolfgang Ketterle, John M. Doyle
arXiv2102.04365 (2021)

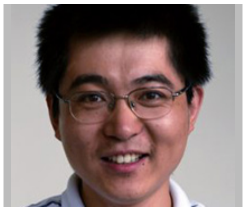
“Pauli blocking of light scattering in degenerate fermions”
Yair Margalit, Yu-Kun Lu, Furkan Cagri Top, Wolfgang Ketterle
arXiv: 2103.06921 (2021)



Experimental sequence for the measurement of spin alignment and doublon fractions. (a) The lattices are ramped up to initialize a single-component Mott insulator with a maximal site occupancy of two. (b) Microwave pulses prepare a superposition of two hyperfine states (|a⟩−i|b⟩)/√2. Ramping down the longitudinal lattice initiates spin-exchange dynamics. (c) Ramping up the lattices stops the exchange dynamics. Microwave pulses transfer the two components to a pair of states with a Feshbach resonance. (d) Either |ab⟩ doublons or all doublons are removed with the help of Feshbach-enhanced inelastic losses. The remaining atoms are transferred back to the F=1 hyperfine states and are counted via absorption imaging to measure Np or Nd.

“Tunable Single-Ion Anisotropy in Spin-1 Models Realized with Ultracold Atoms”
Woo Chang Chung, Julius de Hond, Jinggang Xiang, Enid Cruz-Colón, Wolfgang Ketterle
Physical Review Letters 126, 163203 (2021) | arXiv: 2101.01316 (2021)

“Transverse spin dynamics in the anisotropic Heisenberg model realized with ultracold atoms”
Paul Niklas Jepsen, Wen Wei Ho, Jesse Amato-Grill, Ivana Dimitrova, Eugene Demler, Wolfgang Ketterle
arXiv: 2103.07866 (2021)



LUQIAO LIU, *EECS*

"Resonant Spin Transmission Mediated by Magnons in a Magnetic Insulator Multilayer Structure"
Yabin Fan, Joseph Finley, Jiahao Han, Megan E. Holtz, Patrick Quarterman, Pengxiang Zhang, Taqiyyah S. Safi, Justin T. Hou, Alexander J. Grutter, Luqiao Liu
Advanced Materials (2021)

"Quantum engineering with hybrid magnonics systems and materials"
D. D. Awschalom, C. H. R. Du, R. He, F. J. Heremans, A. Hoffmann, J. T. Hou, H. Kurebayashi, Y. Li, L. Liu, V. Novosad, J. Sklenar, S. E. Sullivan, D. Sun, H. Tang, V. Tiberkevich, C. Trevillian, A. W. Tsen, L. R. Weiss, W. Zhang, X. Zhang, L. Zhao, C. W. Zollitsch
IEEE Xplore (2021) | arXiv: 2102.03222 (2021)

SETH LLOYD, *ME, ES, Physics*

"Quantum Earth Mover's Distance: A New Approach to Learning Quantum Data"
Bobak Toussi Kiani, Giacomo De Palma, Milad Marvian, Zi-Wen Liu, Seth Lloyd
arXiv:2101.03037 (2021)

"Hamiltonian singular value transformation and inverse block encoding"
Seth Lloyd, Bobak T. Kiani, David R.M. Arvidsson-Shukur, Samuel Bosch, Giacomo De Palma, William M. Kaminsky, Zi-Wen Liu, Milad Marvian
arXiv: 2104.01410 (2021)

"Resonant Quantum Principal Component Analysis"
Zhaokai Li, Zihua Chai, Yuhang Guo, Wentao Ji, Mengqi Wang, Fazhan Shi, Ya Wang, Seth Lloyd, Jiangfeng Du
arXiv:2104.02476 (2021)

KEVIN P. O'BRIEN, *EECS*

"Broadband Microwave Isolation with Adiabatic Mode Conversion in Coupled Superconducting Transmission Lines"
Mahdi Naghiloo, Kaidong Peng, Yufeng Ye, Gregory Cunningham, Kevin P. O'Brien
arXiv: 2103.07793 (2021)

"Near-Ideal Quantum Efficiency with a Floquet Mode Traveling Wave Parametric Amplifier"
Kaidong Peng, Mahdi Naghiloo, Jennifer Wang, Gregory D Cunningham, Yufeng Ye, Kevin P O'Brien
arXiv: 2104.08269 (2021)

WILLIAM D. OLIVER, *EECS, Physics, Lincoln Laboratory*

"Probing quantum information propagation with out-of-time-ordered correlators"
J. Braumüller, A. H. Karamlou, Y. Yanay, B. Kannan, D. Kim, M. Kjaergaard, A. Melville, B. M. Niedzielski, Y. Sung, A. Vepsäläinen, R. Winik, J. L. Yoder, T. P. Orlando, S. Gustavsson, C. Tahan, W. D. Oliver
arXiv:2102.11751 (2021)

"Error mitigation via stabilizer measurement emulation"
A. Greene, M. Kjaergaard, M. E. Schwartz, G. O. Samach, A. Bengtsson, M. O'Keeffe, D. K. Kim, M. Marvian, A. Melville, B. M. Niedzielski, A. Vepsalainen, R. Winik, J. Yoder, D. Rosenberg, S. Lloyd, T. P. Orlando, I. Marvian, S. Gustavsson, W. D. Oliver
arXiv:2102.05767 (2021)

"Fabrication of superconducting through-silicon vias"
J. L. Mallek, D. W. Yost, D. Rosenberg, J. L. Yoder, G. Calusine, M. Cook, R. Das, A. Day, E. Golden, D. K. Kim, J. Knecht, B. M. Niedzielski, M. Schwartz, A. Sevi, C. Stull, W. Woods, A. J. Kerman, W. D. Oliver
arXiv:2103.08536 (2021)

WILLIAM D. OLIVER, *EECS, Physics, Lincoln Laboratory*

“Deep Neural Network Discrimination of Multiplexed Superconducting Qubit States”
B. Lienhard, A. Vepsäläinen, L. C. G. Govia, C. R. Hoffer, J. Y. Qiu, D. Ristè, M. Ware, D. Kim, R. Winik, A. Melville, B. Niedzielski, J. Yoder, G. J. Ribeill, T. A. Ohki, H. K. Krovi, T. P. Orlando, S. Gustavsson, W. D. Oliver
arXiv:2102.12481 (2021)

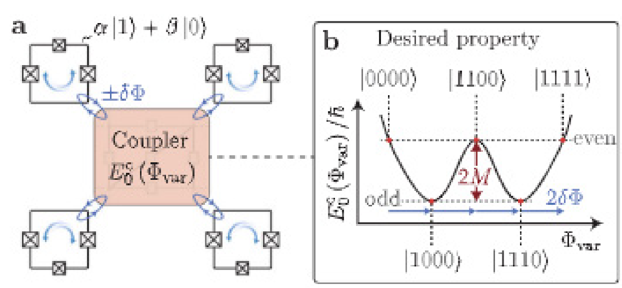
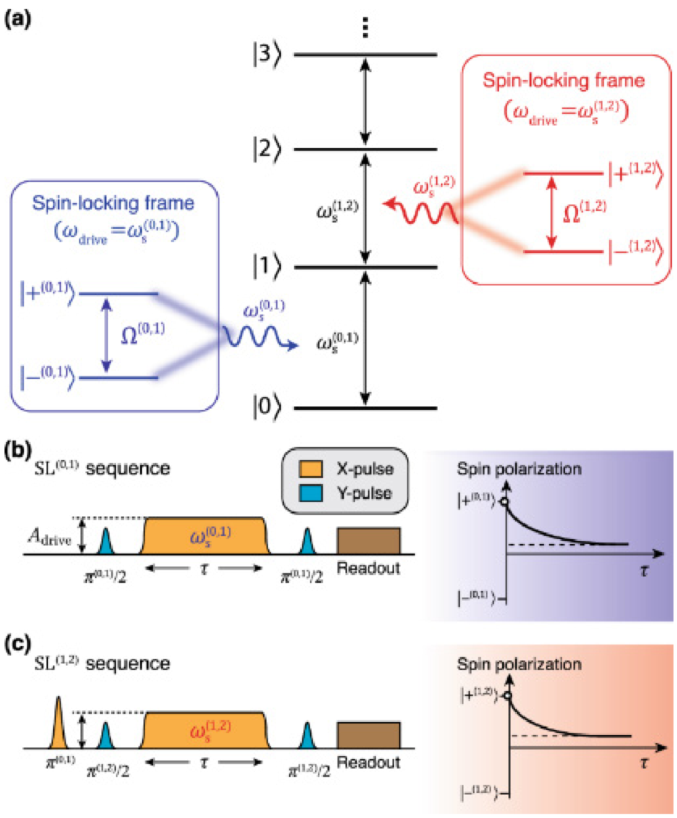


Fig. 3 Coupler spectral property enabling 4-local interaction. a Four superconducting flux qubits are coupled mutually inductively to a shared coupler circuit. The states $|0\rangle$, $|1\rangle$ of each qubit are determined by the direction of the persistent circulating current in the qubit loop. By mutual induction, the magnetic field generated by the qubit's persistent current adds a small flux offset $\pm\delta\Phi$ to the coupler circuit. **b** The coupler has a ground-state energy $E_0^c(\Phi_{\mathrm{var}})$ that depends on an external flux Φ_{var}. If this energy spectrum follows a double-well shape with spacing $2\delta\Phi$ as indicated in the figure, the 4-qubit states with even and odd excitation numbers separate into two energy manifolds and the coupler mediates an effective 4-local interaction term. The challenge is to find a robust coupler circuit with such a double-well spectrum. The behavior of the coupler energy over a small external flux range should not be confused with the inductive double-well potential of the flux qubit.

“Automated design of superconducting circuits and its application to 4-local couplers”
T. Menke, F. Häse, S. Gustavsson, A. J. Kerman, W. D. Oliver, A. Aspuru-Guzik
npj Quantum Information 7, 49 (2021) | arXiv:1912.03322 (2019)

WILLIAM D. OLIVER, *EECS, Physics, Lincoln Laboratory*

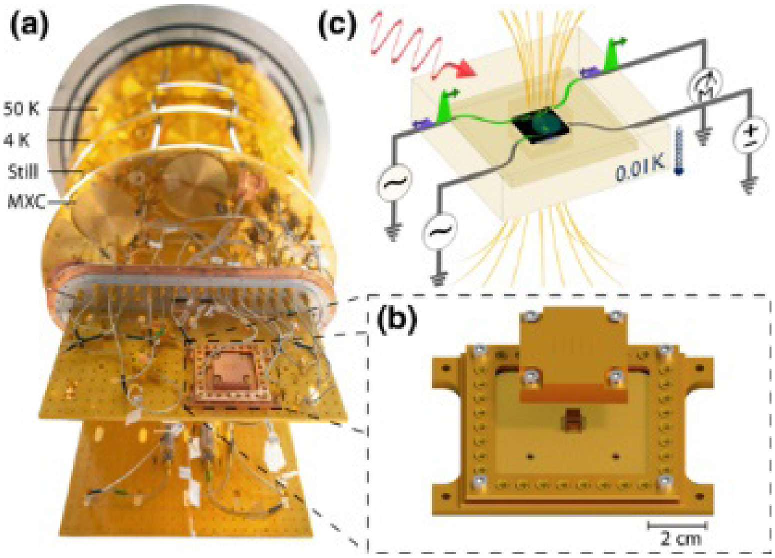


a A transition between the $(j-1)$th and jth level of a multi-level system is driven resonantly to form the jth spin-locking basis (dressed states) $\{||+(j-1,j)\rangle|+(j-1,j)\rangle, |-(j-1,j)\rangle|-(j-1,j)\rangle\}$ which are separated by the Rabi frequency $\Omega(j-1, j)$. The two-level system formed by the basis $\{||+(j-1,j)\rangle|+(j-1,j)\rangle, |-(j-1,j)\rangle|-(j-1,j)\rangle\}$ acts as the jth spin-locked noise spectrometer. b, c Spin-locking (SL) sequences used to measure the relaxation of spin polarization $||+(0,1)\rangle|+(0,1)\rangle$ and $||+(1,2)\rangle|+(1,2)\rangle$ as a function of the spin-locking duration τ, respectively.

"Multi-level quantum noise spectroscopy"
Y. Sung, A. Vepsäläinen, J. Braumüller, F. Yan, J. I-J. Wang, M. Kjaergaard, R. Winik, P. Krantz, A. Bengtsson, A. J. Melville, B. M. Niedzielski, M. E. Schwartz, D. K. Kim, J. L. Yoder, T. P. Orlando, S. Gustavsson, W. D. Oliver
Nature Communications 12, 967 (2021) | arXiv:2003.02782 (2020)



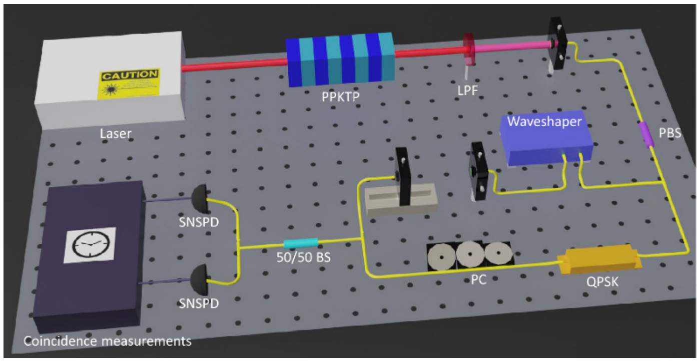
WILLIAM D. OLIVER, *EECS, Physics, Lincoln Laboratory*



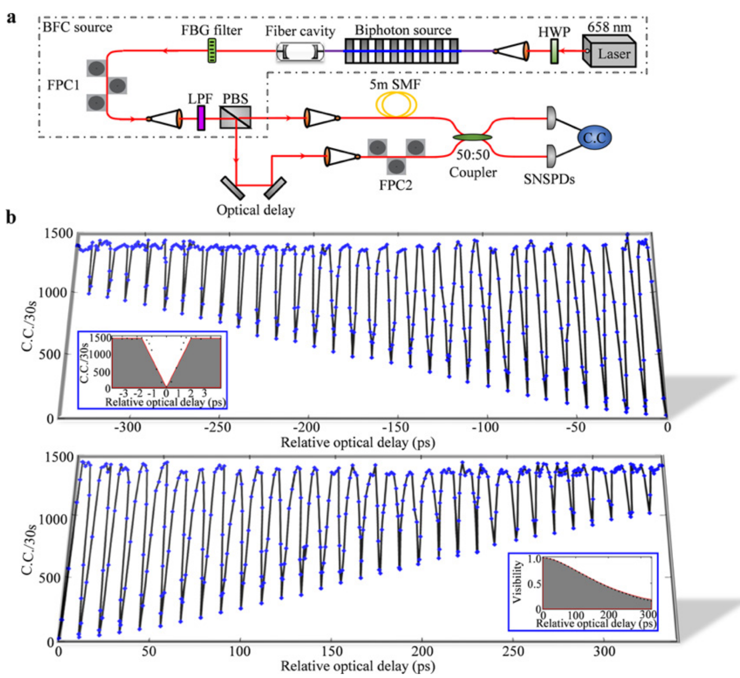
Package environment, layout, and requirements. (a) Dilution refrigerator with multiple temperature stages holding the qubit chip enclosed in a microwave package. The microwave package interfaced with through microwave lines is mounted on a cold finger in the mixing chamber reaching a base temperature of approximately 10 mK. (b) The microwave package consists of a metal enclosing, microwave connectors, an interposer for signal fan out, and a microwave cavity in the center surrounding the quantum chip. (c) The purpose of a microwave package is to shield the enclosed qubit chip from external radiation (red oscillating arrow) and stray magnetic fields (yellow lines) while providing impedance-matched (transmitted green pulse and reflected blue pulse at the input and output), low-crosstalk communication channels (crosstalk in green at input), and a thermal link to the dilution refrigerator.

"Microwave package design for superconducting quantum processors"
S. Huang, B. Lienhard, G. Calusine, A. Vepsäläinen, J. Braumüller, D. K. Kim, A. J. Melville, B. M. Niedzielski, J. L. Yoder, B. Kannan, T. P. Orlando, S. Gustavsson, W. D. Oliver
PRX Quantum 2, 020306 (2021) | arXiv:2012.01438 (2020)

JEFFREY H. SHAPIRO, *EECS*



“Single-photon frequency shifting with a quadrature phase-shift keying modulator”
C. Chen, J. E. Heyes, J. H. Shapiro, F. N. C. Wong
Nature Scientific Reports volume 11, Article number: 300 (2021)



“648 Hilbert-space dimensionality in a biphoton frequency comb: entanglement of formation and Schmidt mode decomposition”
K. Chang, X. Cheng, M. C. Sarihan, A. K. Vinod, Y. S. Lee, T. Zhong, Y. Gong, Z. Xie, J. H. Shapiro, F. N. C. Wong, C. W. Wong
npj Quantum Information 7, 48 (2021)

VIVISHEK SUDHIR, *ME*

“Acceleration-induced effects in stimulated light-matter interactions”
B. Šoda, V. Sudhir, A. Kempf
arXiv: 2103.15838 (2021)

“Approaching the motional ground state of a 10 kg object”
C. Whittle, E.D. Hall, S. Dwyer, N. Mavalvala, V. Sudhir,
(LIGO Instrument Science group)
arXiv: 2102.12665 (2021)

“Unruh Effect of Detectors with Quantized Center-of-Mass”
V. Sudhir, N. Stritzelberger, A. Kempf
arXiv: 2102.03367 (2021)

VLADAN VULETIC, *Physics*

“Probing Topological Spin Liquids on a Programmable Quantum Simulator”
Giulia Semeghini, Harry Levine, Alexander Keesling, Sepehr Ebadi,
Tout T. Wang, Dolev Bluvstein, Ruben Verresen, Hannes Pichler,
Marcin Kalinowski, Rhine Samajdar, Ahmed Omran, Subir Sachdev,
Ashvin Vishwanath, Markus Greiner, Vladan Vuletic, Mikhail D. Lukin
arXiv: 2104.04119 (2021)

LINDLEY WINSLOW, *Physics*

"The search for low-mass axion dark matter with ABRACADABRA-10cm"
Chiara P. Salemi, Joshua W. Foster, Jonathan L. Ouellet, Andrew Gavin, Kaliroe M. W. Pappas, Sabrina Cheng, Kate A. Richardson, Reyco Henning, Yonatan Kahn, Rachel Nguyen, Nicholas L. Rodd, Benjamin R. Safdi, Lindley Winslow
arXiv: 2102.06722 (2021)

MARTIN ZWIERLEIN, *Physics*

"Quantum Register of Fermion Pairs"
Thomas Hartke, Botond Oreg, Ningyuan Jia, Martin Zwierlein
arXiv: 2103.13992 (2021)

Publications

Exponential suppression of bit or phase flip errors with repetitive error correction
Zijun Chen, et. al., including MIT-CQE member E. Farhi
arXiv: 2102.06132 (2021)

Realizing topologically ordered states on a quantum processor
K. J. Satzinger, et al., including MIT-CQE members: A. Greene, E. Farhi
arXiv: 2104.01180 (2021)

Information Scrambling in Computationally Complex Quantum Circuits
Xiao Mi, et. al., including MIT-CQE member E. Farhi
arXiv: 2101.08870 (2021)

Coherent manipulation of an Andreev spin qubit
M. Hays, et. al., including MIT-CQE member K. Serniak
arXiv: 2101.06701 (2021)

Crucial Milestone for Scalable Quantum Technology: 2D Array of Semiconductor Qubits That Functions as a Quantum Processor
"By putting four such qubits in a two-by-two grid, demonstrating universal control over all qubits, and operating a quantum circuit that entangles all qubits, we have made an important step forward in realizing a scalable approach for quantum computation." [Nature, arxiv]

Beyond Qubits: Key Components for a Qutrit-Based Quantum Computer Demonstrated
The new study makes use of a quantum circuit that is inspired by the longstanding physics question: What happens to information when it enters a black hole? [PRX]

Quantum walks on a programmable two-dimensional 62-qubit superconducting processor
We have designed and fabricated an 8x8 two-dimensional square superconducting qubit array composed of 62 functional qubits. We used this device to demonstrate high fidelity single and two particle quantum walks. [arxiv]

Capturing a single photon of light: Harnessing quantum's 'noise problem'
"A Josephson junction in quantum computing is analogous to a transistor for modern electronics, so they are super important," said Kin Chung Fong, a quantum information processing scientist at Raytheon BBN Technologies. [Science, arxiv]

NIST team probes indestructible quantum states that may aid quantum computing
They may not be impervious to bullets like Superman, but groups of electrons that gather along the edges of some ultrathin materials have their own superpowers. [Nat Comms]

UChicago, Fermilab physicists build a quantum bit that can search for dark matter

We know that there's a huge amount of mass all around us that isn't made of the same stuff you and I are made of," said Fermilab scientist Aaron Chou. "The nature of dark matter is a really compelling mystery that a lot of us are trying to solve." [PRL]

Quantum material's subtle spin behavior proves theoretical predictions

"Seeing this kind of behavior was surprising, because this is one of the oldest problems in the quantum physics community, and spin chains are one of the key foundations of quantum mechanics," said Alan Tennant, who leads a project on quantum magnets at the Quantum Science Center, or QSC, headquartered at ORNL. [Nat Phys]

Quantum computer has the edge for NP verification

Their work shows that it is possible for a quantum computer to verify solutions to problems classified as NP-complete using a so-called interactive proof protocol and only minimal, unverified information about the solution. [Nat Comms]

Error Protected Quantum Bits Entangled: A Milestone in the Development of Fault-Tolerant Quantum Computers

The quantum physicists from Innsbruck have now succeeded for the first time in entangling two quantum bits coded in this way. The entanglement of two quantum bits is an important resource of quantum computers, giving them a performance advantage over classical computers. [Nature]

Researchers Demonstrate High-Fidelity Quantum Teleportation

Using fiber-coupled devices, including state-of-the-art low-noise superconducting nanowire single-photon detectors and off-the-shelf optics, have demonstrated sustained, long-distance (44 km of fiber) teleportation of photonic qubits at the telecommunication wavelength of 1,536.5 nm with state-of-the-art fidelity (> 90%). [PRXQ]

A self-correcting qubit

Jeffrey Gertler and co-workers report that they have sidestepped this issue by building a quantum system that autonomously detects and corrects an error without relying on the slow classical computation step. [Nature]

Applying quantum computing to a particle process

"We've essentially shown that you can put a parton shower on a quantum computer with efficient resources," said Christian Bauer, "and we've shown there are certain quantum effects that are difficult to describe on a classical computer that you could describe on a quantum computer." [PRL]

Quantum Computing Enables Simulations to Unravel Mysteries of Magnetic Materials

"The underlying method behind solving materials science problems on quantum computers had already been developed, but it was all theoretical," said Paul Kairys. "We developed new solutions to enable materials simulations on real-world quantum devices." [PRXQ]

Implementing a quantum approximate optimization algorithm on a 53-qubit NISQ device

The researchers created a QAOA and ran it on Google's state of the art NISQ computing platform. As Barak notes, their QAOA worked as a combination of smaller algorithms that have been created to run simulations on a quantum computer, such as simulated annealing. [NatPhys]

Physicists Propose a 'Force Field' to Protect Sensitive Quantum Computers From Noise

"We have designed a circuit composed of state-of-the-art superconducting circuit elements and a nonreciprocal device, that can be used to passively implement the GKP quantum error-correcting code," the team writes in their paper. [PRXQ]

Photonic chip brings optical quantum computers a step closer

Arrazola et al. implemented their photonic circuit on a silicon nitride chip that is compatible with the fabrication processes used by the semiconductor industry. The authors produced a squeezed state in each of four micrometre-sized devices known as optical ring resonators on the chip using an effect called four-wave mixing. [Nature]

New quantum theory heats up thermodynamic research

"Our findings seem odd because we expect physical quantities such as entropy to have meaning independent of who calculates them. In order to resolve the paradox, we must realise that thermodynamics tells us what useful things can be done by an experimenter who has devices with specific capabilities." [Nat Comms]

Majorana-based quantum computation gets a handy new platform

Researchers at the University of Maryland, US have now identified a more experimentally feasible way to generate Majorana fermions, potentially paving the way for Majorana-based quantum computation. [PRL]

A team of researchers from the National Institute of Standards and Technology (NIST) found that, with just a few tweaks, optical fiber can be used to communicate with the qubits sitting inside superconducting quantum computers, with the same level of accuracy as existing methods. [Nature, arxiv]

Deterministic spin-photon entanglement from a trapped ion in a fiber Fabry–Perot cavity

We report the realization of a quantum network node using a trapped ion inside a fiber-based Fabry–Perot cavity. We show the generation of deterministic entanglement at a high fidelity of 90.1(17)% between a trapped Yb ion and a photon emitted into the resonator mode. [Nature]

Moving Chips Closer to Cold Qubits
These cold cathedrals of quantum computing cannot tolerate the extra heat given off by the conventional computing chips that control them. [IEEE]

Zero–trade-off multiparameter quantum estimation via simultaneously saturating multiple Heisenberg uncertainty relations
We show that to achieve the highest precisions for multiple parameters at the same time requires the saturation of multiple Heisenberg uncertainty relations simultaneously. Guided by this insight, we experimentally demonstrate an optimally controlled multipass scheme for the estimation of all three parameters in SU(2) operators. [Science Advances]

Extremely Energy Efficient Microprocessor Developed Using Superconductors
The team explored the use of an extremely energy-efficient superconductor digital electronic structure, called the adiabatic quantum-flux-parametron (AQFP), as a building block for ultra-low-power, high-performance microprocessors, and other computing hardware for the next generation of data centers and communication networks.

Qubit-ADAPT-VQE: An Adaptive Algorithm for Constructing Hardware-Efficient Ansätze on a Quantum Processor
Here, we address all these key outstanding issues of the algorithm. We present a hardware-efficient variant of ADAPT-VQE that drastically reduces circuit depths using an operator pool that is guaranteed to contain the operators necessary to construct exact ansätze. [PRX Quantum]

Adiabatic quantum state transfer in a semiconductor quantum-dot spin chain
By adiabatically modifying exchange couplings, we transfer single- and two-spin states between distant electrons in less than 127 ns. We also show that this method can be cascaded for spin-state transfer in long spin chains. [Nature]

Quantum computer based on shuttling trapped ions
Pino et al. report the construction and operation of a prototype microchip-based, trapped-ion quantum computer that incorporates a promising architecture based on ion shuttling. [Nature]

Optimal operation points for ultrafast, highly coherent Ge hole spin-orbit qubits
Here, taking Ge as an example, we show that group IV gate-defined hole spin qubits generically exhibit optimal operation points, defined by the top gate electric field, at which they are both fast and long-lived. [Nature]

Primary Thermometry of Propagating Microwaves in the Quantum Regime
Here, we propose and experimentally demonstrate primary thermometry of propagating microwaves using a transmon-type superconducting circuit. [PRX]

Team finds an easier optimal detection scheme for near-term quantum sensors
The authors applied filter functions and optimal quantum control theories to a use case of quantum bit (qubit) sensors that mirror a classic problem in signal detection theory: optimal detection of a known signal from background noise with a controllable quantum sensor. [npjQI]

A speed limit also applies in the quantum world
Physicists have now shown what the speed limit is for complex quantum operations. The results are important for the realization of quantum computers, among other things. [PRX]

Programmable photonic chip lights up quantum computing
Scientists from the Ontario, Canada-based quantum computing firm Xanadu and the US National Institute of Standards and Technology have taken a big step towards that future by building a light-based chip that can be programmed through cloud access.

How Close Is Ordinary Light To Doing Quantum Computing?
Classically entangled light, sometimes called "structured light," is not a new concept. But until now no one had entangled more than two properties at once. [IEEE]

New Superconducting Thermometer Can Accelerate Quantum Computer Development
Researchers at Chalmers University of Technology, Gothenburg, Sweden, have developed a novel type of thermometer that can simply and quickly measure temperatures during quantum calculations with extremely high accuracy

Experimental demonstration of quantum advantage for NP verification with limited information
We show an experimental demonstration of a quantum computational advantage in a prover-verifier interactive setting, where the computational task consists in the verification of an NP-complete problem by a verifier who only gets limited information about the proof sent by an untrusted prover in the form of a series of unentangled quantum states. [Nature]

AFRL measures first superconducting quantum bits (qubit), first-ever demo for a DOD service lab

The superconducting qubit test chip was manufactured and initially measured at Massachusetts Institute of Technology Lincoln Laboratory (MIT-LL) to serve as a calibration benchmark for the Information Directorate's cryostat and microwave infrastructure.

Materials challenges and opportunities for quantum computing hardware

For each platform, we present reasons for particular material choices, survey the current understanding of sources of noise and dissipation, describe materials limitations to scaling, and discuss potential new material platforms. [Science]

Breakthrough for room temperature optical quantum computing

Researchers at the KTH Royal Institute of Technology in Sweden have developed a technique to integrate quantum computing with optical fibre networks at room temperature.

Realization of a multinode quantum network of remote solid-state qubits

Here, we report on the realization of a three-node entanglement-based quantum network. We combine remote quantum nodes based on diamond communication qubits into a scalable phase-stabilized architecture, supplemented with a robust memory qubit and local quantum logic. [Science]

Coding for Qubits: How to Program in Quantum Computer Assembly Language

To deliver that combination of precision and flexibility, Landahl says, they created Jaqal, which includes commands to initialize the ions as qubits, rotate them individually or together into various states, entangle them into superpositions, and read out their end states as output data. [IEEE]

Politics and Funding

New Microelectronics Initiative Sets Up Possible Funding Infusion

Concerned about the eroding U.S. share of the global micro-electronics market, last year Congress fast-tracked legislation focused on bolstering domestic semi-conductor R&D and manufacturing. Chip companies are now pressing the Biden administration and Congress to robustly fund the initiatives authorized by the legislation. [Letter]

National Artificial Intelligence Initiative

Welcome to AI.gov, home of the National AI Initiative and connection point to ongoing activities to advance U.S. leadership in AI.

Senate Taking Endless Frontier Act Dispute Into Floor Debate

The committee also incorporated various standalone bills into the Endless Frontier Act during the meeting. These include pandemic recovery legislation for science agencies, the Combatting Sexual Harassment in Science Act, Rural STEM Education Act, Quantum Network Infrastructure and Workforce Development Act, AI Scholarship-For-Service Act, and Bioeconomy R&D Act.

Germany to invest €2bn in building first quantum computer

The science ministry will contribute €1.1bn by 2025 to support R&D in quantum computing, while the economy ministry will contribute €878m to support the development of applications.

State to set up first dedicated quantum computer engineering centre

The State is to scale up its capacity to exploit the rapidly emerging field of quantum computing by setting up its first dedicated quantum computer engineering centre (QCEC) in Cork.

Hyperion Offers Snapshot of Quantum Computing Market

The nascent quantum computer (QC) market will grow 27 percent annually (CAGR) reaching $830 million in 2024 according to an update provided today by analyst firm Hyperion Research at the HPC User Forum being held this week

Petascale Supercomputer-Bulgaria Consortium, Sofia Tech Park, InfinityQ Sign MOU to Develop Quantum Technologies

The agreement stipulates that a quantum computing module based on InfinityQ technology to be installed to the Bulgarian petascale super-computer Discoverer, which is positioned in Sofia Tech Park.

DOE Announces $10M for Quantum Information Science, Nuclear Physics Research

“Because of its potential to seed technologies of the future, research in QIS has become a national priority, and the nuclear science community brings important insights and capabilities to the table,” said Timothy Hallman, DOE Associate Director of Science for Nuclear Physics.

NSA, Army Launch 'Qubit Collaboratory' to Advance Quantum Information Science
In a broad agency announcement released Friday, ARO and LPS describe early research areas to be pursued via the project—called the LPS Qubit Collaboratory, or LQC—and invite proposals to push forward experimental efforts that make sense for cooperative approaches.

DOE to Provide $25 Million toward Development of a Quantum Internet
"Recent efforts at developing operational quantum networks have shown notable success and great potential," said Barb Helland, DOE Associate Director of Science for Advanced Scientific Computing Research. "This opportunity aims to lay the groundwork for a quantum internet by taking quantum networking to the next level."

Senators push quantum computing at DoD
The two bills from Sens. Maggie Hassan, D-N.H., and John Thune, R-S.D., are the QUANTUM for National Security Act, which would impact the Pentagon, and the Quantum Network Infrastructure and Workforce Development Act.

Biden says Japan and U.S. committed to working together to meet China challenge
Biden said the two countries had agreed to work together on 5G, semi-conductor supply chains, artificial intelligence, genomics and quantum computing.

European Quantum Industry Consortium kicks-off work
The event gathered more than 100 members from all sectors of the quantum technologies industry in Europe, representing SMEs, large corporations, venture capitalists as well as research organizations, academic institutions and other industrial associations from all over the continent. [QuIC]

Chinese firms to set up quantum chip R&D lab to catch up with global leaders
Two Chinese semiconductor companies have agreed to jointly set up a laboratory for quantum chips to develop low-temperature integrated circuit technology, aiming to build a complete production chain for the crucial high-tech component of the future that is currently dominated by foreign industry leaders.

FACT SHEET: The American Jobs Plan
In addition to a $5 billion increase in funding for other climate-focused research, his plan will invest $15 billion in demonstration projects for... advanced nuclear, rare earth element separations, floating offshore wind, biofuel/bioproducts, quantum computing, and electric vehicles, as well as strengthening U.S. technological leadership in these areas in global markets.

Canada's Defense Strategy Falls Behind in the Quantum Age

Canada's first federal department quantum "strategy" was finally released on Jan. 18 by the Department of National Defence and the Canadian Armed Forces—the so-called "Defence Team." Yet this new report falls far short of delivering a meaningful strategy, even just for defense.

White House Issues Interim National Security Strategic Guidance

The world's leading powers are racing to develop and deploy emerging technologies, such as artificial intelligence and quantum computing, that could shape everything from the economic and military balance among states to the future of work, wealth, and inequality within them," the document reads. [PDF]

UAE joins quantum computing challenge

The Technology Innovation Institute (TII) in Abu Dhabi announced that its Quantum Research Centre has developed the first simulation version of Qibo, an open-source quantum computing framework, in cooperation with researchers from around the world.

Air Force Research Laboratory Partners with QC Ware to Apply Quantum Machine Learning in Identifying Flight Patterns of Unmanned Aircraft

The research collaboration will focus on evaluating the performance of the algorithm, using real data and implementing the algorithm on currently available quantum hardware. The experiment's objective is to determine how much quantum resources are needed in terms of qubit count and error rate to achieve performance speed-ups over classical algorithms for clustering and classification.

NEC, D-Wave and the Australian Department of Defence Collaborate on Quantum Computing Initiative

The technology optimises how autonomous vehicles are used to resupply army forces from a central base. NEC Australia and D-Wave were selected via a competitive proposal process.

German Aerospace Center and Cambridge Quantum Partner on Battery Development Through Quantum Computing

The collaboration will see DLR – the national aeronautics and space research centre of the Federal Republic of Germany – use CQC's quantum algorithms for solving partial differential equation (PDE) systems to render a 1D simulation of a lithium-ion battery cell.

Biden Commits to Investing 'Closer to 2%' of GDP in Science Research

The president referenced infrastructure, immigration, quantum computing and much more in his first formal press conference. "The future lies in who can, in fact, own the future as it relates to technology—in quantum computing, a whole range of things, including the medical fields."

China emerges as quantum tech leader while Biden vows to catch up

In terms of patents related to hardware in this field, such as devices that exchange photons, Huawei ranked second with 100 patents, and Beijing University of Posts and Telecommunications ranked fourth with 84 patents. Chinese companies also hold many patents for software technology in this field.

The State of Quantum – Highlighting the NSF Center for Quantum Networks

Even as we get more enthusiastic about quantum technology, we need to focus on the hard technical challenges first (including discovering applications) to fuel the next level of investments.

Officials Aim to Diversify the U.S. Quantum Workforce Early On

"The numbers that I could find said something like a total few thousand quantum experts worldwide. Worldwide, there is a shortage," Abiodun Ilumoka, a program director in the National Science Foundation's Education and Human Resources Directorate.

Final FY21 Appropriations: DOE Office of Science

Congress directs the Office of Science to increase funding for artificial intelligence from $71 million to at least $100 million and for quantum information science from $195 million to at least $245 million. Of the QIS funding, $125 million is for the five research centers DOE established last year in accord with the National Quantum Initiative Act.

Quantifying Utility of Quantum Computers

"Quantum Benchmarking is focused on the fundamental question: How will we know whether building a really big fault-tolerant quantum computer will revolutionize an industry?" Altepeter said. "Companies and government researchers are poised to make large quantum computing investments in the coming decades, but we don't want to sprint ahead to build something and then try to figure out afterward if it will be useful for anything."

China ramps up tech commitment in 5-year plan, eyes 7% boost in R&D spend

China highlighted seven key areas related to technology it aims to boost: next-generation artificial intelligence, quantum information, brain science, semiconductors, genetic research and biotechnology, clinical medicine and health, and deep space, deep sea and polar exploration. The government also said it would establish more national laboratories to research quantum information and artificial intelligence.

Pronouncements and Commentary

IBM on track with next-level, 1,121 qubit quantum computer by 2023

"The key thing that we focused on in the last six months is really an articulation of our roadmaps, so the roadmap around hardware, the roadmap around software, and we've also done quite a bit of ecosystem development," said Jamie Thomas, general manager of strategy and development of IBM Systems.

Arqit raising $400 million with a SPAC to launch quantum encryption satellites in 2023

British quantum technology encryption startup Arqit is raising $400 million in the space industry's latest SPAC deal, supporting the launch and construction of two satellites in 2023 to protect against growing hacking threats.

CINECA and D-Wave Expand Access to Quantum Computing Technology and Resources in Italy

CINECA, which is made up of 69 Italian universities, 25 national research institutions, the Ministry of Education, and the Ministry of Universities and Research, will benefit from expanded, real-time access to the Leap quantum cloud service.

ColdQuanta Announces $20M in Funding to Commercialize Cold Atom Quantum Technology

The investment will be used to rapidly accelerate the commercialization of the company's Cold Atom Quantum Technology, in parallel with the company's Series B funding raise. This investment brings ColdQuanta's total funding to $74 million.

Agnostiq Secures $2M Seed Round to Further Develop SaaS-based Quantum Solutions

One of only a handful of available SaaS-based quantum solutions hosted on the cloud, Agnostiq's platform is comprised of three main technologies that make it easier for enterprises to build their own quantum computing applications.

Intel says it has solved a key bottle-neck in quantum computing

Intel just took a significant step toward making quantum computing more practical. The company and QuTech say they've demonstrated the first instance of high-fidelity two-qubit control using its Horse Ridge cryogenic control processor.

Senetas and Thales launch the world's first quantum resistant network encryption solution

Thales and Senetas have collaborated to launch the world's first quantum-resistant network encryption solution, capable of protecting customer data (at speeds up to 100 Gbps) against future quantum attacks.

IBM Debuts Qiskit Runtime for Quantum Computing; Reports Dramatic Speed-up

An IBM blog by researchers Blake Johnson and Ismael Faro said, "Last fall, we made the ambitious promise to demonstrate a 100x speedup of quantum workloads in our IBM Quantum roadmap for scaling quantum technology. Today, we're pleased to announce that we didn't just meet that goal; we beat it."

GlobalFoundries and PsiQuantum partner on full-scale quantum computer

Palo Alto, California-based PsiQuantum has plans to create a million-qubit quantum computer. Globalfoundries is a major chip-maker that will manufacture the silicon photonic and electronic chips that are part of the Q1.

Atos and SENAI CIMATEC Launch Center of Excellence in Quantum Computing in Brazil

Located in Salvador, Bahia, the Latin America Quantum Computing Center (LAQCC) aims to promote the adoption of quantum technologies, provide training to build a local quantum computing workforce and encourage scientific research in the most diverse areas, such as chemistry and biology.

Cambridge Quantum Computing Integrates tket Platform with Strangeworks Ecosystem

With infrastructure-level integration, Strangeworks users will benefit from tket's enterprise-level support for multiple devices and languages as well as the SDK's ability to enable rapid prototyping and benchmarking to extract maximum value from devices in the Noisy Intermediate Scale Quantum (NISQ) era.

U.S. venture giant Bessemer set to lead US$100-million funding of Toronto quantum computing upstart Xanadu, sources say

U.S. venture capital giant Bessemer Venture Partners has signed on to lead a US$100-million funding of Toronto startup Xanadu Quantum Technologies Inc., as competition intensifies in a global race to bring quantum computers to market.

How a 1981 conference kickstarted today's quantum computing era

"It's hard to put yourself back in time," says Charlie Bennett, a distinguished physicist and information theorist who was part of the IBM Research contingent at the event. "If you'd said 'quantum computing,' nobody would have understood what you were talking about."

Collaboration has mission to build UK's first commercial quantum computer

"The system we will build here will be larger than anything we currently have available in the US," says Anna Stockklauser, Rigetti's technical lead for quantum engineering. "An initial version of the machine will be available for our UK partners to use early next year, and we will then iterate the design over time."

Women in Quantum | Free Mentoring Program launch
The mentoring program will cover various areas of competencies, from which mentees get to pick and will be matched with the ideal mentor. If you would like to participate, please enroll here before the program starts.

AWS, QCI look to bridge classical and quantum computing
The offering permits inexperienced quantum users to submit complex problems to one of several quantum-based systems through AWS' Braket quantum-based service.

Goldman Sachs and QC Ware Collaboration Brings New Way to Price Risky Assets within Reach of Quantum Computers
Goldman Sachs and QC Ware researchers have been working to answer this question: "How can we cut the current timeline in half yet still get a significant speed-up?" By successfully sacrificing some of the speed up from 1000x to 100x, the team was able to produce Shallow Monte Carlo algorithms that can run on near-term quantum computers expected to be available in 5 to 10 years.

How Merck works with Seeqc to cut through quantum computing hype
Part of the role of the In Silico Research group is to develop those models that can solve quantum problems using evolving technologies such as data analytics and AI and applying them to natural sciences to make experimental work less time-consuming.

UK cyber spy chief says: quantum computing is closer but beware the risk
"That means we need to get ahead of the curve - we need to be designing quantum-resistant algorithms, we need to be designing quantum-proof cyber security approaches such that we're prepared for the future when it comes but so we're also prepared for those adversaries who might use a quantum computer to look back at things that we currently think are secure."

Amazon's New Quantum Computer Design Relies On Tiny Schrödinger's Cats
"If you look at the error rate gap in terms of where the hardware is now and where it needs to be to handle large-scale problems with known societal and commercial benefit, there's about a nine orders of magnitude gap," says Oskar Painter.

Ally explores fintech products using quantum computing with Microsoft
The two companies say that they'll apply research on quantum-inspired algorithms to understand ways they can be tapped to solve complex optimization challenges.

Atos Unveils Global R&D Lab for Cybersecurity, High Performance Computing and Quantum
The new 8,000 m2 lab, which hosts around 350 of Atos' highly qualified engineers, provides a modern space dedicated to research in quantum computing, high-performance computing, edge, artificial intelligence and cybersecurity.

Nvidia Launches cuQuantum; Dips a Toe in Quantum Computing

Nvidia reported it collaborated with Caltech to develop "a state-of-the-art quantum circuit simulator with cuQuantum running on NVIDIA A100 Tensor Core GPUs. It generated a sample from a full-circuit simulation of the Google Sycamore circuit in 9.3 minutes on Selene, a task that 18 months ago experts thought would take days using millions of CPU cores."

IonQ integrates platform with Qiskit quantum computing open source SDK

Qiskit users with an IonQ account can run quantum programs IonQ's platform with little modification. Zapata's quantum software platform Orquestra will integrate via a direct IonQ partnership as well as Qiskit.

Fraunhofer launches quantum computing research platform in Germany

In a joint project with IBM, the Fraunhofer-Gesellschaft will operate the quantum computer, installed in a center near Stuttgart, under German data protection law.

615 Million Euros Awarded to Quantum Delta NL for Quantum Research in the Netherlands

Quantum Delta NL is a cooperation of companies and research institutes in which the research has been organised in five hubs at the universities of Delft, Leiden, Amsterdam, Twente and Eindhoven.

Finnish Quantum Institute Announced

alto University, University of Helsinki and VTT Technical Research Centre of Finland have signed an agreement to collaborate on quantum science and technology, under the umbrella of InstituteQ: The Finnish Quantum Institute.

Nation's First Quantum Startup Accelerator, Duality, Launches at UChicago Polsky Center and the Chicago Quantum Exchange

Duality's purpose is to help quantum startups bridge the gap between the laboratory and the marketplace that is a critical barrier to success for emerging technologies. Led by the Polsky Center and the Chicago Quantum Exchange, Duality is also reinforced by founding partners, the University of Illinois Urbana-Champaign, Argonne National Laboratory and P33

Fujitsu takes on IBM in race for most powerful quantum computer

Japanese tech giant Fujitsu has announced a new initiative to build on top of Riken research institute's ongoing work with advanced super-conducting quantum computing technologies to create a 1000 qubits quantum computer within the next few years.

Could Quantum Computing Solve Maritime Complexities?

This is why ExxonMobil is working with IBM to address explore the role quantum computing can play in optimizing maritime and vehicle shipping routes, a complex optimization problem that can be applied across not only maritime, but other industries such as automotive and supply chain.

Honeywell says quantum computers will outpace standard verification in '18 to 24 months'
Honeywell expects that as advances in quantum computing continue to accelerate over the next 18 to 24 months, the ability to replicate the results of a quantum computing application workload using a conventional computing platform simulation will come to an end.

SOCOM wants to prioritize stronger communications encryption
"I personally changed our modernization priorities and restructured our funding to modernize those capabilities," SOCOM Commander Gen. Richard Clarke told the Senate Armed Services Committee during a hearing about the need for stronger encryption as quantum computing emerges as a threat to traditional security measures. [Hearing Video]

Japan's first leading-edge quantum computer to be installed this year
IBM Japan Ltd. announced on March 23 that the computer made by its U.S. parent IBM Corp. will be installed at Kawasaki Business Incubation Center (KBIC) in the city of Kawasaki, The University of Tokyo, which holds exclusive access rights, will seek to put the machine to practical tasks in cooperation with companies through a dedicated consortium.

Zapata and KAUST team up to accelerate fluid dynamics research using quantum computers
Using Orquestra, KAUST will focus primarily on Computational Fluid Dynamics (CFD) research, which has direct applications in airplane and automobile aerodynamic design.

Quantum Week 2021 Unveils the Latest in Quantum Computing and Engineering
The IEEE International Conference on Quantum Computing and Engineering (QCE 2021), 18 - 22 October 2021, is bridging the gap between the science of quantum computing and the development of an industry surrounding it.

PsiQuantum expects commercial quantum computer by 2025
"We're now at a point where we have solved the critical roadblocks on the path to building a quantum computer with a million qubits, the scale required for all known useful commercial applications," said Jeremy O'Brien, chief executive of PsiQuantum.

Canada Carves Out $40 Million for D-Wave in Quantum Investment Push
D-Wave will apply the funds toward the development of its next-generation system with a more powerful quantum processor that furthers the advantage of the quantum approach over classical computers. The funds will also help the Burnaby, British Columbia-based company boost access to its cloud-based service.

Quantum Computer Start-up IonQ Plans IPO via SPAC
IonQ "intends to file paperwork in about a week with the Securities and Exchange Commission to go public on the New York Stock Exchange through a special-purpose acquisition company deal valuing the combined

entity at about $2 billion. The deal will need approval from the SEC and SPAC shareholders.

Israel Allocates $60 Million to Build First Quantum Computer
The Ministry of Defense and Innovation Authority are taking bids from multinational companies, Israeli businesses and universities for a 198 million-shekel ($60 million) project to build a computer with 30 to 40 qubits.

TOPTICA Photonics Joins Project IQuAn to Build an Ion Quantum Processor for HPC
Partners from academia and industry, led by the University of Mainz, have started a collaborative research project with the ambitious goal to build a quantum computer, interface it with an existing supercomputer and also enable access to external users.

Honeywell Sets New Record For Quantum Computing Performance
Through performance upgrades, System Model H1 achieved a quantum volume of 512, the highest measured on a commercial quantum computer to date. It is the third time in nine months Honeywell has set a record for quantum volume on one of its systems.

bp joins the IBM Quantum Network to advance use of quantum computing in energy
bp will work with IBM to explore using quantum computing to solve business and engineering challenges and explore the potential applications for driving efficiencies and reducing carbon emissions.

AWS joins PennyLane, an open-source framework that melds machine learning with quantum computing
The PennyLane framework was created by a company called Xanadu Quantum Technologies Inc. It provides an interface to common machine learning libraries such as PyTorch and TensorFlow that are used to train machine learning models.

D-Wave demonstrates performance advantage in quantum simulation of exotic magnetism
"This work is the clearest evidence yet that quantum effects provide a computational advantage in D-Wave processors," said Dr. Andrew King, principal investigator for this work at D-Wave. [Nat Comms]

IQM Announces EU Consortium to Accelerate the Commercialization of Quantum Computing
The scope of the project is to accelerate commercialization through an innovative co-design concept. This project focuses on application-specific quantum processors, which have the potential to create a fastlane to quantum advantage.

Samsung is using quantum computing to research better batteries
The tech firm and Imperial College London researchers are using Honeywell's System Model H1 to explore uses of quantum computing in battery development. Ideally, the platform will tackle complex algorithms that might be too daunting for conventional computers.

NEC and ParityQC Collaborate to Develop Highly-scalable, Practical Quantum Computers

The collaboration entails NEC implementing the ParityQC Architecture, ParityQC's new paradigm on how to solve optimization problems on a quantum computer, into its own superconducting parametron quantum devices.

Bavarian State and Institutions Launch 'Munich Quantum Valley' to Develop Quantum Computing Technology

With Munich Quantum Valley as the central element of the Bavarian quantum initiative, the partner organizations aim to advance the development of quantum science and technology at both the national and international level over the next 10 years.

Quantum computing research helps IBM win top spot in patent race

IBM secured 9,130 US patents in 2020, more than any other company as measured by an annual ranking, and this year quantum computing showed up as part of Big Blue's research effort. Internationally, IBM ranked second to Samsung in patents for 2020.

JPM: Boehringer partners with Google to bring quantum computing to biopharma R&D

The three-year pharmaceutical project is the first of its type for Google's Quantum AI division, and will be co-led by a new Quantum Lab at Boehringer—forming one part of the company's digital transformation strategy alongside investments in machine learning and data science.

July 2021

5–9 Jul: (postponed 2022) International Conference on Quantum Communication, Measurement and Computing, Lisbon, Portugal

5–7 Jul: Platform for Advanced Scientific Computing, Geneva, Switzerland

5–9 Jul: Conference on the Theory of Quantum Computation, Communication, and Cryptography, Riga, Latvia

7–9 Jul: Conference on Reversible Computation, Nagoya, Japan

7–9 Jul: International Workshop on Quantum Computing: Circuits Systems Automation and Applications, Tampa, Florida

19–23 Jul: Supercomputing Frontiers Europe

22 Jul: Workshop on Quantum Internet and Networking, Athens, Greece

26–30 Jul: ACM Symposium on Principles of Distributed Computing, Salerno, Italy

August 2021

1–5 Aug: Conference on Computational Physics

2–7 Aug: International Congress on Mathematical Physics, Geneva, Switzerland

22–24 Aug: Hot Chips

23–27 Aug: QCrypt

September 2021

6–10 Sept: Summer School on Post-quantum Algebraic Cryptography, Cargèese, France

13–15 Sept: International Conference on Applications of Quantum Technologies

October 2021

6–8 Oct: International Conference on Integrated Quantum Photonics, Copenhagen, Denmark.

6–13 Oct: Quantum Control in Quantum Technologies, Obergurgl, Austria

18–20 Oct: Frontiers in Quantum Computing, University of Rhode Island, Kingston, Rhode Island

18–22 Oct: IEEE Quantum Week

November 2021

8–19 Nov: Scientific Quantum Computing Simulations on Near-term Devices

15 Nov: International Workshop on Quantum Computing Software

29 Nov–2 Dec: European Quantum Technology Conference, Dublin, Ireland

January 2022

3 Jan–25 Feb: Towards Classically Intractable Quantum Simulations of Physics and Chemistry, Santa Barbara, CA

July 2022

11–15 Jul: International Conference on Quantum Communication, Measurement and Computing, Lisbon, Portugal