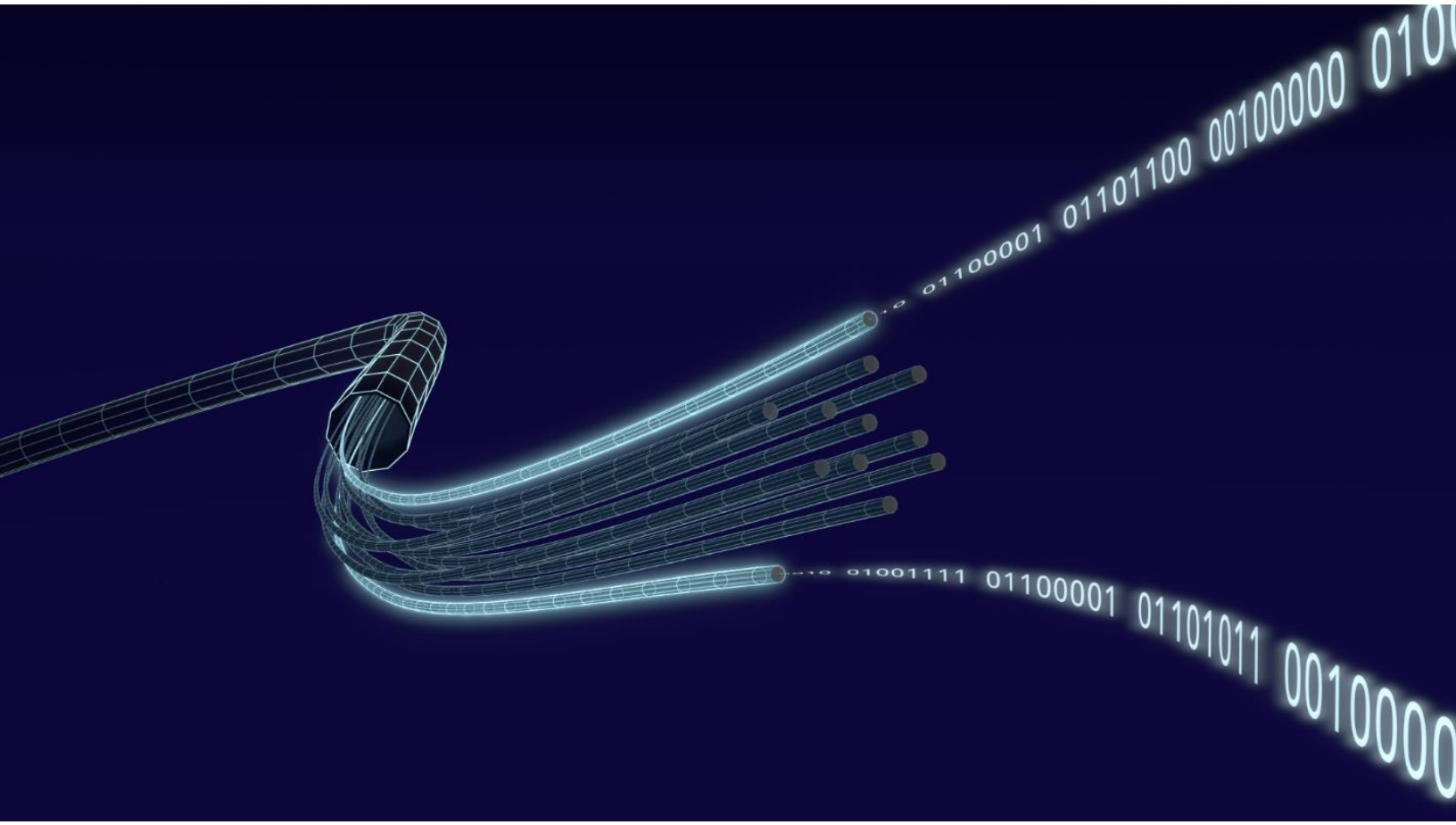

NATIONAL ACADEMIES
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Innovations in Quantum Sensing and Communications

A Virtual Unclassified Colloquium

October 5-6, 2022

11am -3pm ET

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About This Colloquium

Under the sponsorship of ODNI, Academies staff conduct semi-annual colloquia as part of an on-going series. Each colloquium covers a major topic of interest to the intelligence community and hosts leading experts from government, private industry, and academia to participate in presentations and panel discussions. The next decade promises a flurry of new advances in quantum sensing and communications that will change the scientific landscape on a fundamental level. The purpose of this unclassified colloquium is to collaborate with the academic world and private sector to identify emerging innovations at the edge of scientific development and address how they can inform future investments and developments by ODNI and the broader United States Government (USG). The sponsor for this colloquium is seeking novel research in the fields of quantum sensing and communications that will be available in the next three to seven years for its office to invest in to maintain strategic and competitive advantages in the intelligence domain.

The goal of the colloquium is to establish ties between these multidisciplinary working groups and the larger USG that may otherwise be overlooked. The format for this colloquium will be two half-day sessions where experts can outline the state of future quantum sensing and communications research and how these novel developments can enable future ODNI activities. Colloquium members will make short presentations on these on-the-horizon technologies and dedicate much of the time to discussion on how to leverage these technologies for the USG.

This event is part of an ongoing colloquium series organized by the Intelligence Community Studies Board of the National Academy of Sciences, Engineering, and Medicine and is sponsored by the Office of the Director of National Intelligence.

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About The Intelligence Community Studies Board

The National Academies of Sciences, Engineering and Medicine have been called upon by government agencies and the U.S. Congress to provide objective, science-based advice on important issues affecting the nation for more than 150 years. The U.S. military turns to us for independent advice on topics related to research, development, and application of science and technology in support of military matters. We provide a level of independence, quality, and visibility that cannot be matched by other scientific advisory boards. Our board members are widely recognized industry, academic, and former military experts that serve without compensation and are formally appointed by the President of the National Academy of Sciences.

The Intelligence Community Studies Board (ICSB) provides both classified and unclassified forums to convene leading technical and intelligence experts to evaluate scientific and technology approaches to facilitate threat-informed acquisition decisions.

For more information on the ICSB including our projects and member biographies please visit our website at [www.nationalacademies.org/ICSB.](www.nationalacademies.org/ICSB)

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Innovations in Quantum Sensing and Communications: Day One

October 5, 2022
11:00 AM – 3:00 PM ET

11:00 – 11:05	**Introduction and Administrative Announcements** Nia Johnson | ICSB Program Officer
11:05 – 11:15	**Welcome Remarks** Dr. Michael Marletta | ICSB Committee Co-Chair
11:15 – 11:45	**Keynote** Charles Tahan | National Quantum Coordination Office
11:45 – 12:30	**Quantum Signal Processing** Dr. Isaac Chuang | MIT
12:30 – 01:15	**Quantum Simulation on Parallel Quantum Computers** Dr. Nathan Wiebe | University of Washington
01:15 – 01:30	**Break**
01:30 – 2:15	**Controllable Quantum Systems for Simulations, Networking and Sensing** Dr. Mikhail Lukin | Harvard University
02:15 – 03:00	**Panel Discussion**
03:00	**Adjourn**

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Innovations in Quantum Sensing and Communications: Day Two

October 6, 2022
11:00 AM – 3:00 PM ET

11:00-11:15	**Welcome Remarks and Recap of Previous Day** Dr. Michael Marletta | ICSB Chair
11:15 – 12:00	**A Novel T^3 Atom Interferometer** Dr. Frank Narducci | Naval Postgraduate School
12:00 – 12:45	**Rydberg Atom Sensors: Transforming Communication Receivers and the Detection RF Signals** Dr. Christopher L. Holloway | NIST
12:45 – 01:00	**Break**
01:00 – 01:45	**The Missing Link: Connecting Quantum Computers** Dr. Paul Kassebaum | SandboxAQ
01:45 – 02:30	**Towards Modular Superconducting Quantum Computers** Dr. Jason Orcutt | IBM
02:30-03:00	**Discussion**
03:00	**Adjourn**

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Meeting Information

Zoom Meeting Sign-on & Q&A Processes, Etiquette and Tips

Meeting Moderators:

- Day One: Gabrielle Risica, CSTB, NASEM
- Day Two: Linda Nhon, BCST, NASEM

Sign On Processes:

- Dial in 10 minutes before the meeting starts to confirm connectivity.
- Type in your full name, not just your email address in participant window.
- At start time, all participants will be muted except the speaker.
- Moderator will take roll 5 minutes before the meeting start.

Q&A Process:

- Participants 'raise hand' and moderator will call on participant for clarifying questions related to immediate slide, topic, or question from a participant.
- Longer-form questions to be held until Q&A session following the presentation.
    - If possible, please write the question in the chat box so all participants can see it.

For every session:

- Questions will be first come, first served.
- Moderator reserves right to move questions to front if it is relevant to the discussion at hand.
- Moderator will ensure as many participants have a chance to ask questions as possible.
    - Moderator will call on those who haven't asked questions before returning to a participants' second/third questions per session.
- Moderator will have control over time limits and microphones.

During the Q&A portion:

- If your question has already been answered, please note in the chat box to disregard.
- Once each question has been answered, the session will open to comments.
    - Use the 'hand raise' to comment via microphone to the group.
    - Moderator will do their best to call on raised hands in the order they were received.

Videoconference Etiquette Tips:

- Arrive early
- Know how to use the meeting technology
- Avoid bandwidth consuming activities such as streaming during conference
- Sit up and keep your microphone close
- Speakers should use web camera if available; all attendees are encouraged to use web cameras as well for a more interactive experience.

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Meeting Information

- Limit background noise (please mute phone or computer notifications)
    - We know many are at home; do the best you can!
    - Mute microphone when not speaking
- Identify yourself
- Avoid multitasking
- Speak clearly
- Be polite
- Make your presence known
- Keep questions short and on-topic

Zoom Shortcuts:

M is for mute. Press Cmd+Ctrl+M (macOS) or Alt+M (Windows) when you are the meeting host and want to mute everyone else on the line.

S is for share. Press Cmd+Shift+S (macOS) or Alt+Shift+S (Windows) to share your screen.

Additional Notes:

Breaks – We will have scheduled breaks, but feel free to step out just as you would normally in a meeting. Take a quick call, use the restroom, stretch your legs; no problems, and no need to apologize.

System Crash – we hope this will not be an issue but if the meeting crashes we will send an email to the committee and attendees detailing our plan moving forward.

Resources:

https://www.conferencecalling.com/blog/run-conference-call-question-and-answer-sessions

https://www.sae.org/binaries/content/assets/cm/content/standards/virtual-meetings-best-practice-guide.pdf

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Speaker Bios

Dr. Michael Marletta

ICSB Committee Co-Chair

Dr. Michael Marletta (NAS/NAM) is professor of chemistry, professor of molecular and cell biology, and the CH and Annie Li Chair in the Molecular Biology of Diseases at the University of California, Berkeley (UCB). After an A.B. degree in biology and chemistry from SUNY Fredonia in 1973, he received a Ph.D. in 1978 from University of California, San Francisco (UCSF) followed by a two year postdoctoral appointment at the Massachusetts Institute of Technology (MIT). In 1980, Dr. Marletta joined the faculty at MIT as an assistant professor in the Department of Applied Biological Sciences and was promoted to associate professor in 1986. In 1987, he moved to the University of Michigan as associate professor of medicinal chemistry in the College of Pharmacy and in 1989 associate professor of biological chemistry in the Medical School. In 1991, he was promoted to professor and was appointed as the John G. Searle Professor of Medicinal Chemistry. In 1997, he became an investigator in the Howard Hughes Medical Institute. Dr. Marletta moved to UCB in 2001 where he assumed the positions of professor of chemistry, Department of Chemistry and professor of biochemistry and molecular biology, Department of Molecular and Cell Biology. He was appointed the Aldo DeBenedictis Distinguished Professor of Chemistry in 2002. He served as chair of the Department of Chemistry at UCB from 2005-2010. In July 2011, he joined the faculty of the Scripps Research Institute and was named president-elect. He assumed the presidency in January 2012 to 2014. In 2015 he returned to Berkeley with appointments in the department of chemistry and molecular and cell biology.

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Speaker Bios

Keynote Speaker: Charles Tahan

Director of the National Quantum Coordination Office, White House Office of Science and Technology

Dr. Charles Tahan is the Assistant Director for Quantum Information Science (QIS) and the Director of the National Quantum Coordination Office (NQCO) within the White House Office of Science and Technology Policy. The NQCO ensures coordination of the National Quantum Initiative (NQI) and QIS activities across the federal government, industry, and academia.

Dr. Tahan is on detail from the Laboratory for Physical Sciences where he drove technical progress in the future of information technology as Technical Director. Research at LPS spans computing, communications, and sensing, from novel device physics to high-performance computer architectures. As a technical lead, Dr. Tahan stood up new research initiatives in silicon and superconducting quantum computing; quantum characterization, verification, and validation; and new and emerging qubit science and technology. As a practicing physicist, he is Chief of the intramural QIS research programs at LPS and works with students and postdocs from the University of Maryland-College Park to conduct original research in quantum information and device theory. His contributions have been recognized by the Researcher of the Year Award, the Presidential Early Career Award for Scientists and Engineers, election as a Fellow of the American Physical Society, and as an ODNI Science and Technology Fellow. He continues to serve as Chief Scientist of LPS and Chief, Quantum Information Science.

Dr. Tahan earned a PhD in Physics at the University of Wisconsin-Madison in 2005 and a B.Sc. in Physics and Computer Science with Highest Honors from the College of William & Mary in 2000. From 2005-2007 he was a National Science Foundation Distinguished International Postdoctoral Research Fellow at the University of Cambridge, UK; the Center for Quantum Computing Technology, Australia; and the University of Tokyo, Japan. He served as chief technical consultant for quantum information science and technology programs in DARPA's Microsystems Technology Office (MTO) while at Booz Allen Hamilton from 2007-2009. He has a long-term commitment to science and society including creating one of the first games meant to build intuition about quantum computing.

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Speaker Bios

Dr. Isaac Chuang

Massachusetts Institute of Technology

Prof. Chuang is a pioneer in the field of quantum information science. His experimental realization of two, three, five, and seven quantum bit quantum computers using nuclear spins in molecules provided the first laboratory demonstrations of many important quantum algorithms, including Shor's quantum factoring algorithm. The error correction, algorithmic cooling, and entanglement manipulation techniques he developed provide new ways to obtain complete quantum control over light and matter, and lay a foundation for possible large-scale quantum information processing systems.

Prof. Chuang came to MIT in 2000 from IBM, where he was a research staff member. He received his doctorate in Electrical Engineering from Stanford University, where he was a Hertz Foundation Fellow. Prof. Chuang also holds two bachelors and one masters degrees in Physics and Electrical Engineering from MIT, and was a post-doctoral fellow at Los Alamos National Laboratory and the University of California at Berkeley. He is the author, together with Michael Nielsen, of the textbook Quantum Computation and Quantum Information.

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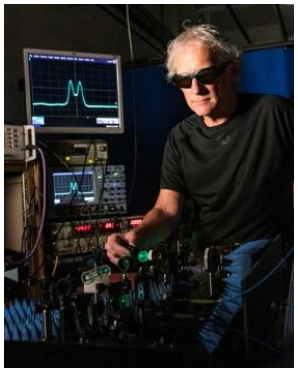
Speaker Bios



Dr. Chris Holloway

National Institute of Standards and Technology

Since 2000 Dr. Holloway has been with the National Institute of Standards and Technology (NIST), Boulder, CO, where he works on electromagnetic theory. He is also on the Graduate Faculty at the University of Colorado at Boulder. Dr. Holloway was awarded the 1999 Department of Commerce Silver Medal for his work in electromagnetic theory and the 1998 Department of Commerce Bronze Medal for his work on printed circuit boards.

His research interests include electromagnetic field theory, wave propagation, guided wave structures, remote sensing, numerical methods, and EMC/EMI issues. Dr. Holloway is a member of Commission A of the International Union of Radio Science and is an Associate Editor for the IEEE Transactions on Electromagnetic Compatibility. Dr. Holloway is the chairman for the Technical Committee on Computational Electromagnetic (TC-9) of the IEEE Electromagnetic Compatibility Society.

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Speaker Bios

Dr. Paul Kassebaum

SandboxAQ

Dr. Paul Kassebaum is a physicist who has helped companies make audiences aware of, interested in, understand how to use, and make an impact with quantum technologies. He is currently the Technical Director of Public Sector at SandboxAQ. He has previously worked at IBM Quantum, where he managed partnerships with global system integrator companies (e.g., Deloitte, Capgemini); and at MathWorks, where he managed partnerships with Big Science projects (e.g., LIGO, SLAC). He holds a B.Eng. from the Cooper Union and a Ph.D. in physics from WPI.

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Speaker Bios

Dr. Mikhail Lukin

Harvard University

Mikhail Lukin received the Ph.D. degree from Texas A&M University in 1998. He has been on a faculty of Harvard Physics Department since 2001, where he is currently George Vasmer Leverett Professor of Physics, and a co-Director of Harvard-MIT Center for Ultracold Atoms and of Harvard Quantum Initiative in Science and Engineering. His research interests include quantum optics, quantum control of atomic and nanoscale solid-state systems, quantum metrology, nanophotonics, and quantum information science.

He has co-authored over 400 technical papers and has received a number of awards, including the Alfred P. Sloan Fellowship, David and Lucile Packard Fellowship for Science and Engineering, NSF Career Award, Adolph Lomb Medal of the Optical Society of America, AAAS Newcomb Cleveland Prize, APS I.I.Rabi Prize, Vannevar Bush Faculty Fellowship, Julius Springer Prize for Applied Physics, Willis E. Lamb Award for Laser Science and Quantum Optics, Charles Hard Townes Medal, and the Norman F. Ramsey Prize. He is a fellow of the OSA, APS, and AAAS and a member of the National Academy of Sciences.

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Speaker Bios

Dr. Francesco Narducci

Naval Postgraduate School

Prof. Narducci graduated with top honors in both physics and math from Drexel University in Philadelphia, Pa in 1989. He then went to the University of Rochester to earn a Master of Arts in 1991 and a Ph.D. in 1996. The late Prof. Leonard Mandel supervised his Ph.D. dissertation, entitled Photon correlations in single and multi-atoms systems.

Upon completion of his degree, he joined the Naval Air Systems Command as a staff physicist establishing his own research team to investigate effects in various atomic systems, including cold atom and warm cells. He served as a program manager for the Office of Naval Research from 2000-2003. He was elected a NavAir Associate Fellow in 2006 and a full NavAir Fellow in 2012. He won the Dolores Etter Award for Top Navy Scientist (Individual) in 2013 and become the Senior Science and Technology Manager: Position, Navigation and TimeKeeping. He joined the faculty of the Naval Postgraduate School in July 2017 and is now Professor of Physics. He continues his research while teaching.

Also, "on the side", he has served as Associate Editor for Physical Review A (currently the longest serving editor) and Associate Editor for Physical Review Letters. He has also guest edited a special issue of the Journal of Modern Optics for the last 10 or so years devoted to the Proceedings of the Conference of The Physics of Quantum Electronics.

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Speaker Bios

Dr. Jason Orcutt

IBM Quantum

Dr. Jason Orcutt is a Research Staff Member in the Experimental Quantum Computing department at IBM's Thomas J. Watson Research Center. Presently, Jason manages the Optics for Quantum Scalability research group and is the primary investigator for IBM team working on the Army Research Office / Laboratory for Physical Sciences (ARO/LPS) Cross Quantum Technology Systems (CQTS) program.

Jason received a B.S. in Electrical Engineering from Columbia University in 2005 and his M.S. and Ph.D. degrees in Electrical Engineering and Computer Science from MIT in 2008 and 2012 respectively. His graduate work at MIT was partially funded by a Graduate Research Fellowship from the National Science Foundation (2005-2008). Before joining IBM, he worked as a research scientist at MIT on DARPA's Photonically Optimized Embedded Microprocessors (POEM) program in collaboration with Micron Technology, University of California Berkeley and University of Colorado Boulder. This work lead to the demonstration of the first microprocessor that utilized integrated optical links for core-to-memory computation.

Since joining IBM Research in 2013, Jason has led and contributed to a variety of projects related to integrated photonics, data communication, sensing, and quantum computing. Starting in transitioning the monolithic silicon photonics platform developed in IBM Research to manufacturing at GLOBALFOUNDRIES, Jason led photodiode development, receiver design & WDM transceiver demonstrations. Under the ARPA-E AIMS program aimed at reducing fugitive methane emissions through low SWaP spectroscopic sensors, Jason led external cavity laser efforts, prototype layout and process integration. Leading the successful proposal to the ARO/LPS CQTS program, Jason proposed the SiGe/Si microwave-optical transduction.

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Speaker Bios

Dr. Nathan Wiebe

University of Washington

Nathan Wiebe is a researcher in quantum computing who focuses on quantum methods for machine learning and simulation of physical systems. His work has provided the first quantum algorithms for deep learning, least squares fitting, quantum simulations using linear-combinations of unitaries, quantum Hamiltonian learning, near-optimal simulation of time-dependent physical systems, efficient Bayesian phase estimation and also has pioneered the use of particle filters for characterizing quantum devices as well as many other contributions ranging from the foundations of thermodynamics to adiabatic quantum computing and quantum chemistry simulation.

He received his PhD in 2011 from the university of Calgary studying quantum computing before accepting a post-doctoral fellowship at the University of Waterloo and then finally joining Microsoft Research in 2013. In 2019 he left Microsoft to accept a joint appointment at the university of Washington and Pacific Northwest National Labs.

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