Our Quantum Opportunity

Reimagine what's possible

Joe Vetere
Senior Staff Quantum Engineer
Oak Ridge National Laboratory
05/29/2025

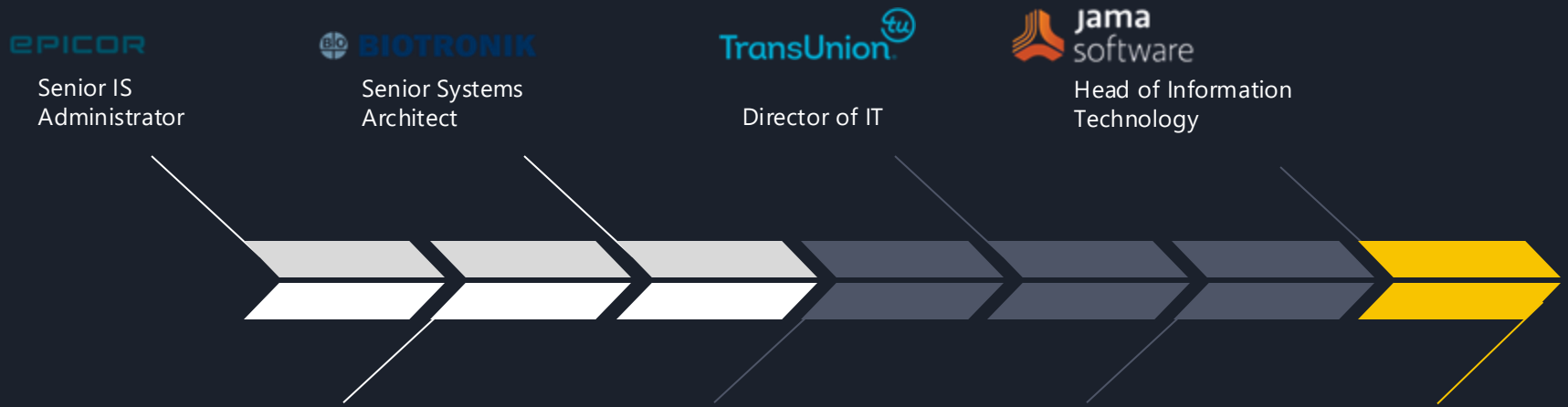
Overview

01 It's not just for physicists

02 It's a new frontier

03 We need pioneers

Journey


EPICOR
Senior IS Administrator
BIOTRONIK
Senior Systems Architect
TransUnion
Director of IT
jama software
Head of Information Technology
Pratt & Whitney
An RTX Business
IT Manager
AIRSHIP
Director of Information Technology
STUMPTOWN
Senior Director Technology & eComm
OAK RIDGE
National Laboratory
Senior Staff Quantum Engineer

Growth

Education & Certifications

BS Computer Science & Network Engineering
MS Electrical & Computer Engineering
PhD Electrical & Computer Engineering*
Applied Physics*
Semiconductor Manufacturing, Processing and Devices
Large-Scale Universal Quantum Computation
Fabless Design of Photonic Integrated Circuits

Programs & Projects

NASA Fundamental Physics Advisory Group
DARPA Underexplored Systems for Utility-Scale Quantum Computing
DARPA Quantum Benchmarking Initiative
GridQ Quantum Energy Grid

Bridging Expertise

Quantum Domain

AMO Physics
Charged Particle Accelerators
Deep/Machine Learning
Electromagnetic Wave Dynamics & Processing
Energy & Lattice Dynamics
Evolutionary Computation
Optimization Algorithms
Quantum Computing Architecture
Quantum Device & Materials Engineering
Cirq, PennyLane, Qiskit, QuTiP
Ansys Lumerical

Technical Proficiencies

Ansible
Atlassian
Amazon Web Services
AWS Lambda
AWS RDS
Microsoft Azure
C++
Chef
DataDog
Docker
Git
Google Cloud Platform
Grafana
Jenkins
Javascript
Kubernetes
Mathematica
MatLab
Okta
PagerDuty
Postgres
Python
PyTorch/TensorFlow
Scientific Python Ecosystem
SNS/SQS
Splunk
TensorFlow Quantum
Terraform

The Phenomena Powering Tomorrow's Systems

Superposition

The system exists in all possible states simultaneously until measured.

Entanglement

Linked particles affect each other, instantly, regardless of distance.

Tunnelling

Particles can pass through barriers forbidden by classical physics.

Quantum Probability

These systems operate on a spectrum of probabilities, not certainties

Superposition

The system exists in all possible states simultaneously until measured.

State Superposition and Decoherence. “Physics Reimagined” of the Fondation Paris-Sud supported by Air Liquide: https://toutestquantique.fr/en/superposition/

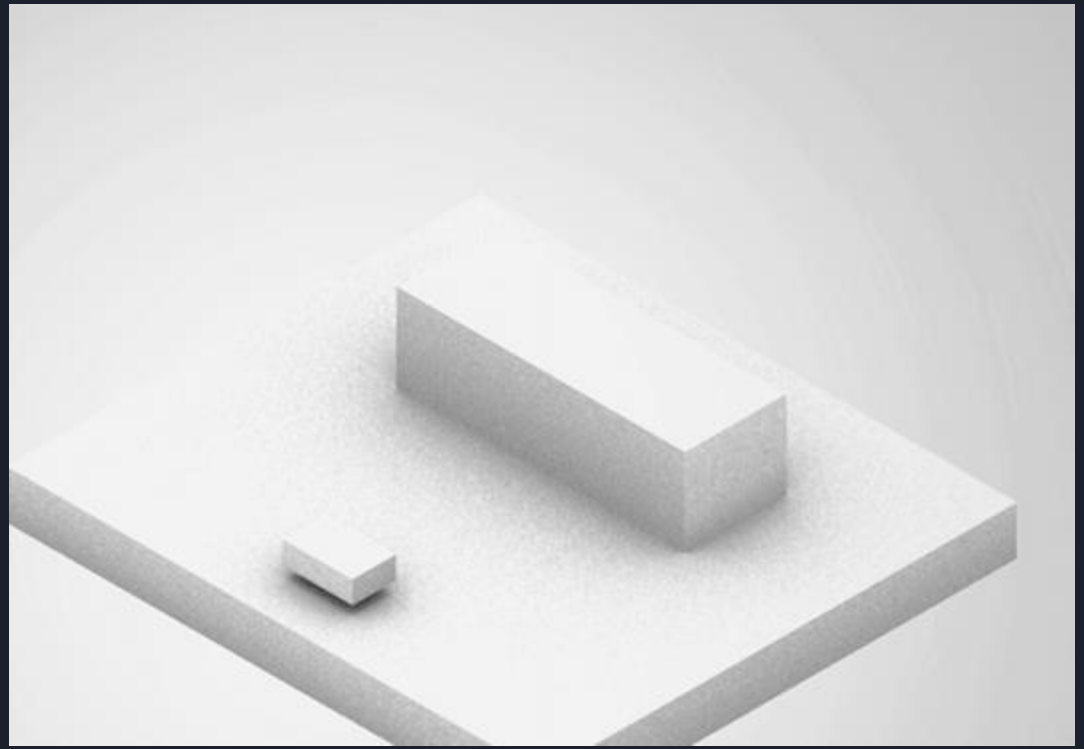
Entanglement

Linked particles affect each other, instantly, regardless of distance.

Quantum Entanglement - Instant Connection Across Space. Skill Sphere: https://www.youtube.com/shorts/jcC83EzTPCY

Tunnelling

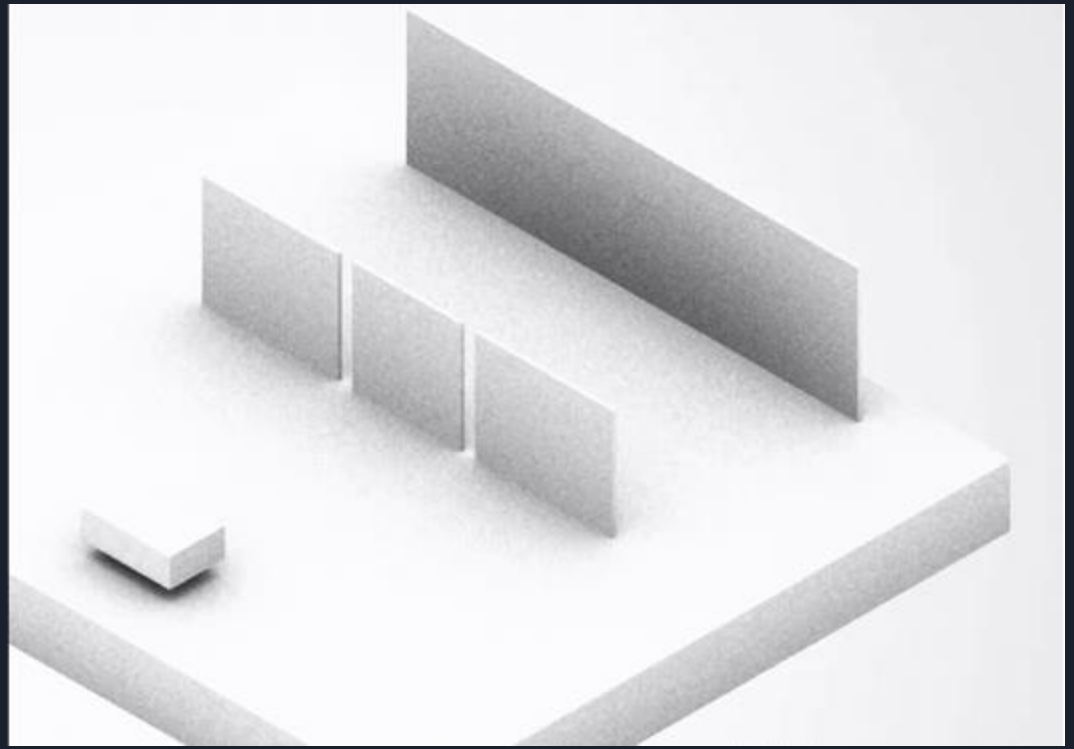
Particles can pass through barriers forbidden by classical physics.



The Tunnel Effect. “Physics Reimagined” of the Fondation Paris-Sud supported by Air Liquide: https://toutestquantique.fr/en/tunnel-effect/

Quantum Probability

These systems operate on a spectrum of probabilities, not certainties.

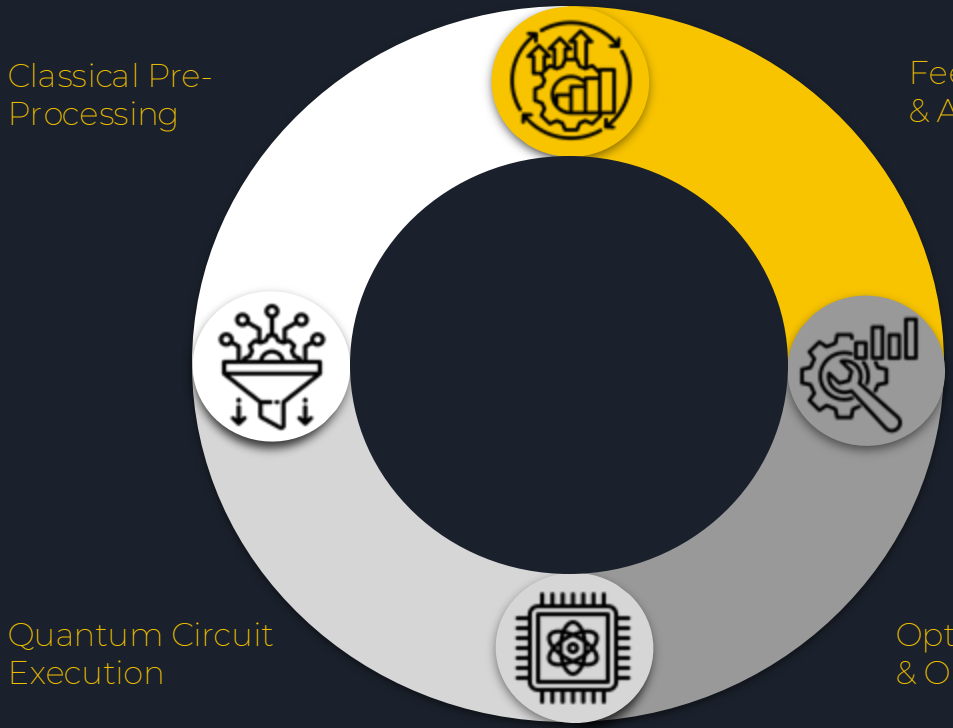


Wave Particle Duality. "Physics Reimagined" of the Fondation Paris-Sud supported by Air Liquide: https://toutestquantique.fr/en/duality/

A New Frontier
Hybrid Quantum - Classical Workflows

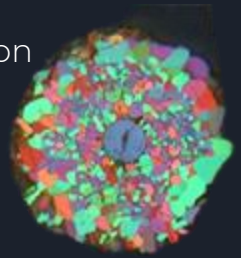
Why Hybrid Matters

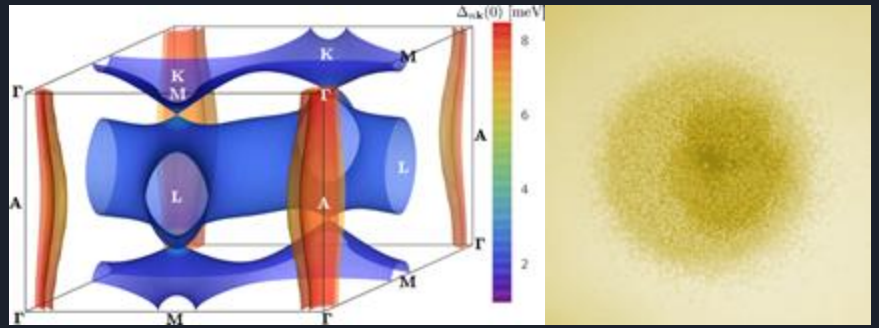
- Quantum ≠ standalone replacement for classical systems
- Hybrid workflows play to each system's strengths
- Most near-term wins will come from collaboration, not separation
- This is where engineers, system architects, and classical experts can lead



Engineering New Materials With HPC + Quantum

Hybrid Quantum-Classical Simulation is enabling smarter design and engineering of low power and highly efficient semiconductors & superconductors





Hybrid Quantum-Classical

Model electron interactions at grain boundaries and defects

Classical HPC Systems

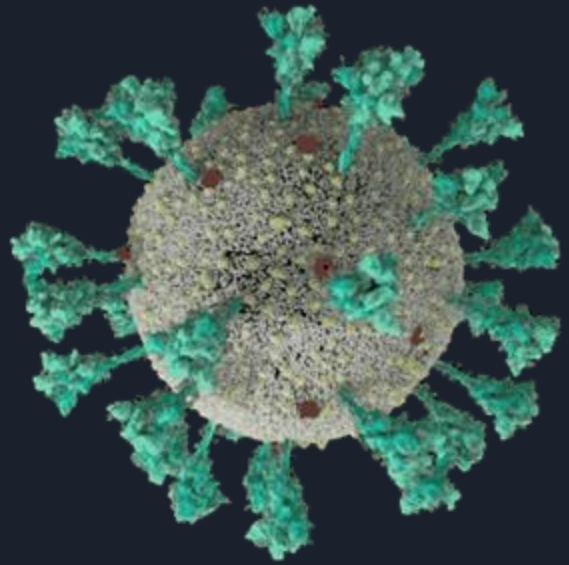
Simulate thermal, mechanical and system-level behavior

Machine Learning Models

Generalize across fabrication tolerances and material variants

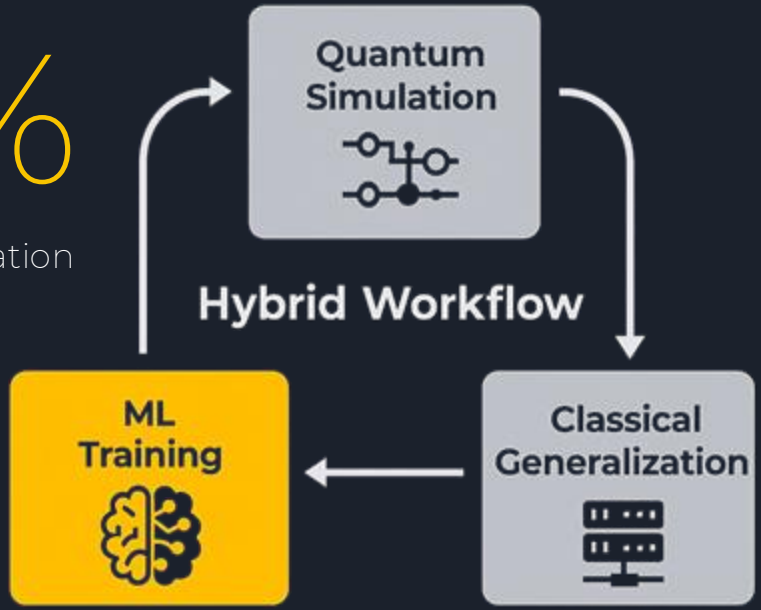
How Quantum Computers Are Transforming Materials Science. The Quantum Zeitgeist, Ivy Delaney, August 30, 2024: https://quantumzeitgeist.com/how-quantum-computers-are-transforming-materials-science/
Bohmian Trajectories as the Foundation of Quantum Mechanics. S Goldstein, R Tumulka, N Zanghi Quantum trajectories, 2011: https://arxiv.org/pdf/0912.2666v1
The Pilot-Wave Perspective on Quantum Scattering and Tunneling http://arxiv.org/abs/1210.7265v2
A Quantum Potential Description of One-Dimensional Time-Dependent Scattering: From Square Barriers and Square Wells Dewdney, Foundations of Physics, Vol. 12, No. 1, 1982: https://link.springer.com/article/10.1007/BF00726873
A Better Way to Picture Atoms. Minute Physics: https://www.youtube.com/watch?v=W2Xb2GFK2yc&t=135s

Accelerating Molecular Discovery With HPC + Quantum



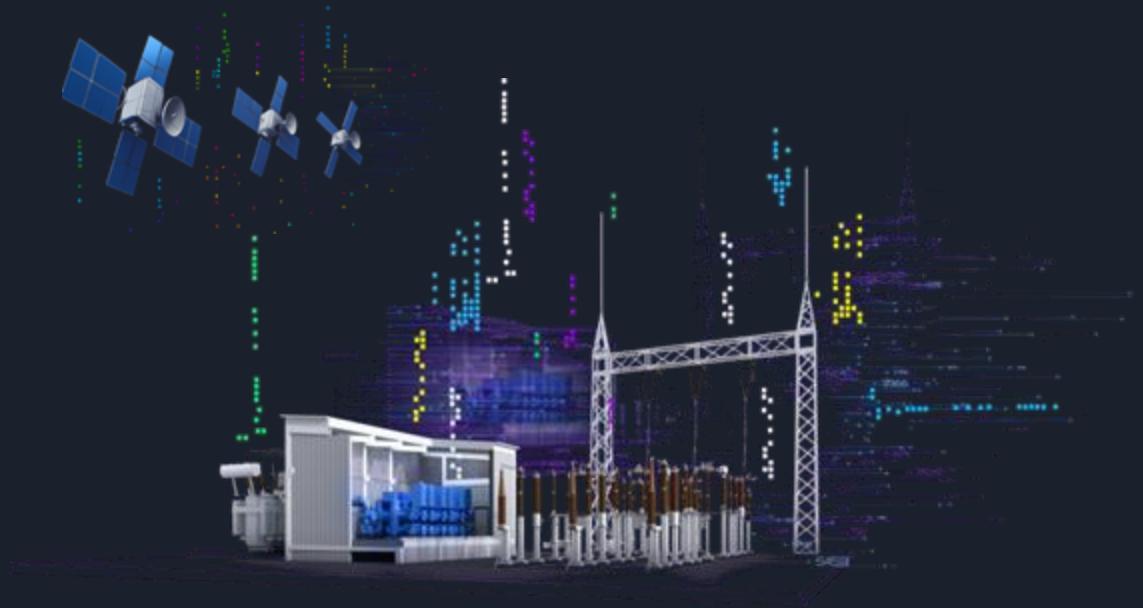
70%

Reduction Simulation Time



Building a Visual Consensus Model of the SARS-COV-2 Life Cycle. Coronavirus Structural Task Force, National Science Foundation, the German Federal Ministry of Education and Research and the University of Utah's 1U4U Initiative: https://animationlab.utah.edu/cova
The AlphaFold Protein Structure Database. European Molecular Biology Laboratory: https://alphafold.ebi.ac.uk/
Quantum-computing-enhanced algorithm unveils potential KRAS inhibitors. Ghazi Vakili, M., Gorgulla, C., Snider, J., *et al*., Quantum-Accelerated Drug Discovery, Nature Biotech, 2024: https://www.nature.com/articles/s41587-024-02526-3
Folding Energy Landscapes with Hybrid Architectures. Anouar Benali, Thomas Plé, Olivier Adjoua, et al : https://arxiv.org/pdf/2504.07948

Optimizing Complexity:
HPC + Quantum in Logistics & Energy



Energy Grid

- Load Forecasting
- Fault Detection
- Real-time Optimization
- Unit Commitment
- National Cybersecurity

Satellite Operations

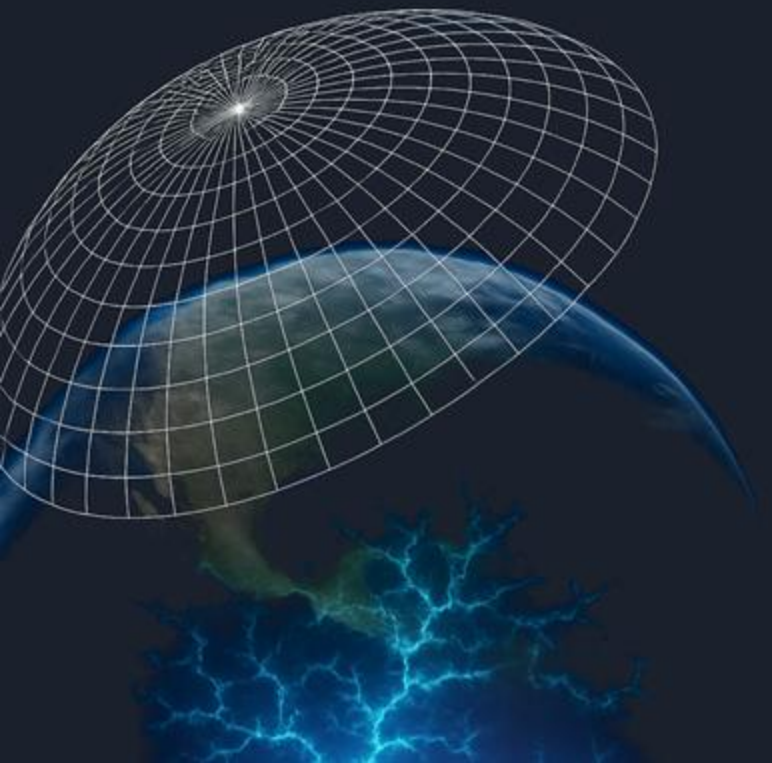
- Scheduling
- Resource Estimation
- Imaging
- Securing Next-Gen Communications

Hybrid Quantum Approach Could Help Astronauts On Deep Space Missions. The Quantum Insider, Matt Swayne, February 27, 2025: https://thequantuminsider.com/2025/02/27/hybrid-quantum-approach-could-help-astronauts-on-deep-space-missions/

IonQ and Oak Ridge National Laboratory Unveil Novel Approach to Scalable Quantum Computing. IonQ, College Park, MD, December 23, 2024: https://ionq.com/news/ionq-and-oak-ridge-national-laboratory-unveil-novel-approach-to-scalable https://toutestquantique.fr/en/duality/

Quantum Optimization for the Future Energy Grid: Summary and Quantum Utility Prospects. Jonas Blenninger, David Bucher, Giorgio Cortiana, et al., March 26, 2024: https://arxiv.org/abs/2403.17495

Materials & Climate Models
Simulating Nature at Nature's Scale



Quantum Accelerated PDE Solvers

Speed-up of Navier–Stokes (motion of viscous fluid substances) on hybrid systems. Useful for chaotic flows.

Parameterization of Intractable Earth Systems Models

Nonlinear convective parameterization of cloud formation, turbulence, and convection.

4D Variational Methods and Data Assimilation

Reduce complexity of four-dimensional variational method that optimizes initial conditions based on both past data and model physics.

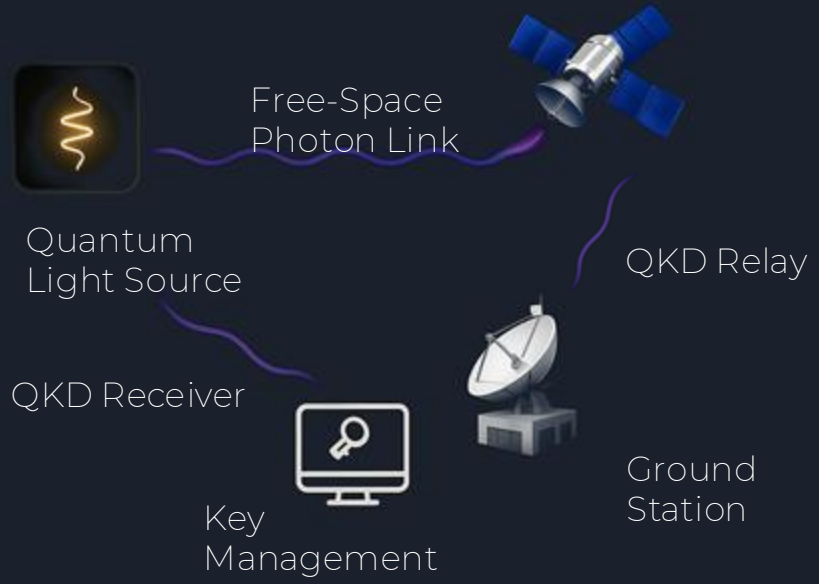
Variational Quantum Linear Solver. Carlos Bravo-Prieto, Ryan LaRose, M. Cerezo, et al., September 12, 2019: https://arxiv.org/abs/1909.05820

BEyond observation: an approach for ObjectNav. Daniel V. Ruiz, Eduardo Todt, June 21, 2021: https://arxiv.org/abs/2106.11379

Hybrid Quantum-Classical Machine Learning for Near Real-time Space to Ground Communication of ISS Lightning Imaging Sensor Data. Samih Fadli, Bharat S Rawal, 2023 IEEE 13th Annual Computing and Communication Workshop and Conference (CCWC), March 8, 2023: https://ieeexplore.ieee.org/abstract/document/10099338

Quanv4EO: Empowering Earth Observation by means of Quanvolutional Neural Networks. Alessandro Sebastianelli, Francesco Mauro Giulia Ciabatti, et al., Submitted to IEEE Transactions on Geoscience and Remote Sensing, July 24, 2024: https://arxiv.org/abs/2407.17108

Next Generation Communications and Encryption for Surface, Orbit and Beyond



Zeilinger Experiment

Satellite-to-Ground QKD

Lunar Gateway Communications

Global Commercial Momentum

Record-breaking 12,900 km Ultra-Secure Quantum Satellite Link. Stellenbosch University, ScienceDaily, 19 March 2025: www.sciencedaily.com/releases/2025/03/250319142833.htm

The Deep Space Quantum Link Prospective Fundamental Physics Experiments Using Long-baseline Quantum Optics. Makan Mohageg, Luca Mazzarella, Charis Anastopoulos, et al., EPJ Quantum Technology 9, October 8, 2022: https://epjquantumtechnology.springeropen.com/articles/10.1140/epjqt/s40507-022-00143-0

Honeywell Partners With European Space Agency To Protect Sensitive Information Transmitted By Satellite. Ahjay Rai, October 2, 2024: https://aerospace.honeywell.com/us/en/about-us/press-release/2024/10/honeywell-partners-with-european-space-agency-to-protect-sensitive-information-transmitted-by-satellite

Get Involved in the Quantum Ecosystem

R&D + Materials Teams

Partner on Hybrid Simulation Pipelines

Security + Infra Teams

Evaluate Quantum Resistant Protocols

AI/ML + Modelling Teams

Explore Quantum Enhancements

Strategy Leaders

Consortia & Startup Partnerships

Thank you!

The future unfolds in the systems we design today.

Let’s lead the transition together. Whether you're building infrastructure, solving at scale, or redefining what's computationally possible; your expertise has a role in shaping the quantum era.

Questions? Thoughts? Paradoxes?

Let’s talk. I’m always happy to connect, collaborate, or continue the conversation.

Joe Vetere


Phoenix, AZ


joe@vetere.us


845.401.0449


in/joe-vetere-56777a2/


the-Joe

References

- State Superposition and Decoherence. “Physics Reimagined” of the Fondation Paris-Sud supported by Air Liquide: https://toutestquantique.fr/en/superposition/
- Quantum Entanglement - Instant Connection Across Space. Skill Sphere: https://www.youtube.com/shorts/jcC83EzTPCY
- The Tunnel Effect. “Physics Reimagined” of the Fondation Paris-Sud supported by Air Liquide: https://toutestquantique.fr/en/tunnel-effect/
- Wave Particle Duality. “Physics Reimagined” of the Fondation Paris-Sud supported by Air Liquide: https://toutestquantique.fr/en/duality/
- How Quantum Computers Are Transforming Materials Science. The Quantum Zeitgeist, Ivy Delaney, August 30, 2024: https://quantumzeitgeist.com/how-quantum-computers-are-transforming-materials-science/
- Bohmian Trajectories as the Foundation of Quantum Mechanics. S Goldstein, R Tumulka, N Zanghì Quantum trajectories, 2011: https://arxiv.org/pdf/0912.2666v1
- The Pilot-Wave Perspective on Quantum Scattering and Tunneling: http://arxiv.org/abs/1210.7265v2
- A Quantum Potential Description of One-Dimensional Time-Dependent Scattering: From Square Barriers and Square Wells Dewdney, Foundations of Physics, Vol. 12, No. 1, 1982: https://link.springer.com/article/10.1007/BF00726873
- A Better Way to Picture Atoms. Minute Physics: https://www.youtube.com/watch?v=W2Xb2GFK2vc&t=135s
- Building a Visual Consensus Model of the SARS-COV-2 Life Cycle. Coronavirus Structural Task Force, National Science Foundation, the German Federal Ministry of Education and Research and the University of Utah's 1U4U Initiative: https://animationlab.utah.edu/cova
- The AlphaFold Protein Structure Database. European Molecular Biology Laboratory: https://alphafold.ebi.ac.uk/
- Quantum-computing-enhanced algorithm unveils potential KRAS inhibitors. Ghazi Vakili, M., Gorgulla, C., Snider, J. *et al*., Quantum-Accelerated Drug Discovery, Nature Biotech, 2024: https://www.nature.com/articles/s41587-024-02526-3
- Folding Energy Landscapes with Hybrid Architectures. Anouar Benali, Thomas Plé, Olivier Adjoua, et al.: https://arxiv.org/pdf/2504.07948
- Hybrid Quantum Approach Could Help Astronauts On Deep Space Missions. The Quantum Insider, Matt Swayne, February 27, 2025: https://thequantuminsider.com/2025/02/27/hybrid-quantum-approach-could-help-astronauts-on-deep-space-missions/
- IonQ and Oak Ridge National Laboratory Unveil Novel Approach to Scalable Quantum Computing. IonQ, College Park, MD, December 23, 2024: https://ionq.com/news/ionq-and-oak-ridge-national-laboratory-unveil-novel-approach-to-scalable https://toutestquantique.fr/en/duality/
- Quantum Optimization for the Future Energy Grid: Summary and Quantum Utility Prospects. Jonas Blenninger, David Bucher, Giorgio Cortiana, et al., March 26, 2024: https://arxiv.org/abs/2403.17495
- Variational Quantum Linear Solver. Carlos Bravo-Prieto, Ryan LaRose, M. Cerezo, et al., September 12, 2019: https://arxiv.org/abs/1909.05820
- BEyond observation: an approach for ObjectNav. Daniel V. Ruiz, Eduardo Todt, June 21, 2021: https://arxiv.org/abs/2106.11379
- Hybrid Quantum-Classical Machine Learning for Near Real-time Space to Ground Communication of ISS Lightning Imaging Sensor Data. Samih Fadli, Bharat S Rawal, 2023 IEEE 13th Annual Computing and Communication Workshop and Conference (CCWC), March 8, 2023: https://ieeexplore.ieee.org/abstract/document/10099338
- Quanv4EO: Empowering Earth Observation by means of Quanvolutional Neural Networks. Alessandro Sebastianelli, Francesco Mauro Giulia Ciabatti, et al., Submitted to IEEE Transactions on Geoscience and Remote Sensing, July 24, 2024: https://arxiv.org/abs/2407.17108
- Record-breaking 12,900 km Ultra-Secure Quantum Satellite Link Stellenbosch University, ScienceDaily, 19 March 2025: www.sciencedaily.com/releases/2025/03/250319142833.htm
- The Deep Space Quantum Link: Prospective Fundamental Physics Experiments Using Long-baseline Quantum Optics. Makan Mohageg, Luca Mazzarella, Charis Anastopoulos, et al., EPJ Quantum Technology 9, October 8, 2022: https://epjquantumtechnology.springeropen.com/articles/10.1140/epjqt/s40507-022-00143-0
- Honeywell Partners With European Space Agency To Protect Sensitive Information Transmitted By Satellite. Ahjay Rai, October 2, 2024: https://aerospace.honeywell.com/us/en/about-us/press-release/2024/10/honeywell-partners-with-european-space-agency-to-protect-sensitive-information-transmitted-by-satellite