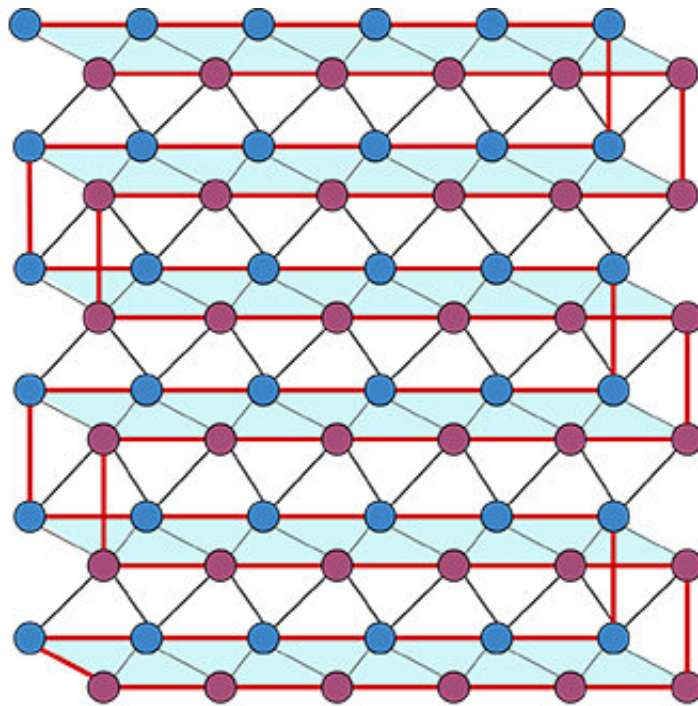


# Researchers publish significant step toward quantum advantage

December 10 2020

---



Layout of qubits in Google's Sycamore architecture. Credit: A. Montanaro

The team, led by Bristol researcher and Phasecraft co-founder, Dr. Ashley Montanaro, has discovered algorithms and analysis which significantly lessen the quantum hardware capability needed to solve problems which go beyond the realm of classical computing, even supercomputers.

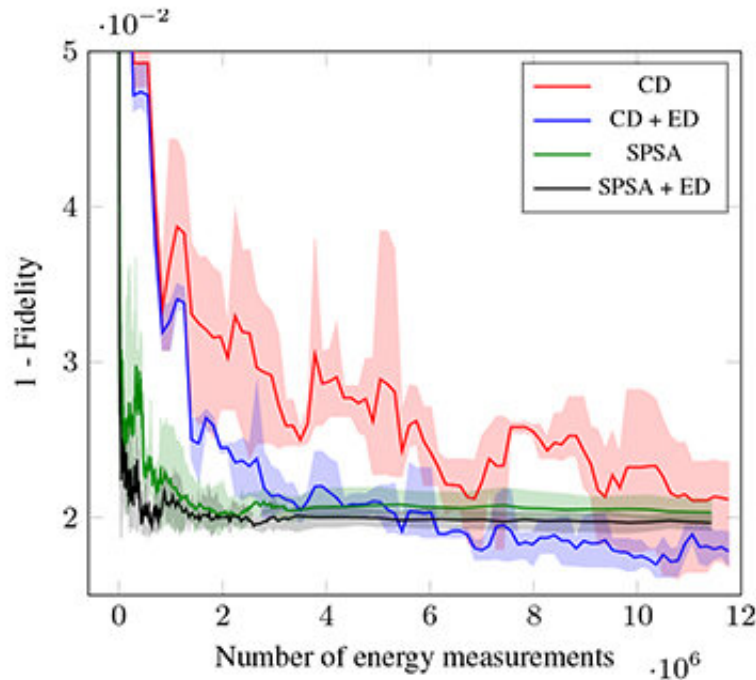
In the paper, published in *Physical Review B*, the team demonstrates how optimised quantum algorithms can solve the notorious Fermi-Hubbard model on near-term hardware.

The Fermi-Hubbard model is of fundamental importance in condensed-matter physics as a model for strongly correlated materials and a route to understanding high-temperature superconductivity.

Finding the ground state of the Fermi-Hubbard model has been predicted to be one of the first applications of near-term quantum computers, and one that offers a pathway to understanding and developing novel materials.

Dr. Ashley Montanaro, research lead and cofounder of Phasecraft: "Quantum computing has critically important applications in materials science and other domains. Despite the major quantum hardware advances recently, we may still be several years from having the right software and hardware to solve meaningful problems with [quantum computing](#). Our research focuses on algorithms and software optimisations to maximise the quantum hardware's capacity, and bring quantum computing closer to reality.

"Near-term quantum hardware will have limited device and computation size. Phasecraft applied new theoretical ideas and numerical experiments to put together a very comprehensive study on different strategies for solving the Fermi-Hubbard model, zeroing in on strategies that are most likely to have the best results and impact in the near future.



Performance of variational algorithms in a noisy simulation. Credit: A. Montanaro

"The results suggest that optimising over quantum circuits with a gate depth substantially less than a thousand could be sufficient to solve instances of the Fermi-Hubbard model beyond the capacity of a supercomputer. This new research shows significant promise for the capabilities of near-term quantum devices, improving on previous research findings by around a factor of 10."

*Physical Review B*, published by the American Physical Society, is the top specialist journal in condensed-matter physics. The peer-reviewed research paper was also chosen as the Editors' Suggestion and to appear in *Physics* magazine.

Andrew Childs, Professor in the Department of Computer Science and Institute for Advanced Computer Studies at the University of Maryland:

"The Fermi-Hubbard model is a major challenge in condensed-matter physics, and the Phasecraft team has made impressive steps in showing how quantum computers could solve it. Their work suggests that surprisingly low-depth circuits could provide useful information about this [model](#), making it more accessible to realistic quantum hardware."

Hartmut Neven, Head of Quantum Artificial Intelligence Lab, Google: "Sooner or later, quantum computing is coming. Developing the algorithms and technology to power the first commercial applications of early quantum computing hardware is the toughest challenge facing the field, which few are willing to take on. We are proud to be partners with Phasecraft, a team that are developing advances in quantum software that could shorten that timeframe by years."

Phasecraft Founder Dr. Toby Cubitt: "At Phasecraft, our team of leading quantum theorists have been researching and applying quantum theory for decades, leading some of the top global academic teams and research in the field. Today, Ashley and his team have demonstrated ways to get closer to achieving new possibilities that exist just beyond today's technological bounds."

Phasecraft has closed a record seed round for a quantum company in the UK with £3.7m in funding from private-sector VC investors, led by LocalGlobe with Episode1 along with previous investors. Former Songkick founder Ian Hogarth has also joined as board chair for Phasecraft. Phasecraft previously raised a £750,000 pre-seed round led by UCL Technology Fund with Parkwalk Advisors and London Co-investment Fund and has earned several grants facilitated by InnovateUK. Between equity funding and research grants, Phasecraft has raised more than £5.5m.

Dr. Toby Cubitt: "With new funding and support, we are able to continue our pioneering research and industry collaborations to develop

the quantum computing industry and find useful applications faster."

**More information:** 'Strategies for solving the Fermi-Hubbard model on near-term quantum computers,' by Cade, C., Mineh, L., Montanaro, A. and Staniscic, S. in *Physical Review B*.

Provided by University of Bristol

Citation: Researchers publish significant step toward quantum advantage (2020, December 10) retrieved 26 June 2024 from <https://phys.org/news/2020-12-publish-significant-quantum-advantage.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.