Quantum Computing Opportunities

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This committee, as directed by the Chairman of the Board, the Honorable Stockwell Day, has been tasked to outline 'moonshot' ideas for consideration. Here we discuss quantum computing.

Quantum computing is a rapidly-developing field of information processing which utilizes novel quantum physical phenomena to exponentially increase computing power. Current everyday computers rely on storing and processing data in the form of series of bits, representing zeros and ones (or 'off' and 'on' in terms of switches). Conversely, in quantum physics (generally on very small scales) it is possible to create situations where the same object could be measured as a zero or a one. This can be thought of as being both a zero and a one at the same time (denoted as a superposition), analogous to the commonly-referenced thought experiment of Schrödinger's cat. These states offer tremendous potential in various computational situations, allowing for incredible efficiency over conventional computers. A common analogy to get an idea of the scale is that a quantum computer to an everyday computer is like what an everyday computer is to an abacus. When successfully commercialized, quantum computing will be game-changing, with endless possibilities.

However, with present technology, it is difficult in practice to implement the commercially necessary quantum superposed states. Examples of candidates to construct quantum computers include optical lattices, where atoms are held in place by crossing laser beams, or superconducting devices, which rely on the unusual properties of electrical superconductors (typically at extremely cold temperatures). Different architectures are also being considered, including analog quantum computers to simulate specific situations (such as in quantum chemistry) or universal quantum computers which have more general uses but are more difficult to create.[1]

Developing these quantum computers is an accelerating research area and there are numerous efforts currently being undertaken around the world. In the United States, the National Quantum Initiative (NQI) Act was signed into law in December 2018 as an overarching program to advance quantum computing research via project funding, establishment of collaborative centers, and subcommittee formations.[2] Research teams from countless global universities are involved in this field, with some even having dedicated centers, such as the Institute for Quantum Computing in Waterloo, Canada, or the Yale Quantum Institute in the US. These universities include Columbia University, where I currently work; attached below is an example of a recent partnership between the US NQI Act and lead researcher Sebastian Will (with whom I previously worked). The private sector is similarly pivoting to capitalize on these emerging technologies, with strong involvement from companies like IBM and Google.

At Strategem Capital, we see clear opportunities in this blossoming field. We are aiming to work with leading scientists and government agencies and become affiliated with premier institutions in order to capitalize on the revolutionary technology of quantum computing. It has industry-altering potential and we are in a prime position to promote innovation and advance the scientific knowledge. Our goal is to create a world-class groundbreaking research facility in Calgary, Canada, ideally with support from governmental funding agencies.

To our shareholders, this is leading-edge technology and we have a vision to be part of it. Referencing a relevant common (while scientifically misleading) idiom, if we can be involved in even a piece of this, we can see a quantum leap for this company.

Respectfully submitted,

Science and Technology Advisory Committee
Graydon Flatt, Chairman
John Waterer, PhD
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[1] https://www-03.ibm.com/press/us/en/pressrelease/48258.wss
[2] https://www.quantum.gov

Columbia Leads Effort to Build a Quantum Simulator

The project is supported by an NSF Convergence Accelerator award that funds team-based, multidisciplinary initiatives addressing challenges of national importance.

By Carla Cantor
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https://news.columbia.edu/columbia-leads-NSF-effort-build-quantum-simulator-computing

Quantum technologies—simulators and computers specifically—have the potential to revolutionize the 21st century, from improved national defense systems to drug discovery to more powerful sensors and communication networks.

But the field still needs to make major advances before quantum computing can surpass existing tools to process information and live up to its promise.

A multidisciplinary research team led by Columbia University is in a position to bring quantum technology out of the lab into real-world applications. The team has received a $1 million National Science Foundation (NSF) Convergence Accelerator award to build a quantum simulator, a device that can solve problems that are difficult to simulate on classical computers. The project includes physicists, engineers, computer scientists, mathematicians, and educators from academia, national labs, and industry.

"This funding will enable us to develop the concept for a quantum simulator that can help tackle real-world challenges," said Sebastian Will, assistant professor of physics at Columbia and principal investigator on the project. "For this we brought a diverse team together that includes experts in atomic physics, photonics, electronics, and software, as well as future users of the platform."

The National Science Foundation launched its Convergence Accelerator program, a major new research investment unique for NSF and the federal government, in 2019 to help quickly transition research and discovery aligning with NSF's "Big Ideas" into practice. In 2020, the NSF continues to invest in two transformative research areas of national importance: quantum technology and artificial intelligence.

Columbia is one of 11 institutions nationwide to receive a Phase One Convergence Accelerator award for quantum technology. These awards support the National Quantum Initiative Act passed in 2018 to accelerate the development of quantum science and information technology applications. The U.S. Congress has authorized up to $1.2 billion of research funding for quantum information science, including computing.

The hope of developing a quantum computer with the potential to resolve seemingly intractable problems across many different industries and applications relies on controlling microscopic quantum systems with higher and higher precision in order to put them to work for computing tasks.

With this grant, the Columbia team will develop hardware and software concepts to develop a versatile quantum simulator based on ordered arrays of atoms. The group will store quantum information in individual atoms and program them to perform quantum simulations. Besides developing the device, the plan is to make it accessible to a broad user base via cloud-computing.

Over the next nine months, the 2020 cohort Convergence Accelerator teams will work to develop their initial concept, identify new team members, and participate in a curriculum focusing on design, team science, pitch preparation, and presentation coaching. After developing a prototype, the teams will participate in a pitch competition and proposal evaluation. Teams selected for phase two will be eligible for additional funding: up to $5 million over 24 months.

By the end of phase two, teams are expected to deliver solutions that impact societal needs at scale.

"The quantum technology and AI-driven data and model-sharing topics were chosen based on community input and identified federal research and development priorities," said Douglas Maughan, head of the NSF Convergence Accelerator program. "This is the program's second cohort, and we are excited for these teams to use convergence research and innovation-centric fundamentals to accelerate solutions that have a positive societal impact."

The simulator project team includes collaborators from Columbia University, principal investigator Sebastian Will, co-principal investigators Alex Gaeta and Nanfang Yu, and others; Brookhaven National Lab, co-principal investigators Layla Hormozi and Gabriella Carini, and others; City University of New York; Flatiron Institute; and industry partners from Atom Computing, QuEra, IBM, and Bloomberg.