Towards Quantum Research, Quantum Computing and Quantum Technologies

Farai Mazhandu

President, OneQuantum Africa

Table of Contents

Abstract

We develop in the paper the importance for Africa to participate in the next quantum revolution and propose ways to meet this challenge. We illustrate the topics with the example of OneQuantum Africa initiative that is gathering researchers and students from all Africa and promoting quantum research, quantum computing and quantum technologies through education and sharing of experience. We propose some directions driven from experience to meet this ambitious but essential challenge.

Keywords: Quantum, Computing, Technologies, Revolution

Towards Quantum Research, Quantum Computing and Quantum Technologies

Introduction

Quantum physics, which governs the behavior of matter on an atomic scale, brings new capabilities that lead to a wave of new technologies that will create new businesses and help solve many of today's global challenges. After delivering groundbreaking technologies such as the transistor, solid-state lighting and lasers, and GPS, we are now entering the second quantum revolution. Africa's competitive advantage is its talented young population. It simply cannot afford to be left out of the quantum revolution, which will sit at the core of building new enterprises, future careers, and workforces, as well as driving accessible innovation.

About 60% of people in Africa are under the age of 25, and the number of young people is expected to grow in the decades ahead. To these young people, Africa is full of potential and opportunity. We must give them access to skills and education in the newest technologies like quantum to support their innovative spirit and equip them for the future. This is our opportunity to lead.

We should aim to reach out to every country and university in Africa such that everyone who has an interest in quantum is supported to succeed. An example is given by

General thoughts

It is essential to remember that Africa has sufficient materials and human resources to build shared prosperity. All we need to do is unleash this potential.

Here are some key learnings from our engagements at OneQuantum Africa:

- Africa should work towards technology transfer for scientific and economic independence
- A strong foundation in education enables capacity building and mastering of emerging technologies like quantum
- Scientists in Africa should explore bilateral collaborations as a starting point with a vision to scale to regional and continental levels
- Communities that reach beyond academia are essential to moving quantum forward not only in Africa but globally
- Young people are generally curious and talented such that introducing them to new fields like quantum computing needs to happen now
- We need to take advantage of open access and communities to join forces and start work on some of the biggest challenges and opportunities in the continent to attract the necessary support from local governments and organizations
- Collaboration is vital to enhance the level of science and technology in the continent
- Quantum tech is a sensitive industry such that as Africans, we need to participate and contribute to shaping it to build trust and ensure tech sovereignty

- Unlike other decades where African countries were just beneficiaries of emerging technologies, now is the time for the African continent to pioneer ground-breaking innovations
- Africa's quantum opportunity strongly depends on building a solid foundation in education

In Africa we should:

1. Gather and harness expertise from the continent to shape a broad vision and play a guiding role in accelerating the development of quantum science and technology in our continent.
2. Scan the ecosystem and look at our local circumstances to deeply understand the importance and necessity of accelerating the development of quantum science and technology
3. Seize major strategic opportunities like our youthful population, abundant natural resources, diaspora community, and influential leaders on the global stage to: accurately grasp the development trend, key tasks, and implementation path required to increase investments in basic theoretical research and scientific and technological applications, continuously improve independent innovation ability, improve the scientific research platform system, strengthen the support of talents, strengthen the foundation of quantum science and technology development, and,promote the deep integration of quantum science and technology with economic and social development.
4. Build quantum science and technology development highland, in order to speed up the conversion of new and old kinetic energy, promote high-quality development through the exploration of synergies between quantum tech and other important technologies like HPC, AI, IoT, and 5G.

Some quotes

"South Africa and Africa have missed the rise of the electronic industry. Our focus on Quantum technology gives us the opportunity to leapfrog into the Quantum world and be a major player in the field. By harnessing the quantum world, we open an exciting future that is developing before our eyes: seeing smaller, better and with less light for enhanced medical imaging (quantum ghost imaging), networks that are fundamentally secure and unbreakable taking cybersecurity beyond its man-made limitations (quantum secure communication) and exponentially faster computers (quantum computing) to solve assumed "unsolvable" problems, from finance to drug design."

Professor Andrew Forbes, WitsQ Director

"Unless African entrepreneurs and Universities work together to advance this technology and make it mainstream, we will be left behind in the race towards Quantum supremacy."

Andile Ngcaba, Founding Partner & Chairman at Convergence Partners Investments

"Africa has so much distributed strength, and it is essential to bring people from different backgrounds together. To take meaningful advantage of emerging technologies will require that we open room to have many people with their own talents joining. For example, materials scientists have a lot to say about the materials and the defects that hinder or advance progress in quantum computing devices. Electrical engineers have a role to play in how to fabricate and control the qubits. Computer scientists and applied mathematicians help us to build algorithms and solve problems. Chemists and biologists know the challenging issues to solve. Those in humanities and liberal arts understand how to use technology for good, build legal frameworks to support innovation, tackle issues like privacy and security, develop the right policies to nurture ecosystems, and help us avoid ethical challenges and past mistakes."
Farai Mazhandu, President, OneQuantum Africa

Summary

Our action plan should include: Building a platform to bring together professionals interested in Quantum technology. Collaborate with governmental and non-governmental actors to raise awareness about quantum technology, highlighting their role in Africa's socio-economic transformation.Developing national and international partnerships to support innovation and entrepreneurship to steer Africa's digital economy toward a quantum-enabled economy.Assist through experts from diverse backgrounds in developing national skills and competencies in Quantum Technology, including Physical foundation of Quantum Technology, Quantum Computing, and simulation, Quantum Computing hardware and sensors, Quantum Communication, soft and practical skills. Encourage deeper collaborations between universities and public entities to encourage research and development to maximize quantum technology capacity building.

References

African Physics Newsletter: July 2021 (mailchi.mp)

[2102.00759] Ethical Quantum Computing: A Roadmap (arxiv.org)

[2010.13778] Achieving a quantum smart workforce (arxiv.org)

[2109.03601] Assessing the Needs of the Quantum Industry (arxiv.org)

[2006.16444] Preparing for the quantum revolution -- what is the role of higher education? (arxiv.org)

2108.01311.pdf (arxiv.org)

Join Qiskit Advocates to Expand Your Network and Grow | by Farai Mazhandu | Qiskit | Medium