

# Overview of the UTC Quantum Center

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# Quantum Quiz

1. What is a quantum?
2. When did the discipline start (when were the scientific foundations established) and by whom?
3. At what point in the timeline of development are *quantum computers*, compared to *digital computers*?
4. What is a qubit?
5. True or False: The pioneers of quantum mechanics were confident that they had it all figured it out.

# Quantum Quiz: Answers to Questions 1 & 2

## 1. What is a quantum?

From Wikipedia: In physics, a quantum (pl.: quanta) is the minimum amount of any physical entity (physical property) involved in an interaction. . . . For example, a photon is a single quantum of light of a specific frequency (or of any other form of electromagnetic radiation). Similarly, the energy of an electron bound within an atom is quantized and can exist only in certain discrete values.

## 2. When did the discipline start (when were the scientific foundations established) and by whom?

Two milestone events (of several)

December 1900: Max Planck reported his findings on energy being absorbed or released only in tiny, differential, discrete packets to the German Physical Society [Wikipedia]

Summer 1925: Completion of a consistent theory of quantum mechanics by Werner Heisenberg, Max Born, and Pascual Jordan

[Dan Styer (Oberlin College), A Brief History of Quantum Mechanics, <https://www2.oberlin.edu/physics/dstyer/StrangeQM/history.html>]

### Q3. Timelines: Digital vs. Quantum Computers

A speaker at the 2024 SIAM (Society for Industrial & Applied Mathematics) Quantum Intersections Convening Workshop, Washington, D.C., in early October, presented this figure:

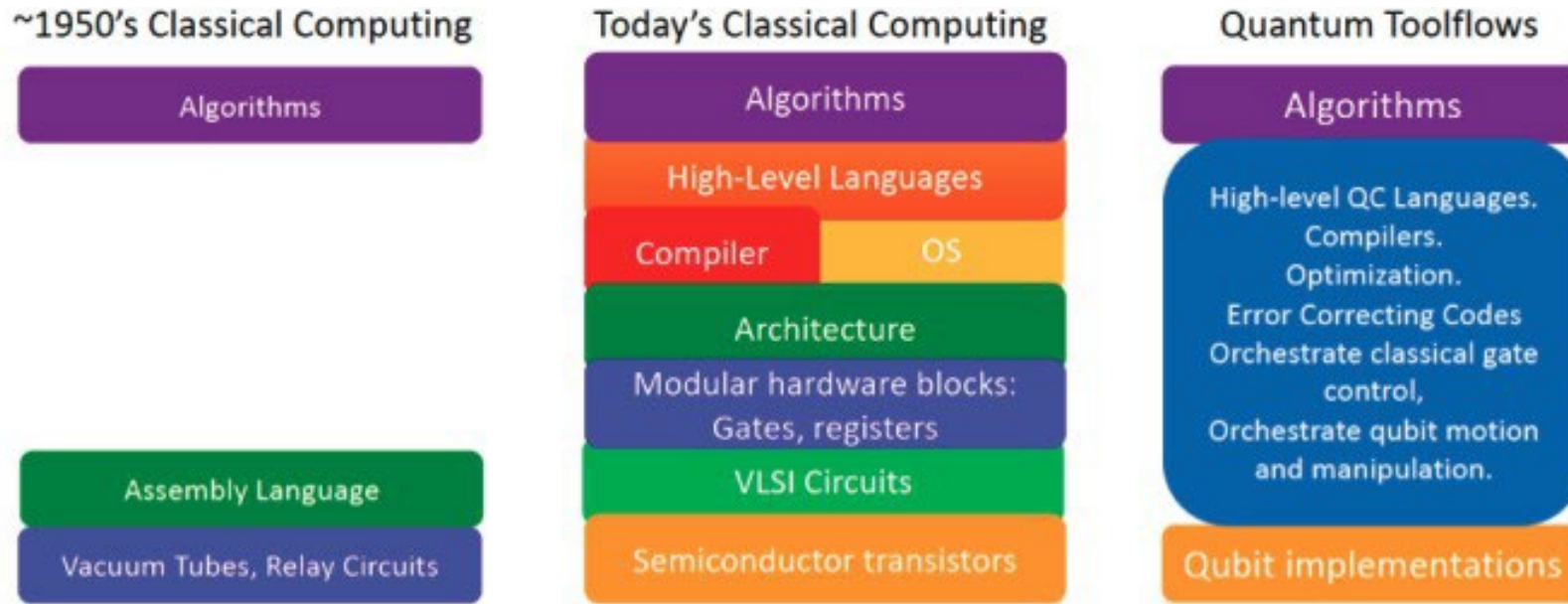


Figure 3: Illustration of the layers involved in classical computing circa 1950s, current classical computing and quantum toolflows.

from [Margaret Martonosi and Martin Roetteler, Next Steps in Quantum Computing: Computer Science's Role, (2019), <https://arxiv.org/abs/1903.10541>]

## Q4. What is a Qubit, Physically?

From Thomas Wong's Book\*:

Physically, any quantum system with two distinct states can be used as a qubit . . . some examples include:

- Photons, or quantum particles of light
- Trapped ions
- Cold atoms
- Nuclear magnetic resonance
- Quantum dots
- Defect qubits
- Superconductors

\* [Thomas G. Wong, (2022), Introduction to Classical and Quantum Computing, Rooted Grove]

# Words of Wisdom - Answering Question 5

Richard Feynman\*

I think I can safely say that nobody understands quantum mechanics.

Niels Bohr\*

If you are not confused by quantum physics then you haven't really understood it.

Nielsen & Chuang (in Mike & Ike\*\*)

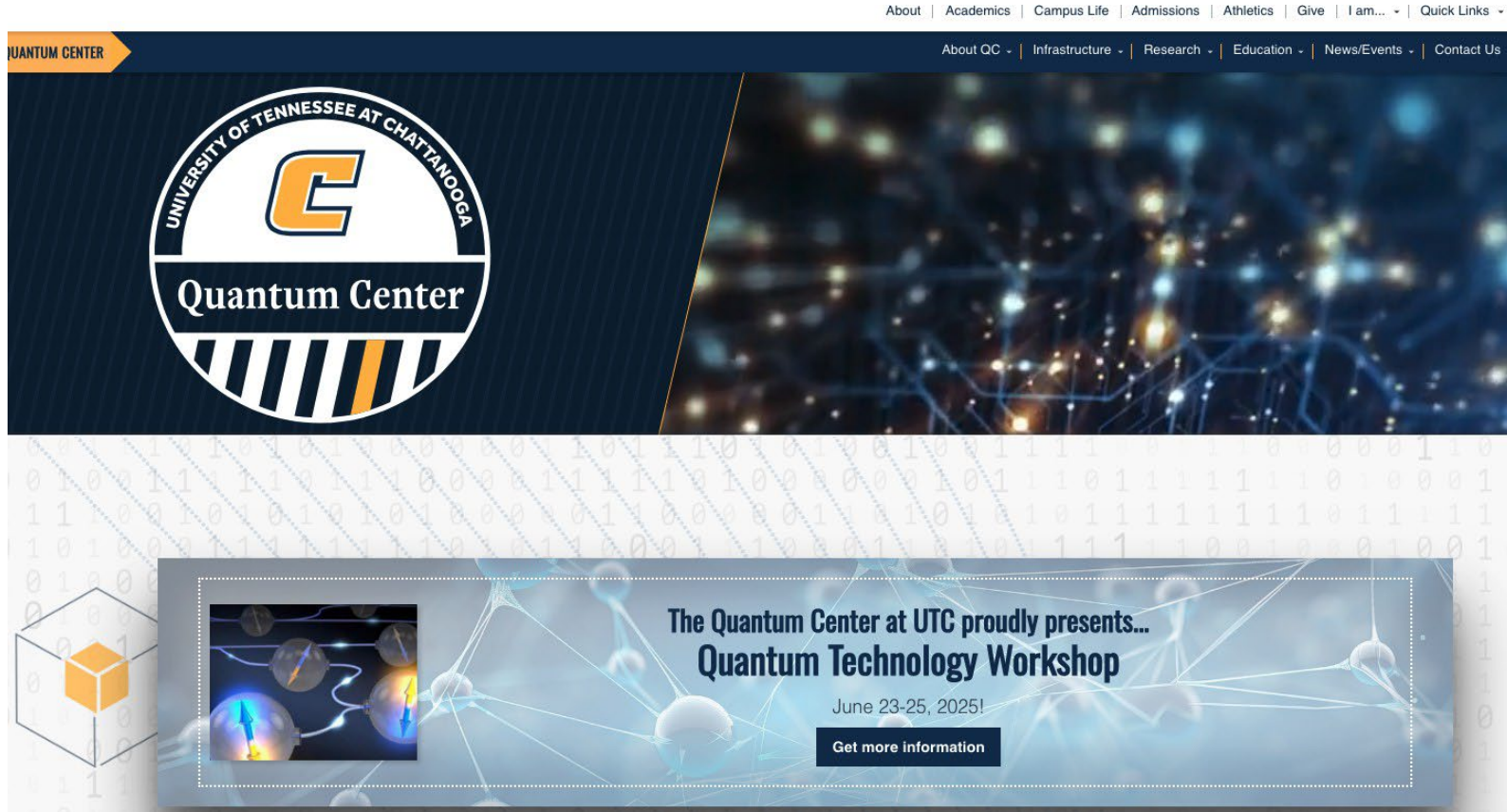
The postulates of quantum mechanics were derived after a long process of trial and (mostly) error, which involved a considerable amount of guessing and fumbling by the originators of the theory.

\* Nobel Laureates

\*\*[Michael A. Nielsen & Isaac L. Chuang, (2010). Quantum Computation and Quantum Information (10th Anniversary Edition), Cambridge University Press]

# UTC Quantum Center

A web search on UTC quantum leads to <https://www.utc.edu/research/quantum-center:>



Workshop in 2025: Commemorates the 100th anniversary of  
aforementioned achievement by Heisenberg, Born, and Jordan



# Quantum Center History - Slide 1 of 2\*

7/2022 - UTC Quantum Initiative (QI) launched (\$3M investment)

8/2022 – Dr. Tian Li, TX A&M, joins UTC (Q sensing & Q control)

9/2023 – Partnership Agreement with EPB signed

11/2023 – UTC connected to EPB Q network

2/2024 – NIST Community Project approved, \$3.5M/4yr investment to establish the UTC Quantum Center

3/2024 – American Physical Society-TV features UTC QI at March meeting

3/2024 – Proceedings of National Academy of Science invites paper on Q sensing (Dr. Li)

4/2024 – UTC joins Chattanooga Quantum Collaborative

\* Dr. Reinhold Mann, UTC Vice Chancellor for Research, provided this slide and several subsequent slides.



# Quantum Center History - Slide 2 of 2

4/2024 – Dr. Rick Mukherjee (Hamburg U) accepts offer, move will be completed by 12/2024

5/2024 – TVA supports use-case pilot project

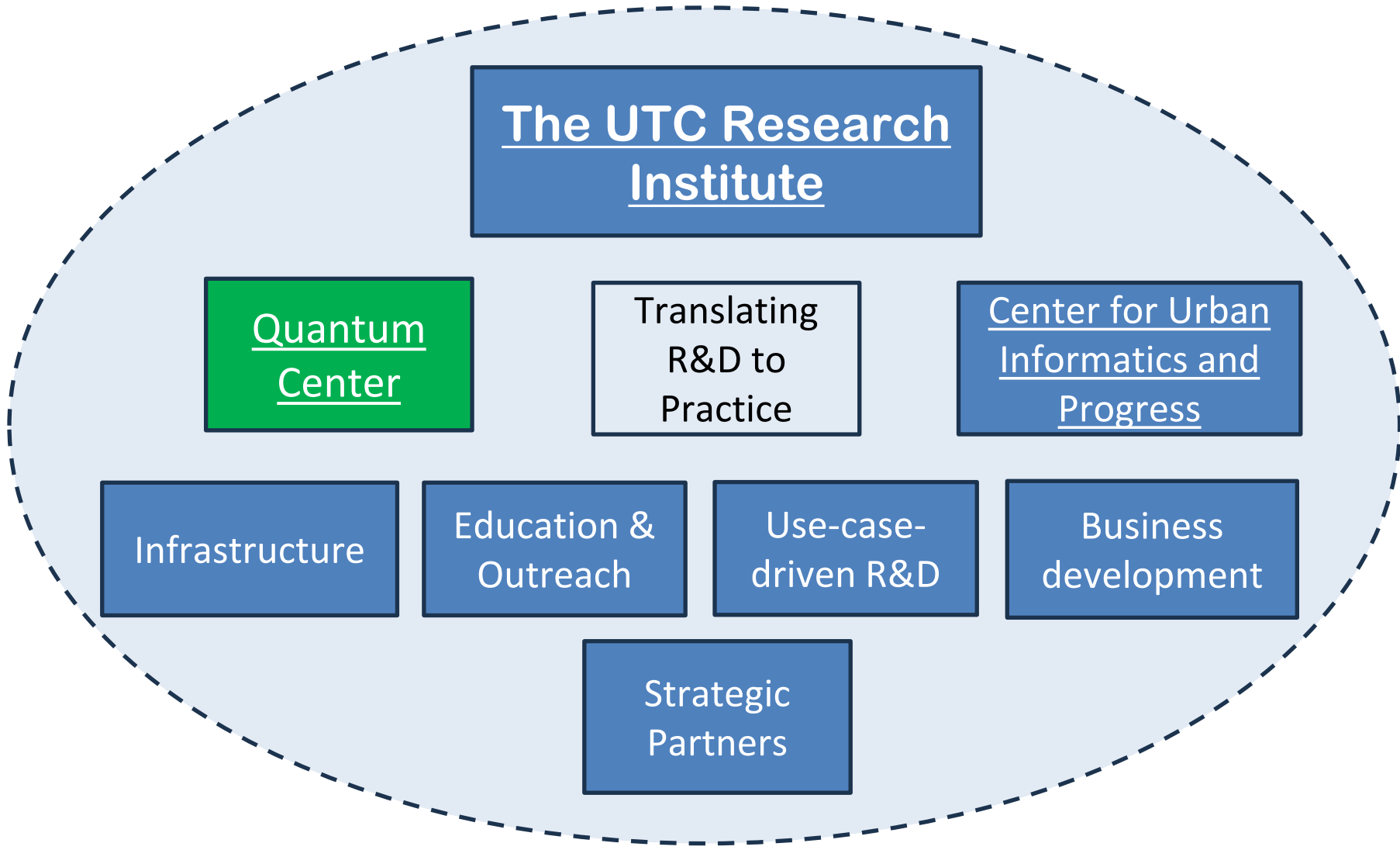
7/2024 – MOU with ORNL Quantum signed - collaborative R&D, education and WFD

8/2024 – Dr. Tian Li awarded \$800K grant from highly competitive NSF ExpandQISE program

9/2024 – QISE Governor's Chair search approved by UT-ORII  
(UT-Oak Ridge Innovation Institute)

9/2024 – UTC Center for Professional Education offers Introduction to QISE course for professionals in the work force, first cohort of engineers from Volkswagen

# UTC Quantum Center is a Component of UTC RI



# UTC Quantum Center - Staffing

| Infrastructure                            | Education  | Use case-driven R&D  | Business Development  |
|---|--|--|---|
| <p>Dr. Tian Li<br/>Dr. Rick Mukherjee</p> | <p>Dr. Tatiana Allen<br/>Dr. Christopher Cox<br/>Mr. John Freeze<br/>Dr. Shewanee Howard-Baptiste</p> <p>QISE Governor's Chair – search underway</p> | <p>Dr. Tian Li<br/>Dr. Yu Liang<br/>Dr. Rick Mukherjee<br/>Dr. Don Reising<br/>Dr. Mina Sartipi<br/>Dr. Kazi Raez</p> <p>QISE Governor's Chair – search underway</p> <p>1-2 Research Faculty<br/>4 post-docs<br/>4 graduate students</p> | <p>Dr. Reinhold Mann<br/>Dr. Tian Li<br/>Dr. Rick Mukherjee</p> |

# Governor's Chair Proposal - Successful

**Proposal to lead search for  
Governor's Chair in Quantum Science and Technology  
with focus on  
Applications of Quantum Information Science including  
Quantum Networking, Quantum Algorithm and Software  
Development, and Integration of HPC**

The University of Tennessee at Chattanooga (UTC) and the Oak Ridge National Laboratory (ORNL) propose to create a Governor's Chair (GC) position to strategically engage and advance regional capabilities in Quantum Information Science at both institutions and their key technology and economic development partnerships.

July 27, 2024



Position flyer:

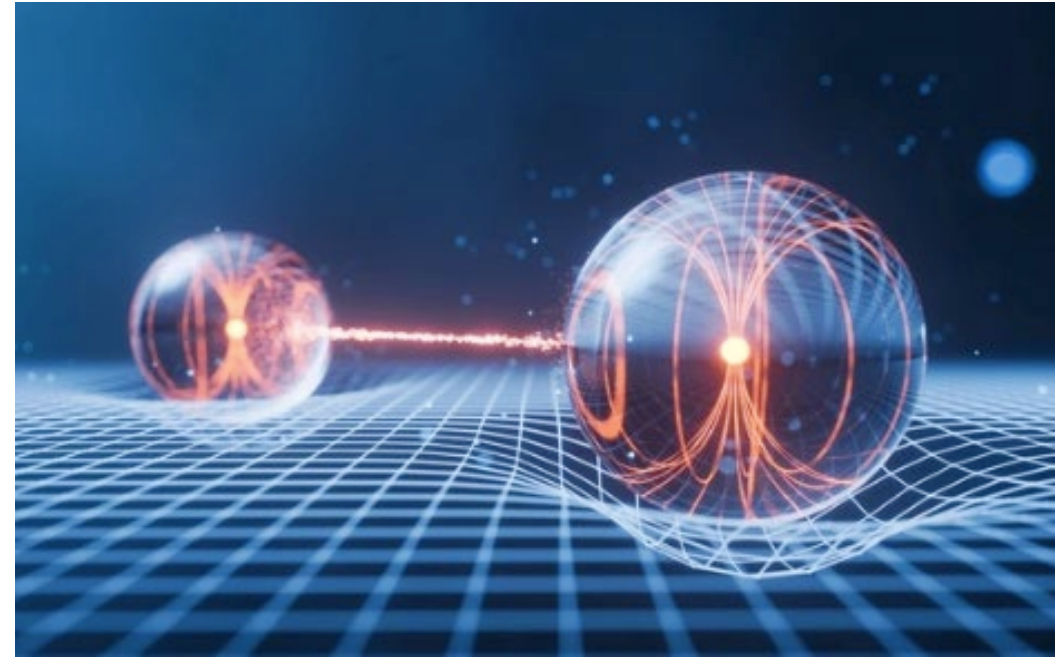
<https://www.utc.edu/research/quantum-center/news-and-events/join-our-team/governors-chair-professor>

# Education & Workforce Development - QISE

- Credit certificate in QISE, adding courses to offer a Minor in QISE
  - Intro to QISE
  - Physics Concepts
  - Math Concepts
  - Quantum Computing
- Quantum Computing for Computer Scientists – Grad course offered in CS Dept
- QaaS (Quantum as a Service)
  - Pilot in QML with Terra Quantum, April 3 – May 8, 2024 (~30 faculty and graduate students)
  - Discussions with IonQ, qBraid, and other providers
- Non-credit certificate - Introduction to QISE, Center for Professional Education
  - First cohort of engineers from Volkswagen, September 2024 – 18-hour course
  - More courses and certificates in Quantum to be offered

# Path Forward

- Staffing and establishing a QISE graduate program and increasing undergraduate offerings are priorities and part of sustaining the UTC Quantum Center.
- We are a founding member of the Chattanooga Quantum Collaborative, aiming to drive innovation and economic development .
- We are working to demonstrate the value of QISE in important use cases, including Smart Cities and resilient critical infrastructures.
- We will host an annual Quantum Technology workshop starting in June 2025.



<https://www.utc.edu/research/quantum-center>