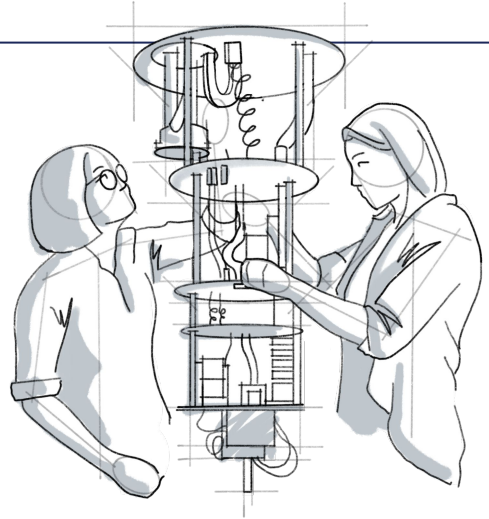


Quantum Computing

The Future of Computation

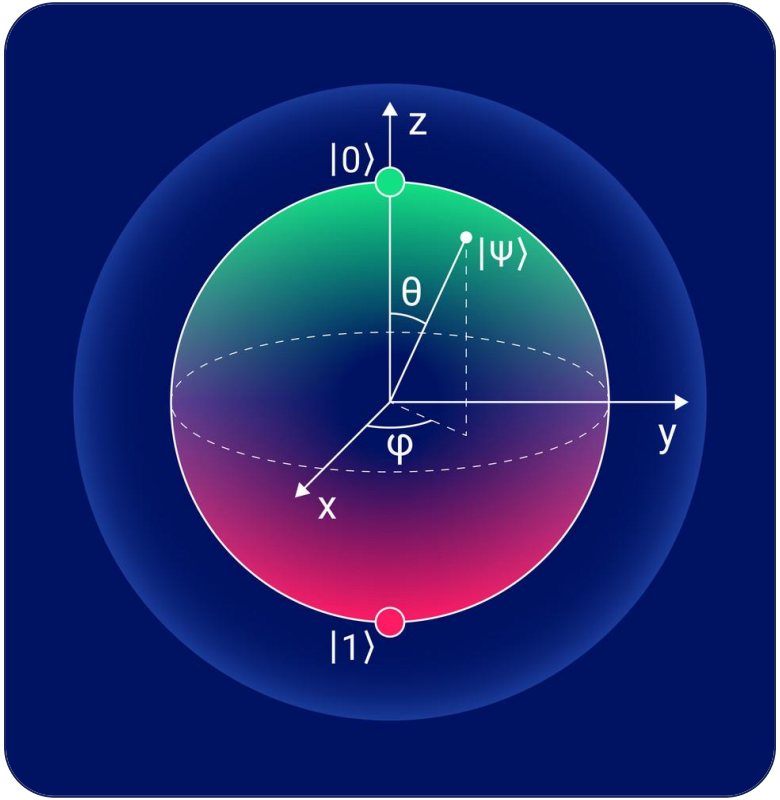
Luke Keely

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Introduction to Quantum Computing

Quantum computing is likely to become a new standard for complex calculation and big data.

This presentation covers its fundamental principles, historical development, current status, and potential future applications.



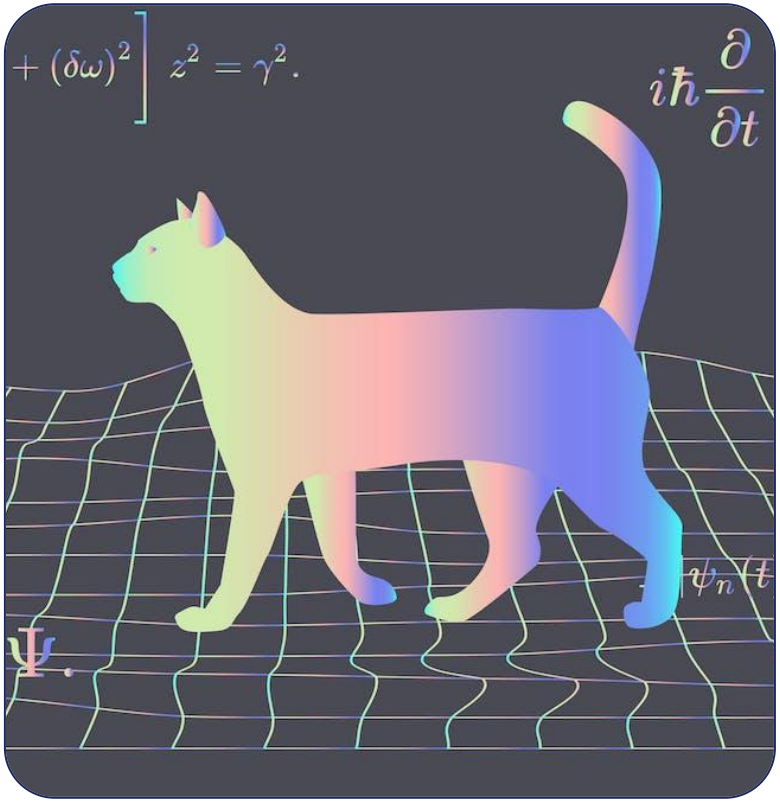
Basics of Quantum Mechanics

Quantum Mechanics is the physics that deals with really small particles.

Key principles;

Superposition, is the idea that a quantum system can exist in multiple states at once.

Entanglement, is a connection between particles where the state of one instantly influences another.

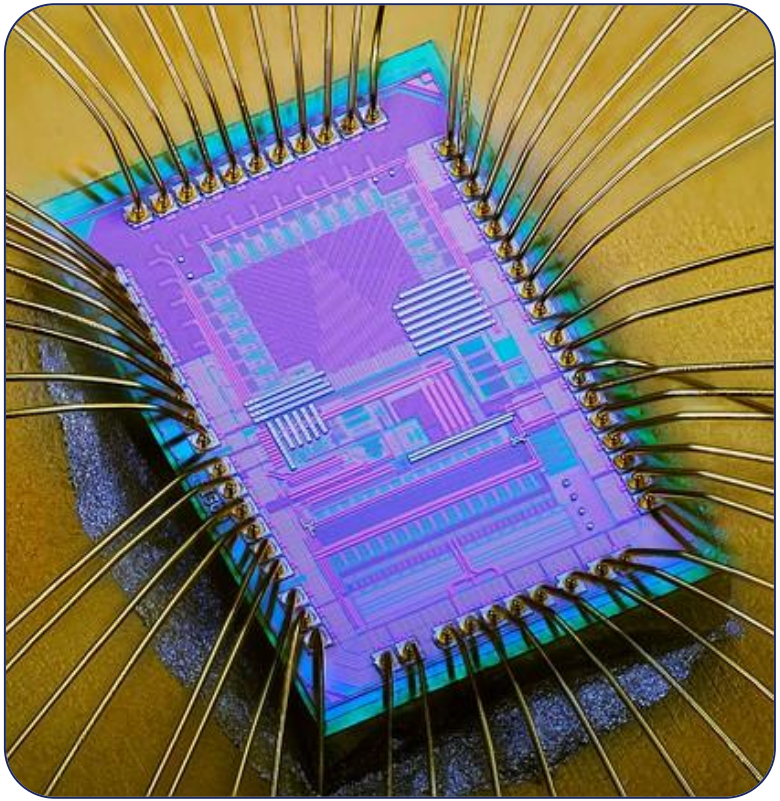


Quantum vs Classical Computers

Classical computers use **bits** that are either 0 or 1 while quantum computers have **qubits** which can exist in **superposition**.

These qubits can be **entangled**.

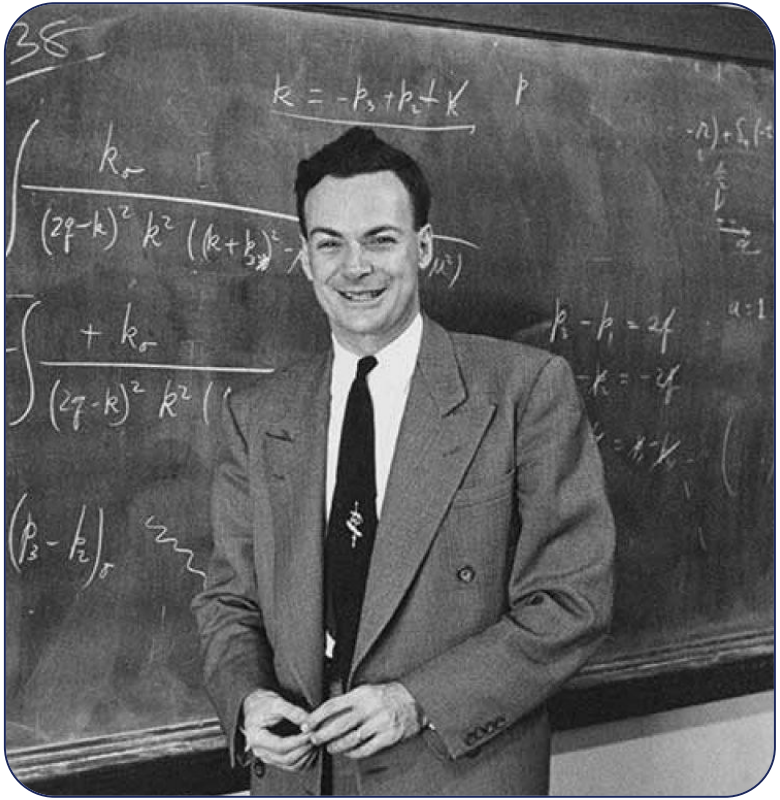
These quantum principles allow complex operations, where some computations to be done over **100 million times faster**.



Evolution of Quantum Computing

Milestones in Quantum Computing History:

- **1981**: Richard Feynman proposes the need for quantum computing to simulate quantum systems.
- **1994**: Peter Shor devises an algorithm for faster factorization of large numbers.
- **2019**: Google solves a problem in **200 seconds** that would take a supercomputer **10,000 years**.

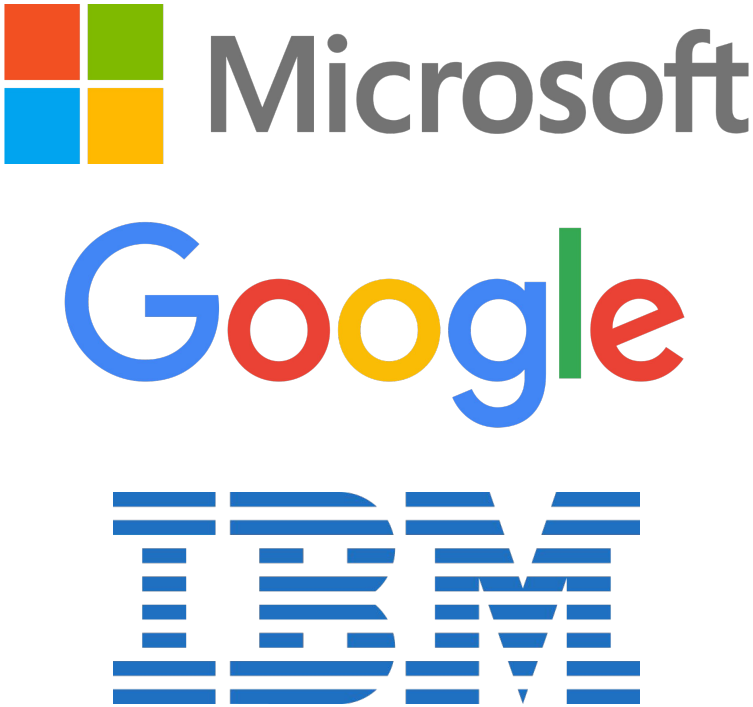


Photograph of Theoretical Physicist Richard Feynman

Current Advancements

Big tech companies are working hard on quantum computing application.

- **Microsoft**: Developing Azure Quantum ‘ecosystem’ for cloud-based quantum programming.
- **Google**: Focusing on building fault-tolerant quantum computers and quantum chemistry simulations.
- **IBM**: Building advanced quantum hardware and offering cloud-based quantum computing services.

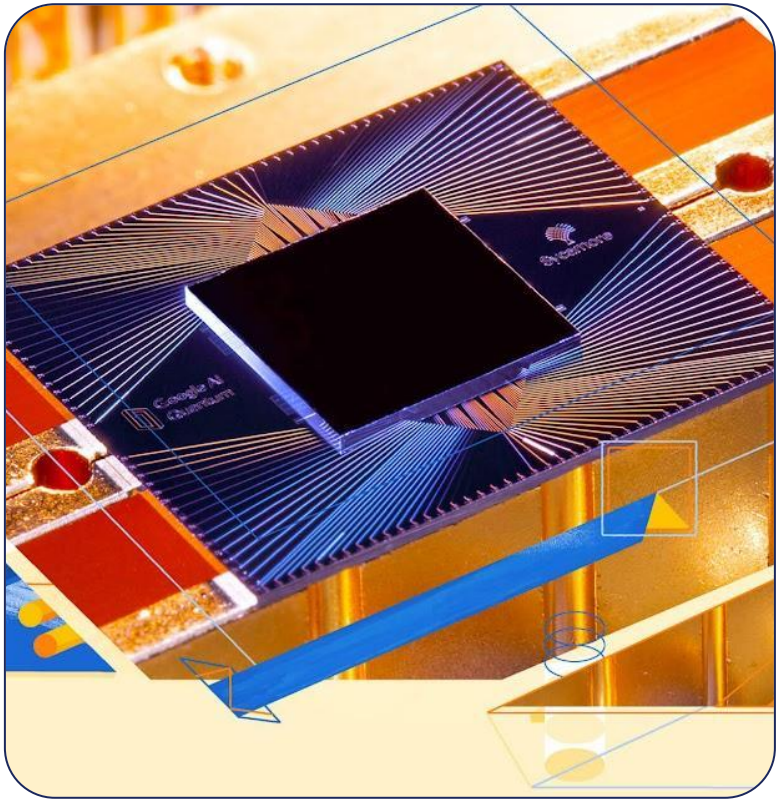


Future Advancements

Advancements: More reliable qubits and improved error correction algorithms, wider range of applications.

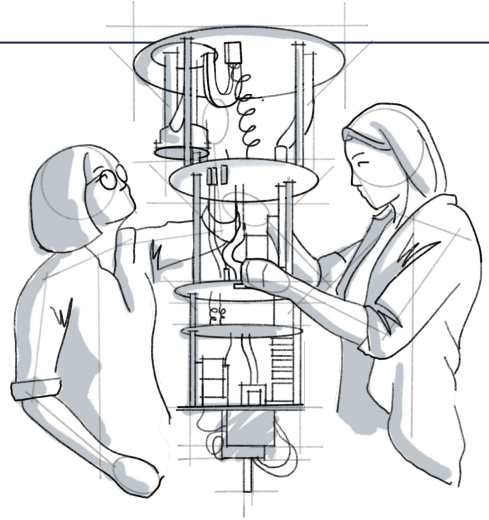
Applications: Short-term focus on database searching and material science; long-term potential in healthcare and AI.

Hybrid Systems: Algorithms that use both quantum and classical resources for real-world problem-solving.



Challenges

- **Security Risks**: Algorithms like Shor's could crack current encryption standards, leaving data vulnerable.
- **Accessibility**: High costs and technical expertise required could widen the digital divide.
- **Ethical Concerns**: Increased computing power could enable higher levels of mass surveillance and impact personal privacy.



Thank you

Luke Keely

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin