Theoretical quantum physics

with Dr Salini Karuvade

Talking *points*

Knowledge & Comprehension

1. What are the similarities and differences between bits and qubits?
2. In your own words, how would you explain the quantum phenomena of superposition and entanglement?
3. What are the causes and consequences of decoherence?
4. How does quantum error correction allow scientists to use quantum computers, despite the problem of decoherence?

Application

5. How do you think quantum computers will be used to advance the fields of engineering and medicine?

Analysis

6. Why do you think scientists are primarily focused on developing methods to manage and minimise the effects, rather than the causes, of decoherence?

Evaluation

7. In the field of cyber security, quantum computers will have the ability to both cause and prevent cyber-attacks. If you were a quantum physicist, how would you justify the development of technology that can cause both harm and good?
8. To what extent do you think quantum computers will affect daily life over the coming decades?
9. Salini co-founded a peer-support group for women and non-binary EQUS colleagues. Why do you think groups like these are important? What type of support do you think they offer? Why do you think such support is needed?

Activities

1. Play quantum games!

Play Quander (**quander.cs.uchicago.edu/Lite**), an online video game developed by the University of Chicago to explain quantum concepts in a fun way. You can play several parts of the game for free, including Qupcakery, a quantum cupcake game that gives you a flavour of quantum physics by introducing the ideas of entanglement and quantum gates. Which quantum concepts do you understand better after playing?

2. Compare theoretical and experimental physics

"Collaboration between experimental and theoretical physicists is crucial for making ground-breaking discoveries in quantum physics," says Salini. Research online to find out more about the work of theoretical and experimental physicists, then create a a venn diagram that compares and contrasts the two roles. Consider:

- What similarities and differences do you think exist between the roles, in terms of the skills and knowledge they need and their day-to-day activities?
- How would each role approach issues in quantum physics? What methods would they each use?
- How would collaborations between theorists and experimentalists help them solve challenges that they could not solve alone?
- Which role would you prefer, and why?

More *resources*

- This article provides a comprehensive and accessible introduction to quantum computers: **www.technologyreview.com/2019/01/29/66141/what-is-quantum-computing**
- This article outlines some common misconceptions about quantum computers: **www.quantamagazine.org/why-is-quantum-computing-so-hard-to-explain-20210608**
- This video shows what a quantum computer looks like, and has a great analogy to explain how quantum computers are completely different to classical computers, not simply faster versions of them: **www.youtube.com/watch?v=e3fz3dqhN44&t=840s**