Argonne NATIONAL LABORATORY

WHAT IS QUANTUM INFORMATION SCIENCE?

Leveraging counter-intuitive behavior on the atomic scale to create powerful changes in information science on a practical scale

Scientists are racing to develop quantum-based systems that can store, transport, manipulate, and protect information.

Qubits—quantum bits—are the fundamental components of quantum computing and other quantum information systems. They are analogous to the bit in classical computers, either 0 or 1. What makes qubits truly strange is that they can simultaneously be both 0 and 1. This overlapping state gives quantum computers tremendously increased horsepower. The qubit itself can come in many different forms—electrons, particles of light, even tiny defects in otherwise highly structured materials.

Scientists are seeking to design qubits that maintain information in their quantum states for seconds ("coherence") and can link with other qubits ("entanglement").

Quantum technologies could transform national and financial security, drug discovery, and the design and manufacturing of new materials, while deepening our understanding of the universe.

Learn more at **www.anl.gov**.

COHERENCE

- Ability to maintain quantum information
- Challenge is maintaining it long enough to perform desired operations
- Upon decoherence, a qubit becomes capable of holding only 0 or 1

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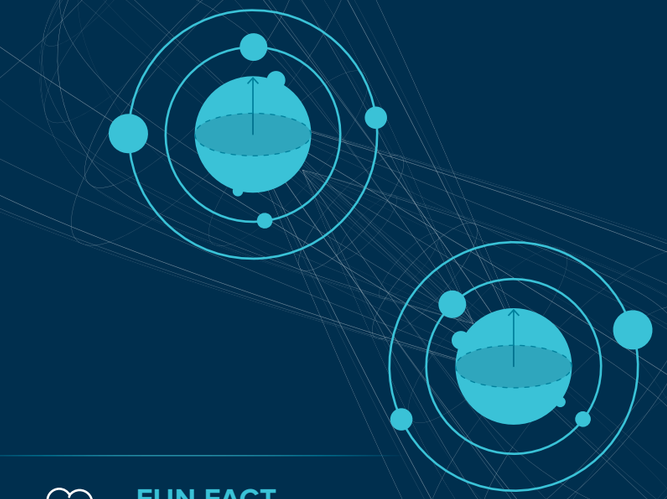
ENTANGLEMENT

- Knowing the state of one quantum object instantaneously reveals information about the state of another linked one
- Even over vast distances



FUN FACT

A skeptical Albert Einstein famously characterized entanglement as "spooky action at a distance." Today, scientists are finding many possible real-world applications for this property.

REAL-WORLD APPLICATIONS

SENSING

What is possible: unprecedented sensitivities for data capture. Vastly improved biomedical imaging, including MRI, for studying cancer and other cells.

COMMUNICATION

Transmission of information across long distances, making "unhackable" networks for communications.

COMPUTING

Performing complex tasks in minutes that supercomputers could not complete in years. Accelleration of new drugs and materials discovery.

U.S. DEPARTMENT OF ENERGY
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