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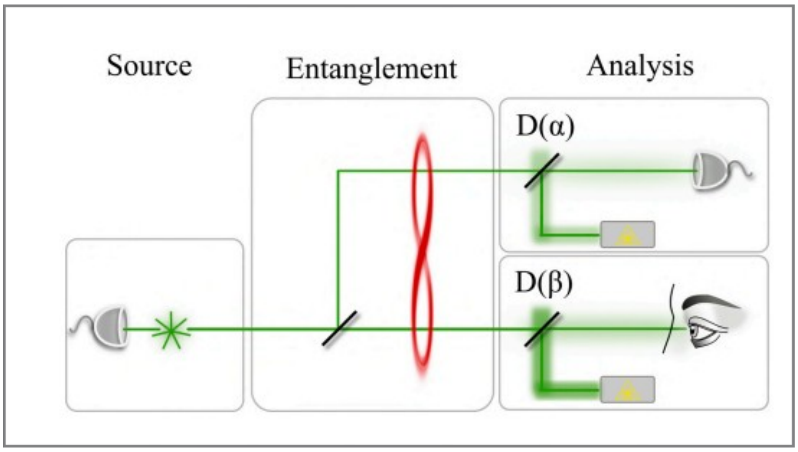
ADVANCEMENTS IN QUANTUM TECHNOLOGY MAY HELP US UNDERSTAND ENTANGLEMENT

The year 2025 marks the 100th anniversary of the birth of quantum mechanics, a field that has fundamentally transformed science and technology. Over the past century, quantum mechanics has given rise to numerous innovations, including lasers, MRI scanners, and computer chips. However, despite these technological advancements, some of the profound questions posed by the founders of quantum mechanics remain unanswered. Today, researchers are exploring new ways to address these questions through quantum information science, particularly by linking Albert Einstein's relativity principle to the qubit, a fundamental unit in quantum computing.

Quantum information science is an emerging field focused on the development of quantum computers, which rely on qubits instead of classical bits. Qubits, grounded in the early 20th-century discoveries of Max Planck and Albert Einstein, exhibit unique properties that give quantum computers their remarkable potential. Unlike classical bits, which represent information as either 0 or 1, qubits can exist in a state of quantum superposition, allowing them to perform multiple calculations simultaneously. This property is further enhanced when qubits are entangled, enabling quantum computers to solve certain problems exponentially faster than classical computers.

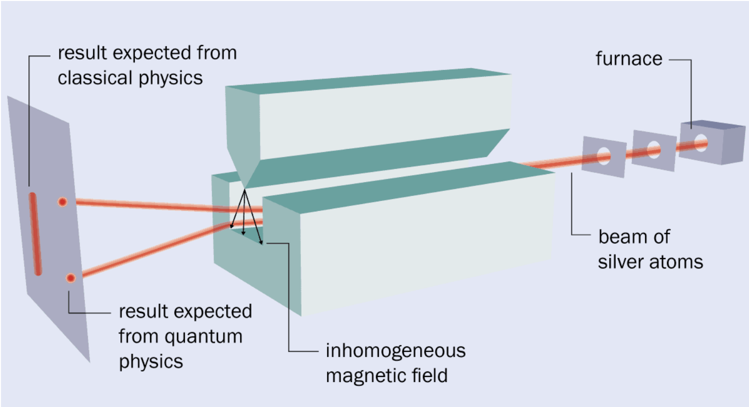
Despite the significant progress in quantum computing, the underlying principle behind quantum entanglement, where particles remain interconnected regardless of the distance between them, is still not fully understood. One of the biggest challenges is finding an explanation that does not involve "spooky actions at a distance," a term Einstein used to describe the seemingly instantaneous correlation between entangled particles. A promising approach, proposed by researchers in quantum information theory, involves using Einstein's relativity principle.



https://www.technologyreview.com/2016/02/17/162219/the-experiment-that-will-allow-humans-to-see-quantum-entanglement/

The relativity principle asserts that the laws of physics are the same for all observers, regardless of their orientation or motion. By applying this principle to quantum information theory, researchers have proposed that the phenomenon of quantum entanglement may arise from the relativity principle itself, rather than from a mysterious force acting at a distance. This approach shifts the focus from forces to information principles, offering a novel way of understanding quantum mechanics.

To illustrate, consider an electron's spin, a property that can be measured vertically or horizontally. When measured vertically, the electron's spin will be either up or down. However, when measured horizontally, the same electron can exhibit spin to the left or right, despite having no apparent reason to do so based on its vertical measurement. This behavior can be explained by the concept of quantum superposition, where the electron exists in a combination of both left and right spin states. The 50–50 distribution of these outcomes aligns with the relativity principle, suggesting that the electron's spin is consistent across different



https://physicsworld.com/a/how-the-stern-gerlach-experiment-made-physicists-believe-in-quantum-mechanics/

This perspective eliminates the need for faster-than-light forces to explain quantum entanglement, staying within the boundaries of Einstein's theory of special relativity. By linking quantum entanglement to the relativity principle, researchers have opened up a new way of thinking about the fundamental nature of quantum mechanics. As we enter the second century of quantum mechanics, this approach may offer critical insights into the unanswered questions that have intrigued physicists for decades, potentially leading to even greater technological advancements.

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