Hitting Rewind on Quantum Processes

A new technique for reversing the evolution of a quantum system could become a key tool in quantum information technology.

By **Ryan Wilkinson**

In the macroscopic world, physical processes seem to unfold in one time direction—for example, eggs can be scrambled but not unscrambled. However, in the quantum realm, processes can be reversed using so-called rewinding protocols. Now David Trillo at the Institute for Quantum Optics and Quantum Information, Vienna, and his colleagues have demonstrated such a protocol for two-level quantum systems [**1**, **2**]. Whereas previous approaches had a low probability of success, this one is ensured to work, opening the door for practical applications.

The new protocol works by making the target system evolve along a quantum superposition of different paths. In some paths, the system is allowed to progress freely; in the others, it is acted on by an unknown quantum operation. The subsequent interference of these paths causes the system to return to its initial state. Remarkably, this protocol requires no knowledge of the target system, its internal dynamics, or the applied operation. Moreover, the rewinding is optimally efficient and can reach an arbitrarily high probability of success.

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Trillo and his colleagues demonstrated their protocol using an intricate optical setup, in which they reversed the evolution of a two-level system in the form of a photon with two possible polarization states. They stress, however, that the approach is not restricted to photonic platforms. They suggest that this ability to return a quantum system to a past state with guaranteed success has implications for our understanding of quantum mechanics and could have applications in many areas of quantum information technology.

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REFERENCES

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