Filming quantic measurement for the first time

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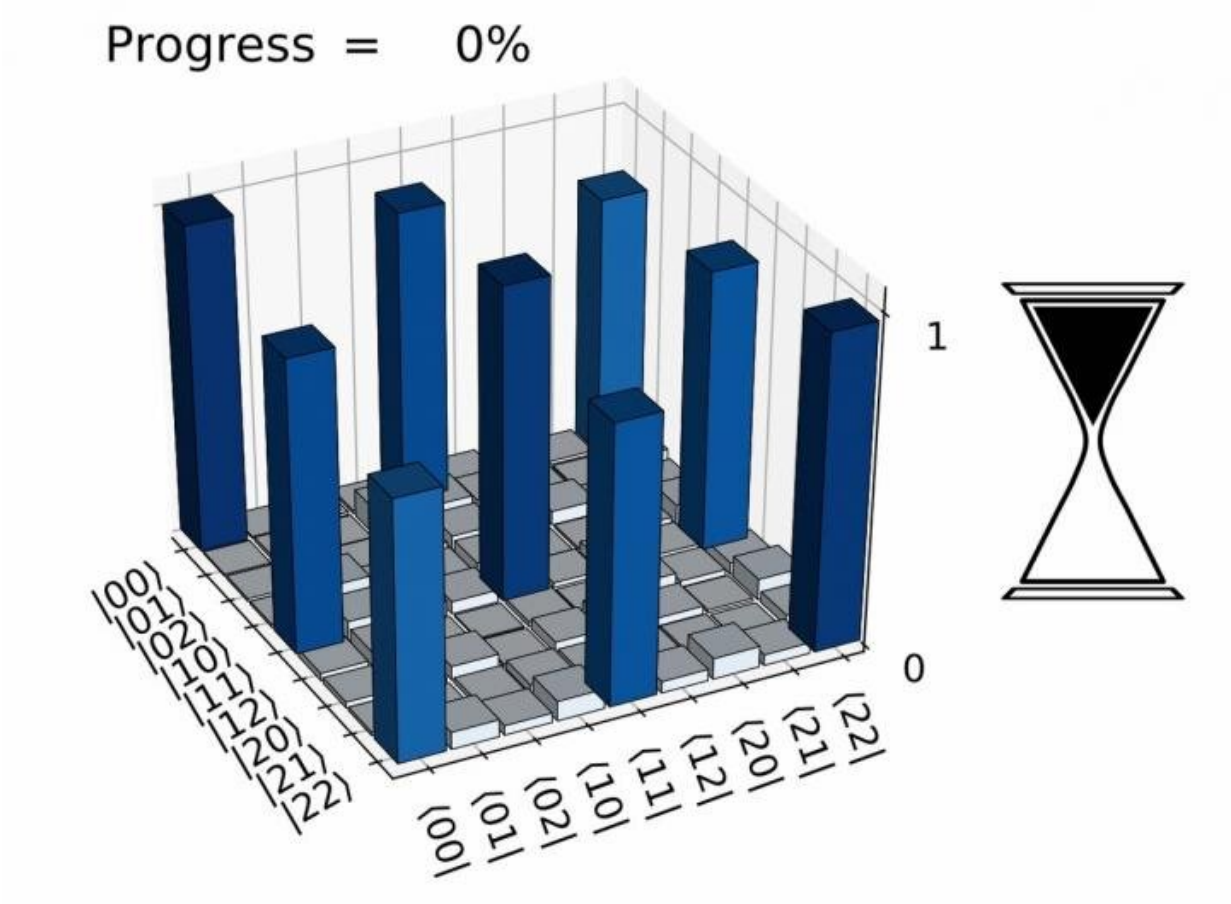


Animated GIF explaining the process. Credit: University of Sevile

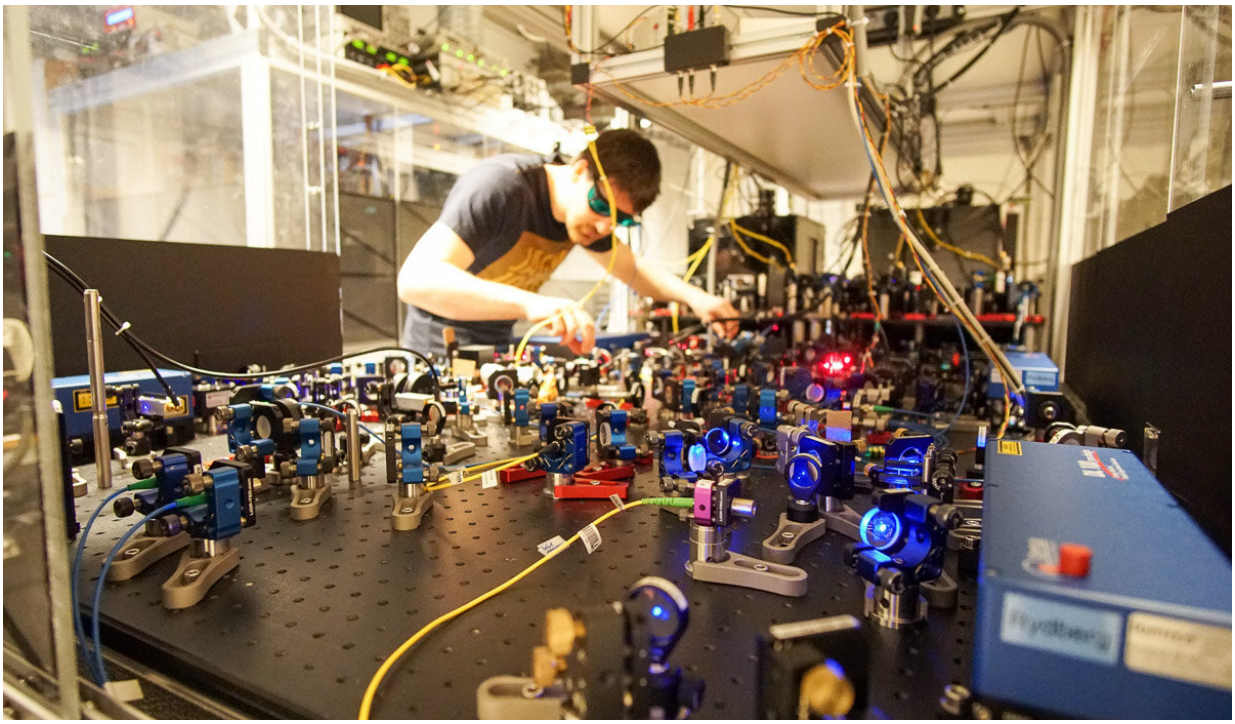
Quantum physics deals with microscopic systems such as atoms and light particles. It is a theory that makes it possible to calculate the

probabilities of the possible results of any measurement taken on these systems. However, what happens during the measurement was a mystery. A team of researchers from the University of Seville, the University of Stockholm (Sweden) and the University of Siegen (Germany) has, for the first time, managed to "film" what happens during the measurement of the quantum system.

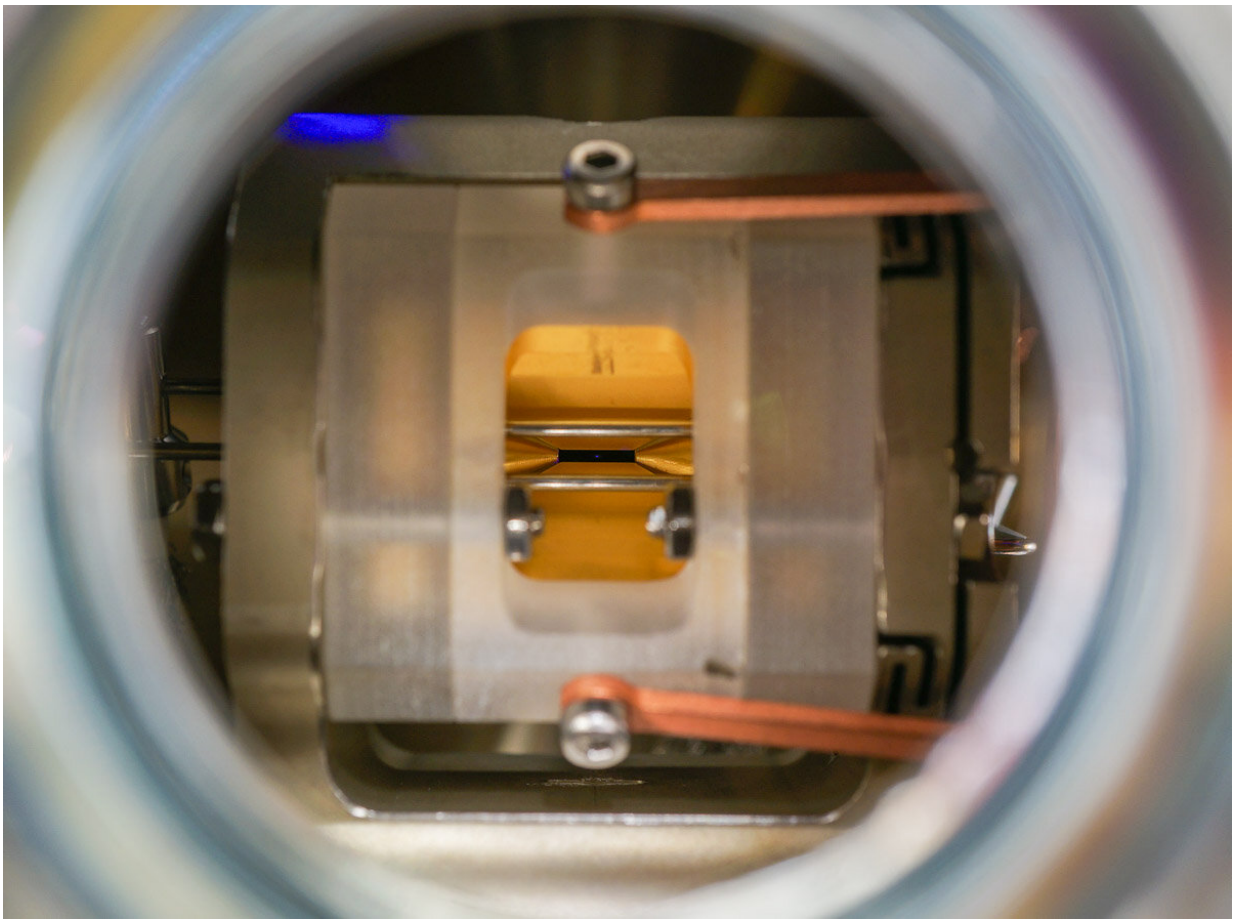
To do that, they used a strontium ion (an electrically-charged atom) trapped in an electrical field. The measurement of the ion lasts barely a millionth of a second but the researchers have managed to make a "film" of the process by reconstructing the quantum state of the system at different moments. The results confirm one of the most subtle predictions in quantum physics.

"The experiment is interesting for two reasons, according to the teacher Adán Cabello, of the Department of Applied Physics II at the University of Seville. "On the one hand, it shows the change of quantum state during a measurement is not instant—as many believe—but that it happens gradually." Also, "the experiment demonstrates that the quantum measurements that preserve quantum states with the maximum information are real processes that occur in nature and are not just theoretical idealizations."

The result of the experiment can be summarised in an animated GIF that shows was happens to the quantum state of the ion during this millionth of a second. The state can be visualised using a three-dimensional board. The heights of the towers indicate the degree of superposition of the possible quantum states. The film shows how, during the measurement, some of the superpositions are lost—and how loss is gradual—while others are preserved just as it has to happen in an ideal quantum measurement.



Working in the lab. Credit: Universidad de Sevilla



Credit: Universidad de Sevilla

More information: Fabian Pokorny et al, Tracking the Dynamics of an Ideal Quantum Measurement, *Physical Review Letters* (2020). DOI: 10.1103/PhysRevLett.124.080401

Provided by University of Seville