Measuring how long quantum tunneling takes

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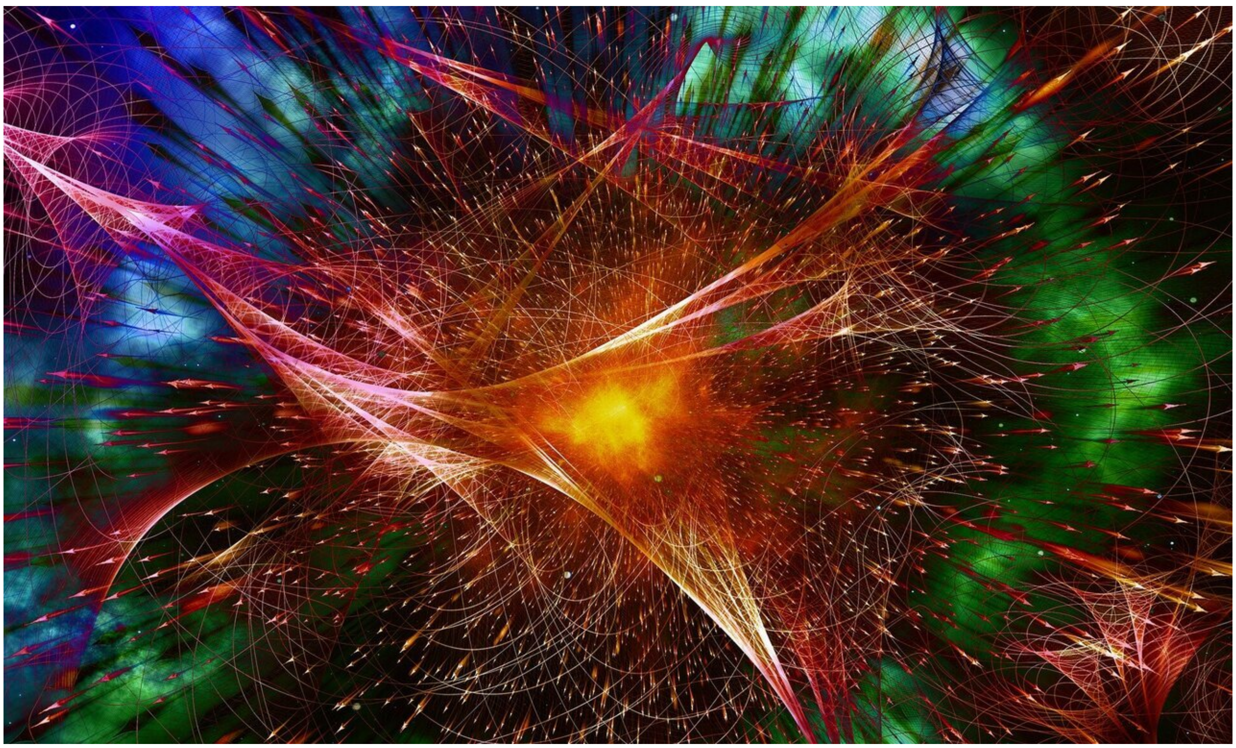

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A team of researchers at the University of Toronto has found a way to measure how long quantum tunneling takes to happen. In their paper published in the journal *Nature*, the group describes experiments they conducted and the result they found when attempting to measure how long quantum tunneling takes under certain circumstances.

In one sense, quantum tunneling is simple—it is a phenomenon in which a particle passes through an energy barrier despite lacking the energy to do so. Scientists do not really know how it works, but have found uses for it anyway—like making scanning tunneling microscopes. One factor of quantum tunneling that has been debated by physicists over the past century is how much time it takes for a particle to pass through an energy barrier.

The difficulty in answering this question lies in the definition of time itself, and how it applies to quantum tunneling. In this new effort, the researchers took a simplified approach to measuring how long it takes for one type of particle (a rubidium atom) to pass through a very specific kind of energy barrier (a laser beam). The "clock" in their experiments was the spin of the rubidium atoms used—since the duration of their spin is a known quantity, they can be used as clocks by measuring how much spin occurs while they are subjected to tests—such as passing through a laser beam. Thus, all the researchers had to do was note the current state of spin for the atom before it entered the beam and then measure it again when it exited.

Execution of the plan involved trapping a cloud of rubidium atoms using a laser beam and then using the same laser beam to move the atoms into the path of another laser beam—and measuring their spin on either side of the second beam. To make it easier to measure the spin of the atoms, the researchers first ultra-cooled the cloud before sending them through the energy barrier. Measurement of the change in spin showed the tunneling took approximately 0.62 milliseconds.

In further investigations, the researchers would like to learn more about the trajectory of the atoms as they move through the barrier—and they also note that some theories have suggested particles are able to move through a barrier without ever having passed through its interior.

More information: Ramón Ramos et al. Measurement of the time spent by a tunnelling atom within the barrier region, *Nature* (2020). DOI: 10.1038/s41586-020-2490-7