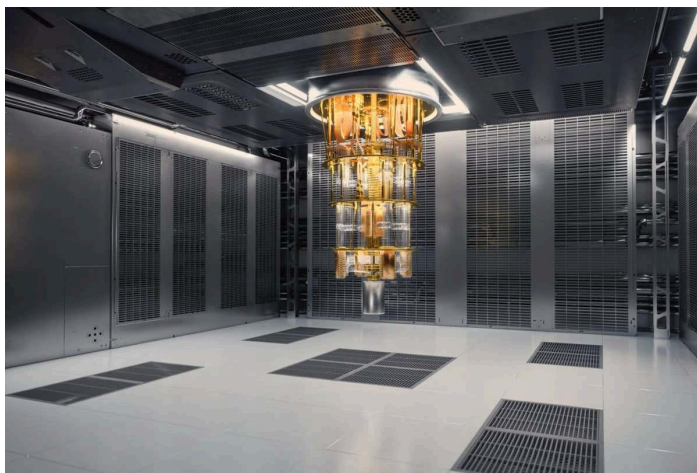


Quantum computer uses a time crystal as a control dial

Making a strange state of matter called a time crystal inside a quantum computer helped researchers stabilise a fragile quantum state inspired by Schrödinger's cat

By [Karmela Padavic-Callaghan](#) on February 7, 2024



Could quantum computers be made more stable using time crystals? John D/Getty Images

Time crystals can be used to stabilise fragile states within [quantum computers](#), which could one day give them an edge over traditional computers.

When Nobel laureate [Frank Wilczek first theorised](#) that time crystals exist in 2012, the idea was controversial because their defining characteristic is that they flip between two configurations forever without any energy input – a seeming violation of the laws of physics. Since then, however, several research groups have created time crystals in the lab, [including inside a quantum computer](#).

[Biao Huang](#) at the University of Chinese Academy of Sciences and his colleagues created a kind of control knob for their quantum computer using what is known as a discrete time crystal, a configuration that oscillates following a pattern in time – this is analogous to patterns in 3D space that atoms must arrange themselves in to make crystals such as table salt.

The qubits in this quantum computer are made from tiny circuits that perfectly conduct electricity and can be controlled with microwaves. Unlike in conventional computers where bits either have a value of 1 or 0, here the qubits' quantum states allow them to be equivalent to 1

and 0 simultaneously. Huang says that it is a bit like the famous thought experiment of Schrödinger's cat, which is simultaneously in a state of both "dead" and "alive" before its status is confirmed.

The researchers put the qubits into a special state called the Greenberger-Horne-Zeilinger (GHZ) state, in which they are all inextricably linked through [quantum entanglement](#).

Being able to make very large GHZ states – meaning they are comprised of lots of qubits – would push the limits of physicists' understanding of how quantum effects diminish for [bigger and bigger objects](#). It would also be useful because lots of quantum entanglement is a necessary ingredient for many quantum computing and [communication applications](#), says Huang. Past experiments, however, showed that the more qubits that comprise the GHZ state, the more fragile it gets – it becomes increasingly easy for [its special characteristic](#) to be destroyed by small disturbances in the quantum computer.

The researchers were able to minimise enough disturbances in their device to make a record-breakingly large GHZ state that included 60 qubits – 28 more than the previously "fattest" so-called cat state. But to make a similar state last longer, they turned to the discrete time crystal.

They hit the qubits with a specific sequence of microwaves, each of which changed qubits' states or made them interact. The microwave pulses also put these qubits in just the right states for their quantum properties to oscillate in time and form a time crystal.

"We used the structure of the discrete time crystal to construct a 'safe house' for sheltering the fragile GHZ states," says Huang. "As far as we know, this is the first practical application of a discrete time crystal. Our work tells people that time crystals are not only conceptually interesting but also have practical value."

The complicated microwave sequences the team used introduced some imperfections, so the experiment where the GHZ state was housed in a time crystal involved 36 qubits rather than 60. Yet, Huang says the state was less fragile than before.

The oscillation of the time crystal screens out disturbances that would normally make the GHZ state collapse into only one of its mixed parts, says [Francisco Machado](#) at Harvard University. While time crystals had been made in quantum computers before, the researchers used a new construction process to make theirs just right for stabilising the GHZ state, he says.

"This is very impressive experimental work and demonstrates great technical progress," says [Mario Krenn](#) at the Max Planck Institute for the Science of Light in Germany.

Reference:

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