Quantum world made and controlled by our hands.

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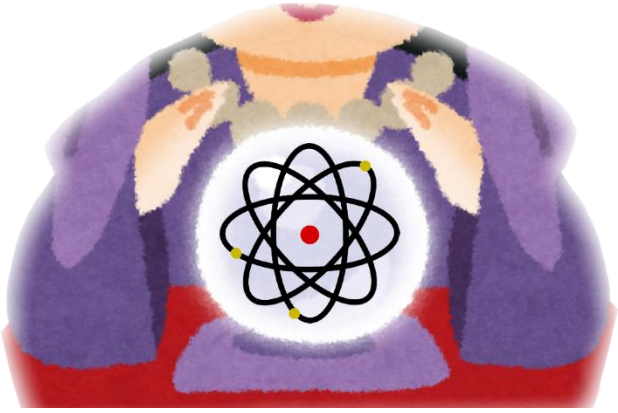

Can you imagine what happens in a very tiny and cold world, about smaller than micrometers and at a temperature near absolute zero? In such a world, sometimes counterintuitive phenomena occur, making us humans confused in understanding what is happening, so confusing that even Einstein was confused. These worlds are successfully described by quantum mechanics, which is one of the most important studies of physics in the 20th century.

Despite the strange phenomena quantum worlds bring, researchers have come to think that this effect might be useful to do something interesting. The idea of quantum computers is one of the most famous ambitions to take advantage of quantum worlds, first proposed by great physicist Richard Feynman in the 1980s. The idea stemmed from Feynman's belief that the principles of quantum mechanics could be used to address computationally hard tasks that conventional computers struggle with, and quantum computers are currently believed to have the potential to solve complex problems much more efficiently than conventional computers. Initially, the research focused on theory, and some of them could demonstrate the superiority of quantum computers for specific problems. However, the challenge lay in physically implementing the core element of quantum computers. That is a qubit.

In conventional computers such as laptops, information is stored in bits, which can represent either 0 or 1. On the other hand, a qubit, the quantum version of a bit, can exist in 0 and 1 simultaneously, thanks to the power of quantum mechanics. This unique property, known as superposition, can have the possibility to surpass conventional computers, which was Feynman's original idea.

To perform what is theoretically predicted about quantum computers, it is required to realize a qubit in a real-world implementation. Progress in this area was important since the successful realization of a qubit essentially meant making quantum computers a reality. However, it posed significant challenges due to the delicate nature of quantum systems and the need to protect them from environmental disturbances. The researchers had to come up with ideas to overcome those barriers. Finally, in 1999, Nakamura and his colleagues could realize physical implementation for a qubit, which opened the road to the dream computer [1]. In their research, they claimed that they were able to demonstrate controlling and manipulating their self-designed quantum device, making a significant milestone in the ability to create and manipulate the quantum world using solid-state devices.

To perform their experiments, Nakamura and his colleagues created a tiny electronic device made of aluminum. The device was so small scaled on the order of 1 um, enabling the researchers to observe quantum effects. However, to achieve their goal of seeing quantum effects, they had to fight against the disturbance coming from the environment around the device, since the quantum world is vulnerable to small distractions. To avoid those, they made an ingenuous plan for the design of the device. On top of that, they put a lot of thought into how to measure the quantum device.

In their experiment, by carefully applying voltage pulses to the device, they were able to observe the quantum phenomenon called coherent oscillations. This result means it is possible to control the quantum world made by humans, paving the way for the development of quantum computers.

The study conducted by Nakamura and his team served as a significant milestone in the advancement of quantum computing research. It provoked a huge interest among researchers in the physical implementation of quantum computers. Inspired by the groundbreaking paper, scientists became increasingly interested in improving the control of qubits and finding better ways to implement them.

The countless efforts of researchers have yielded remarkable results in improving the quality of qubits. Compared to 20 years ago, current qubits have approximately 100,000 times better quality. This enhancement in qubit quality has paved the way for integrating a higher number of qubits into a single chip. As a result, several companies and research institutions have made announcements about their own quantum computers, which can be accessed and utilized through cloud computing these days. This is surely an image that people 20 years ago could not believe in.

Moreover, some research studies have insisted that they confirmed that their quantum computers with their tens of qubits were better than conventional computers in specific problems. Although these claims of “quantum advantage” are controversial among scientific communities, they demonstrate the progress being made in the field and point towards exciting future achievements.

Besides the advancements in quantum computers, there has been another development in the application of artificial quantum devices. Researchers have explored the possibility of using these devices to measure and control other quantum materials. This line of research has already produced great successes and is expected to continue contributing to our understanding and usage of quantum technology.

These remarkable achievements in the field of quantum computers can be traced back to the initial breakthrough made by Nakamura and his team. Their work inspired quite a few interests and progress in the physical implementation of quantum systems. As researchers explore further into quantum technologies, we can expect even more fascinating advancements and discoveries in the future.

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<References>

[1] Y. Nakamura, Yu A. Pashkin, and J. S. Tsai. "Coherent control of macroscopic quantum states in a single-Cooper-pair box." *nature* 398.6730 (1999): 786-788.