Quantum computing could improve thanks to liquid electrons
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English translation

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When solving complex problems, classical computing as we know it is a binary system where bits can be at 1 or 0, choosing one state at a time. This would not be the best option when solving problems of great complexity, although luckily we have a solution. This would be to use quantum computing, which works with qubits and can be both 1 and 0, that is, both states at the same time. However, **quantum computing** is not perfect and has errors, but fortunately it has now been found that **electrons in liquid state** could **solve these problems**.

Quantum computing has proven to be able to solve highly complex operations at an incredibly fast speed, compared to the traditional binary system. However, not all are advantages, as quantum computing faces several problems. We have the case of quantum **decoherence**, which would cause a physical system to stop having quantum effects and become like classical computing. Here, all the advantages offered by this type of computing **would be lost** and therefore, **we must avoid this type of error at all costs**.

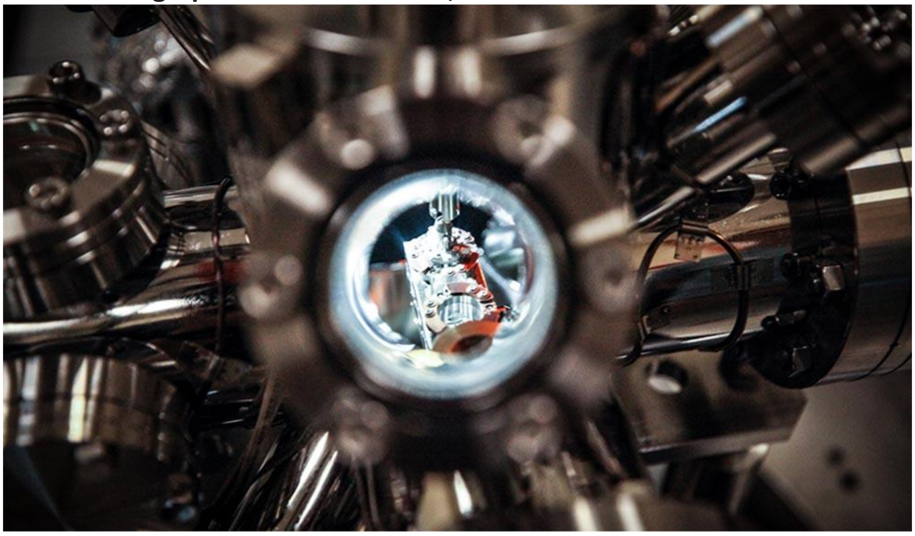
Electrons in liquid state are key to quantum science

Preventing coherence **errors** in quantum computing is a key factor in making sure it runs smoothly. Now, thanks to scientists at Nanyang Technological University in Singapore, a way to prevent these errors has been discovered, taking another step in the field of quantum computing. The key to doing this is to use **parafermions**, **clustered electrons that behave like liquids**. According to their experiment, they have managed to observe that electrons can have **strong interactions** with temperatures close to **-273 degrees Celsius**.

The orderly movement of electrons provides us with electricity, although if we analyze this pattern we would not find perfect cohesion. **Electrons have a negative electric charge and repel** each other, which results in quite a bit of chaos in this process. However, if the electrons behave like a **liquid**, **these conflicts are reduced** and a more orderly movement occurs until their destination. When they get electrons to behave in this way, it is called "**helical Tomonaga-Luttinger liquid**", a state where interactions between them are reduced.

This is directly related to quantum computing, as these electrons in liquid state **decrease errors in a quantum computing system**. All this would be improved if they were previously cooled to absolute zero, as they would slow down until they became almost immobile.

The famous graphene has been used, but at the atomic level



Continuing the experiment, the scientists used an **atomic-thick graphene substrate**. Next to this, crystals of the same thickness of **tungsten ditelluride** have been deposited. This is called "quantum spin Hall insulator", since it isolates gravity inside while having electrons on its outside. After mixing the two and cooling them to absolute zero, the researchers used a **microscope at a distance of one nanometer**. This is equivalent to a size less than that of a transistor used in hardware such as **GPUs**.

After this, it was observed that the electrons of the graphene and tungsten substrate increased the repulsion and a value of the Luttinger liquid of 0.21 to 0.33 was recorded. This would indicate the strength of the interactions and in the case of being a 1, it would mean that the interactions are the weakest. This spin property of electrons has been exploited by teams such as **IBM's Quantum One and Quantum Two**, which use **superconducting qubits**.

"When the Luttinger parameter is less than 0.5, the interactions are strong and the electrons are forced to perform a collective motion. This is the area in which **parafermions** are predicted," says Assistant Professor Weber.

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