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English translation

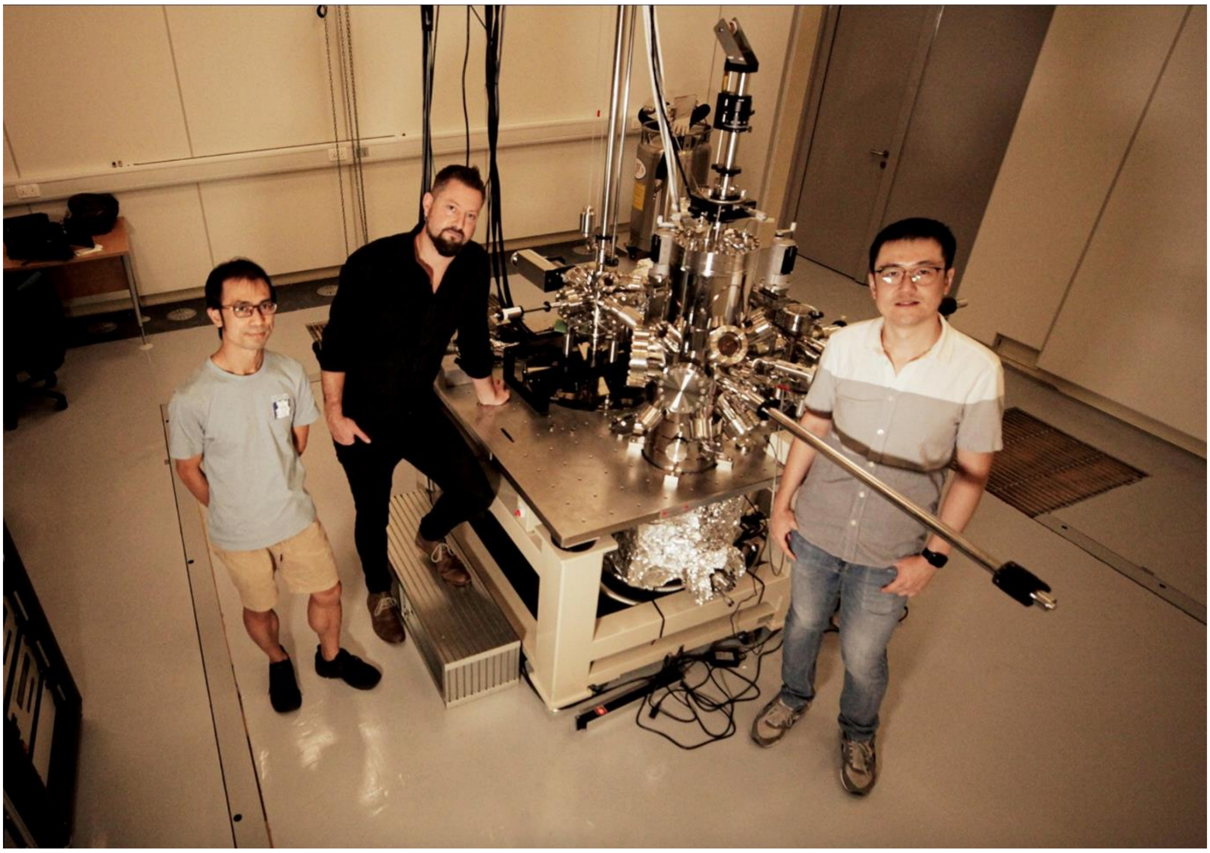
Quantum Computing Can Be Powered by Liquid-Like Electrons

The field of quantum computing may have received an increase in consistency and error prevention. in the form of parafermions: grouped electrons that behave like liquids in a special state of matter. Scientists from Nanyang Technological University in Singapore. They showed experimental results that they hoped would lead to parafermions when the electrons maintained temperatures close to absolute zero (-273 degrees Celsius). The research made a breakthrough by showing that there are conditions under which electrons can have strong interactions — something scientists have only theorized about so far.

The regular movement of electrons leads to what we know as electricity. But even when electrons are moving in this "regular" order, they don't actually move. Because they are negatively charged, electrons repel each other, tending to move in different directions (such as gases) one by one and haphazardly. They are similar to disabled drivers: they can reach their destination with several "bumps" along the way. But when electrons behave like a liquid, it's similar to replacing the distorted drivers with regular ones; Drivers who know and respect each other's limits, speeds, and directions to reduce conflicts and better achieve their goals.

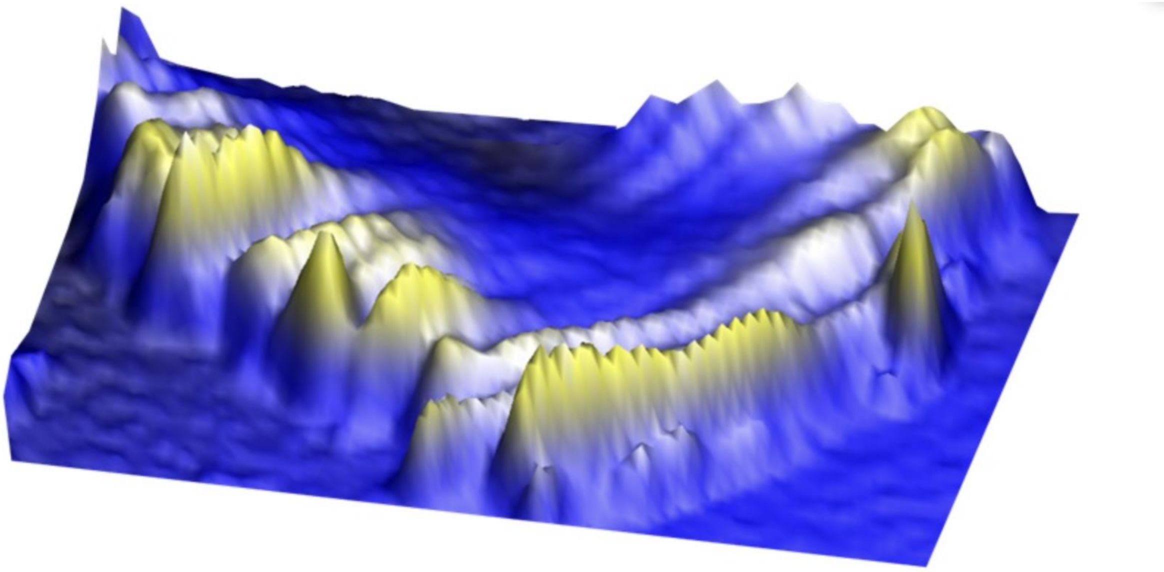
Of course, drivers like these are the subject of much theoretical thinking, but at least it has been experimentally proven that strong electron interactions exist.

When electrons are activated in what is known as the "helical Tomonaga-Luttinger fluid," there is less particle interaction and energy exchange between them and the system. This, in turn, reduces the amount of systemic and environmental interference that is often the cause of errors and collapsed quantum states in quantum systems. Electrons that were previously cooled close to absolute zero are also an important element, because they allow some materials to reach a superconducting state, where electrons pass through its surface without any electrical resistance, further reducing possible elements of environmental interference. Cooled to absolute zero (4.5 degrees Kelvin or -269 degrees Celsius in the experiment), the system forces the particles to slow down so that they become almost motionless.


From left to right: Dr. Que Yande, senior research fellow at Nanyang Technological University; Prof. Bent Weber, who led the research; and PhD student Jia Junxiang, the first author of the study, with a scanning tunneling microscope at the university. (Image credit: SPMS/NTU Singapore)

Electrons (and spin properties) have been used as quantum programmable particles for some time. Therefore, improvements in electron control that lead to less disruption mean fewer errors and better consistency; this means longer lifespan for true qubits that can store or process information. In fact, some quantum systems (such as IBM's Quantum One and Quantum Two) already use superconducting qubits.

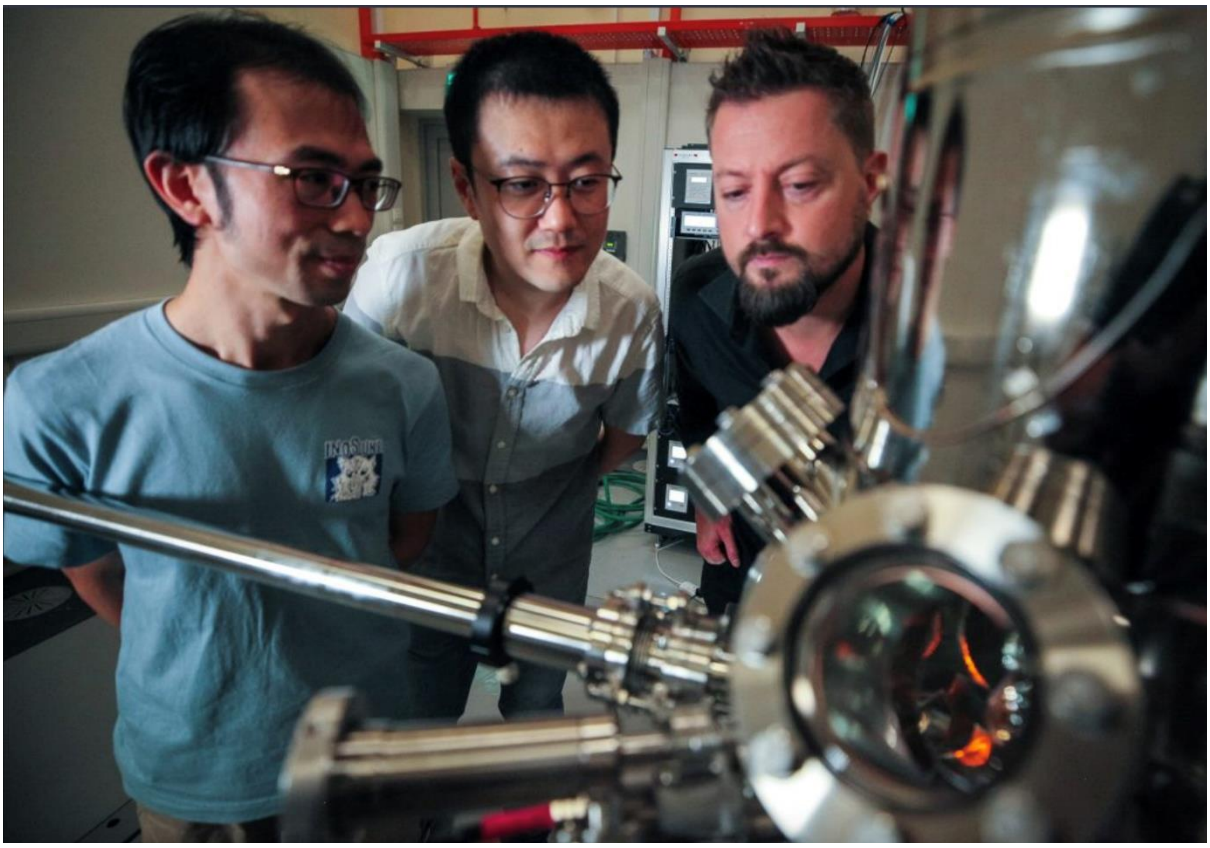
In this case, the scientists used an atom-thick graphene substrate in which they deposited atom-thick crystals of tungsten ditelluride: an almost two-dimensional material known as the "quantum spin Hall insulator," which in itself insulates gravity but has electrons on it. Outside. After piecing together the graphene/tungsten ditelluride substrate and cooling it toward absolute zero, the research team put it under a scanning tunneling microscope that was just a nanometer from its surface: smaller than a DNA strand and smaller than any transistor ever produced (even look at the ones powering the latest top graphics cards).



The fluctuations in the "electronic liquid" were examined by the atomically sharp end of a scanning tunneling microscope. It can also be a topographic image of the sea. (Image credit: SPMS/NTU Singapore)

The researchers noticed that when placed under the scanning tunneling microscope and cooled to absolute zero, the electrons in the graphene/tungsten substrate increased their thrust. Their thrust was so strong that the electrons were forced to move en masse due to the interaction between the repulsion field of each electron. The researchers recorded a Luttinger parameter in the range of 0.21 to 0.33. This parameter represents the strength of the interactions between particles; When it reaches 1, the interactions are at their weakest point.

When the luttinger parameter is less than 0.5, the interactions are strong and the electrons are forced into mass motion. This is the area where the initials are presumed to exist." "Since the Luttinger parameter can only vary from 0 to 1, this is a really remarkable range of variations," he continued. "Control of the Luttinger parameter at such low values has never before been observed in any helical Tomonaga-Luttinger fluid."



From left to right: Dr Que Yande, senior research fellow at NTU Singapore SPMS; PhD student Jia Junxiang, the first author of the study; and Asst. Prof. Bent Weber of the school who conducted the research with a scanning tunneling microscope at the university. (Image credit: SPMS/NTU Singapore)

The team now plans to further reduce temperatures by taking advantage of NTU Singapore's new Ultra-Low Vibration Laboratory, which was built earlier this year. The lab will allow experiments to be conducted at temperatures as low as 150 millikelvin (mK) — even closer to absolute zero, which should allow researchers to see the true testimony of stronger thrust between electrons and groups of the parafermions.

Interestingly, the researchers' approach seems to be somewhat linked to Microsoft's race to implement so-called topological qubits and their necessary (and still lacking in action) Majorana mods.

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