VOL. 36 AUG 2023

NTU Q

IS ROOM TEMPERATURE SUPERCONDUCTING QUANTUM COMPUTER NOW POSSIBLE?

Picture of LK-99.

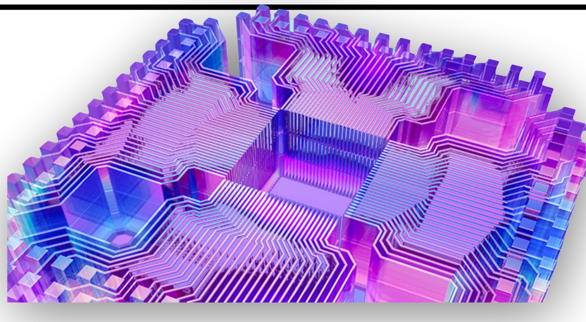
Very recently, on Friday July 28, a groundbreaking development in the field of superconductivity have shocked people all around the world. Researchers from South Korea discovered a new lead-based copper-doped material, LK-99, capable of exhibiting superconductivity at room temperature and pressure. The preprints appeared on the arXiv titled “The First Room-Temperature Ambient-Pressure Superconductor” claimed LK-99 has critical temperature 127°C (400K), greatly exceeding the previous record of -135°C. Labs around the world have since frantically racing to reproduce LK-99 of their own.

Few days later, two independent teams, one from the Shenyang National Laboratory for Materials Science and another led by Sinéad Griffin at Lawrence Berkeley, have conducted separate studies. Both teams utilized X-ray structural data of LK-99 and employed density functional theory (DFT) calculations to analyze its predicted behavior. Remarkably, their findings align closely, suggesting that LK-99 has the potential to be effective in practical applications.

Pioneering companies like IBM and Google have placed their bets on superconducting quantum computers, drawn by their fast gate time and scalability. However, one of the disadvantage is that they must be kept very cold (below 100mK), which can be expensive and inconvenient. Should the breakthrough in room temperature superconductors prove to be valid, it could signify a tremendous leap forward for quantum computing applications.

READMORE

HOW SUPERCONDUCTING QUBIT WORKS



In practice, although electrons and atoms provide reliable qubits, their properties are not easily modifiable, thus limiting their versatility. Making an artificial atom is one of the most popular way to overcome this problem. So what makes superconductor unique for making artificial atoms? Superconducting materials can conduct current without resistance when cooled below critical temperature. This is because two conduction electrons are pushed together by shifted positive nuclei, forming Cooper pairs. Most importantly, these coupled electrons need not obey the Pauli's exclusion principle, and can thus occupy lower conduction energy levels without limitation. These circuits thus produce no heat and dissipation when carrying electric current, allowing for control and measurement through physical operations like microwave and magnetic flux pulses.

The transmon qubit, a type of superconducting charge qubit, is realized by a superconductor LC circuit with Josephson junction as its inductor. Josephson junction behaves as a non-linear non-dissipating inductor, making the energy levels of the superconducting circuit unevenly spaced, i.e. anharmonic. The anharmonicity allow us to uniquely address the state of the qubit using microwave at the transition frequency. We can thus select two states, usually the ground state and first excited state, to represent $|0\rangle$ and $|1\rangle$ of a qubit.

READMORE

SELECTED EVENTS

Qiskit Quantum Explorers

Quantum explorers is a self-paced, game-based educational program. It is free to participate in and is meant to give participants a solid foundational understanding and proficiency in quantum computing!

計畫補助單位：MOST 科技部 Ministry of Science and Technology

IBM Quantum Computer Hub at National Taiwan University

Rm.711, Dept. of Physics /Center for Condensed Building

No. 1, Sec.4 Roosevelt Rd., Da’an Dist. Taipei City 106319, Taiwan

ntuq2018@gmail.com :+886 2-33669928 http://quantum.ntu.edu.tw/