

Reliable and extremely fast quantum calculations with germanium transistors

January 14 2020

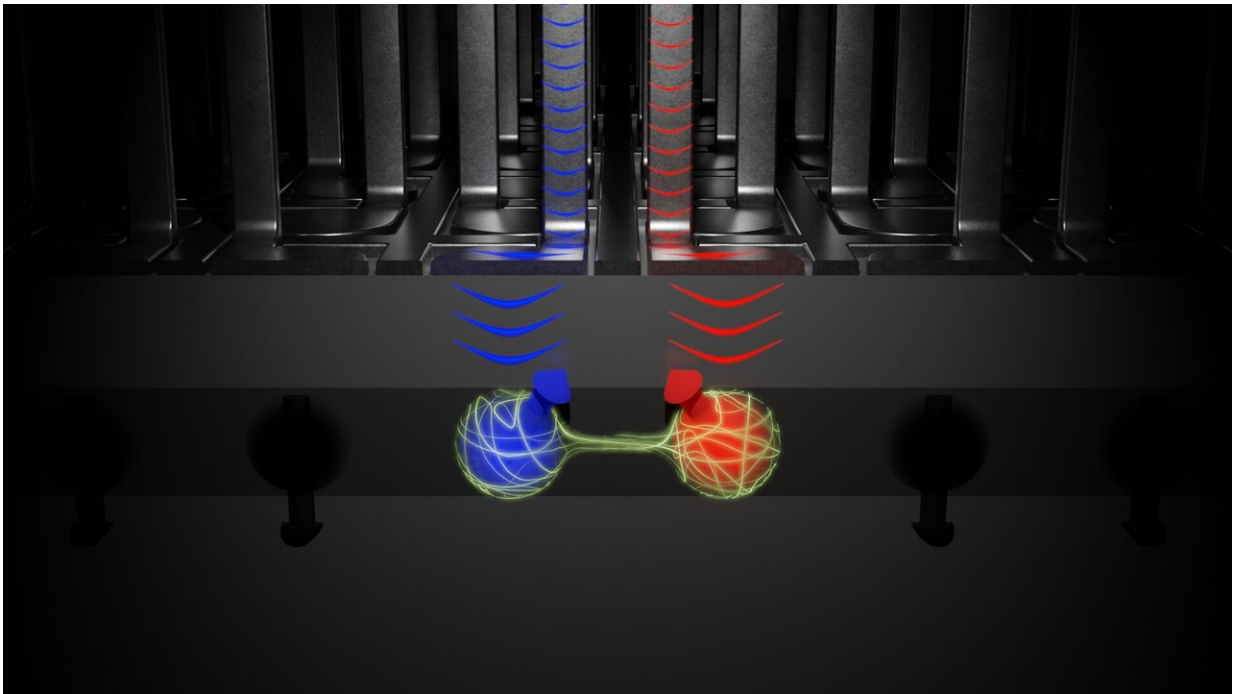


Illustration of two quantum bits made out of germanium transistors for a quantum computer. Credit: QuTech

Transistors based on germanium can perform calculations for future quantum computers. This discovery by the team of Menno Veldhorst is reported in *Nature*.

The development of quantum computing seems to be going very quickly.

The [building blocks](#) for such a [computer](#) are so-called [quantum bits](#). Over the past two decades, researchers around the world have studied new and existing systems to function as quantum bits, including [transistors](#). These tiny switches are present in billions on the chips of our computers, telephones and televisions.

"We have been working with transistors as the building blocks for a quantum computer for some time, now," says Nico Hendrickx, first author and Ph.D. student at QuTech. "Until now, however, it hasn't been possible to perform quantum calculations using only transistors. Other elements were needed, as well, and this provided a limitation for upscaling. We now show that a single transistor can function as a quantum bit by using germanium."

1947

"The very first transistor from 1947 was made of germanium. The whole semiconductor revolution, and thus our mobile phones and all other electronics, could, in theory, have been based on germanium instead of silicon," says principal researcher Menno Veldhorst. "After all, it was known in 1947 that germanium actually has better properties as a semiconductor than silicon. But it turned out that there were difficulties in manufacturing, which made silicon the material of choice for the [semiconductor industry](#)."



The team in the lab (from top to bottom, from left to right): Menno Veldhorst, Amir Sammak, Giordano Scappucci, Nico Hendrickx and David Franke. Credit: Ernst de Groot for QuTech

Platform

"We also already knew that germanium could be an excellent material for making quantum bits, but the challenges in manufacturing have long remained a bottleneck," says Hendrickx. "We've now solved these problems, and after that, it went very quickly. In the article in *Nature*, we show that we can perform reliable and extremely fast quantum calculations with germanium."

"This means that germanium has matured in about a year's time from

constructing the material to a platform on which quantum calculations can be carried out," says Veldhorst. This development is unprecedentedly fast, and that is extremely promising on the road to a functional quantum computer."

Research groups all over the world are developing germanium as a material for quantum bits. "QuTech is the leading party in this field. We have been quick to develop [germanium](#) quantum technology and are optimistic about the possibilities for further upscaling. In addition, we are already looking at how we can collaborate with partners from industry, with the great advantage that our methods fit in well with the existing technology that provided the basis for our current information age," concludes Veldhorst.

More information: N. W. Hendrickx et al. Fast two-qubit logic with holes in germanium, *Nature* (2020). [DOI: 10.1038/s41586-019-1919-3](https://doi.org/10.1038/s41586-019-1919-3)

Provided by QuTech

Citation: Reliable and extremely fast quantum calculations with germanium transistors (2020, January 14) retrieved 28 April 2024 from <https://phys.org/news/2020-01-reliable-extremely-fast-quantum-germanium.html>

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