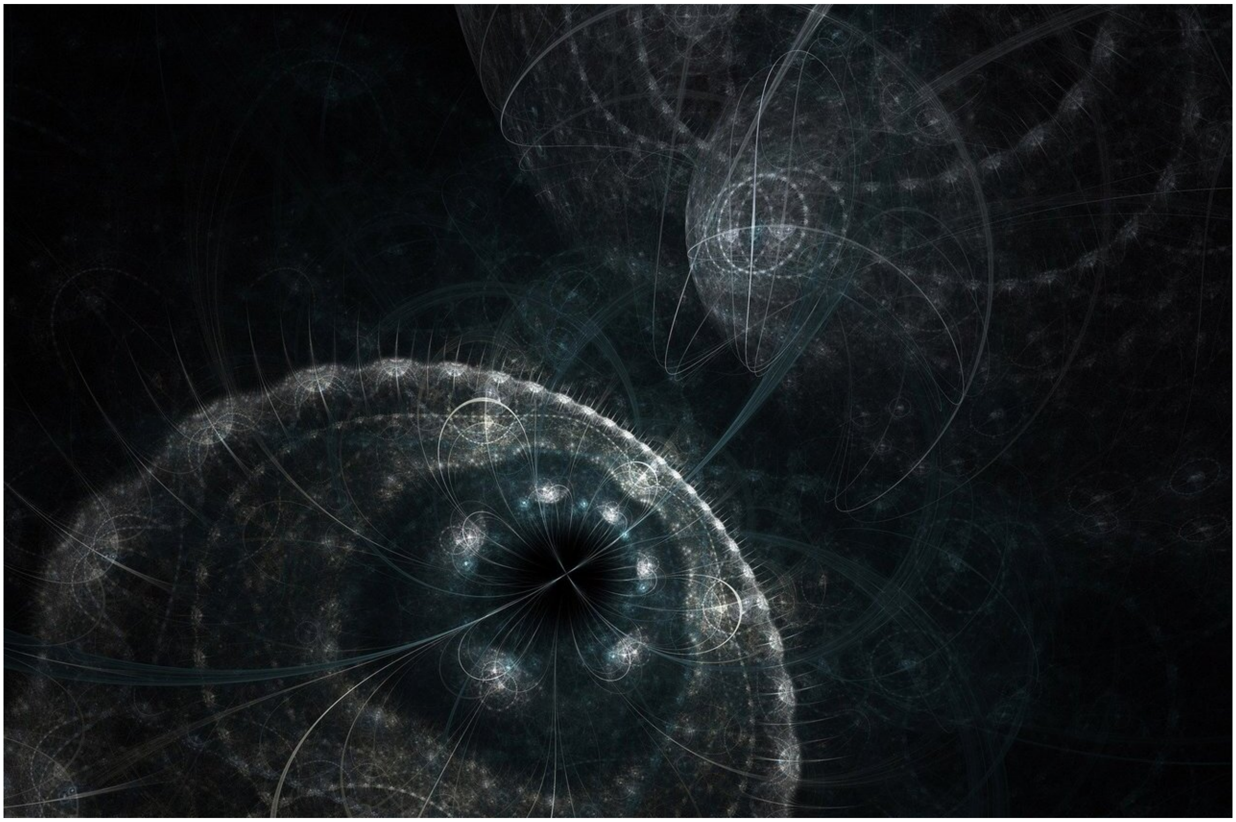
New research unlocks properties for quantum information storage and computing

June 6 2019



Credit: CC0 Public Domain

Researchers at Rensselaer Polytechnic Institute have come up with a way to manipulate tungsten diselenide (WSe2) —a promising two-dimensional material—to further unlock its potential to enable faster, more efficient computing, and even quantum information processing and storage. Their findings were published today in *Nature Communications*.

Across the globe, researchers have been heavily focused on a class of two-dimensional, atomically thin semiconductor materials known as monolayer transition metal dichalcogenides. These atomically thin semiconductor materials—less than 1 nm thick—are attractive as the industry tries to make devices smaller and more power efficient.

"It's a completely new paradigm," said Sufei Shi, assistant professor of chemical and biological engineering at Rensselaer and corresponding author on the paper. "The advantages could be huge."

Shi and his research team, in partnership with staff from the clean room facilities within the Center for Materials, Devices, and Integrated Systems at Rensselaer, have developed a method to isolate these thin layers of WSe2 from crystals so they can stack them on top of other atomically thin materials such as boron nitride and graphene.

When the WSe2 layer is sandwiched between two boron nitride flakes and interacts with light, Shi said, a unique process occurs. Unlike in a traditional semiconductor, electrons and holes strongly bond together and form a charge-neutral quasiparticle called an exciton.

"Exciton is probably one of the most important concepts in light-matter interaction. Understanding that is critical for solar energy harvesting, efficient light-emitting diode devices, and almost anything related to the optical properties of semiconductors," said Shi, who is also a member of the department of electrical, computer, and systems engineering at Rensselaer. "Now we have found that it actually can be used for quantum information storage and processing."

One of the exciting properties of the exciton in WSe2, he said, is a new quantum degree of freedom that's become known as "valley spin"—an expanded freedom of movement for particles that has been eyed for quantum computing. But, Shi explained, excitons typically don't have a long lifetime, which makes them unpractical.

In a previous publication in *Nature Communications*, Shi and his team discovered a special "dark" exciton that typically can't be seen but has a longer lifetime. Its challenge is that the "dark" exciton lacks the "valley-spin" quantum degree of freedom.

In this most recent research Shi and his team figured out how to brighten the "dark" exciton; that is, to make the "dark" exciton interact with another quasiparticle known as a phonon to create a completely new quasiparticle that has both properties researchers want.

"We found the sweet spot," Shi said. "We found a new quasiparticle that has a quantum degree of freedom and also a long lifetime, that's why it's so exciting. We have the quantum property of the 'bright' exciton, but also have the long lifetime of the 'dark' exciton."

The team's findings, Shi said, lay the foundation for future development toward the next generation of computing and storage devices.

At Rensselaer, Shi was joined on this publication by postdoctoral scholar Zhipeng Li and graduate students Tianmeng Wang and Zhen Lian, all from the department of chemical and biological engineering. This research was also done in close partnership with the National High Magnetic Field Lab and other research institutions.

More information: Zhipeng Li et al, Emerging photoluminescence from the dark-exciton phonon replica in monolayer WSe2, *Nature Communications* (2019). DOI: 10.1038/s41467-019-10477-6

Provided by Rensselaer Polytechnic Institute

Citation: New research unlocks properties for quantum information storage and computing (2019, June 6) retrieved 18 April 2024 from https://phys.org/news/2019-06-properties-quantum-storage.html