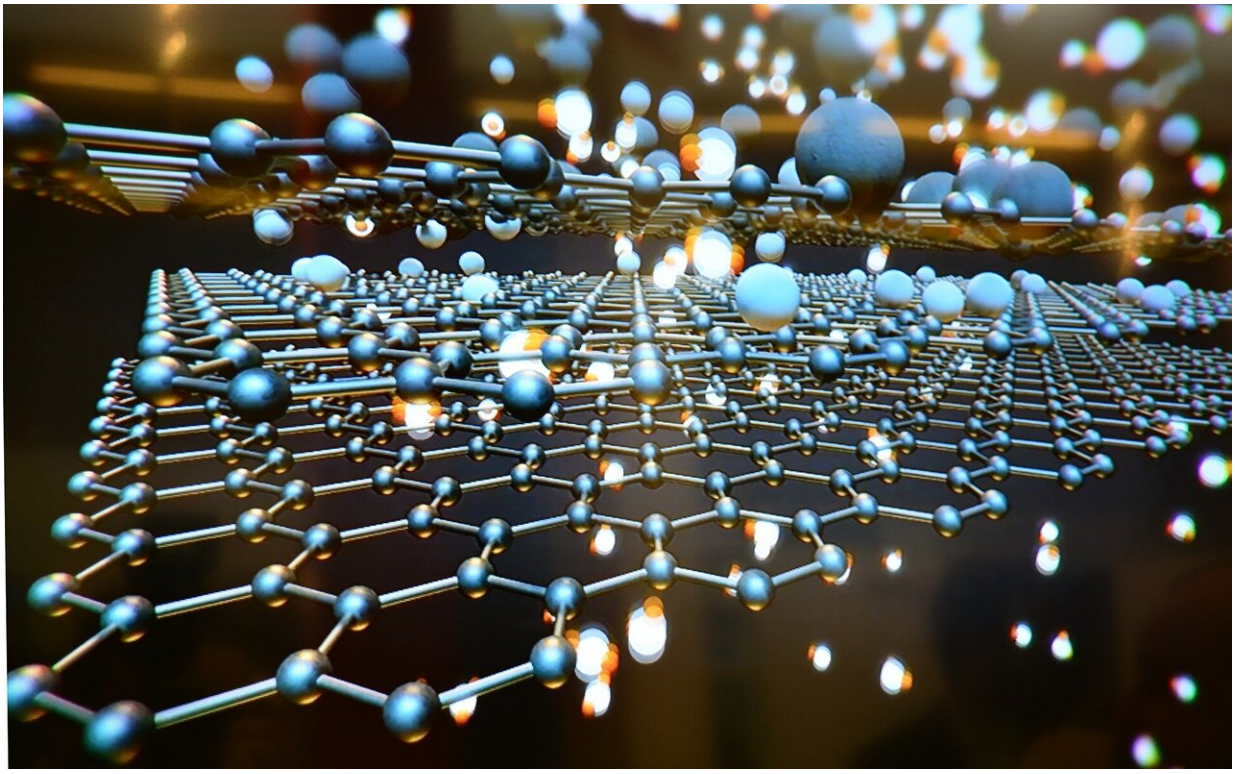
Researchers expand search for new state of matter

April 6 2020, by Bob Whitby



Credit: CC0 Public Domain

A recent discovery by University of Arkansas physicists could help researchers establish the existence of quantum spin liquids, a new state of matter. They've been a mystery since they were first proposed in the 1970s. If proven to exist, quantum spin liquids would be a step toward

much faster, next-generation quantum computing.

Scientists have focused attention and research on the so-called Kitaev-type of spin liquid, named in honor of the Russian scientist, Alexei Kitaev, who first proposed it. In particular, they have looked extensively at two materials—$RuCl_3$ and Na_2IrO—as candidates for this type. Both have small quantum spin numbers.

"Traditional candidates are pretty limited to only these two," said Changsong Xu, a researcher in the Department of Physics and first author of a paper published in the journal *Physical Review Letters*.

In their recent work, U of A physicists have greatly expanded the number of materials that might be candidates as Kitaev quantum spin liquids by looking at materials with higher quantum spin numbers, and by putting materials under physical strain to tune their magnetic states.

"Suddenly, we realize there are dozens of candidates we can propose," said Xu.

Quantum spin liquids are defined by their unusual magnetic arrangement. Magnets have a north and south pole, which combined are called dipoles. These are typically produced by the quantum spin of electrons. Inside a magnetic material, dipoles tend to all be parallel to each other (ferromagnetism) or periodically alternate their up and down direction (antiferromagnetism).

In the case of hypothetical quantum spin liquids, dipoles aren't as well ordered. Instead, they exhibit unusual ordering within a small distance of each other. Different ordering creates different types of spin liquids.

Xu, along with Distinguished Professor of Physics Laurent Bellaiche and colleagues in China and Japan, used computational models to predict a

Kitaev quantum spin liquid state in materials such as chromium iodide and chromium germanium telluride. The work, which was supported by grants from the Arkansas Research Alliance and the Department of Energy, will give researchers many more materials to study in a search to prove the existence of quantum spin liquids, said Xu.

More information: Changsong Xu et al. Possible Kitaev Quantum Spin Liquid State in 2D Materials with S=3/2, *Physical Review Letters* (2020). DOI: 10.1103/PhysRevLett.124.087205

Provided by University of Arkansas