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Discovery of new material is key step toward more powerful computing

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A new material created by Oregon State University researchers is a key step toward the next generation of supercomputers.

Those "quantum computers" will be able to solve problems well beyond the reach of existing computers while working much faster and consuming vastly less energy.

Researchers in OSU's College of Science have developed an inorganic compound that adopts a crystal structure capable of sustaining a new state of matter known as quantum spin liquid, an important advance toward quantum computing.

In the new compound, lithium osmium oxide, osmium atoms form a honeycomb-like lattice, enforcing a phenomenon called "magnetic frustration" that could lead to quantum spin liquid as predicted by condensed matter physics theorists.

Corresponding author Mas Subramanian, Milton Harris Professor of Materials Science at OSU, explains that in a permanent magnet like a compass needle, the electrons spin in an aligned manner - that is, they all rotate in the same direction.

"But in a frustrated magnet, the atomic arrangement is such that the electron spins cannot achieve an ordered alignment and instead are in a constantly fluctuating state, analogous to how ions would appear in a liquid," Subramanian said.

The lithium osmium oxide discovered at OSU shows no evidence for magnetic order even when frozen to nearly absolute zero, which suggests an underlying quantum spin liquid state is possible for the compound, he said.

"We are excited about this new development as it widens the search area for new quantum spin liquid materials that could revolutionize the way we process and store data," Subramanian said. "The quantum spin liquid phenomenon has so far been detected in very few inorganic materials, some containing iridium. Osmium is right next to iridium in the periodic table and has all the right characteristics to form compounds that can sustain the quantum spin liquid state."

Arthur Ramirez, condensed matter physicist at the University of California, Santa Cruz, one of the co-authors in the paper, noted that this compound is the first honeycomb-structured material to contain osmium and expects more to follow.

Ramirez also noted that this study demonstrates the importance of multidisciplinary collaboration involving materials chemists and condensed matter physicists engaged in synthesis, theory and measurements to tackle emerging science like quantum spin liquid.

The next step for Subramanian's team is exploring the chemistry needed to create various perfectly ordered crystal structures with osmium.

The National Science Foundation is funding the research through its DMREF program: Designing Materials to Revolutionize and Engineer our Future. Findings were published today in *Scientific Reports*.

The concept of quantum computing is based on the ability of subatomic particles to exist in more than one state at any time.

Classical computing relies on bits - pieces of information that exist in one of two [states](), a 0 or a 1. In [quantum computing](), information is translated to [quantum]() bits, or qubits, that can store much more information than a 0 or 1 because they can be in any "superposition" of those values.

Think of bits and qubits by visualizing a sphere. A bit can only be at either of the two poles on the sphere, whereas a qubit can be anywhere on the sphere. What that means is much more information storage potential and much less energy consumption.

Provided by Oregon State University

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