Building block for quantum computers more common than previously believed

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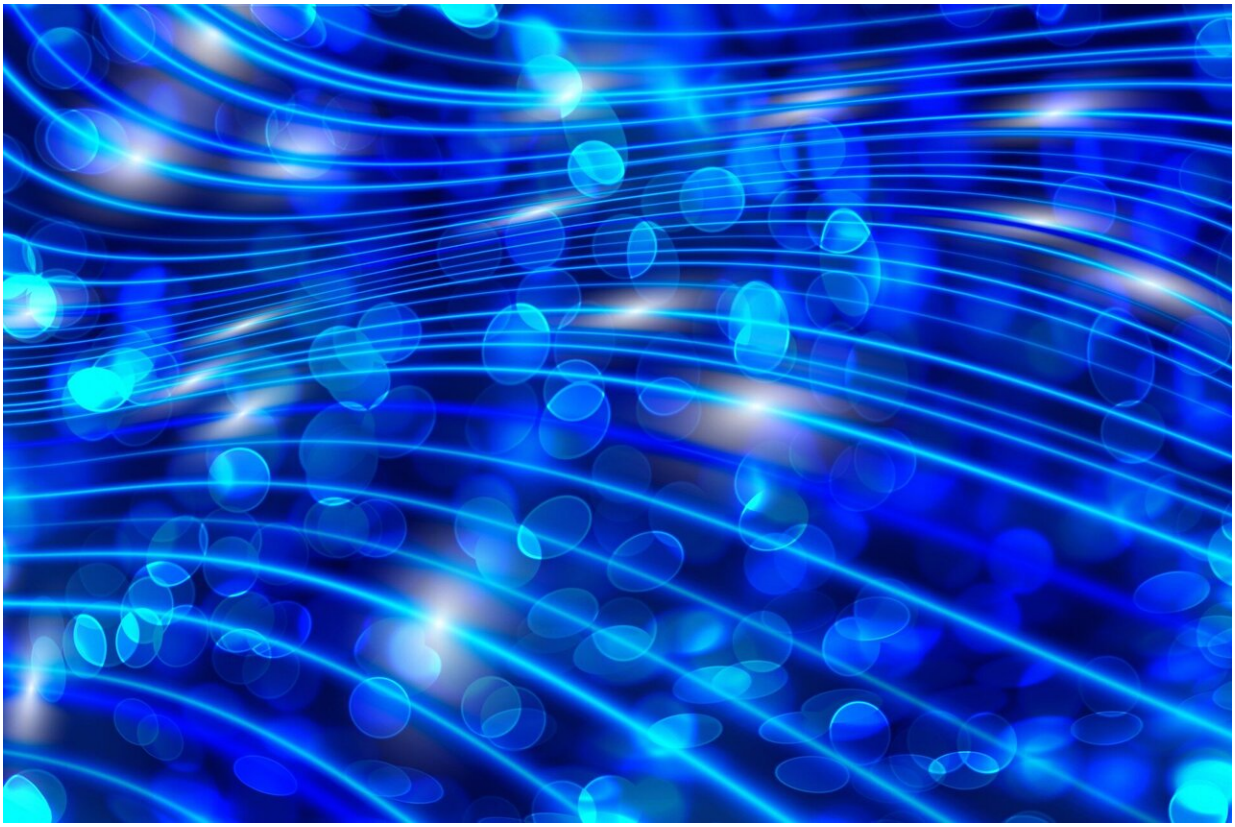

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Advanced, fault-tolerant quantum computers may be closer to reach than scientists have projected, according to recent advances reported by Johns Hopkins researchers in a new study recently published in *Physical*

Review Letters.

The researchers built on their previous study about the search for basic building blocks of materials called superconductors with spin-triplet pairing, which were considered to be very rare. The rare property of spin-triplet pairing can give rise to an exotic electronic state called Majorana fermions, which can be used as fault-tolerant quantum bits, a basic working unit for prospective quantum computers that may eventually replace the noise-prone prototypes under development by Google and IBM.

A major roadblock is the rarity of the triplet-pairing superconducting material. To make things even more difficult, superconductivity and its underlying pairing mechanism are notoriously known as the few physical properties that cannot be calculated or predicted. The material search must carry on largely in a painstaking trial-and-error fashion, unheeded by any theoretical guidance.

The new finding focuses on a particular type of crystal, a noncentrosymmetric superconductor. Unlike most common crystalline materials that demonstrate inversion symmetry, that is, a crystal structure that is indistinguishable with its inversion image, this special class of materials breaks inversion symmetry, exhibiting an inversion image distinctive from itself. This low symmetry is predicted to indicate the presence of the otherwise elusive spin-triplet pairing. These "lowly" materials comprise a potential rich mine of quantum-computer-building materials. However, decisive evidence of spin-triplet pairing in these crystals has been lacking.

Using a new experimental method, the Hopkins researchers examined a prototype of this superconductor, α-BiPd. Their experiment found the presence of the highly unusual half-integer quantization of magnetic flux in polycrystalline rings of α-BiPd, which comprises smoking-gun

evidence for spin-triplet pairing.

This new finding paints a promising and encouraging future when more building-block materials emerge from materials with low symmetry. The enriched material portfolio could accelerate the development of fault-tolerant quantum computers, and in the farther future, usher in general-purpose quantum computing that could reach ordinary people.

More information: Xiaoying Xu et al. Spin-Triplet Pairing State Evidenced by Half-Quantum Flux in a Noncentrosymmetric Superconductor, *Physical Review Letters* (2020). DOI: 10.1103/PhysRevLett.124.167001

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