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News

'Overwhelming' evidence for monopoles

Multiple experiments reveal materials with single points of north and south.

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One of those facts of life that physicists live with is that every magnet ever made has a north and a south pole. When researchers try to split the two, they simply get another magnet with poles of its own. There's no reason that should be the case, and for decades they have been on the hunt for a single pole, or monopole.

Researchers may have found the once elusive monopole. *Alamy*

"People have been looking for monopoles in cosmic rays and particle accelerators — even Moon rocks," says Jonathan Morris, a researcher at the Helmholtz Centre for Materials and Energy in Berlin.

Now Morris and others have found the strongest evidence yet for magnetic monopoles, in small crystals about the size of an ear plug. When the crystals are chilled to near absolute zero, they seem to fill with tiny single points of north and south. The points are less than a nanometre apart, and cannot be measured directly. Nevertheless, Morris and other physicists believe they are there. They make their case in two papers published today in the journal *Science*[1,2], and other work published on the pre-print server arXiv.org[3,4].

The crystals are made of materials known as 'spin ice', because their atoms are arranged in a way similar to those in water ice. Specifically, its atoms sit at the vertices of four-sided pyramids. Each atom behaves like a tiny bar magnet, and when the crystal is cooled to near absolute zero, the atom-magnets align. Sometimes, three of the pyramid's four corners align together and create a region of north or south magnetic charge at the centre of the pyramid. The charge isn't attached to any physical object, but it behaves just as a monopole would.

Unquestionable evidence?

Theoretical work had shown that monopoles probably exist, and they have been measured indirectly. But the *Science* papers are the first direct experiments to record the monopole's effects on the spin-ice material. The papers use neutrons to detect atoms in the crystal aligned into long daisy chains[1,2]. These daisy chains tie each north and south monopole together. Known as 'Dirac strings', the chains, as well as the existence of monopoles, were predicted in the 1930s by the British theoretical physicist Paul Dirac. Heat measurements in one paper[1] also support the monopole argument.

The two, as yet unpublished, papers on arXiv add to the evidence. The first provides additional observations[3], and the second uses a new technique to determine the magnetic charge of each monopole to be 4.6×10^{-13} joules per tesla metre[4]. All together, the evidence for magnetic monopoles "is now overwhelming", says Steve Bramwell, a materials scientist at University College London and author on one of the *Science* papers[2] and one of the arXiv papers[4].

"This sort of measurement makes monopoles more substantial, at least in my mind," says Peter Schiffer, a researcher at Pennsylvania State University in University Park. Whether the monopoles will be seen directly is another question, says Schiffer. Like any charged particle, opposites attract, and the north and south poles typically cluster together less than a nanometre from each other. That makes them extremely hard to detect individually. But, Schiffer says, "I'm very hesitant to say that anything is impossible."

Even without directly seeing one, Bramwell says that he is certain that the monopoles are there. "I don't think anybody could question it after this flurry of papers," he says.

References

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