Discovery of fastest ever magnetic wave propagation

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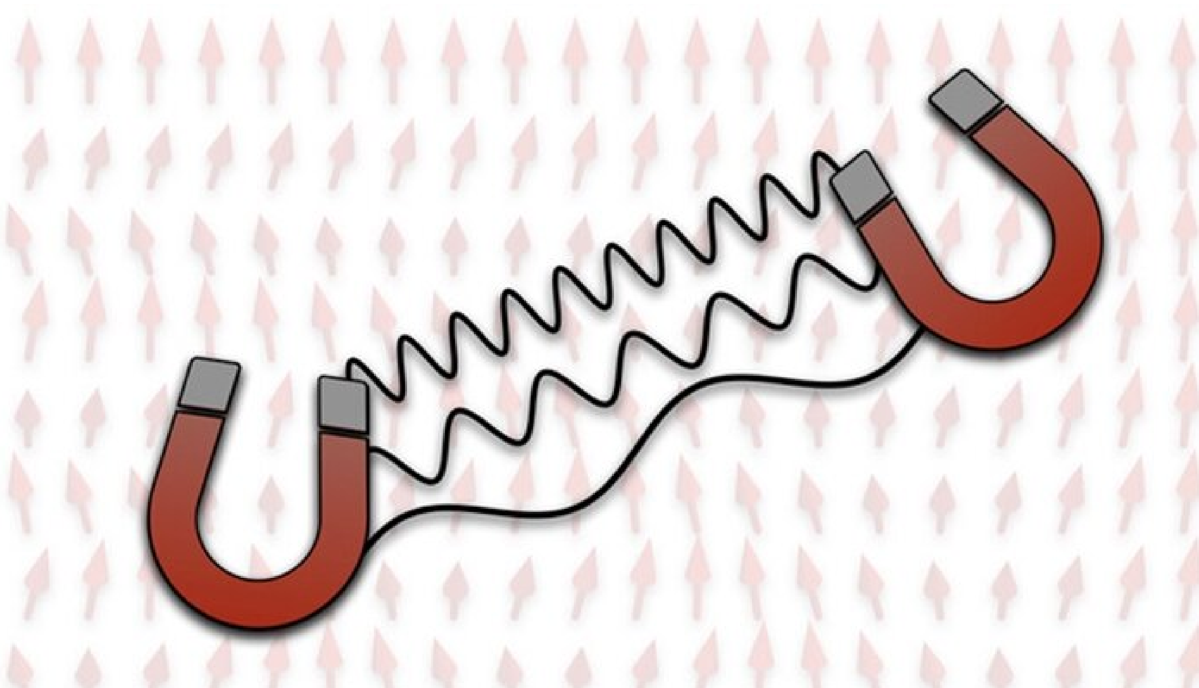

Credit: Radboud University

Like light waves, magnetic waves move through materials at a fixed maximum velocity. However, at the smallest possible length scale (nanometres) and the shortest possible time scale (femtoseconds), magnetism behaves differently. Physicists at Radboud University have discovered that magnetic waves with very short wavelengths can propagate up to 40% faster than previously thought. This supermagnonic propagation offers opportunities for even faster, smaller and more energy-efficient ways of data processing in future computers. The research will be published in *Physical Review Letters* on 25 August.

"The concept is comparable to supersonic aircrafts, which move faster than the maximum speed of sound waves. We therefore call these fastest magnetic waves supermagnonic," explains physicist Johan Mentink. Thanks to a new theoretical methodology inspired by machine learning, the researchers managed to perform calculations on two-dimensional magnets. These calculations revealed that the smallest magnetic waves can travel up to 40% faster than the maximum propagation speed. "Thanks to the machine learning simulations by colleague Giammarco Fabiani and the analytical calculations by Master's student Martijn Bouman, we now understand why these supermagnonic magnetic waves can exist."

Faster, more energy efficient and smaller

In today's computers, information is transferred from A to B by electrons. However, the speed of this information transfer has its limits. In addition, there is an energy loss due to the resistance electrons experience along the way. Alternatively, light pulses can be used for information transfer, as is done in fiber internet, for example. Information transfer using light is faster and more energy efficient.

"However, our objective lies beyond that," Johan Mentink says. "We are looking for a way to make data transfer faster, more energy-efficient and smaller. Light waves are fast, but the wavelength of light is quite long. In order to find smaller solutions, we will have to look at shorter waves: like magnetic waves, for example."

Being faster, smaller and more efficient is vital for future computers. Consider, for example, the huge data centers in our country that already today use a significant part of our power grid's capacity: this consumption will only increase in the future. Johan Mentink: "Our research has shown that, in theory, data transfer using supermagnonic motion can be even faster than was thought possible. However, we do not yet know exactly how magnetism works at the smallest length scales and shortest time scales. In order to eventually use magnetism for data processing in practice, we must first understand the underlying fundamental physics. This research pushes the boundaries of our knowledge and takes us one step closer."

More information: G. Fabiani et al, Supermagnonic Propagation in Two-Dimensional Antiferromagnets, *Physical Review Letters* (2021). DOI: 10.1103/PhysRevLett.127.097202

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