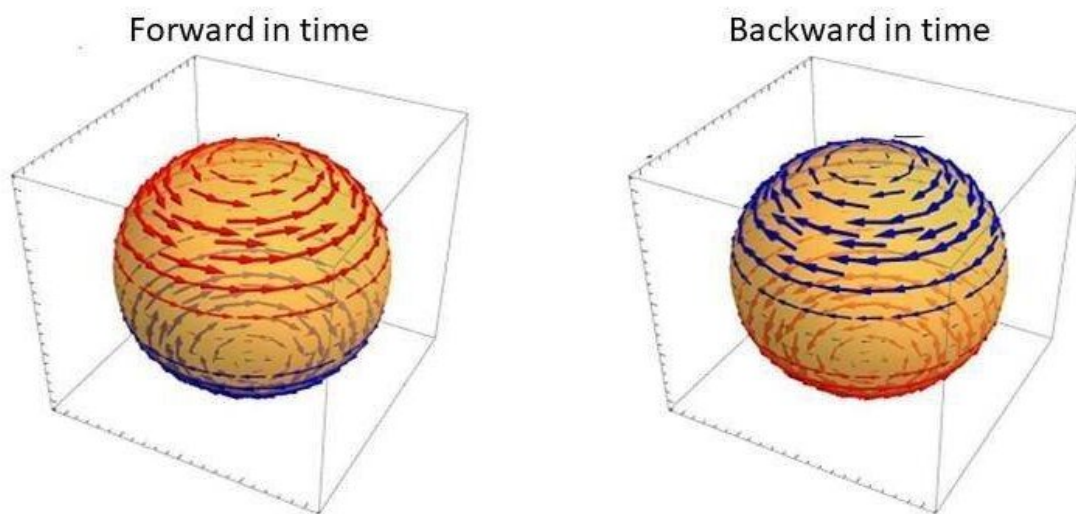


# Superconductors with 'zeitgeist' – when materials differentiate between the past and the future

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Magnetic fields inside a superconductor with broken time-reversal symmetry: Red and blue arrows illustrate the direction and strength of the internal magnetic fields for forward and backward time development. Credit: Hans-Henning Klauss

Physicists at TU Dresden have discovered spontaneous static magnetic

fields with broken time-reversal symmetry in a class of iron-based superconductors. This exceptional property calls for new theoretical models and may become important in quantum computing. The research results have recently been published in the scientific journal *Nature Physics*.

What happened yesterday and what will happen tomorrow are usually two different and quite independent matters. The past and the future of human life are not symmetric and therefore not reversible. In physics, this is different. The fundamental forces of nature in [elementary particles](#), atoms and molecules are symmetric with respect to their development in time: Forwards or backwards makes no difference, scientists call this a [time-reversal symmetry](#).

For decades this [symmetry](#) was also found in all [superconductors](#). Superconductors are materials which can conduct electrical currents at low temperatures without energy dissipation. One of their major applications is the efficient generation of strong magnetic fields, for example in magnetic resonance imaging (MRI) diagnosis. Approximately 99% of all known superconducting materials are time-reversal symmetric.

However, for some years, physicists have been discovering new superconductors which break time-reversal symmetry. To explain these observations, the basic mechanism of superconductivity, which has been known for more than 75 years, had to be modified considerably. Only these novel superconductors are able to spontaneously generate constant internal magnetic fields. This can lead to new applications, for example in quantum computing devices.

An international research team led by Dr. Vadim Grinenko and Prof. Hans-Henning Klauss from the Institute of Solid State and Materials Physics at TU Dresden discovered this new magnetic state with broken

time-reversal symmetry in iron-based superconductors. The synthesis of this versatile class of intermetallic compounds is comparatively simple. Therefore, these iron-based superconductors have an enormous potential for applications.

"In our study, we show that the iron-based superconductors discovered more than twelve years ago continue to reveal new quests for [fundamental research](#) as well as chances for new applications," states Prof. Hans-Henning Klauss.

**More information:** V. Grinenko et al. Superconductivity with broken time-reversal symmetry inside a superconducting s-wave state, *Nature Physics* (2020). [DOI: 10.1038/s41567-020-0886-9](https://doi.org/10.1038/s41567-020-0886-9)

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