# New combination of materials could speeds up computers

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Researchers at Uppsala University have discovered a new combination of materials that paves the way for faster and more effective storage in electronic devices like computers and smartphones. What researchers discovered is that the so-called magnetic damping can be made extremely small, eliminating energy losses in the dynamics of magnetic materials.

The material identified is a binary metallic ferromagnetic alloy of cobalt and iron with damping approaching the magnitude of $10^{-4}$. Damping this low has previously only been observed for metalloids or magnetic insulators, such as certain iron oxides.

Magnetic materials have proven to be very effective for the storage and transfer of data and were the natural successors to the punch card that was first used in the early 1700s. Subsequent developments, including magnetic tape and hard discs, enabled an explosion in information technology and today about 70 percent of all data is stored in magnetic media.

Thus far, we have been able to create micrometre-sized magnetic storage devices and achieved transfer speeds in the order of nanoseconds to meet today's storage needs, with data transfer in the magnitude of 100 petabytes (1,000,000,000,000,000 bytes) a day. To continue to meet advanced storage needs, we need smaller and faster devices and this requires either a new technology for storage and/or the discovery of new magnetic materials.

Uppsala researchers have discovered just such a new magnetic material in the iron-cobalt alloy, and found that damping can be used to achieve maximum energy-efficient data transfer inside the material.

The damping in a magnetic material can be compared with the friction in a hockey puck, which glides along the ice, and which stops after a while due to resistance against the surface. The damping parameter in magnetic materials can be likened here to the coefficient of friction between the hockey puck and the ice.

The phenomenon of low damping in iron-cobalt can be explained by a unique property in the internal electronic structure, in which the damping is proportional to the number of electronic states at the highest occupied energy level.

This new discovery on low damping in the iron-cobalt alloy, along with the fact that the material is easy to produce, is magnetic even at room temperature, and that both iron and cobalt are common elements, can lead to this material becoming a standardised reference material for comparison in the hunt for new and even better alloys.

The cooperation between experiment and theory is very successful in this area of research, and the published study demonstrates the importance of collaboration in meeting the challenges new technologies place on the materials.

The published study provides a new and fundamental understanding of damping mechanisms, which enables theoretic predictions of new and even more energy-efficient materials, among both metals and metalloids, in which damping could be even lower than in the now-identified iron-cobalt alloy.

Contributors to the study, which was published in *Nature Physics* on 16

May, include Danny Thonig, Olle Eriksson and Olof Karis at the Department of Physics and Astronomy at Uppsala University. The research is based on an international collaborative effort involving both theoretic calculations and experimental studies.

**More information:** Martin A. W. Schoen et al. Ultra-low magnetic damping of a metallic ferromagnet, *Nature Physics* (2016). DOI: 10.1038/nphys3770