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Title

The Spinning Magnet (2018)

Permalink

<https://escholarship.org/uc/item/4vj6815t>

Journal

SCIENCE, 359(6377)

ISSN

0036-8075

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Publication Date

2018

Peer reviewed

GEOMAGNETISM

Electrical chaos

A candid portrait of the scientists studying Earth's declining magnetism warns of potential peril if the poles swap places

By **Bruce Buffett**

Earth's magnetic field can be approximated as a dipole with north and south magnetic poles slightly misaligned with the geographic poles. This field protects the environment from the harsh conditions of space, yet

its strength has been declining since Carl Friedrich Gauss first devised a method to measure the absolute intensity in the 1830s.

Fluctuations in the rate of decline are small compared with the average trend, suggesting that the dipole might vanish in less than 2000 years. This trend has led some researchers to speculate that our planet may be entering the early stages of a magnetic reversal. The outcome would be a substantial lowering of our protective shield.

The last time the north and south poles flipped orientation was about 780,000 years ago. The remoteness of this event in time limits what we have been able to infer about it, but the available geological record suggests that the magnetic field remained in a weakened state for 10,000 years or more until it was finally reestablished in the opposite orientation. Should a similar scenario play out today, the weak magnetic field would wreak havoc on our power grids and other infrastructure.



The Spinning Magnet
Alanna Mitchell
Dutton, 2018. 333 pp.

The prospect of an impending magnetic reversal sets the backdrop for Alanna Mitchell's new book, *The Spinning Magnet*, which begins with a historical tour of the theory of electricity and magnetism. She also recounts the story of Bernard Brunhes, a French physicist who, in 1906, was the first to suggest that Earth's magnetic field had once been in the opposite polarity. His conclusions were based on the magnetization acquired by certain minerals in rocks as they are heated and cooled through the "Curie point" (the temperature at which a material develops permanent magnetism from a state of induced magnetism).

At that time, it was easier to believe that the rocks were faulty recorders of the ambient magnetic field than to imagine the colossal change required to flip the polarity of Earth's magnetic field. As a result, Brunhes's ideas languished. By the middle of the 20th century, however, magnetic reversals had become widely accepted, having played an important role in the development of the theory of plate tectonics.

At this point in Mitchell's retelling, the focus of the narrative sharpens on the question of an impending reversal of Earth's magnetic poles. She interviews leading researchers in the field of geomagnetism and describes their efforts to understand the processes that govern the evolution of Earth's magnetic field. New satellite observations are offering fresh insights. She also interviews space scientists to understand how charged particles from the

Power systems are vulnerable to solar flares (shown) and storms when magnetic fields are weakened.

Sun and beyond interact with the magnetic field and how the present-day magnetic field shields our modern electrical infrastructure.

Recent examples of failures in this protective barrier (*I*) serve to highlight the problem. A large solar storm in March 1989 sent high levels of charged particles streaming toward Earth. These particles impinged on the magnetic field and induced electric currents through power grids in Quebec, Canada. The ensuing blackout affected 6 million customers. A reduction in the field strength would allow charged particles to penetrate deeper into the Earth system, causing greater damage with even modest solar storms. A substantial and sustained collapse of the magnetic field during a reversal would likely end our present system of power distribution.

Throughout the book, there is a clear and effective attempt to cast a spotlight on the individuals who have contributed to our understanding of Earth's magnetic field. Mitchell has a sharp eye for mannerisms and a vivid way of bringing personalities to the page. Her explanations are aimed at a nontechnical audience, and the analogies she uses to describe complex scientific ideas are always entertaining. For example, a crowded washroom at a "beer-soaked" sporting event serves as the starting point for an illustration of Pauli's exclusion principle. Her enthusiasm for the book's subject matter shines throughout.

There is little doubt that the magnetic field will reverse again. In the meantime, *The Spinning Magnet* gives readers a nontechnical description of electromagnetism and a measured assessment of the possible consequences for our modern world if it does so in the near future. ■

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10.1126/science.aar4944

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Science

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Science **359** (6377), 751.
DOI: 10.1126/science.aar4944

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