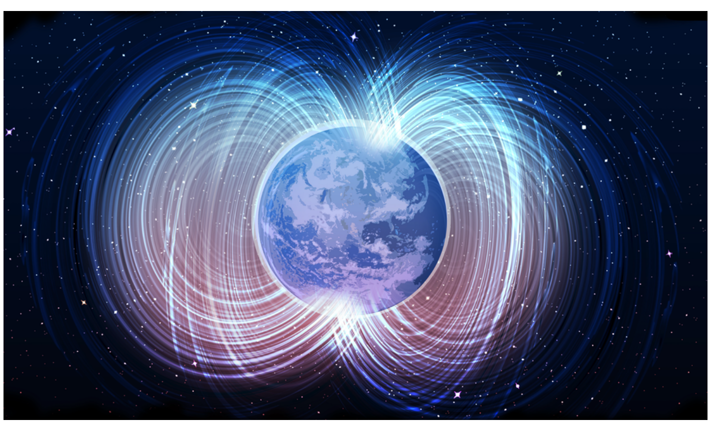
Attempt to Harness Energy from Earth's Rotation

Experiments support a controversial proposal to generate electricity from our planet's rotation by using a device that interacts with Earth's magnetic field.

By **Michael Schirber**

"It seems crazy," says Chris Chyba of Princeton University, talking about the hollow magnetic cylinder he has built to generate electricity using Earth's magnetic field. The cylinder doesn't move—at least not in the lab—but it rotates with the planet and is thus dragged through Earth's magnetic field. "It has a whiff of a perpetual motion machine," Chyba says, but his calculations show that the harvested energy comes from the planet's rotational energy. He and his colleagues now report that 18 microvolts (μV) are generated across the cylinder when it is held perpendicular to Earth's field [**1**]. Next they have to convince other scientists that the effect is real.

Chyba became interested in electricity generation about a decade ago while studying a possible warming mechanism in moons moving through a planet's magnetic field. He wondered if a similar effect might occur for objects on Earth's surface.

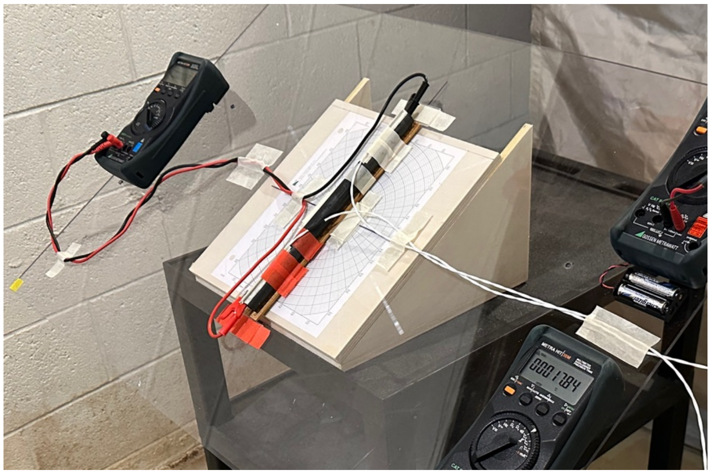


Attractive planet. Earth's magnetic field might potentially allow the harvesting of energy from the planet's rotation, according to new experimental results.
Credit: helenos/stock.adobe.com

At first glance, it seems impossible. One can calculate the magnetic force: The electrons in a metal object located in a Princeton lab, for example, are moving at 350 meters per second through the local magnetic field of 45 microtesla, giving a force per charge of about 10 millinewtons per coulomb. But those electrons will quickly rearrange on the surface of the metal so as to create an electric field of 10 millivolts per meter that exactly cancels the magnetic force. Chyba realized, however, that there could be situations where the electrons can't arrange themselves in a magnetic-force-canceling pattern.

One noncanceling situation is in a hollow cylinder made of manganese-zinc ferrite. This material is both a magnetic shield and a weak conductor—two essential properties for allowing a small voltage to build up on the cylinder when positioned properly in Earth's magnetic field. At least that was the idea that Chyba and Kevin Hand of the Jet Propulsion Laboratory in California proposed in 2016 (see **Focus: Electric Power from the Earth's Magnetic Field**).

Criticisms of that proposal appeared shortly afterward, some based on theoretical arguments [**2**] and others involving experimental tests [**3**]. Chyba and Hand defended their proposal with more theory [**4**], but they knew that an experimental demonstration was necessary. Chyba's brother, Thomas Chyba, an applied physicist in New Mexico contributed to this effort.



Field harvesting. The cylinder is positioned on an inclined surface so that it is perpendicular to both Earth's magnetic field and the direction of Earth's rotational motion. Sensors record the voltage between the cylinder's ends. The experiments were conducted in the dark to avoid contaminating the signal through the photoelectric effect.
Credit: C. Chyba/Princeton University

The researchers acquired a 30-cm-long, 2-cm-wide, hollow, manganese-zinc-ferrite cylinder and orientated it along the north–south direction at an angle of 57° with respect to the ground. This position was perpendicular to both Earth's magnetic field and the direction of Earth's rotational motion, an arrangement the researchers predicted would give the maximum voltage. They placed an electrode at each end of the cylinder and recorded the voltage. For comparison, they also took voltage measurements with the cylinder rotated by 90° (a zero-voltage orientation) and by 180° (a reversed voltage orientation).

In interpreting the data, the team had to deal with a temperature-dependent phenomenon called the Seebeck effect, which causes a small voltage to develop when a material is hotter on one end than the other. The researchers found that the Seebeck effect could account for some of the voltage that they measured. But they showed that there was an additional signal of 18 μV that depended on the orientation of the cylinder. This signal did not appear when the researchers tested several control cylinders, including a solid manganese-zinc-ferrite cylinder, for which their theory predicted no effect. They concluded that this extra voltage was generated by motion through Earth's magnetic field.

Chyba says the next step is for an independent research team to try to reproduce the results. If confirmed, he imagines that the setup could be optimized for power generation. He speculates that many miniature cylindrical components could be connected in series to produce a useful amount of voltage.

Yong Zhu, a microelectronics expert from Griffith University in Australia, is not convinced by the evidence. "There are so many factors that can produce microvolt signals," he says, such as stray capacitance and eddy currents. Ruling out all these possibilities will require more experimental evidence, Zhu says.

Carlo Rovelli, a theoretical physicist from Aix-Marseille University in France, is more open to the idea. He notes that energy is conserved for an electric charge moving in a uniform magnetic field, which seems to rule out the effect. But since the charges in the experiments are moving in a solid material, Rovelli says, this argument is not relevant. "Maybe there is a subtler version of the argument that rules out this possibility; I do not know," he says. "In any case, it is a very interesting story."

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REFERENCES

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