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First Glance: Scientists Catch Waves Growing in Near-Earth Space

New measurement shows the growth of waves that can impact Earth's magnetic shield and influence space weather.

MILWAUKEE, Wis.—When Captain America uses his shield to defend himself from the forces of evil, energy beams and bullets bounce off, allowing Captain America to save the day. Earth has its own shield, in the form of our planet's magnetic field, that protects us from the hot, charged material called "plasma" constantly being hurled at us by the sun.

When this fast-moving plasma hits Earth's magnetic shield, a bow shock is formed (Figure 1). Just like the curve of water that bends to the side in front of a moving ship, the bow shock is where hot plasma is deflected to the side, leaving us on Earth mostly unaffected. A very small portion of the plasma, however, bounces straight back towards the sun.

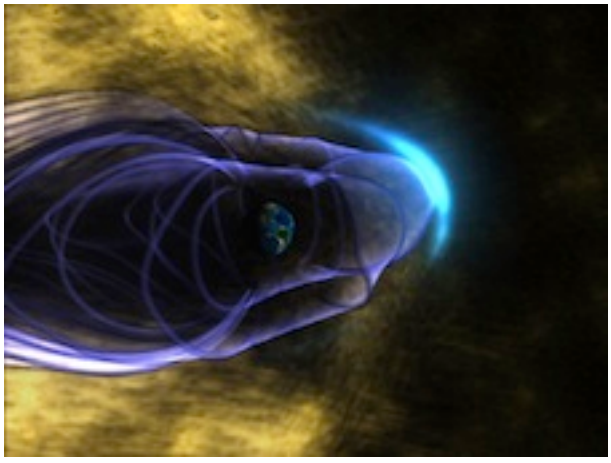

Figure 1: Artist's conception of Earth's magnetic fields in purple, with the bow shock on the right in bright blue. Waves generated from particles reflecting off the bow shock have been detected more clearly than ever before. Credit: Walt Feimer (HTSI)/N

These reflected particles interact with the plasma coming from the sun and make waves. The waves get carried with the plasma towards Earth, making it through the shield where they reach the region of space near our planet.

For the first time, scientists at the University of California, Los Angeles and the Max Planck Institute for Plasma Physics in Germany have been able to see these waves grow in the region of space where they are formed. They did so using satellites that only recently moved into a prime spot for the measurement. Before 2010, a five-spacecraft mission called THEMIS was orbiting Earth. In 2010, two of the spacecraft split off and started orbiting the moon, and the mission was renamed ARTEMIS. When the moon passes between the Earth and sun, ARTEMIS sees the small portion of particles that bounce back from the bow shock; these particles are responsible for generating the waves.

"The two ARTEMIS spacecraft are ideally located for this measurement," said Seth

Dorfman, the lead author of the study. “Close to the bow shock, the waves can come from many places at once, but it's easier to identify the wave source near the moon. This enables a clear measurement of the waves.”

These waves are not just a curiosity—they can affect us here on Earth. When the waves run into the region of space around Earth, they can cause disturbances in Earth's magnetic field all the way to the ground. Strong disturbances or “space weather” may damage our sensitive infrastructure, such as communication satellites and power grids. Much like advances in weather forecasting lets us know when to evacuate before a hurricane, studies of how these waves behave may help us protect our satellites and power grids from space weather damage.

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Abstract

QI2.00004 First Satellite Measurement of the ULF Wave Growth Rate in the Ion Foreshock

Session QI2: Turbulence/Waves
3:00 PM–5:00 PM, Wednesday, October 25, 2017
Room: 102ABC