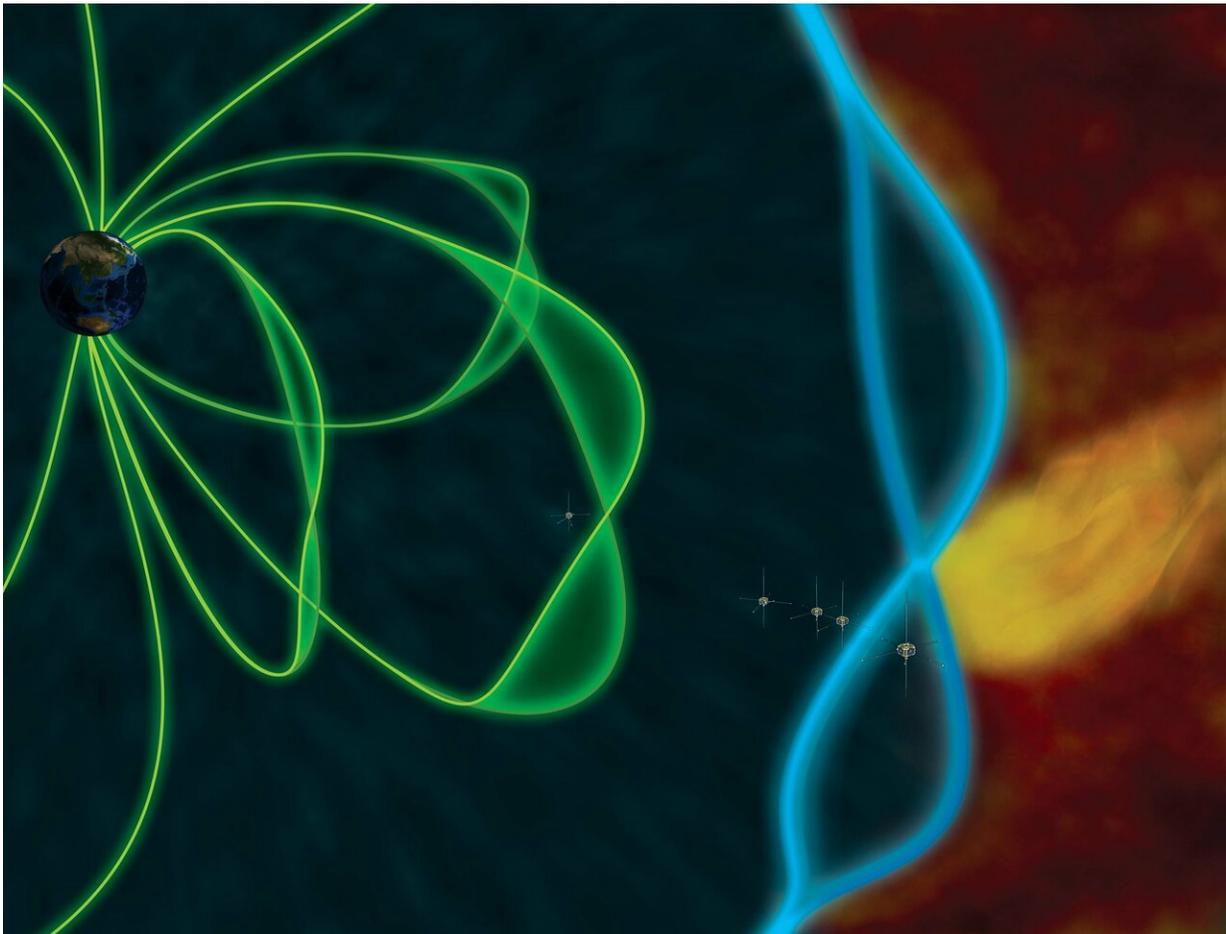


Earth's magnetic shield booms like a drum when hit by impulses

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Artist rendition of a plasma jet impact (yellow) generating standing waves at the magnetopause boundary (blue) and in the magnetosphere (green). The outer group of four THEMIS probes witnessed the flapping of the magnetopause over each satellite in succession, confirming the expected behaviour/frequency of the theorised magnetopause eigenmode wave. Credit: E. Masongsong/UCLA, M. Archer/QMUL, H. Hietala/UTU

The Earth's magnetic shield booms like a drum when it is hit by strong impulses, according to new research from Queen Mary University of London.

As an impulse strikes the outer boundary of the shield, known as the magnetopause, ripples travel along its surface which then get reflected back when they approach the [magnetic poles](#).

The interference of the original and reflected waves leads to a standing wave pattern, in which specific points appear to be standing still while others vibrate back and forth. A drum resonates like this when struck in exactly the same way.

This study, published in *Nature Communications*, describes the first time this effect has been observed after it was theoretically proposed 45 years ago.

Movements of the magnetopause are important in controlling the flow of energy within our [space environment](#) with wide-ranging effects on space weather, which is how phenomena from space can potentially damage technology like power grids, GPS and even passenger airlines.

The discovery that the boundary moves in this way sheds light on potential global consequences that previously had not been considered.

Dr. Martin Archer, space physicist at Queen Mary University of London, and lead author of the paper, said: "There had been speculation that these drum-like vibrations might not occur at all, given the lack of evidence over the 45 years since they were proposed. Another possibility was that they are just very hard to definitively detect.

"Earth's magnetic shield is continuously buffeted with turbulence so we thought that clear evidence for the proposed booming vibrations might require a single sharp hit from an impulse. You would also need lots of satellites in just the right places during this event so that other known sounds or resonances could be ruled out. The event in the paper ticked all those quite strict boxes and at last we've shown the boundary's natural response."

The researchers used observations from five NASA THEMIS satellites when they were ideally located as a strong isolated plasma jet slammed into the magnetopause. The probes were able to detect the boundary's oscillations and the resulting sounds within the Earth's magnetic shield, which agreed with the theory and gave the researchers the ability to rule out all other possible explanations.

Many impulses which can impact our magnetic shield originate from the [solar wind](#), charged particles in the form of plasma that continually blow off the Sun, or are a result of the complicated interaction of the solar wind with Earth's magnetic field, as was technically the case for this event.

The interplay of Earth's magnetic field with the solar wind forms a magnetic shield around the planet, bounded by the magnetopause, which protects us from much of the radiation present in [space](#).

Other planets like Mercury, Jupiter and Saturn also have similar magnetic shields and so the same drum-like vibrations may be possible elsewhere.

Further research is needed to understand how often the vibrations occur at Earth and whether they exist at other planets as well. Their consequences also need further study using satellite and ground-based observations.

More information: 'Direct Observations Of A Surface Eigenmode Of The Dayside Magnetopause'. M.O. Archer, H. Hietala, M.D. Hartinger, F. Plaschke, V. Angelopoulos. *Nature Communications* (2019). [DOI: 10.1038/s41467-018-08134-5](https://doi.org/10.1038/s41467-018-08134-5)

Provided by Queen Mary, University of London

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