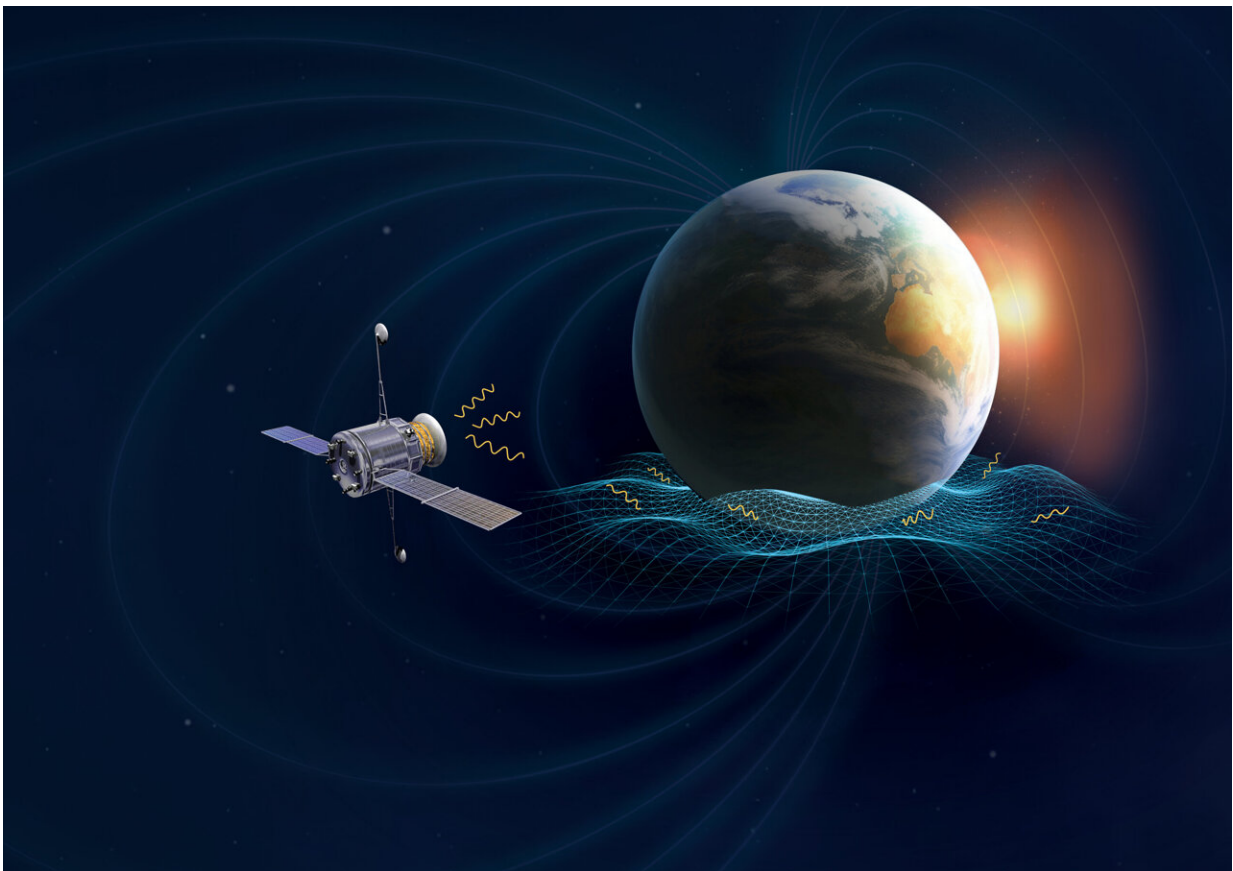


# New approach leverages planetary magnetospheres to detect high-frequency gravitational waves

June 5 2024

---



The groundbreaking concept proposed by HKUST Department of Physics Prof. Liu's team allows a single astronomical telescope in the Earth's magnetosphere to function as a detector for GW signals. Credit: HKUST

A new method of detecting high-frequency gravitational waves (HFGWs) has been proposed by a research team led by Prof. Tao Liu, Associate Professor from the Department of Physics at the Hong Kong University of Science and Technology (HKUST).

The team's innovative approach may enable the successful detection of HFGWs by utilizing existing and technologically feasible astronomical telescopes in planetary magnetospheres, opening up new possibilities for studying the [early universe](#) and violent cosmic events in an effective and technically viable way.

Gravitational waves (GWs) are produced by various astronomical phenomena, such as [phase transitions](#) in the early universe and collisions of primordial black holes. However, their effects are extremely weak and have been discovered only in relatively low frequency band using the method of interferometry.

Observing the universe using GWs thus presents significant technological challenges, particularly in probing the [high-frequency](#) band above one kilohertz, where the usage of interferometry becomes strongly restricted.

To address this difficulty, Prof. Liu and his postdoctoral fellow Dr. Chen Zhang have collaborated with Prof. Jing Ren from the Institute of High Energy Physics at the Chinese Academy of Sciences, and achieved a significant breakthrough in their recent study. The research capitalizes on the intriguing physical effect that GWs residing within a [magnetic field](#) can be converted to potentially detectable electromagnetic waves.

By leveraging the extended paths within planetary magnetospheres, the conversion efficiency is increased, yielding more signals of electromagnetic waves. The detection capability can be further enhanced for telescopes with a wide field of view because of the expansive angular

distribution of signal flux within such a planet laboratory.

This innovative method allows a single astronomical telescope to function as a detector for GW signals. By combining multiple telescopes, a wide coverage of HFGW frequencies, ranging from megahertz to  $10^{28}$  hertz, can be achieved.

This frequency range is equivalent to the electromagnetic spectrum used in [astronomical observations](#) and includes a large portion that has never been explored in the detection of GWs before. The study provides an initial assessment of sensitivity for satellite-based detectors in low Earth orbit and ongoing missions within Jupiter's magnetosphere.

The research was published in [Physical Review Letters](#) in March and was subsequently highlighted by [Nature Astronomy](#) in an article titled "Planet-sized laboratories offer cosmological insights" in May. This emphasizes the significance of the research in paving the way for future studies into novel GW detection technologies.

**More information:** Tao Liu et al, Limits on High-Frequency Gravitational Waves in Planetary Magnetospheres, *Physical Review Letters* (2024). [DOI: 10.1103/PhysRevLett.132.131402](https://doi.org/10.1103/PhysRevLett.132.131402)

Morgan Hollis, Planet-sized laboratories offer cosmological insights, *Nature Astronomy* (2024). [DOI: 10.1038/s41550-024-02285-w](https://doi.org/10.1038/s41550-024-02285-w)

Provided by Hong Kong University of Science and Technology

Citation: New approach leverages planetary magnetospheres to detect high-frequency

gravitational waves (2024, June 5) retrieved 19 June 2024 from  
<https://phys.org/news/2024-06-approach-leverages-planetary-magnetospheres-high.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.