Imperial College London

Lend Me Your Ears Space Weather Citizen Science Through Harnessing Sonification

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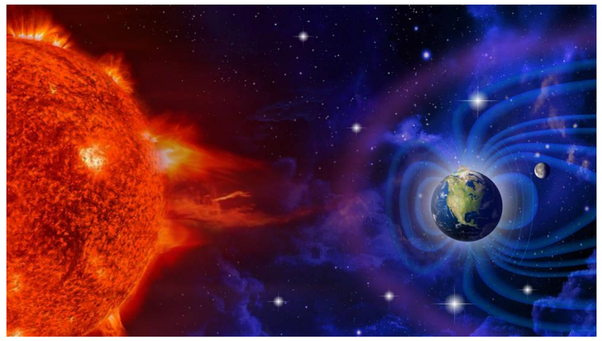
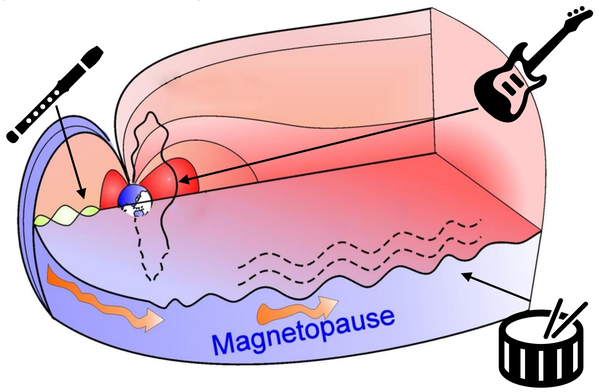
Background

Harmful **space weather**, a risk to our everyday technology, occurs when the solar-terrestrial interaction enables energy from the solar wind to enter Earth's magnetic shield in space, the magnetosphere.



The Sun interacting with Earth's magnetosphere. Credit: NASA Goddard / M.P. Hrybyk-Keith

This interaction is dynamic, resulting in numerous modes of (magnetohydrodynamic) waves. These typically exist as standing waves, akin to resonances in musical instruments but at ultra-low frequencies (ULF; 0.1-100mHz).



Types of magnetospheric ULF wave & their musical analogues. Credit: Q. Zong.

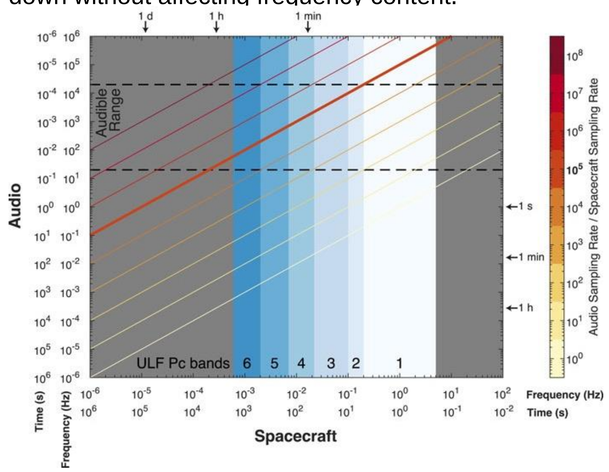
ULF waves transport solar wind energy around the magnetosphere, impacting on key regions e.g. radiation belts, auroral ovals, ionosphere, and the ground. Understanding their excitation and global effects is thus an important area of research.

However, a zoo of different ULF wave phenomena tend to occur simultaneously, posing a challenge to researchers.

Sonification

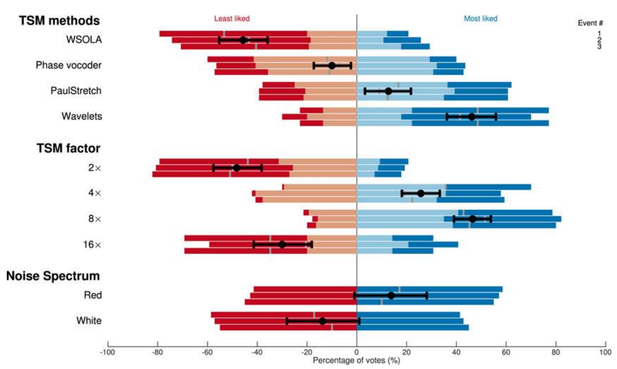
Time-series data of ULF waves from satellites is often analysed visually, though this can struggle to identify the cacophony of waves often present. Our sense of hearing is excellent at disentangling different sources of sounds, so we employ **sonification** –the process of converting data to audio.

The simplest form, **audification**, maps each data sample to an audio sample, changing only playback speed to make the waves fall into the audible range. This has already enabled novel space weather research (Alexander+, 2014; Archer+, 2018). However, for some satellite obits the ULF waves pass by too quickly for effective listening, motivating the need for **time-stretching**, where audio is slowed down without affecting frequency content.



Relationships between data and audio in audification.

We applied existing methods from music to NASA THEMIS data, surveying the public to help identify the best settings (Archer+, 2022).



Quantitative results from the survey.

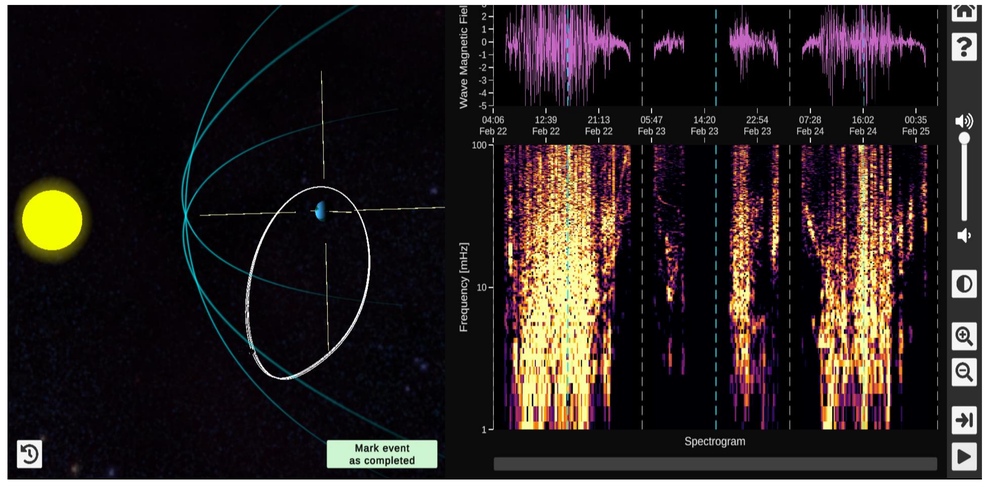
Citizen Science

Members of the public can now listen to these sounds and help identify particular classes of waves simply by listening to data, helping advance space weather research.

The HARP project and interface was thoroughly tested with high school and undergraduate students over 2 years before releasing publicly in April 2023.

Sound is an overlooked but powerful tool for data exploration, bringing it to life for the public.

Getting input from your audiences is really important in developing engaging citizen science projects.



Graphical user interface designed for the HARP (Heliophysics Audified Resonances in Plasmas) project enables citizen scientists to identify sweeping tones in noisy satellite data.

HARP logo

Find out more & get involved **https://listen.spacescience.org**

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