Musical space-weather reports from NASA's LRO mission

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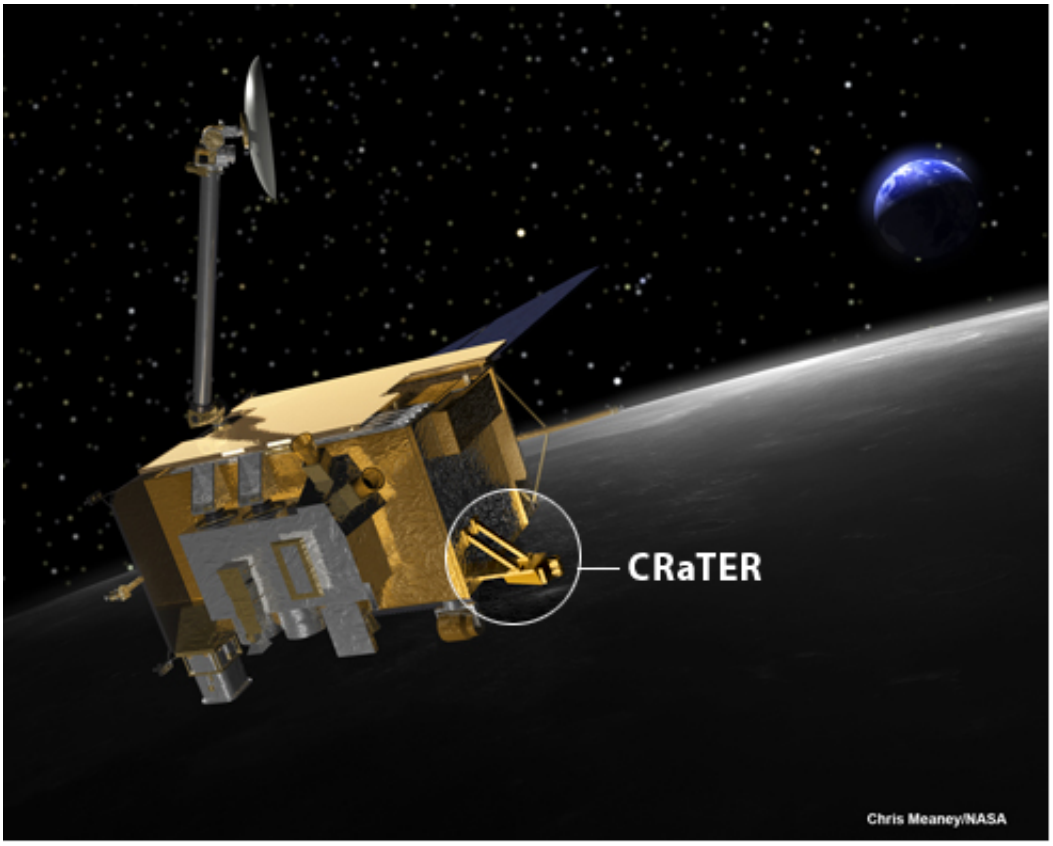

The Cosmic Ray Telescope for the Effects of Radiation, or CRaTER, on NASA's Lunar Reconnaissance Orbiter has six detectors to monitor the energetic charged particles from galactic cosmic rays and solar events.
Credit: NASA/GSFC

(Phys.org) —The latest tool for checking space weather is an internet

radio station fed by data from NASA's Lunar Reconnaissance Orbiter, or LRO.

The radio station essentially operates in real time, receiving measurements of how much radiation the spacecraft is experiencing and converting those into a constant stream of music. The radiation levels determine which instrument is featured, the musical key being used and the pitches played.

"Our minds love music, so this offers a pleasurable way to interface with the data," said the leader of the music project, Marty Quinn of the University of New Hampshire, Durham. "It also provides accessibility for people with visual impairments."

The radiation levels are determined by LRO's Cosmic Ray Telescope for the Effects of Radiation, or CRaTER. Equipped with six detectors, CRaTER monitors the energetic charged particles from galactic cosmic rays and solar events.

The instrument makes two kinds of crucial measurements. One type studies the interaction of radiation in space with a material that is like human tissue; this is helping scientists assess the effects that exposure would have on people and organisms. The other type looks at radiation hitting the moon and the products generated by that interaction, which provides a way to explore the composition of the regolith on the moon.

"CRaTER has discovered wide-ranging and fundamental aspects of such radiation," said Nathan Schwadron, the principal investigator for CRaTER. "For example, we have discovered that tissue-equivalent plastics and other lightweight materials can provide even more effective protection than standard shielding, such as aluminum."

An internet radio station converts radiation measurements from NASA's Lunar Reconnaissance Orbiter into a musical space-weather report. Credit: University of New Hampshire

Each detector on CRaTER reports the number of particles registered every second. These counts are relayed to CRaTER Live Radio, where software converts the numbers into pitches in a four-octave scale. Six pitches are played every second, one for each detector. Higher, tinkly pitches indicate less activity, whereas lower, somber-sounding pitches indicate more activity.

The software selects the primary instrument and a musical key based on recent activity. At the lowest radiation levels, the main instrument will be a piano, playing pitches from one of the major scales. But as the peak radiation level climbs, one of the minor scales will be selected instead, and the piano will be replaced by one of seven other instruments.

For example, when CRaTER picked up elevated radiation counts caused by the solar flare on Jan. 7, 2014, the primary instrument changed to a marimba, which is two instruments up from the piano. A steel drum or guitar instead of a marimba would mean the radiation level had ramped up more. A banjo would mean the peak had climbed to the top of the normal operating range.

If the counts climb beyond the top of the normal operating range – as might happen during a very big event – the software would switch into a second operating range. The piano would again represent the bottom of this range, and the banjo would represent the top. To indicate which range is current, a violin and a cello play sustained notes in the background. If those sustained notes are played at the highest pitches on the scale, the normal operating range is in effect; if those notes drop by even one pitch, the second range is being used.

The radio station is one of CRaTER's official data products and is available online and through an app. The data feed from LRO is live, with one caveat. Whenever the spacecraft moves behind the moon, it cannot line up with data-collecting antennas on Earth, so there is a blackout period of about an hour. During that time, the station reuses the previous hour's data. To indicate that the music is not live, the sound of the bongo drum in the background is changed, and the chiming of the triangle is muted.

The most familiar example of data sonification – conversion into sound – is a simple one: The Geiger counter produces a click every time it detects a radioactive particle.

In the past few decades, scientists in many fields have experimented with sonification, hoping to capitalize on humans' ability to hear small changes instantly, even against a noisy background. Music has the added advantage of making it easy to process many changes at once through

variations in pitch, rhythm, tempo, scale, loudness and instrumentation.

"Music makes it easy for people to take in the data, and it seems to be a natural fit for space missions," said LRO's project scientist, John Keller of NASA's Goddard Space Flight Center in Greenbelt, Md.

Sonification has been used to present data from several NASA spacecraft, especially Voyagers 1 and 2 and Kepler. Quinn previously worked on sonification for other NASA missions, including Mars Odyssey, the Solar TErrestrial RElations Observatory, the Advanced Composition Explorer and the Interstellar Boundary Explorer.

Provided by NASA