Eos

Magnetic Field Pulsations and Aurora Tightly Linked

Mysterious plasma waves from space are generating displays of aurora near Earth's poles.

By **Mark Zastrow**
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An isolated proton aurora observed in the eastern sky of the Athabasca University Geospace Observatory, Canada, at 09:05 universal time on 12 November 2015. Credit: Kazuo Shiokawa

Source: Journal of Geophysical Research: Space Physics

For decades, scientists have been measuring the waves that course through Earth's magnetic field, called geomagnetic pulsations. Like seismometers that can sense the Earth's interior trembling as seismic waves travel through it, magnetometers can measure the tremors in the planet's magnetic field. This magnetic rumbling tends to appear around specific frequencies, resulting in several characteristic bands. Now ***Nomura et al.*** have found that certain kinds of waves in one particular band can trigger displays of aurora.

From a station in Athabasca in northern Alberta, Canada, the team monitored geomagnetic pulsations in the so-called Pc1 band, which spans from 0.2 to 5 Hz. At the same time, they used a very wide field camera to capture images of aurora, which sparkled as protons trapped in Earth's magnetic field entered the atmosphere and smashed into air molecules, causing them to glow.

Over a period of a half hour on an October night in 2006, the team found a striking correlation: Whenever the aurora brightened, the frequency of the Pc1 waves increased. Starting at 0.3 Hz, it rose to about 1 Hz, like the pitch of a whistle, rising more than a full octave. This "rising tone" lasted for tens of seconds, then fell back down to its original frequency—as did the auroral intensity.

Clearly, the rising tones and the aurora are linked, and the team thinks both are caused by a kind of plasma wave that originates at the equator in space, called electromagnetic ion cyclotron (EMIC) waves. These occur when fast-moving hot ions circling the planet's equator cross over into the region of cold dense plasma around the Earth. This instability between hot and cold plasma generates EMIC waves that move along Earth's magnetic field from the equator toward the higher latitudes.

Scientists already know that EMIC waves are capable of disrupting the radiation belts around the planet, knocking ions and electrons out of stable trajectories and sending them crashing into the Earth's atmosphere. The team suspects that in this case, nonlinear-type EMIC waves were diverting protons with a period of tens of seconds into the sky above Athabasca, producing pulsations of the proton aurora—and simultaneously resulting in the rising tones in the Pc1 band.

The data also offer a clue that suggests nonlinear-type EMIC waves could be responsible for another mysterious Pc1 phenomenon: series of high-intensity bursts, which form a characteristic "pearl" structure when the data are visualized. Each pearl lasts for a few tens of seconds, the same as the Pc1 rising tones, suggesting nonlinear-type EMIC waves could be the culprit yet again. (*Journal of Geophysical Research: Space Physics*, **doi:10.1002/2015JA021681**, 2016)

—Mark Zastrow, Freelance Writer

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