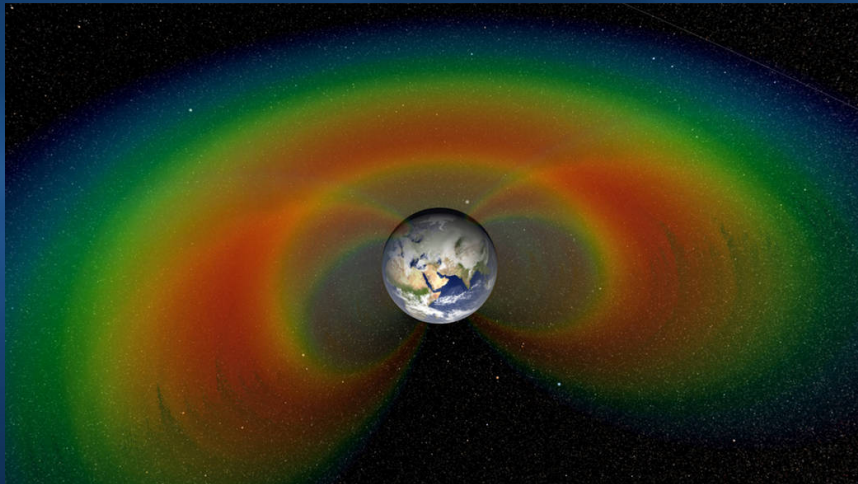


# The Case of the Relativistic Particles Solved with NASA Missions

Encircling Earth are two enormous rings — called the Van Allen radiation belts — of highly energized ions and electrons. Various processes can accelerate these particles to relativistic speeds, which endanger spacecraft unlucky enough to enter these giant bands of damaging radiation. Scientists had previously identified certain factors that might cause particles in the belts to become highly energized, but they had not known which cause dominates.

New research from NASA's Van Allen Probes and Time History of Events and Macroscale Interactions during Substorms — THEMIS — missions, published in *Geophysical Research Letters*, indicates that the verdict is in. The main culprit is a process known as local acceleration, caused by electromagnetic waves called chorus waves. Named after their characteristic rising tones, reminiscent of chirping birds, chorus waves speed up the particles pushing them along like a steady hand repeatedly pushing a swing.

There are two main causes of particle energization in the Van Allen belts: radial diffusion and local acceleration. Radial diffusion, which often occurs during solar storms, pushes particles closer to Earth, where they become highly energized due to the stronger magnetic field there. Many scientists had long thought this was the primary, and even only, cause of energization.



*Before the Van Allen mission, chorus waves were not a widely accepted theory.*

Early on in its mission, the Van Allen Probes showed that local acceleration, which is caused by particles interacting with waves of fluctuating electric and magnetic fields, can also energize particles where they are. The new research, which looked at nearly a hundred events over almost five years, shows that these wave-particle interactions are responsible for energizing particles around Earth 87 percent of the time.

The new results will help researchers improve their models for forecasting space weather now that they've pinpointed the main cause behind radiation belt enhancements.