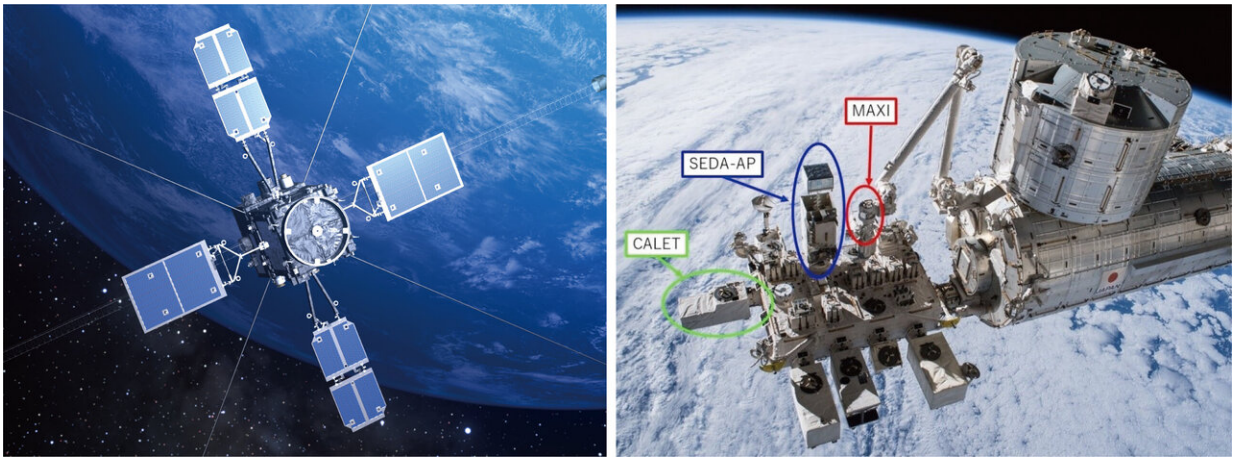
On the trail of causes of radiation events during space flight

October 5 2020



Left: the Arase satellite. Right: Three different detectors on the ISS were complementarily used. SEDA-AP (Space Environment Data Acquisition equipment-Attached Payload), CALET (Calorimetric Electron Telescope), and MAXI (Monitor of All-sky X-ray Image) Credit: Left: ©ERG science team Right: ©JAXA/NASA

Scientists have made significant progress in understanding the sources of radiation events that could impact human space-flight operations. Relativistic electron precipitation (REP) events are instances when high energy electrons move through areas of space at significant fractions of the speed of light. These REP events may pose challenges to human spaceflight, specifically during extravehicular activity (EVA).

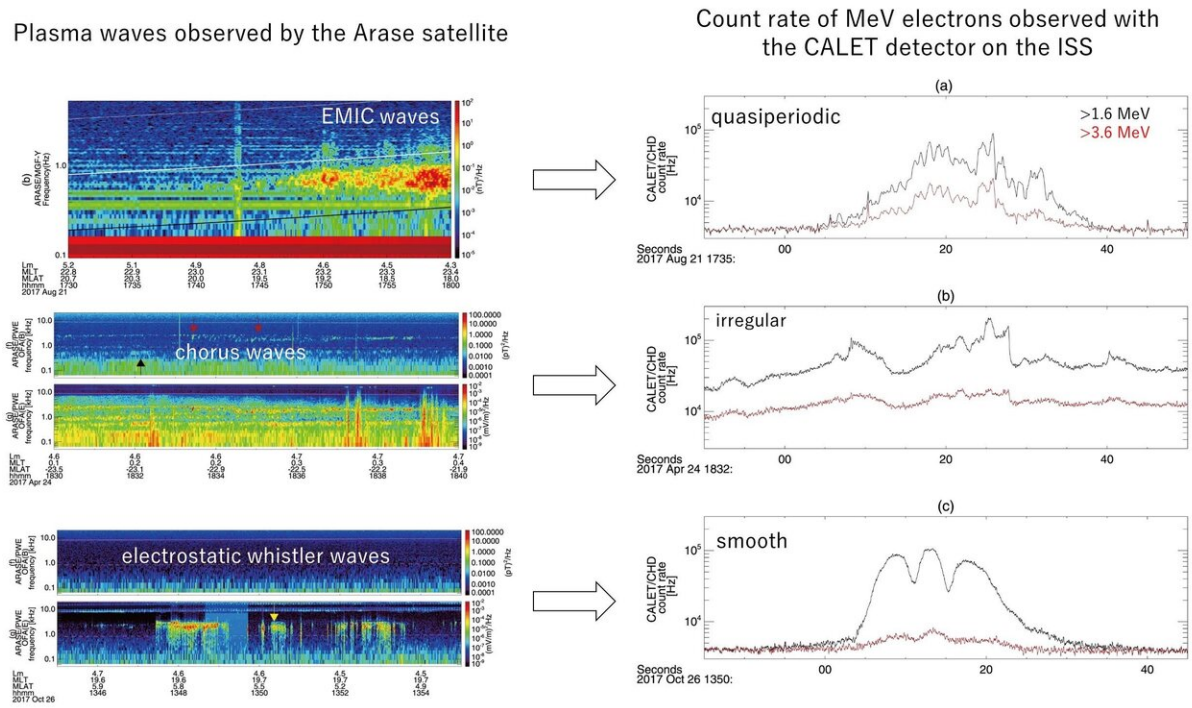
These hazards motivate the question of whether REP events can be forecasted in order to avoid unnecessary human exposure to radiation. In order to predict REP events, their cause must first be determined.

A scientific team led by researchers at the National Institute of Polar Research (NIPR) in Japan has made strides in answering that question. Their findings were published on August 14 in the *Journal of Geophysical Research: Space Physics*.

Ryuho Kataoka, the lead author of the study and an associate professor at NIPR, pinpointed the cause of REP events and emphasized that REP events must be accounted for in human spaceflight missions.

"The importance of understanding REP events has been increasing since the REP events have been clearly identified at International Space Station (ISS)," Kataoka said. "REP events are important because they cause radiation dose during EVAs."

It has been hypothesized that electromagnetic ion cyclotron (EMIC) waves play an important role in REP events at the ISS. It was still an open question, however, whether other mechanisms played a role in REP event generation. EMIC waves are electromagnetic waves that propagate through the plasma in Earth's magnetosphere, causing disturbances in the charged particles within the plasma.



Plasma waves observed by the Arase satellite (left) and count rate of MeV electrons observed with the CALET detector on the ISS (right). Credit: Ryuho Kataoka et al., 2020

Using multiple sensors aboard the ISS, as well as data from the Arase satellite, the research group was able to show that at least three separate processes contributed to REP events. One is indeed EMIC waves. But the data also suggested two other sources: Whistler mode chorus waves and electrostatic whistler waves. Whistler mode waves can be excited by high energy electrons associated with auroral activities, such as the Northern Lights.

"It turned out that REP events at the ISS are caused not only by EMIC waves but also by whistler mode waves, which makes the space weather forecast more difficult," Kataoka said.

With a better understanding of the physical causes of REP events, Kataoka and his team are working towards ways to predict future events. "The next step is the space weather forecast of REP events at the ISS by modeling different kinds of plasma wave activities. The ultimate goal is to obtain a unified theory to understand the interaction between energetic particles and plasma waves, and their impact of radiation dose on the atmosphere, space craft, and human beings."

More information: Ryuho Kataoka et al, Plasma Waves Causing Relativistic Electron Precipitation Events at International Space Station: Lessons From Conjunction Observations With Arase Satellite, *Journal of Geophysical Research: Space Physics* (2020). DOI: 10.1029/2020JA027875

Provided by Research Organization of Information and Systems