Shedding light on the science of auroral breakups

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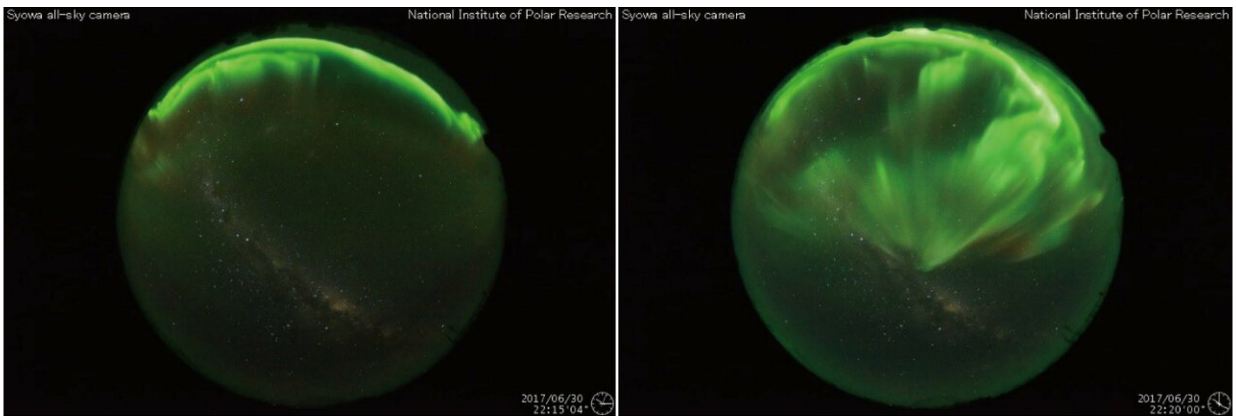

All-sky images of the auroral breakup that occurred around 2220 UT on June 30, 2017. Photographed at Syowa Station, Antarctica. Left: five minutes before the breakup. Right: right after the breakup. Credit: Hiroshi Miyaoka(NIPR)

Auroras, also known as Northern or Southern lights depending on where they occur, are natural displays of light in the Earth's sky. Typically, these lights are dimly present at night. However, sometimes, these otherwise faint features explode in brightness and can even break up into separate glowing hallmarks, appearing as spectacular bursts of luminous manifestations. This striking and picturesque phenomenon is known as an auroral breakup.

Now, Japanese scientists have quantitatively confirmed how energetic this phenomenon can be. Using a combination of cutting-edge, ground-based technology and new space-borne observations, they have demonstrated the essential role of an auroral breakup in ionizing the deep atmosphere. The research advances the understanding of one of the most visually stunning natural phenomena. The findings were published in *Earth, Planets and Space* on January 23, 2019.

The sun fires beams of charged particles, or plasma, toward Earth. Also referred to as solar winds, this plasma is mostly made up of electrons, protons and alpha particles. When these particles interact with the Earth's magnetic field, electrical currents are carried by electrons into the Earth's atmosphere. This reaction between the electrons and their atmospheric constituents emits light of varying color and complexity, visible as an aurora. However, little is known about how energetic the electrons can be when these lights explode into the stunning lightshows known as auroral breakups. So far, the assumption has been that electrons of a specific energy level are responsible for this rare phenomenon.

In the new study, the scientists report that, contrary to conventional thinking, a specific type of electrons with much higher energy, called radiation belt electrons, are involved in the auroral breakup. Named after their location in the Earth's radiation belt, radiation belt electrons had not been clearly associated with auroral breakups before. The research team based their conclusions on a dataset collected via advanced technology and simulations.

"Radiation belt electrons are released from the Earth's magnetic field and charge the mesosphere during auroral breakup. This fact was quantitatively confirmed by both cutting-edge, ground-based and new space-borne observations," adds Ryuho Kataoka, Ph.D., associate professor at the National Institute of Polar Research and the corresponding author. "This study also provides a good example how

Arase satellite and PANSY radar can collaborate to understand the connection between space and atmosphere."

In their future research endeavors, Professor Kataoka and his team hope to understand how the radiation belt electrons are released during the short-lasting period of auroral breakup. "The ultimate goal is to understand the interplay between auroras and radiation belts," Professor Kataoka adds.

More information: Ryuho Kataoka et al, Transient ionization of the mesosphere during auroral breakup: Arase satellite and ground-based conjugate observations at Syowa Station, *Earth, Planets and Space* (2019). DOI: 10.1186/s40623-019-0989-7

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