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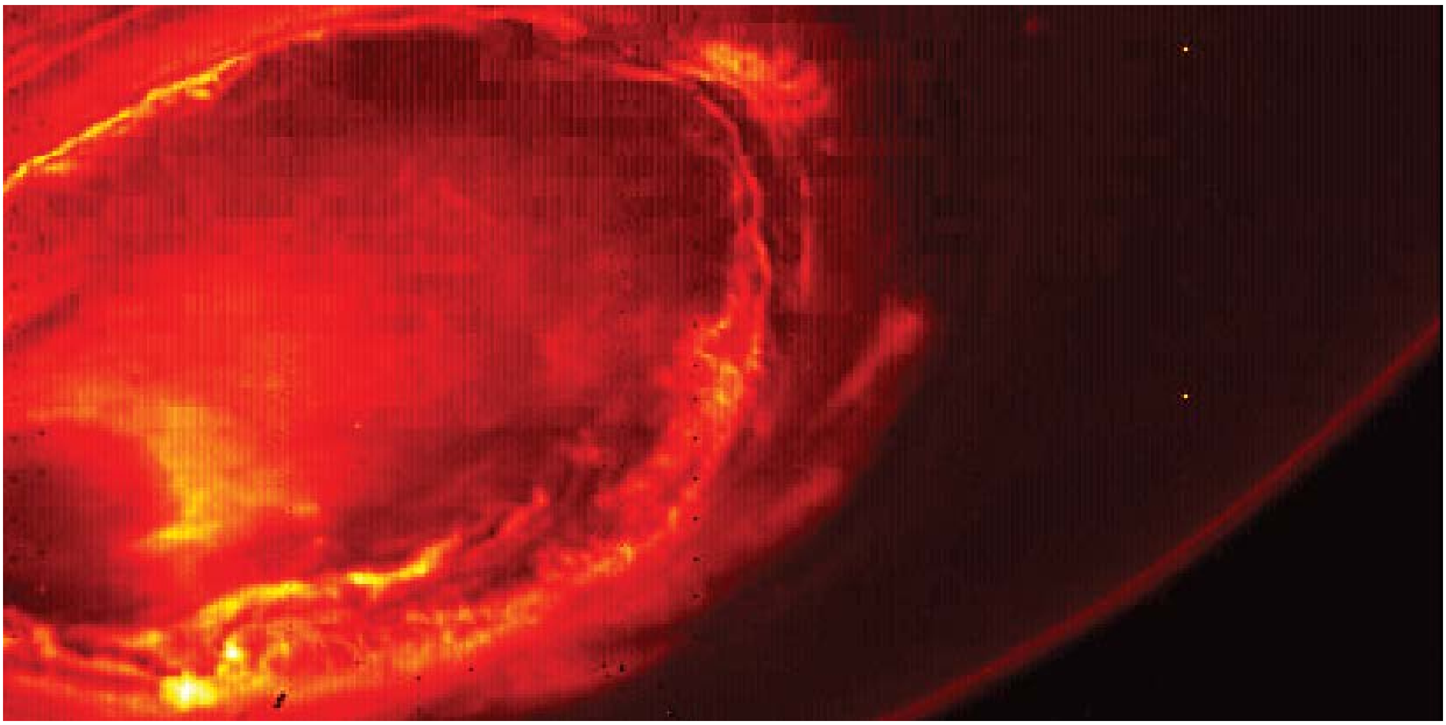
Mysterious Particle Beams Found over Jupiter's Poles



An infrared image of an auroral oval over Jupiter's southern polar regions, captured by NASA's Juno spacecraft on 27 August 2016. Credit: NASA /JPL-Caltech/SwRI/ASI/INAF/JIRAM

Jupiter's auroras are so powerful that if we could stand directly below them, where charged particles from space come crashing into the atmosphere, and see the ultraviolet light they emit, they would appear brighter than the ultraviolet light from the Sun. However, the behavior of these auroras, the most powerful in the solar system, has long been shrouded in mystery.

Last August, NASA's Juno spacecraft deepened that mystery: In a close flyby of Jupiter's poles, it found powerful angular beams of electrons above the aurora, extending in energy to greater than 1 million electron volts. These beams shoot upward over the polar caps and over the main aurora, even where a weaker downward component contains sufficient energy flux to generate the powerful emissions from the main aurora.

Now, as a contribution to a *Geophysical Research Letters* special section on Juno's first encounter with Jupiter, *Mauk et al.* provide the most detailed analysis of this phenomenon yet. Although they don't know the causes, they suggest it may be the key to understanding Jupiter's intense auroras.

Juno's close encounter came on 27 August 2016, just a couple of months after it arrived at Jupiter to study the planet, its moons, and its enormous magnetic field. The spacecraft's pass over the northern and southern poles took it above dancing ovals of auroras, allowing it to peek into the polar regions within.

The authors analyzed data from the Jupiter Energetic Particle Detector Instrument, which measured the trajectories and energies of the charged particles whizzing past. As the craft approached the auroral oval from the more equatorward regions, it saw typical signatures of trapped electrons with up-down differences reminiscent of those generating faint diffuse auroras at Earth.

However, when the spacecraft passed directly over the bright main auroral oval, it detected highly directional angular beams of both downward and upward traveling electrons. When Juno fully crossed inside the oval, deep within the polar caps, the downward beams virtually disappeared, leaving only the upward beams, varying in intensity but always present. This is very unlike what happens at Earth, where spacecraft passing over the most intense auroras find electrons accelerated downward only into what are called energy beams.

The Jovian bidirectional angle beams indicate that Jupiter's auroras are generated by a totally different process than on Earth—a much more random one in which collisions and turbulence propel particles both down and up along magnetic field lines. The team hypothesizes that this may have been happening most strongly in the region below Juno's position, which could explain why Juno saw the large up-down differences in the beams over the main auroral oval.

Juno's orbit evolutions will allow this hypothesis to be tested during future polar passes at even lower altitudes, where predominantly descending energetic electrons may well be observed. (*Geophysical Research Letters*, https://doi.org/10.1002/2016GL072286, 2017) **—Mark Zastrow, Freelance Writer**