Scientists connect the dots between Galilean moon, auroral emissions on Jupiter

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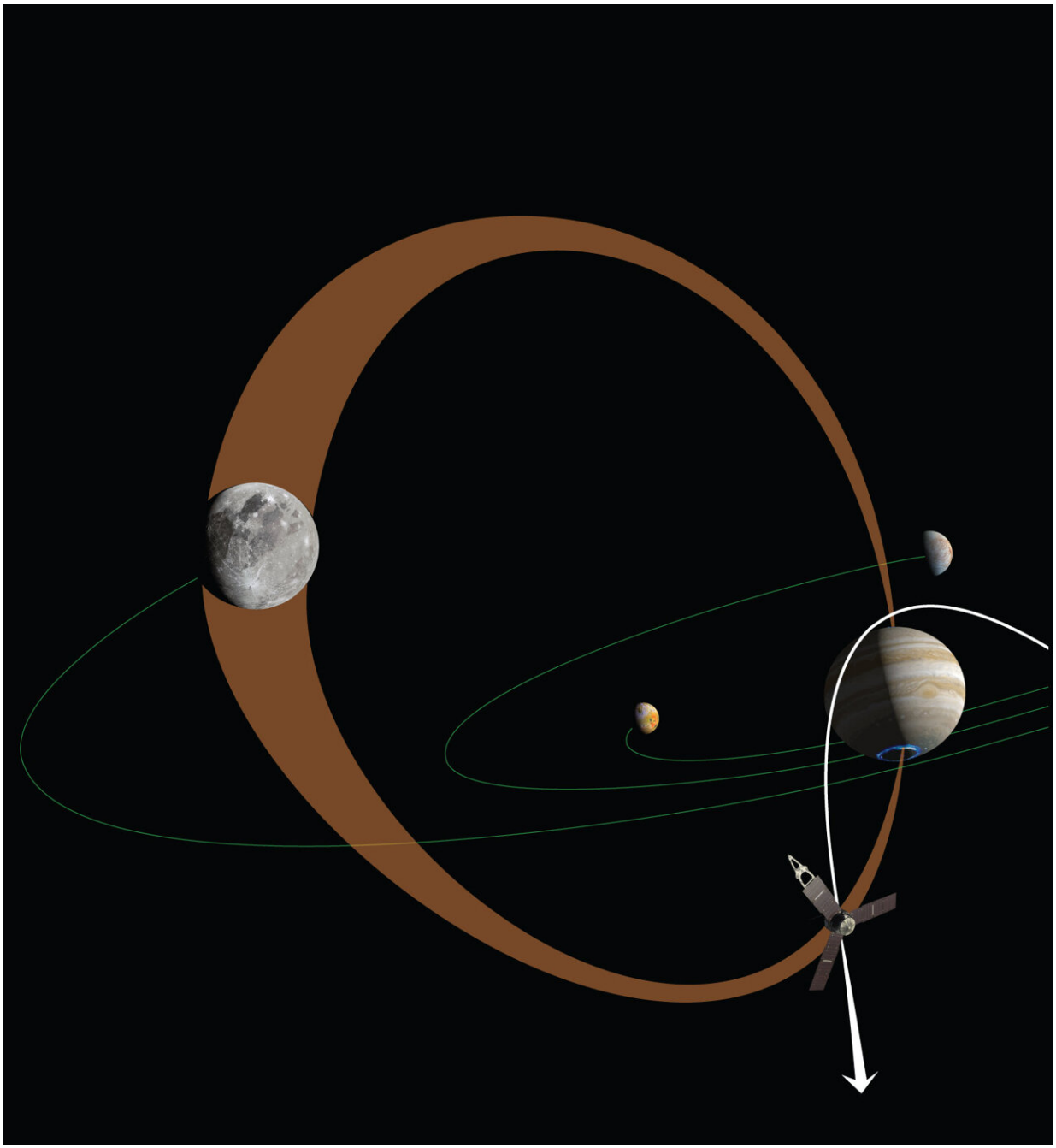

NASA's Juno spacecraft flew through the intense beam of electrons traveling from Ganymede, Jupiter's largest moon, to its auroral footprint on the gas giant. SwRI scientists used the resulting data to connect the particle population traveling along the beam with associated auroral emissions to unveil the mysterious processes creating the shimmering lights. Credit: NASA/Southwest Research Institute/JPL-Caltech/Malin Space Science Systems/Kevin M.

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On November 8, 2020, NASA's Juno spacecraft flew through an intense beam of electrons traveling from Ganymede, Jupiter's largest moon, to its auroral footprint on the gas giant. Southwest Research Institute scientists used data from Juno's payload to study the particle population traveling along the magnetic field line connecting Ganymede to Jupiter while, at the same time, remotely sensing the associated auroral emissions to unveil the mysterious processes creating the shimmering lights.

"Jupiter's most massive moons each create their own auroras on Jupiter's north and south poles," said Dr. Vincent Hue, lead author of a paper outlining the results of this research. "Each auroral footprint, as we call them, is magnetically connected to their respective moon, kind of like a magnetic leash connected to the moon glowing on Jupiter itself."

Like the Earth, Jupiter experiences auroral light around the polar regions as particles from its massive magnetosphere interact with molecules in the Jovian atmosphere. However, Jupiter's auroras are significantly more intense than Earth's, and unlike Earth, Jupiter's largest moons also create auroral spots. The Juno mission, led by SwRI's Dr. Scott Bolton, is circling Jupiter in a polar orbit and flew through the electron "thread" connecting Ganymede with its associated auroral footprint.

"Prior to Juno, we knew that these emissions can be quite complex, ranging from a single auroral spot to multiple spots, which sometimes trail an auroral curtain that we called the footprint tail," said Dr. Jamey Szalay, a co-author from Princeton University. "Juno, flying extremely close to Jupiter, revealed these auroral spots to be even more complex

than previously thought."

Ganymede is the only moon in our solar system that has its own magnetic field. Its mini-magnetosphere interacts with Jupiter's massive magnetosphere, creating waves that accelerate electrons along the gas giant's magnetic field lines, which can be directly measured by Juno.

Two SwRI-led instruments on Juno, the Jovian Auroral Distributions Experiment (JADE) and the Ultraviolet Spectrometer (UVS) provided key data for this study, which was also supported by Juno's magnetic field sensor built at NASA's Goddard Space Flight Center.

"JADE measured the electrons traveling along the magnetic field lines, while UVS imaged the related auroral footprint spot," said SwRI's Dr. Thomas Greathouse, a co-author on this study.

In this way, Juno is both able to measure the electron "rain" and immediately observe the UV light it creates when it crashes into Jupiter. Previous Juno measurements showed that large magnetic perturbations accompanied the electron beams causing the auroral footprint. However, this time, Juno did not observe similar perturbations with the electron beam.

"If our interpretation is correct, this a confirmation of a decade-old theory that we put together to explain the morphology of the auroral footprints," said Dr. Bertrand Bonfond, a co-author of the study from the Liège University in Belgium. The theory suggests that electrons accelerated in both directions create the multi-spot dance of auroral footprints.

"The Jupiter-Ganymede relationship will be further explored by Juno's extended mission, as well as the forthcoming JUICE mission from the European Space Agency," Hue said. "SwRI is building the next

generation of UVS instrumentation for the mission."

A paper describing this research was published in *Geophysical Research Letters*.

More information: V. Hue et al, A Comprehensive Set of Juno In Situ and Remote Sensing Observations of the Ganymede Auroral Footprint, *Geophysical Research Letters* (2022). DOI: 10.1029/2021GL096994

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