Juno detects Jupiter's highest-energy ions

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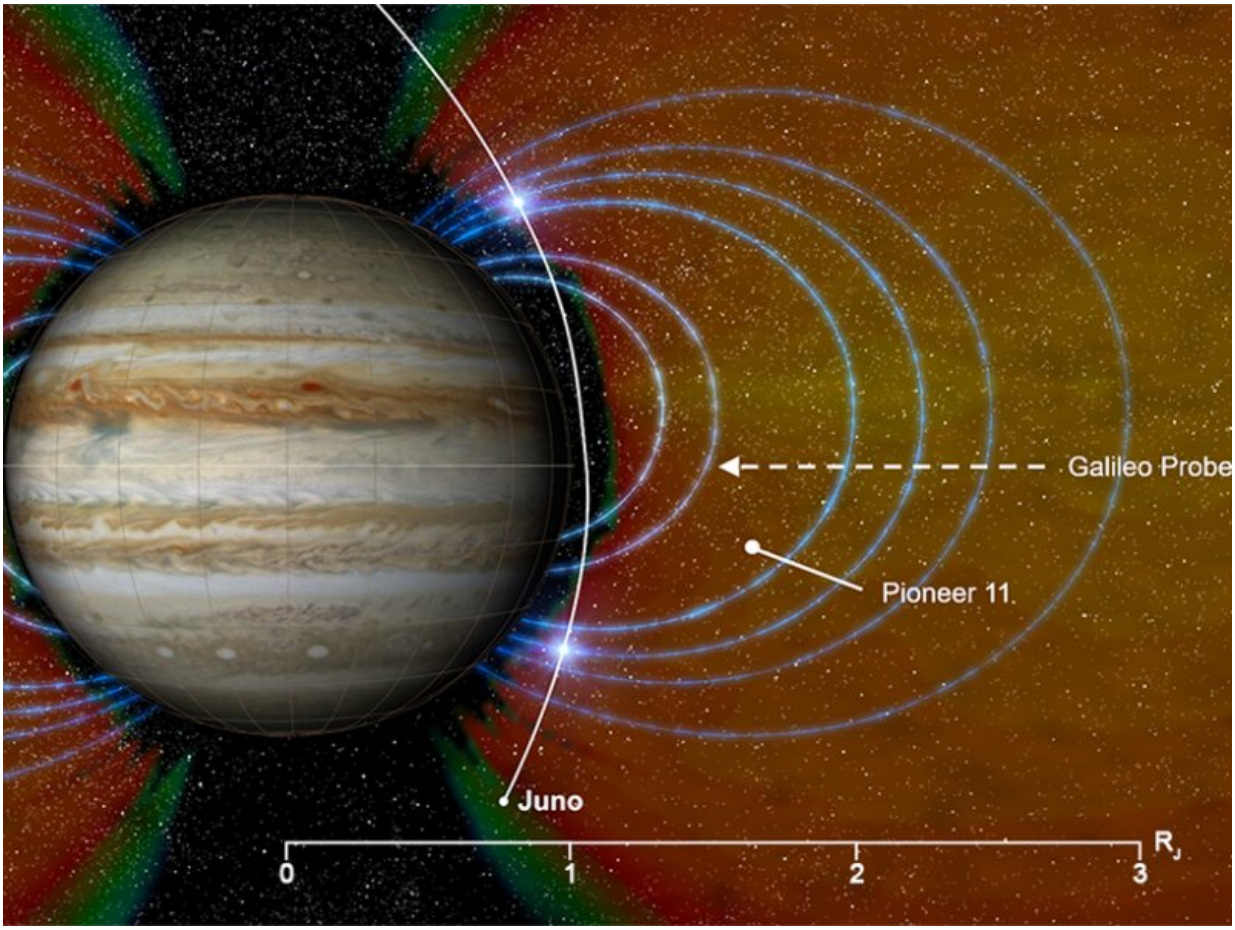

Juno has discovered a new population of highly energetic ions (bright blue spots) at midlatitudes within the inner edge of Jupiter's relativistic electron belt, a region not previously explored. Juno's stellar reference unit star camera records bright streaks in its images when these penetrating ions strike its sensor. The closest approach of Pioneer 11 to the planet and the path of the Galileo probe are also shown. Credit: M. Stetson, D. Santos-Costa, J. Arballo, H. N. Becker, CC BY-NC 4.0

Jupiter's planetary radiation environment is the most intense in the solar system. NASA's Juno spacecraft has been orbiting the planet closer than any previous mission since 2016, investigating its innermost radiation belts from a unique polar orbit. The spacecraft's orbit has enabled the first complete latitudinal and longitudinal study of Jupiter's radiation belts. Becker et al. leverage this capability to report the discovery of a new population of heavy, high-energy ions trapped at Jupiter's midlatitudes.

The authors applied a novel technique for detecting this population; rather than using a particle detector or spectrometer to observe and quantify the ions, they used Juno's star-tracking camera system. Star trackers, or stellar reference units (SRUs), are high-resolution navigational cameras whose primary mission is using observations of the sky to compute the spacecraft's precise orientation. The SRU on board the Juno spacecraft is among the most heavily shielded components, afforded six times more radiation protection than the spacecraft's other systems in its radiation vault.

Despite its heavy protection, ions and electrons with very high energies still occasionally penetrate the shielding and strike the SRU sensor. This study focuses on 118 unusual events that struck with dramatically higher energy than typical penetrating electrons. Using computer modeling and laboratory experiments, the authors determined that these ions deposited 10 and 100 times more energy than deposited by penetrating protons and electrons, respectively.

To identify potentially responsible ion species, the authors examined the morphology of the sensor strikes. Although most strikes trigger only several pixels, a few events with a low incidence angle can create streaks in which energy is deposited as the particle penetrates successive pixels.

Simulation software can predict the energy deposition of various particles moving through matter, providing candidates for the ions encountered by Juno. Ion species as light as helium or as heavy as sulfur could account for at least some of the observed strikes, the authors said. Species from helium through oxygen could account for all the strikes, provided they have energies in excess of 100 megaelectron volts per nucleon.

Finally, the study attributes these ions to the inner edge of the synchrotron emission region, located at radial distances of 1.12–1.41 Jupiter radii and magnetic latitudes ranging from 31 degrees to 46 degrees. This region has not been explored by prior missions, and this population of ions was previously unknown. With total energies measured in gigaelectron volts, they represent the highest-energy particles yet observed by Juno.

More information: Heidi N. Becker et al, High Latitude Zones of GeV Heavy Ions at the Inner Edge of Jupiter's Relativistic Electron Belt, *Journal of Geophysical Research: Planets* (2021). DOI: 10.1029/2020JE006772