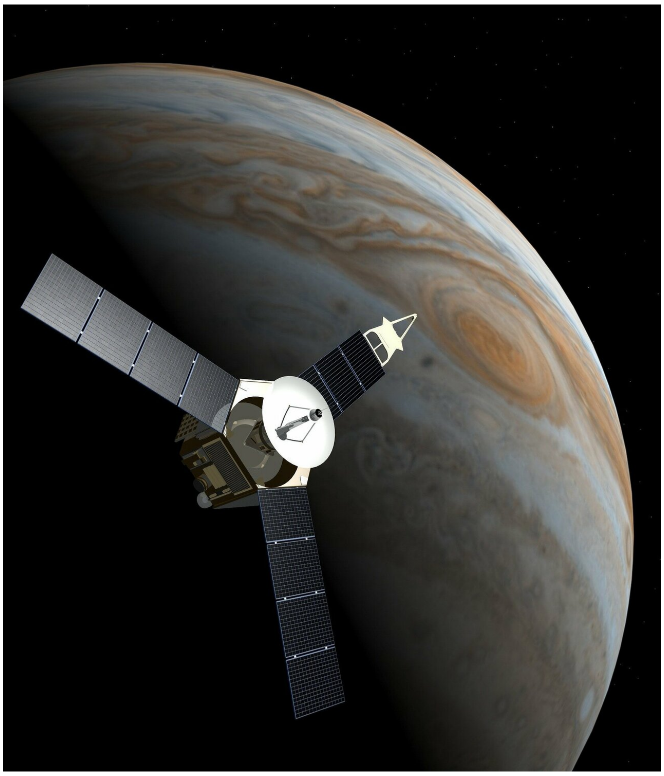
Alternating currents cause Jupiter's aurora

11 July 2019



Credit: CC0 Public Domain

An international team of researchers has succeeded in measuring the current system responsible for Jupiter's aurora. Using data transmitted to Earth by NASA's Juno spacecraft, they showed that the direct currents were much weaker than expected and that alternating currents must therefore play a special role. On Earth, on the other hand, a direct current system creates its aurora. Jupiter's electric current system is kept going in particular by large centrifugal forces, which hurl ionized sulfur dioxide gas from the gas giant's moon Io through the magnetosphere.

Professor Dr. Joachim Saur from the Institute of Geophysics and Meteorology at the University of Cologne was involved in the project. The article "Birkeland currents in Jupiter's magnetosphere observed by the polar-orbiting Juno spacecraft" is published in the current issue of *Nature Astronomy*.

Jupiter, the largest planet in the solar system, has the brightest aurora, with a radiant power of 100 terawatts (100,000,000,000 kilowatts = one hundred billion KW). 100,000 power plants would be needed to produce this light. Similarly to the ones on Earth, Jupiter's aurora display themselves as two huge oval rings around the poles. They are driven by a gigantic system of electrical currents that connects the polar light region with Jupiter's magnetosphere. The magnetosphere is the region around a planet that is influenced by its magnetic field. Most of the electric currents run along Jupiter's magnetic field lines, also known as Birkeland currents.

NASA's Juno spacecraft has been in a polar orbit around Jupiter since July 2016. Its goal is to better understand the interior and aurora of Jupiter. Juno has now measured for the first time the electric direct current system responsible for Jupiter's aurora. For this purpose, the scientists measured the magnetic field environment of Jupiter with high precision in order to derive the electric currents. The total current is approximately 50 million amperes. However, this value is clearly below the theoretically expected values. The reason for this deviation are small-scale, turbulent alternating currents (also referred to as Alfvenic currents), which have so far received little attention. "These observations, combined with other Juno spacecraft measurements, show that alternating currents play a much greater role in generating Jupiter's aurora than the direct current system," Joachim Saur said. He has been doing research on these turbulent alternating currents for 15 years, stressing their importance. Jupiter's aurora differ from those on Earth, which are essentially generated by direct currents. The Earth's northern lights shine about a thousand times weaker because the Earth is smaller than Jupiter, has a weaker magnetic field and rotates more slowly.

"Jupiter's electric current systems are driven by the enormous centrifugal forces in Jupiter's rapidly rotating magnetosphere," Saur remarked. The volcanically active Jupiter moon Io produces one ton of sulfur dioxide gas per second, which ionizes into Jupiter's magnetosphere. "Because of Jupiter's fast rotation—a day on Jupiter lasts only ten hours—the centrifugal forces move the ionized gas in Jupiter's magnetic field, which generate the electric currents," the geophysicist concludes.

More information: Stavros Kotsiaros et al, Birkeland currents in Jupiter's magnetosphere observed by the polar-orbiting Juno spacecraft, *Nature Astronomy* (2019). DOI: 10.1038/s41550-019-0819-7

Provided by University of Cologne