Data from Juno shows Jupiter moons causing footprints in aurorae

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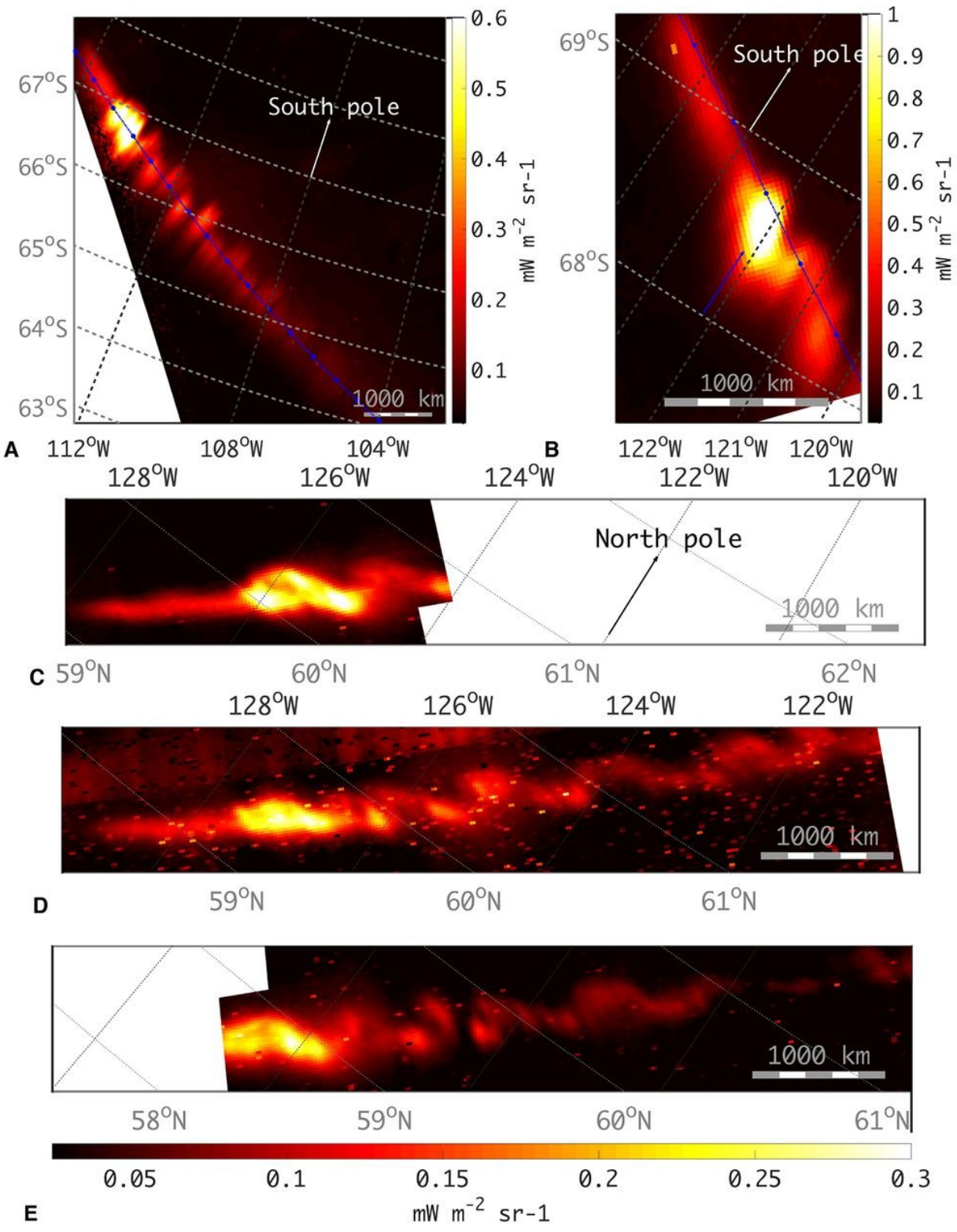

All panels are shown in a polar orthographic projection with parallels and

meridians overplotted. (A) Footprint of Io on the south pole of Jupiter, as seen on 1 September 2017 at 22:50. The main spot (top-left corner of the image) is followed by a series of regularly spaced secondary spots, which are alternate in displacement above and below the median track (shown in blue). The thin blue arc with dots is the sequence of the predicted Io footprint positions, with dots showing its position every 100 s. Radiances are in mW m^{-2} sr^{-1}. (B) As in (A), but showing a later image taken at 23:09. The main spot (indicated by a blue arrow) has an oval shape, with an angular offset from the average direction of the tail (median track). (C to E) The Io footprint in the north aurora, observed at 20:43, 20:48 and 20:53 respectively on 1 September 2017. The model is not shown in (C), (D), and (E) as it lies outside of the visible region. The black and white pixels [especially in (D)] are the effect of penetrating radiation affecting the detector. Credit: (c) *Science* (2018). DOI: 10.1126/science.aat1450

A team of researchers with members from Italy, the U.S. and Belgium has discovered that two of Jupiter's moons cause "footprints" in the planet's aurorae. In their paper published in the journal *Science*, the researchers describe what they found and how it helps better understand both the planet and its moons.

On Earth, as the authors note, an aurora is seen as the Northern or Southern lights—dazzling displays of light in the night sky. Jupiter also has aurorae, but they are caused by a different process. Jupiter has a surrounding magnetosphere—plasma carried by the planet's strong magnetic field. Charged particles from the magnetosphere at times strike the atmosphere of the planet, causing light shows similar to the ones we see on here on Earth. But they have something ours do not—footprints from the planet's moons. These footprints, the researchers explain, are disturbances in an aurora caused by the presence of a moon—in this case, by Io or Ganymede.

The researchers found evidence of the footprints when studying data

sent back to Earth by NASA's Juno space probe. They found that when Io passed close to Jupiter, it caused a double trail of squiggles to appear in a small section of an aurora. The researchers describe it as similar to a Von Kármán vortex—one that streams for hundreds of kilometers. The footprint disappears as the moon moves farther away from the planet.

The group also found a footprint created by Ganymede, a spot in an aurora that, upon closer view, turned out to be two spots—the footprint was split in half. The researchers were not able to find a reason for the split, but note that Ganymede is the only moon orbiting Jupiter that has its own magnetic field. This, they suggest, means that the footprint created by the moon represents the interaction of two magnetospheres.

The researchers suggest that learning more about the footprints caused by Jupiter's moons will help to understand how the moons interact with the planet and how strong magnetic forces in a natural environment interact. They also note that neither footprint was in the location that had been predicted, which indicates that models built to describe such events will need to be adjusted.

More information: A. Mura et al. Juno observations of spot structures and a split tail in Io-induced aurorae on Jupiter, *Science* (2018). DOI: 10.1126/science.aat1450

Abstract
Jupiter's aurorae are produced in its upper atmosphere when incoming high-energy electrons precipitate along the planet's magnetic field lines. A northern and a southern main auroral oval are visible, surrounded by small emission features associated with the Galilean moons. We present infrared observations, obtained with the Juno spacecraft, showing that in the case of Io, this emission exhibits a swirling pattern that is similar in appearance to a von Kármán vortex street. Well downstream of the main auroral spots the extended tail is split in two. Both of Ganymede's

footprints also appear as a pair of emission features, which may provide a remote measure of Ganymede's magnetosphere. These features suggest that magnetohydrodynamic interaction between Jupiter and its moon is more complex than previously anticipated.