Jupiter’s polar auroral bright spots as seen by Juno-UVS

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Background credit: NASA/JPL
Key points

➢ Tens to a hundred of gigawatts (GWs)
➢ Various positions and local times in polar regions:
  • **Northern**: localized
  • **Southern**: scattered
➢ Usually observed at the boundary of the swirl region
➢ Quasiperiodic behaviors:
  • ~2-40 minutes of time interval between two consecutive emissions
➢ Does not statically map to noon, probably not a cusp feature

Haewsantati et al. (2020, in preparation)
Jupiter’s bright spot emissions

The bright spot features:

➢ The emissions in Jupiter’s polar auroras
➢ Spot/compact shape
➢ Very dynamic and very bright in UV aurora

Red circles highlight bright spots observed by Juno-UVS in Northern hemisphere (left) and in Southern hemisphere (right).

Haewsantati et al. (2020, in preparation)
Observation

- Ultraviolet Spectrograph (UVS) instrument on board the Juno spacecraft
- 68-210 nm wavelength range with dog bone-shaped slit
- Acquired a Jupiter’s aurora image every 30 seconds as Juno’s spin period
- Aug 27, 2016 to May 29, 2019
- PJ1 - PJ20

Haewsantati et al. (2020, in preparation)
Methodology

- Image processing and data analysis via Interactive Data Language (IDL)
- Main discussions:
  - The emitted power
  - The ionospheric and magnetospheric positions
  - Quasiperiodic behaviors

Haewsantati et al. (2020, in preparation)
Results: in Northern hemisphere

**PJ1**: Three bright spot emissions within 30 min, appeared nearly the same system III position

**PJ3**: Two distinct bright spot emissions appeared at different SIII longitudes

Haewsantati et al. (2020, in preparation)
**Results:** in Northern hemisphere

**PJ6:** Large bright spot emissions

**PJ13:** Two bright spot emissions

Haewsantati et al. (2020, in preparation)
Results: in Southern hemisphere

PJ4: Six bright spot emissions during ~4-hour observation time, quasiperiodic behavior

PJ9: Bright spot emissions with clear evolution to change in SIII longitude

PJ12: Two bright spot emissions appeared at different SIII longitudes

Haewsantati et al. (2020, in preparation)
Results: in Southern hemisphere

**PJ14**: Many emissions within 30 min of selected time window

**PJ16**: Seven bright spot emissions with quasiperiodic behavior

**PJ20**: Four bright spot emissions during 1-hour of selected time interval

Haewsantati et al. (2020, in preparation)
The Emitted power

- Range from tens to a hundred of gigawatts (GWs)
- Based on the ellipse fits from bright spot images to images in the same perijove
- Time interval between peak (image that appears bright spot emissions): ~2-40 min
- Period analyzed from Lomb-Scargle Periodogram: 13-46 min

Haewsantati et al. (2020, in preparation)
The Emitted power

- Power plot of PJ4:
  - time interval between peak: ~ 30 min
  - evidence of quasiperiodic behaviors (period ~28 min)

Haewsantati et al. (2020, in preparation)
The Emitted power

- Power plot of PJ16:
  - => time interval between peak: ~ 30 min
  - => evidence of quasiperiodic behaviors (period 22-23 min)

Haewsantati et al. (2020, in preparation)
The system III positions and local times

- 60°-70° latitude, 160°-190° SIII longitude
- Analogous to X-ray hot spot region
- Approximate local time: Midnight – morning
- Vogt’s mapping model:
  - >110 R$_J$ in magnetosphere, dawn time
  - Unmapped for > 90% of spot data

Polar plot shows bright spot found in northern hemisphere (plus sign). The color presents the approximated magnetic local time. A star plot shows a referenced magnetic pole (Bertrand et al. 2015)

Haewsantati et al. (2020, in preparation)
The system III positions and local times

- Scattered over the polar region
- Approximate local time: Morning - Night
- Vogt’s mapping model:
  - >110 R J in magnetosphere, dawn time
  - Unmapped for > 90% of spot data

Polar plot shows bright spot found in southern hemisphere (plus sign). The color presents the approximated magnetic local time. A star plot shows a referenced magnetic pole (Bertrand et al. 2015)

Haewsantati et al. (2020, in preparation)
Results: comparison with X-ray observations

- PJ4 VS Chandra observation
  - peak in UV nearly the same time with peak in X-ray light curve
  - under discussion

Haewsantati et al. (2020, in preparation)
➢ Occurrence from both N&S hemispheres
➢ The emitted power is tens GWs, some bright spot emissions can reach up to a hundred GWs.
➢ Reappearance of bright spot emissions within a Juno perijove in the same system III position, indicative of quasiperiodic pulsations
➢ The time interval between two consecutive brightening: \(~2\text{-}40\) minutes, same range as X-ray pulsed emissions
➢ The system III positions of bright spots:
  • **Northern hemisphere:** region around \(175^\circ\) system III longitude and \(65^\circ\) latitude.
  • **Southern hemisphere:** scattered around the polar region
➢ Bright spot emissions can be seen at any local times, contrast from previous studies and probably not associate with cusp process.

Haewsantati et al. (2020, in preparation)
The instruments on board the NASA Juno mission provides scientists with a wealth of unprecedented details about Jupiter. In particular, the Ultraviolet Spectrograph (UVS) is dedicated to the study of Jupiter’s aurora in the 68-210 nm wavelength range. The images taken by Juno-UVS reveals for the first time a complete view of Jupiter’s aurora, including the nightside part hidden from the Earth-orbiting Hubble Space Telescope (HST). This work aims to study Jupiter’s polar aurora using images obtained from the UVS instruments. Here we present the systematic analysis of one of the most spectacular features of Jupiter’s polar-most aurora, called the bright spot. The emitted power of the bright spots ranges from a few to a hundred GWs. Within a Juno perijove, the spots reappear at almost the same positions in system III. The time interval between two consecutive brightenings is a few tens of minutes, comparable to Jupiter’s X-ray pulsation. The comparison of the time interval with X-ray observation is under the investigation. Comparing the difference perijove sequences, the system III positions of bright spots in the northern hemisphere are concentrated in a region around 175 degrees of system III longitude and 65 degrees of latitude. On the other hand, the positions of bright spot aurora the southern hemisphere are scattered all around the pole. Previous studies suggested that the bright spot could correspond to noon facing magnetospheric cusp. However and surprisingly, we have discovered that the bright spots could map to any magnetic local time, putting this interpretation into question.