Io Plasma Torus Observed by EXCEED/Hisaki - Comparison with the Observations by Cassini

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The Jovian magnetosphere

・corotational magnetic field

・the sulfur particles emitted from Io are ionized and trapped by the magnetic field around Io's orbit.

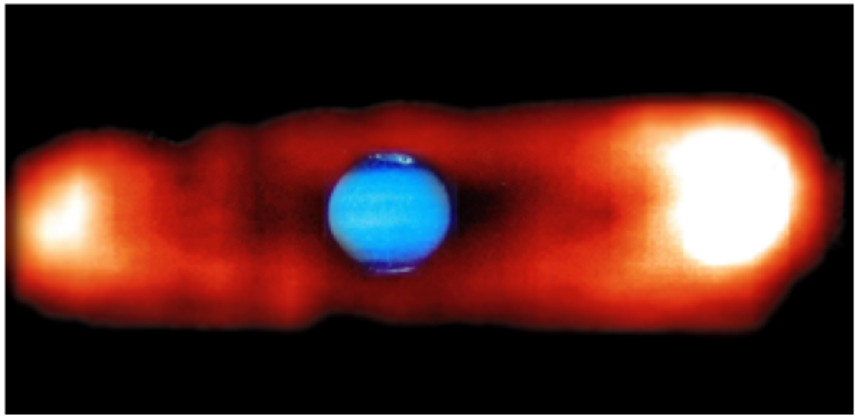
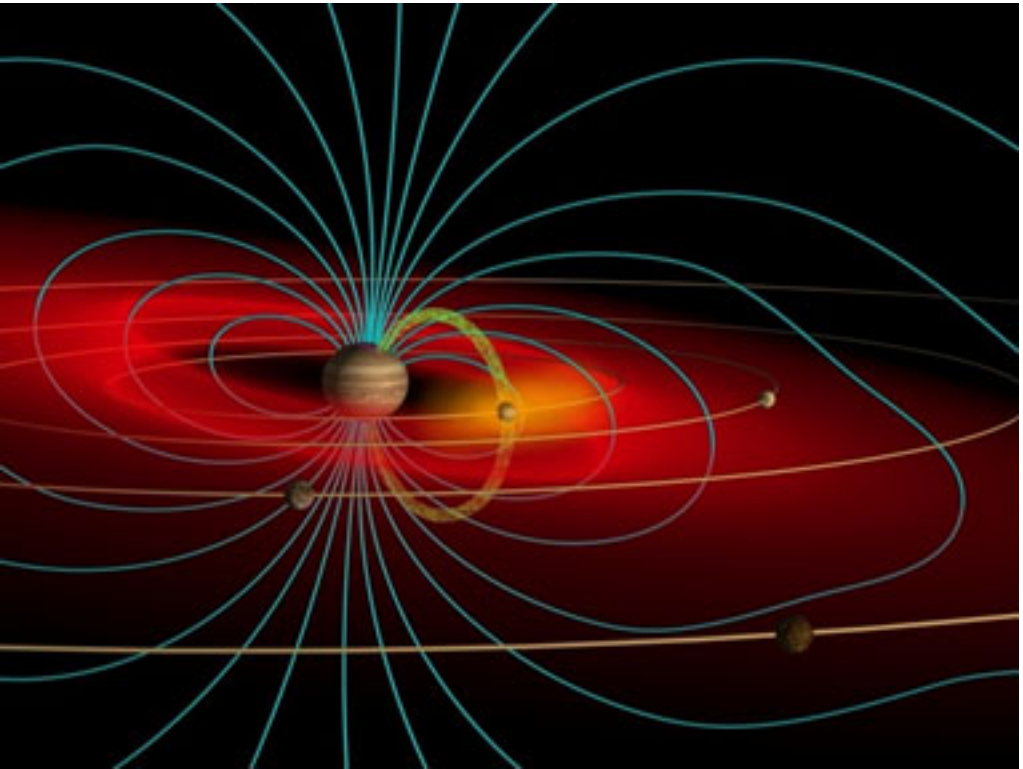


Fig.1. Io plasma torus and Jupiter (*3)



Interchange instability

・There must be things coming inside in stead of things going outside with centrifugal force.

・The magnetic flux tubes with large magnetic density were observed by Galileo. (Thorne,Russel,…)

Fig.2. The jovian magnetosphere(*4)

The spectral image of Io plasma torus by Cassini

- During the flyby of Jupiter (October, 2000-March, 2001)
- Closest distance from Jupiter was 137R_J
- EUV spectral image
- **Jovian aurora** in the center row
- **Io plasma torus** in the other area

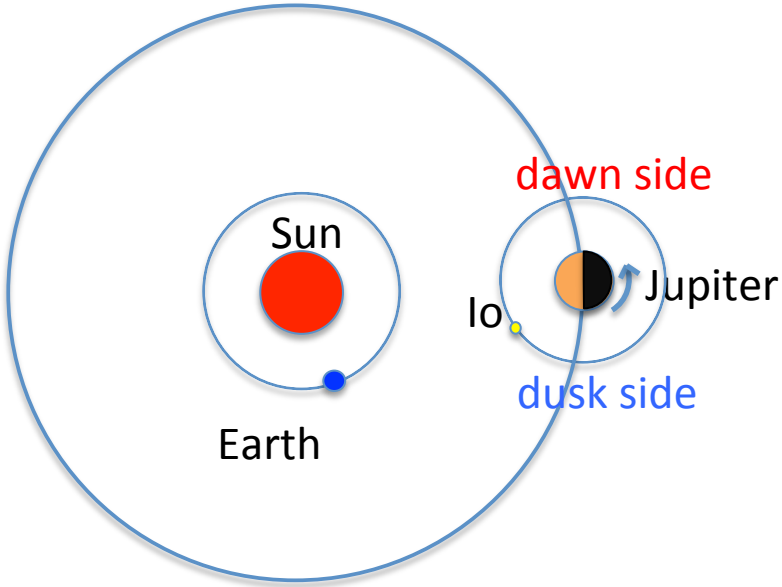


Fig.4. The positional relation

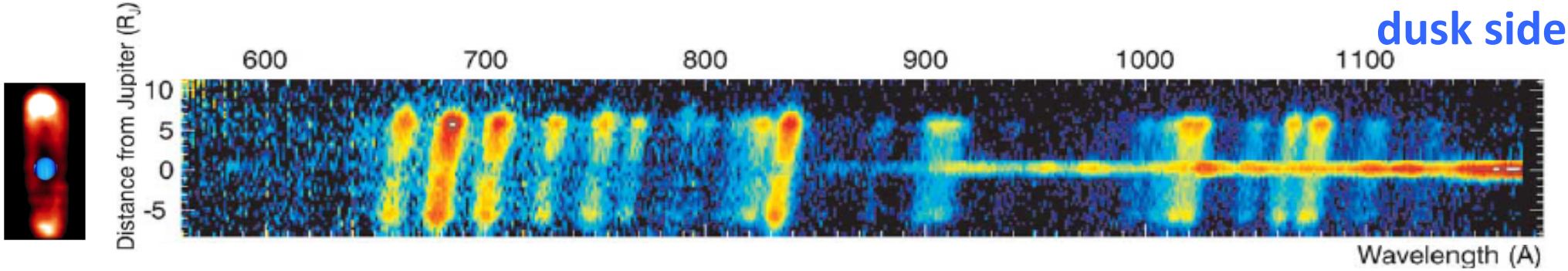


Fig.5. The spectral image of Io plasma torus by Cassini (Steffl.et.al,2003)

The spectral image of Io plasma torus by Hisaki

- Hisaki/EXCEED is the space telescope launched in 2013 and now observing planets in the orbit **around the earth**.
- It has the slit with **dumbbell-like** shape.
- Geocorona (He I 584Å,O II 834Å,OI 989Å,Lyman-β 1025Å,Lyman-α 1216Å) can be seen.

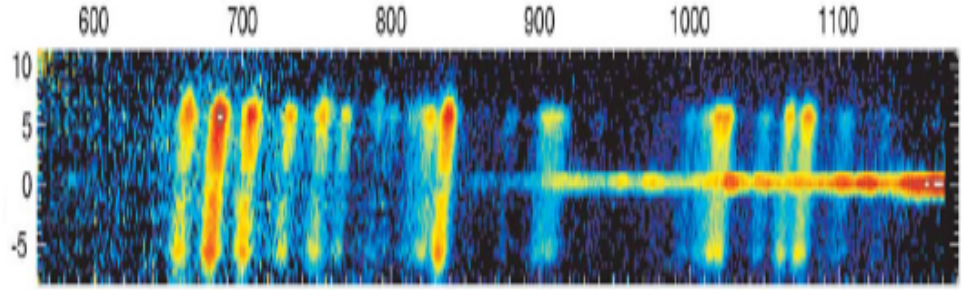
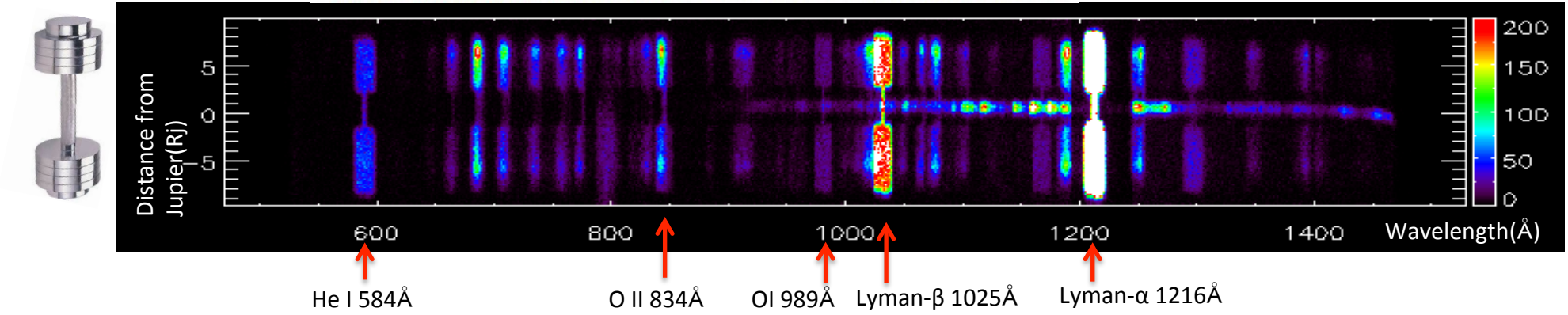
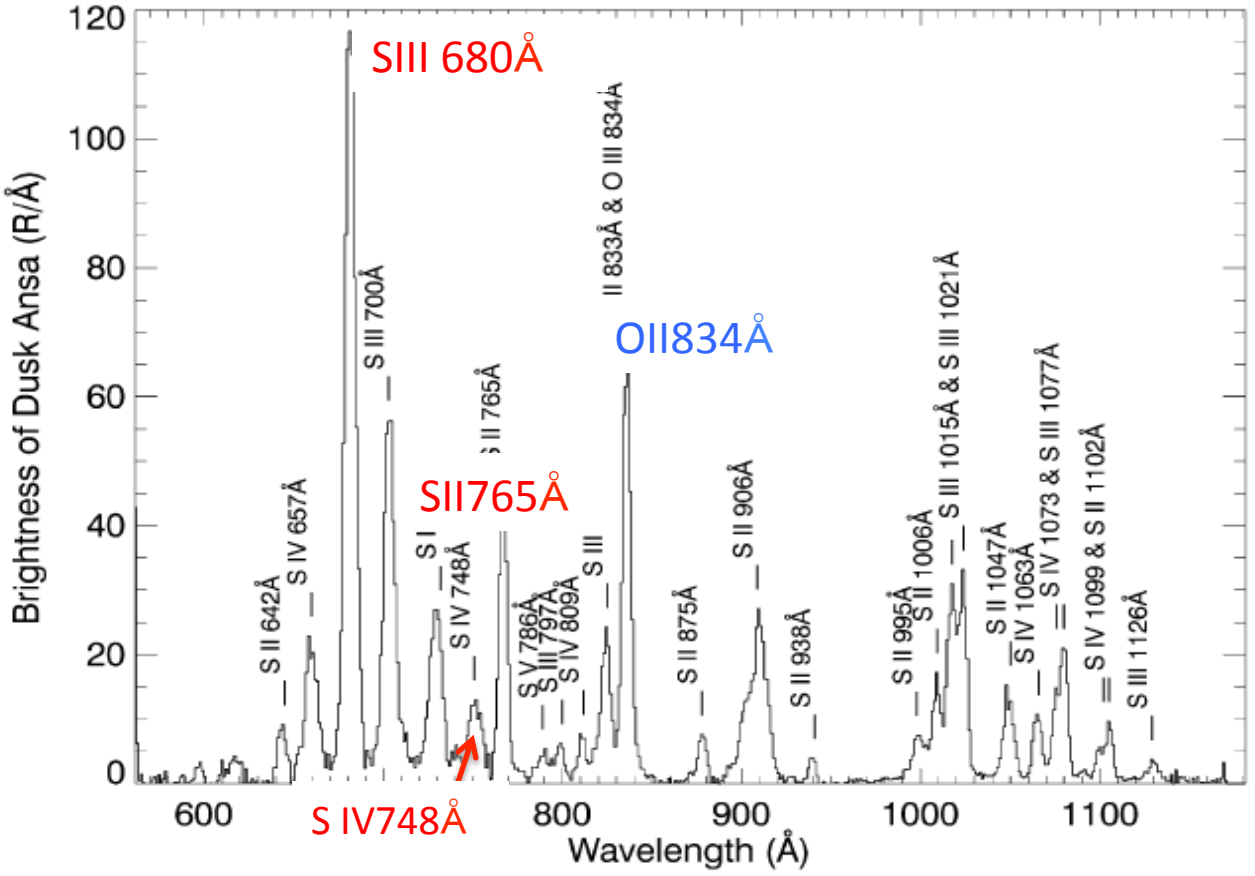


Fig.6. The spectral image of Io plasma torus (left : by Cassini (Steffl,2003),under : by Hisaki)



The spectrum of the Io plasma torus by Cassini



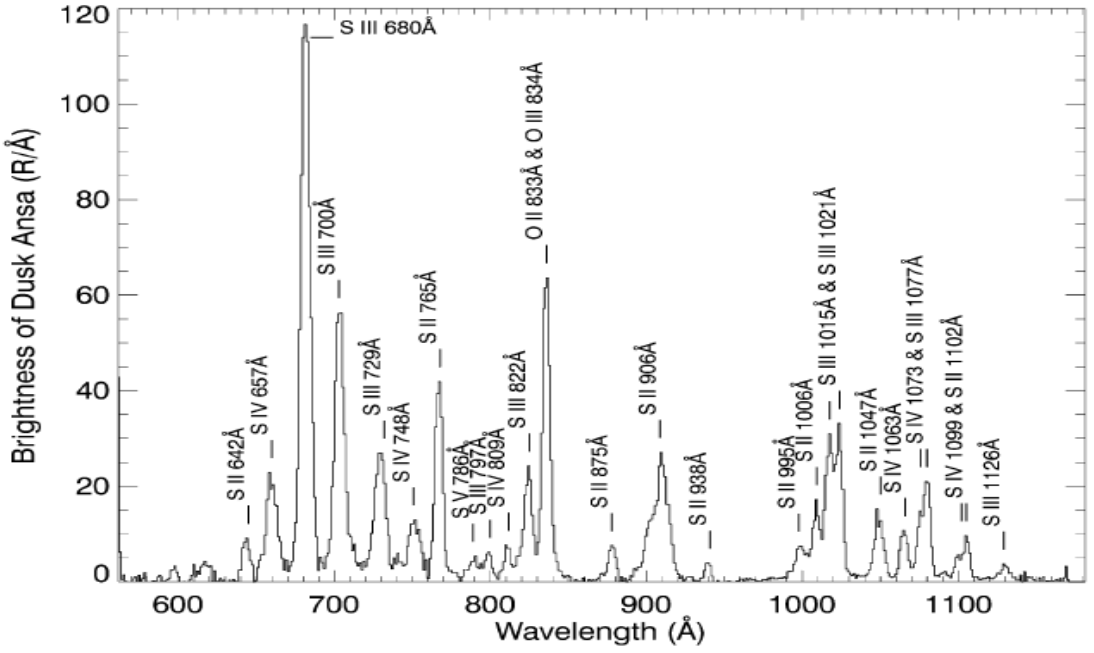
- S and O are the principal components of the Io plasma torus.

Fig.7. The spectrum of the Io plasma torus dusk ansa (Steffl.et.al, 2003)
EUV spectrum of the Io plasma torus dusk ansa(Integration range is from 561Å to 1181Å).

The spectrum of Io plasma torus by Hisaki

・The left figure (Cassini's data)　is plotted with **Rayleigh divided by the wavelength resolution** as the vertical axis.

・The right figure (Hisaki's data)　is plotted with **Rayleigh**.



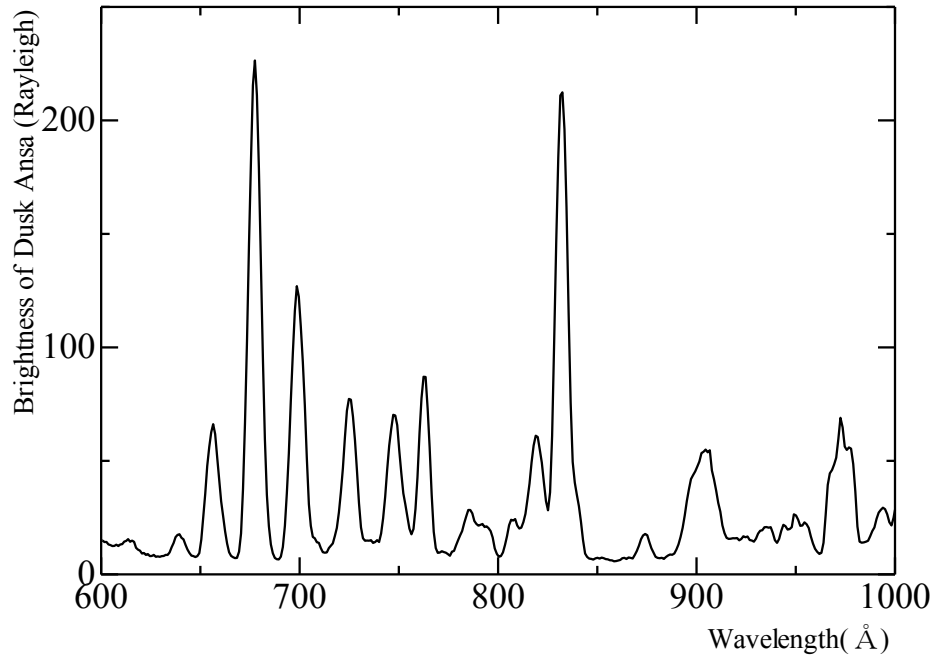


Fig.8. The spectrum of the Io plasma torus dusk ansa (left : by Cassini (Steffl,2003), right : by Hisaki)

The spectrum of Io plasma torus by Hisaki

・The relative brightness of OII 834Å and OI 989Å(geocorona) are larger than Cassini.

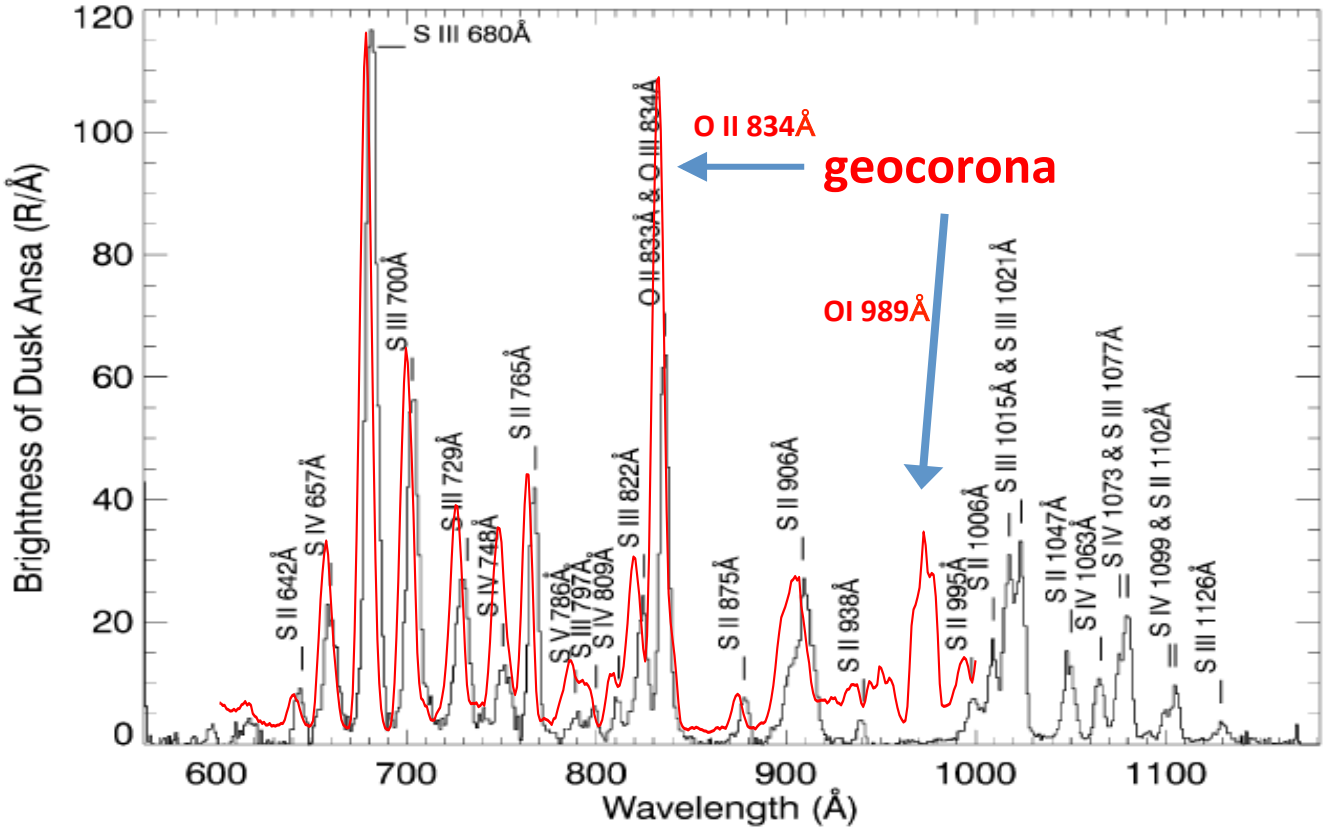


Fig.9. The spectrum of the Io plasma torus dusk ansa by Cassini (Steffl,2003) and Hisaki.
The red line is Hisaki's spectrum matched to SIII 680Å of Cassini.

The SIII 680Å radial brightness profile by Cassini

・The dusk ansa is brighter than the dawn ansa.
・The profile outside 5.5Rj is almost the same in both ansae, but inside 5.5Rj the dusk profile is steeper than the dawn.

dawn-dusk asymmetry

・the brightness peak is about 5.8Rj in both ansae.

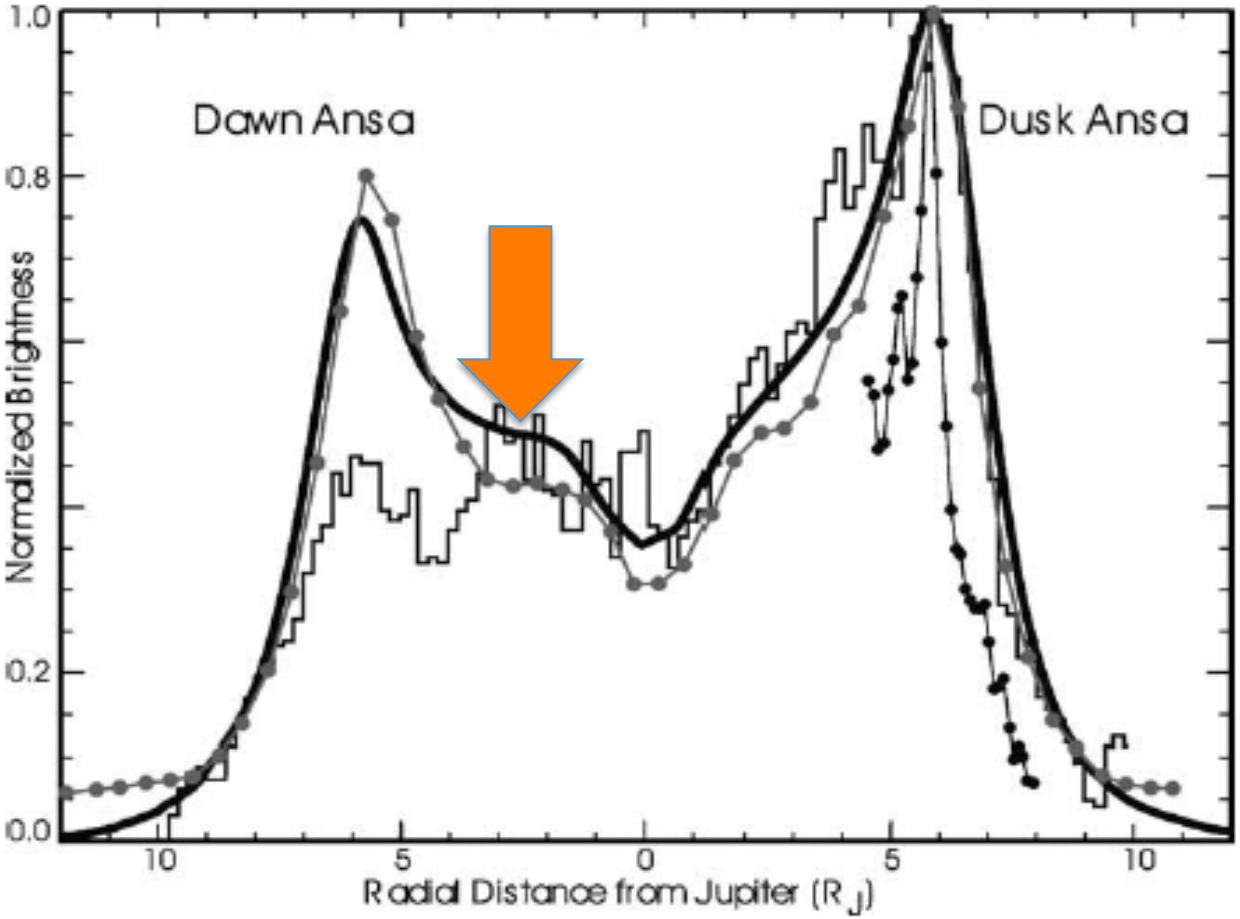


Fig.10. Radial brightness profile (Steffl.et.al, 2003)
The thick black line is Cassini's data. This figure derived by averaging the data of 41 days using 680Å±10Å.

The SIII 680Å radial brightness profile by Hisaki

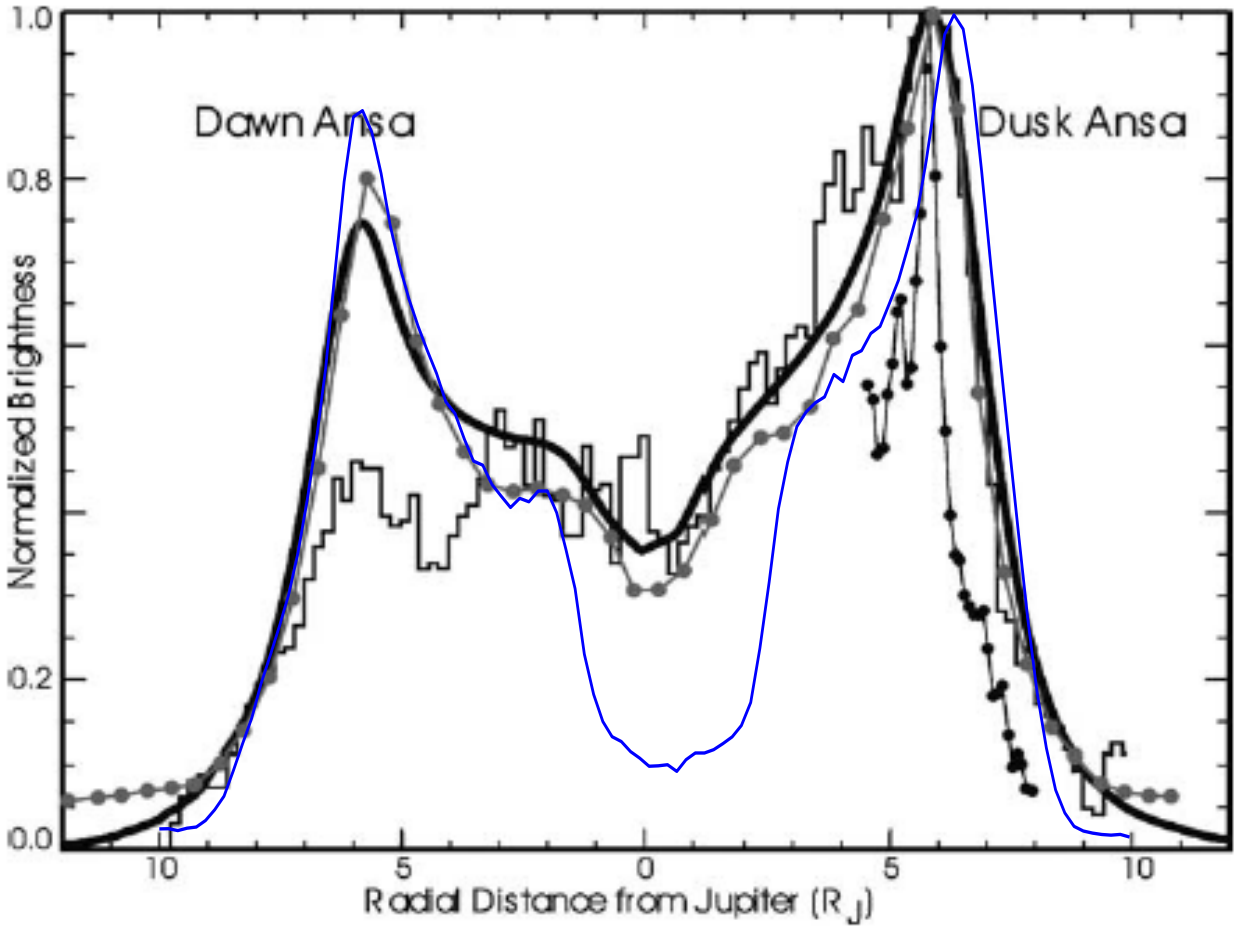


Fig.11. Radial brightness profile (Steffl.et.al, 2003. and Hisaki's result)
The blue line is Hisaki's data. This figure is derived by averaging the data of 29 days using the spectral image in the square area around 680Å(Fig.12).

The SIII 680Å radial brightness profile by Hisaki

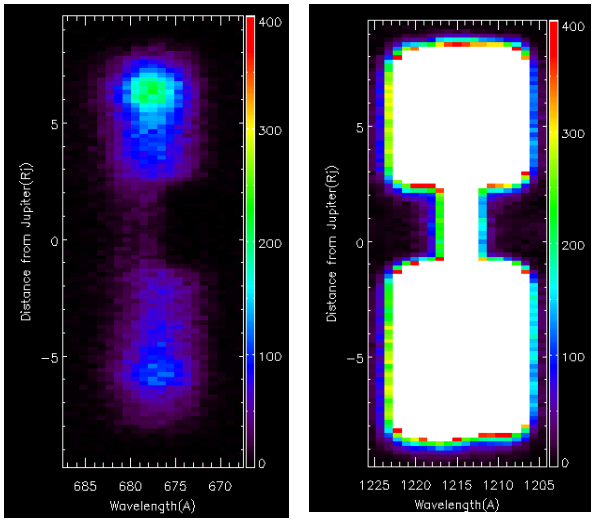


Fig.12. The spectral image (left:SIII 680Å, right:lyman-α)
We use the image in above square area decided by the image of lyman-α which have a strong spectrum.

- The profile around Jupiter is completely different（because of the **dumbbell-like shape slit**?).
- The dusk peak(6.4Rj) is outer than Cassini(5.8Rj).
- The dawn peak is higher than Cassini.
- The profile outside the peak is almost the same.

Total power radiated in 4 spectral features observed by Cassini

- The power of S IV(748Å) reversed that of S II(765Å).

Change in component of torus because of the explosion of Io's volcano. (It can't be explained only by change in the temperture of electrons.)

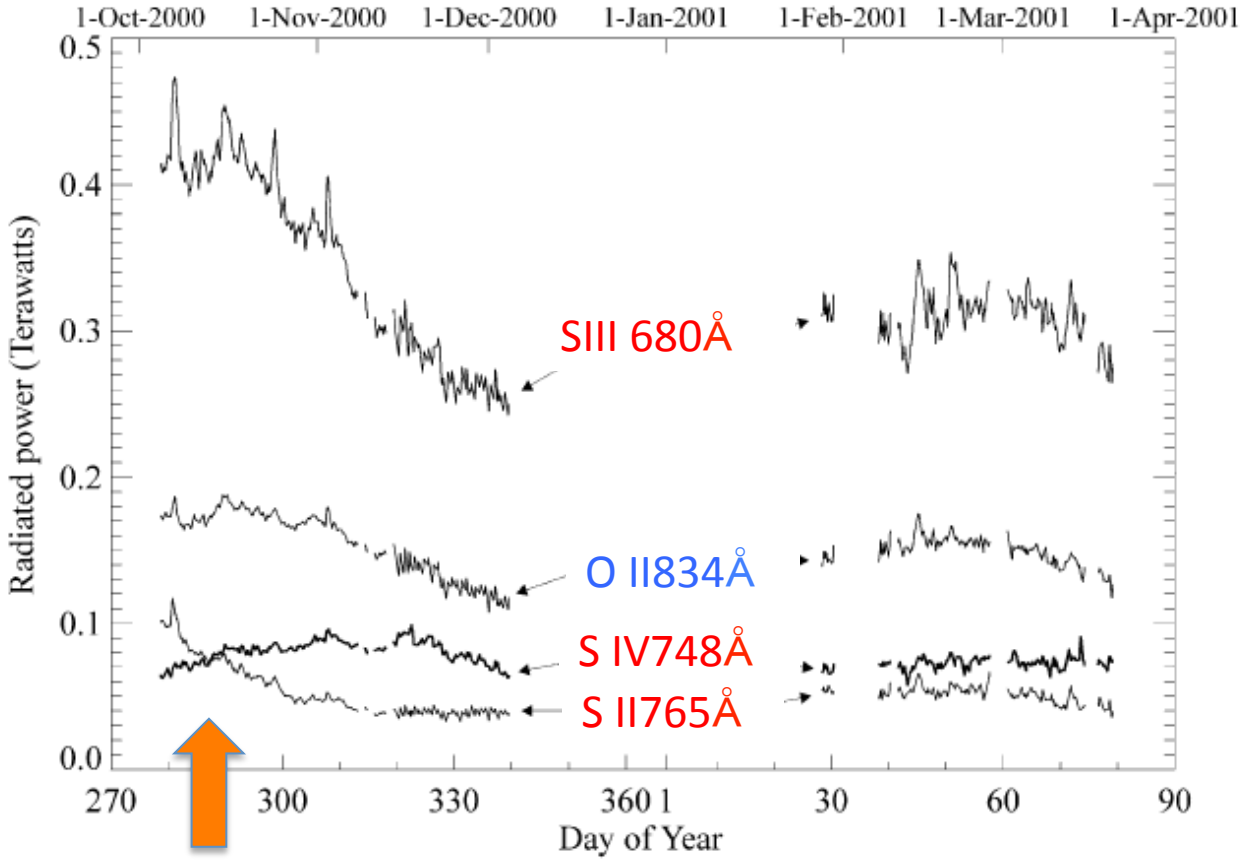


Fig.13. S and O Variations (Steffl.et.al, 2003)

The variation of counts/sec in SIII 680Å spectral features observed by Hisaki

- dusk ansa＞dawn ansa
- dawn-dusk line symmetry (about counts/sec=1)
- Dusk and dawn have the periodic variation (T≒2day).
- Total counts/sec does not change drastically like the Cassini's observation.

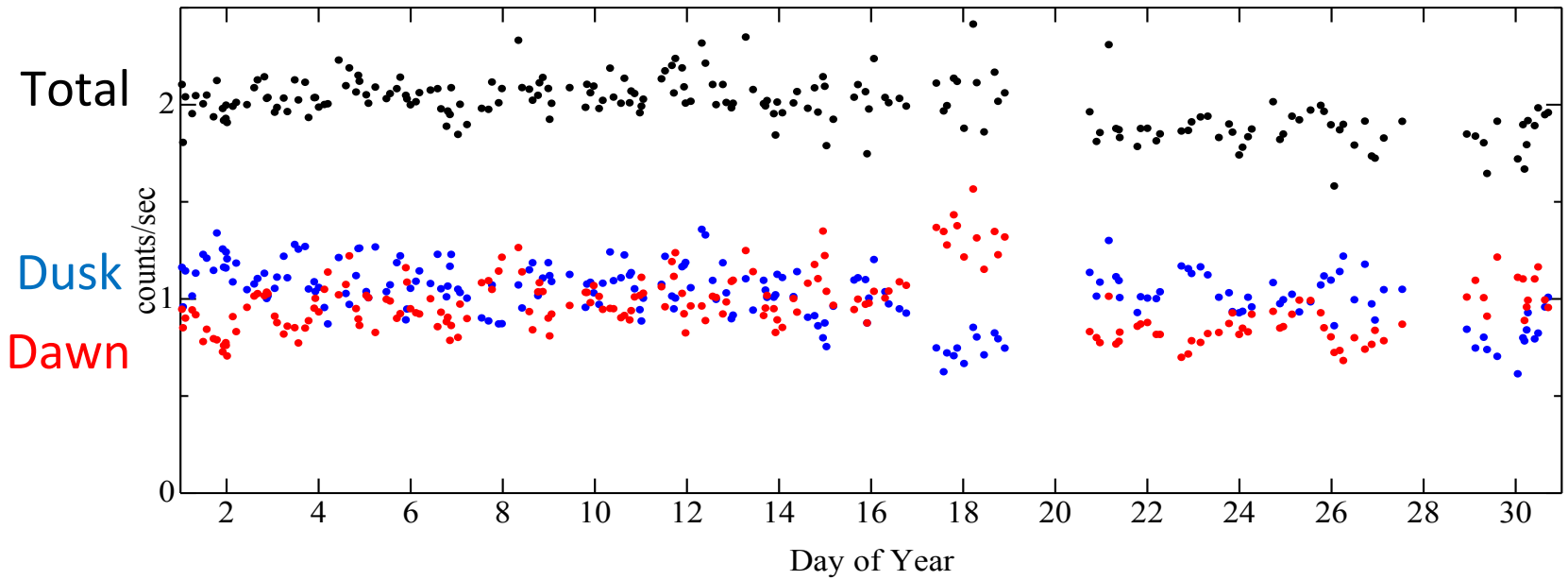
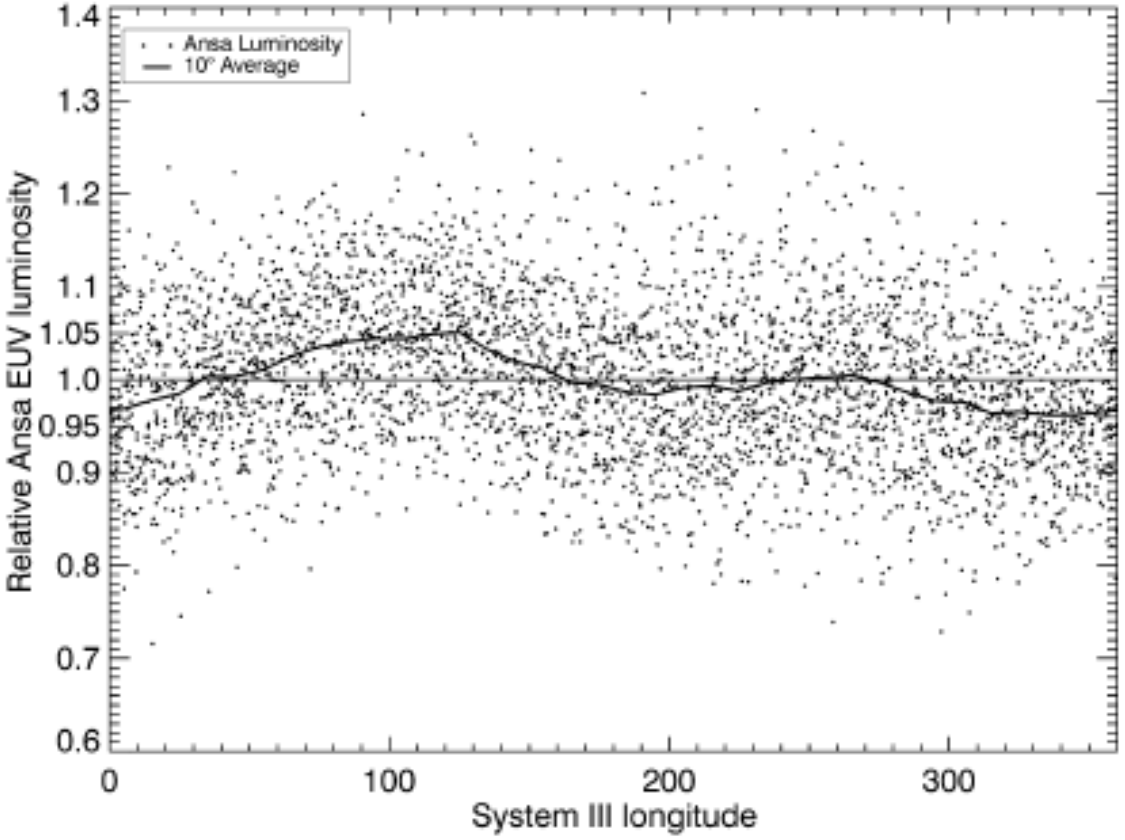


Fig.14 SIII 680Å variation(30 days)

The blue dot is dusk, the red is dawn and the black is the total. In this figure, Day of Year=1 means '2014/01/01'.

The data including the radiation belt is omitted.

Relative luminosity of SIII 680Å of the torus ansae versus SystemIII longitude observed by Cassini

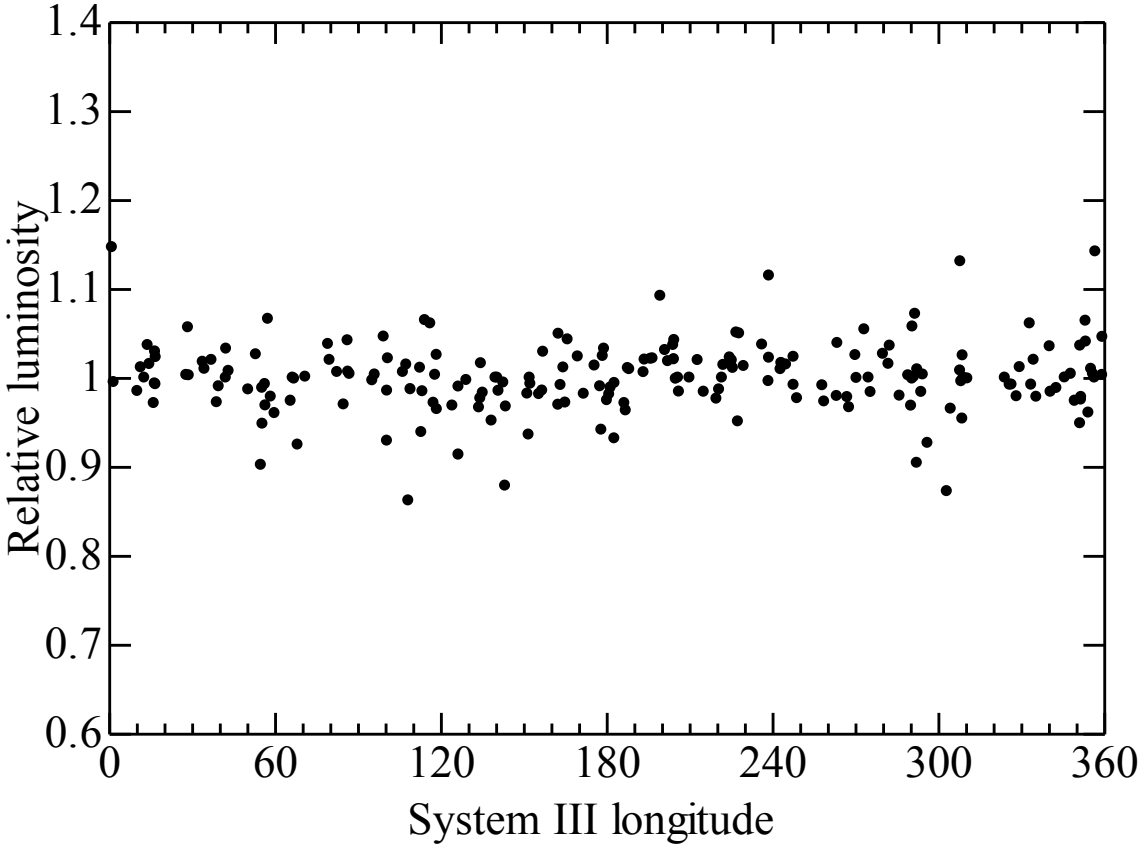


- The brightness peak is near λ_{III}=110°,but the physical significance of the variation is **uncertain** because the scatter is larger than the variation .

Fig.15. Relative luminosity of SIII680Å versus SystemIII longitude by Cassini (Steffl.et.al, 2003)

The thick line is the average of data in 10°longitude bins. To correct for dawn/dusk asymmetry and long-term variations ,each data is divided by the luminosity avraged over 9.925 hour(Jupiter's rotation period) centered on the mesurement time. This figure is derived from 44days data.

Relative luminosity of SIII 680Å of the torus ansae versus SystemIII longitude observed by Hisaki



- Because the scatter is large, the physical significance of the variation seems to be uncertain.
- Using more data is to be required.

Fig.16. Relative luminosity of SIII680Å versus SystemIII longitude by Hisaki (using 30days data)

This figure is derived from 29days data.

Summary

- The various analyses of the jovian magnetosphere using the images taken by Cassini were made. We analyzed it similarly using the images taken by Hisaki/EXCEED.
- As Hisaki is in orbit around the earth, the earth's atmosphere is also taken in the image as geocorona.
- The radial brightness profile by Hisaki have some different features from that by Cassini especially around the Jupiter.
- The brightness ratio between dawn and dusk side at SIII680Å has changed during 2 days.
- The brightness has not changed drastically like the Cassini's observation.
- To identify the dependence of System-III longitude, long-term observation is necessary.

References

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・Thorne.R.M.et.al., Galileo evidence for rapid interchange transport in the Io torus. Geophys.Res.Lett.,1997.

・Russell.C.T., Statistics of depleted flux tubes in the jovian magnetosphere. Planetary Space Sci.,2005

・イオの写真
JAXAウェブページ　２０１４年７月１７日閲覧
（http://spaceinfo.jaxa.jp/ja/jupiter_satellite.html）

・木星の写真
JAXAウェブページ　２０１４年７月１７日閲覧
（http://spaceinfo.jaxa.jp/ja/jupiter.html）

・木星磁気圏の絵　２０１４年７月１７日閲覧
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