A Juno-era View of Electric Currents in Jupiter's Magnetodisk

Zhi-Yang LIU[1] (ZhiyangLiu@pku.edu.cn), Michel BLANC[2], Qiu-Gang ZONG[1]

1. Institute of Space Physics and Applied Technology, Peking University, China
2. IRAP, CNRS-Universite Toulouse III Paul Sabatier, Toulouse, France

PS6.3 / EGU23-1346 / vSP.35

Key Points

1. Four years of **Juno** magnetic field data are examined to delineate the **currents in Jupiter's magnetodisk** in the midnight-to-dawn sector.
2. The **radial current** and the **field-aligned current (FAC)** associated with it are consistent with the corotation enforcement model.
3. The **azimuthal current** decreases as the local time increases, leading to a **field-aligned current emptying the magnetodisk at pre-dawn**.

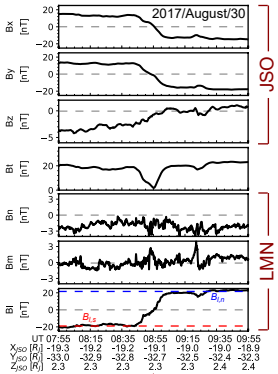
(doi.org/10.22541/essoar.167751577.72637945/v1)

Get the article

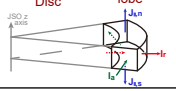
Also see: Liu (2021) studied 404 magnetodisk crossings observed by Juno

Learn more about me

Derive currents from B-field during crossings



404 crossings identified by Liu (2021) are investigated



(1) LMN coordinates
* From minimum variance analysis
* L-axis: lobe B-field
N-axis: disc normal
M-axis: current

$$\vec{j} \approx j_m \hat{x}_m \approx \frac{1}{\mu_0}\frac{\partial B_l}{\partial x_n}\hat{x}_m$$

(2) Get perpendicular currents

$$I_\perp = \int j_m dx_n = \frac{1}{\mu_0}(B_{l,n} - B_{l,s})$$

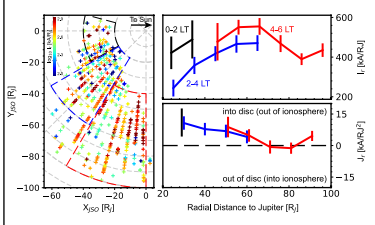
(3) Get B-fields in north ($B_{l,n}$) and south lobes ($B_{l,s}$)

(4) Calculate FACs

$$J_{\parallel,n} + J_{\parallel,s} = \frac{1}{r}\frac{\partial r I_r}{\partial r} + \frac{1}{r}\frac{\partial I_a}{\partial \phi}$$

I_r: radial current
I_a: azimuthal current

FAC associated with radial current



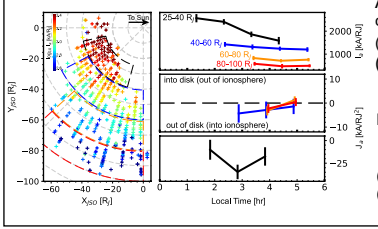
Radial current
(1) ~500 kA/R_J
(2) first ↑ then ↓ as r ↑

Related FAC

$$J_r = \frac{1}{2}\frac{1}{r}\frac{\partial r I_r}{\partial r}$$

(1) r<70: >0 and ↓ as r ↑
(2) 70<r<80: <0 (very small)

FAC associated with azimuthal current



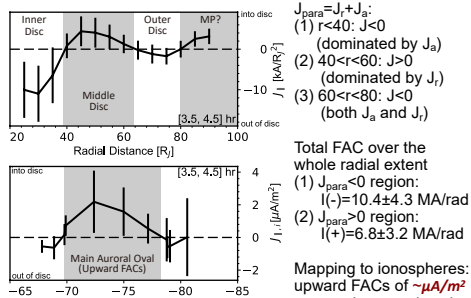
Azimuthal current
(1) ~1000 kA/R_J
(2) decrease as local time ↑

Related FAC

$$J_a = \frac{1}{2}\frac{1}{r^2}\frac{\partial I_a}{\partial \phi}$$

(1) always <0
(2) magnitude ↓ as r ↑

Total FAC in the pre-dawn local time sector

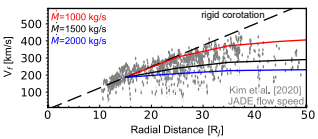


$J_{para}=J_r+J_a$:
(1) r<40: J<0 (dominated by J_a)
(2) 40<r<60: J>0 (dominated by J_r)
(3) 60<r<80: J<0 (both J_a and J_r)

Total FAC over the whole radial extent
(1) J_{para}<0 region: I(-)=10.4±4.3 MA/rad
(2) J_{para}>0 region: I(+)=6.8±3.2 MA/rad

Mapping to ionospheres: upward FACs of ~**$\mu A/m^2$** near main auroral oval

Eestimate radial mass transport rate



Torque balance:

$$\dot{M}\frac{d}{dr}(r^2\omega) = 2\pi r^2 I_r B_n$$

Kim (2020) This work Liu (2021)

Radial mass transport rate~1000-2000 kg/s