SURFACE WAVES ON THE JOVIAN MAGNETOPAUSE

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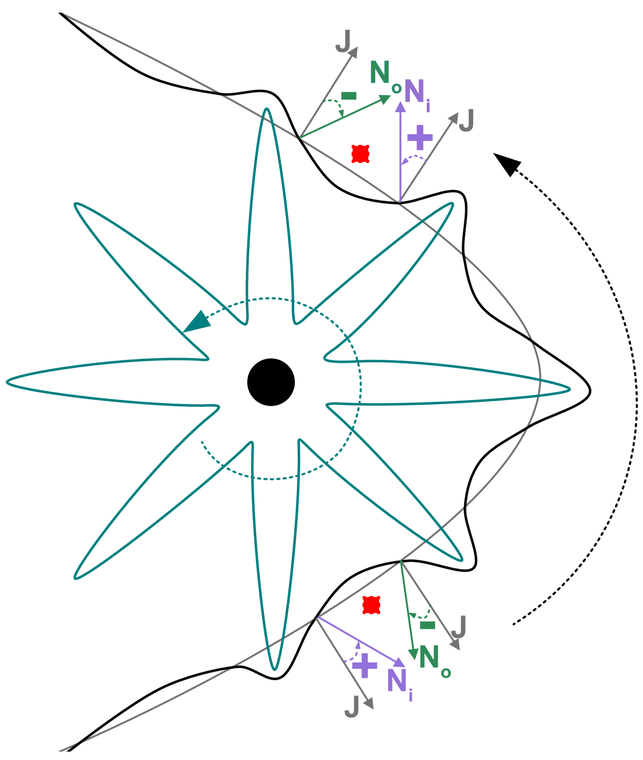
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1. CONTEXT

- The Jovian **magnetopause** is a highly **dynamic** boundary shaped by interactions between Jupiter's co-rotating internal plasma and the solar wind, leading to the development and propagation of wave activity along the boundary.
- This study investigates **wave activity** along the Jovian magnetopause to identify the propagation direction and the physical mechanisms underlying the observed perturbations.

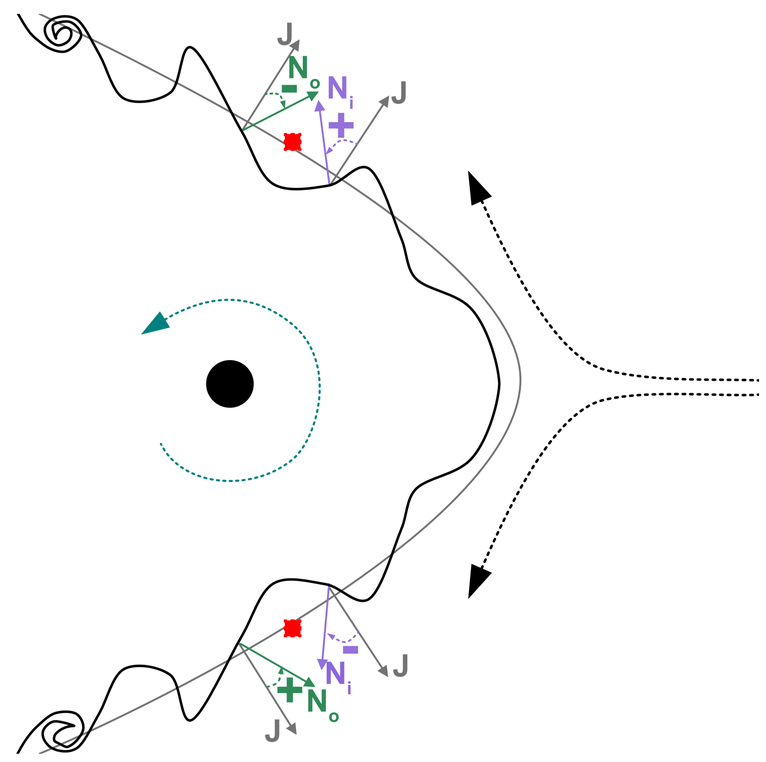
2. THREE POTENTIAL PERTURBATION MECHANISMS

A stationary spacecraft (in red) is in the vicinity of the magnetopause: how will it perceive the propagation of perturbations along the surface of the boundary ?



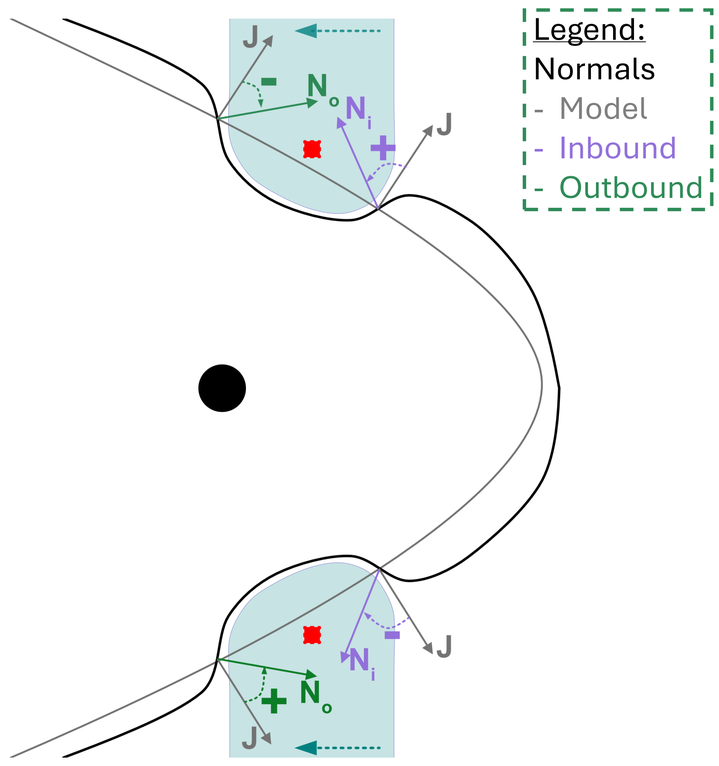
A. Centrifugal interchange instability

- Creation of finger-like plasma structures
- Co-rotate with Jupiter and may graze the magnetopause
- Variability along the boundary
- Surface waves propagate in the co-rotation direction



B. Kelvin-Helmholtz instability

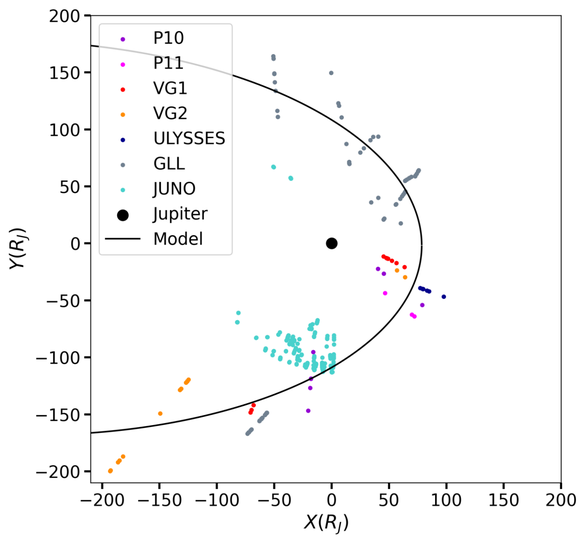
- Strong velocity shear between the solar wind and the co-rotating magnetospheric plasma
- Perturbations along the interface
- Possible vortices characteristic of the instability's non-linear stage
- Tailward propagation



C. Pressure variations

- Variations in the solar wind dynamic pressure
- Compression and decompression of the boundary
- "Fold" in the magnetopause
- Tailward propagation
- Surface waves due to magnetosheath jets ?

3. NORMAL COMPUTATION METHODS



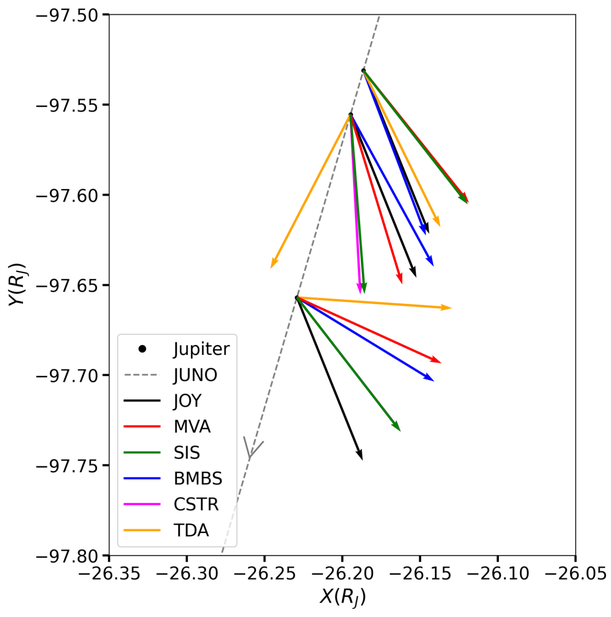
Low-latitude magnetopause crossings from **seven** missions

Different coverage of the dawn and dusk sides of the boundary

Magnetic field around the positions of crossing

Five boundary analysis methods

Optimized and fixed **window-size** options



Obtain the **normal** to the magnetopause at each crossing point

Comparison between the different methods

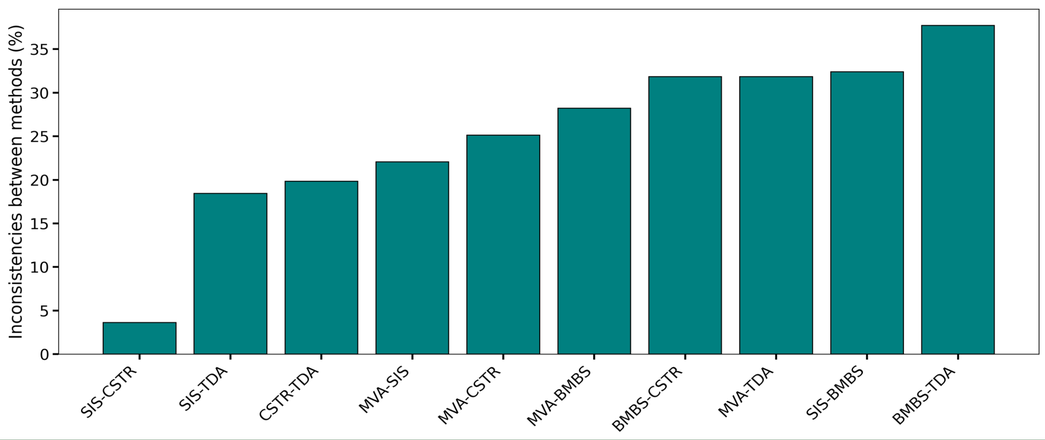
Measure of the **angle** between the method normal and the model of ***Joy et al. (2002)***[1]

Precise orientation of the local boundary normal uncertain

Minimum Variance Analysis (MVA)[2]	Siscoe method (SIS)[3]	BMBS method (BMBS)[4]	Constraint mehtod (CSTR)[5]	Tangential Discontinuity Analysis (TDA)[6]

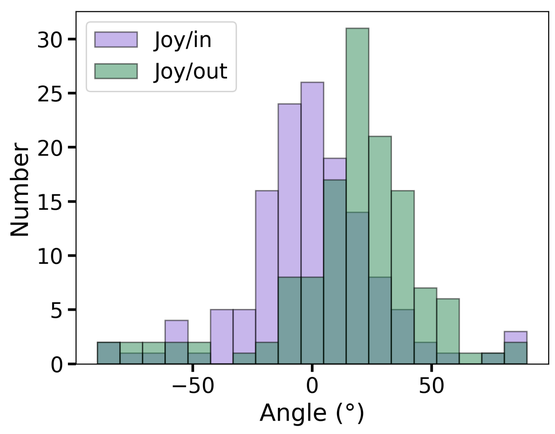
Comparison between the different methods

→ the method from ***Siscoe et al. (1968)***[3] is found to be the most robust one



4. STATISTICAL RESULTS

Dawn side of the magnetosphere

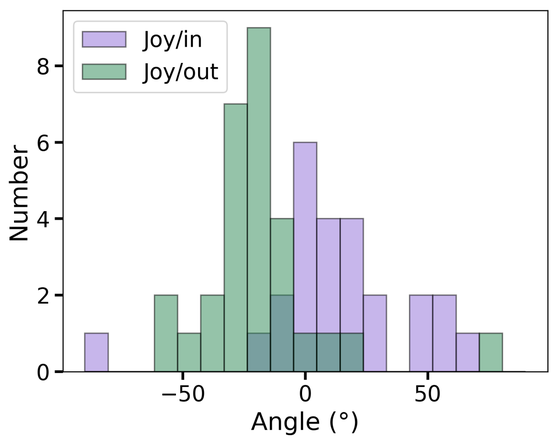


Angle between Siscoe's normals and Joy's normals

Two statistically different distributions

Dependent on the **direction** of the crossing (inbound or outbound)

Dusk side of the magnetosphere



Sign **inversion** between the dawn and dusk sides

Robust across nearly all methods and window-size options

Comparison with the possible perturbation mechanisms

Sign of perturbation **mechanisms B and/or C**

→ **Tailward** propagating perturbations on both the dawn and dusk flanks of Jupiter's magnetopause.

References

Figures are from Wiels et al. (2026) [accepted]

[1]*Joy, S., Kivelson, M., Walker, R., et al. 2002, Journal of Geophysical Research: Space Physics, 107, SMP*

[2]*Sonnerup, B. & Cahill Jr, L. 1967, Journal of Geophysical Research, 72, 171*

[3]*Siscoe, G., Davis Jr, L., Coleman Jr, P., Smith, E., & Jones, D. 1968, Journal of Geophysical Research, 73, 61*

[4]*Ma, X., Otto, A., Delamere, P. A., & Zhang, H. 2016, Advances in Space Research, 58, 231*

[5]*Sonnerup, B. & Cahill Jr, L. 1968, Journal of Geophysical Research, 73, 1757*

[6]*Masters, A., Achilleos, N., Cutler, J., et al. 2012, Planetary and Space Science, 65, 109*

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