

# Supporting Information for " Source of radio emissions induced by the Galilean moons Io, Europa and Ganymede: *in situ* measurements by Juno"

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## Contents of this file:

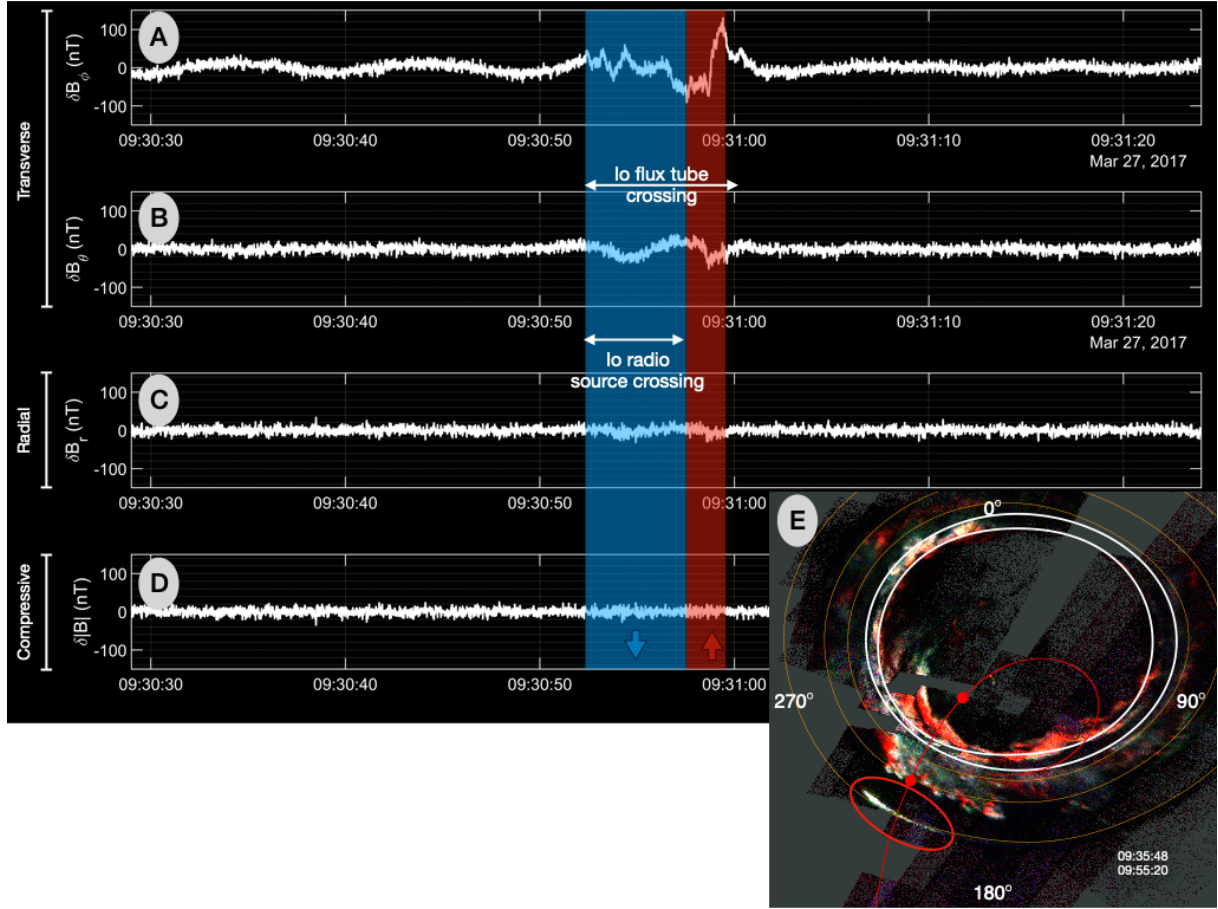
1. Figures S1 to S5

## Introduction

This Supporting Information contains figures that complement the figures and text in the main manuscript. Figure S1 complements Figure 1 by providing details of magnetic disturbances. Figure S2 to S4 provides Juno data for the three other Io-induced radio emission source crossings discussed in the text of the main manuscript. Finally, Figure S5 gives details of magnetic disturbances during the Ganymede-induced radio emission source crossing of PJ#20.

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**Figure S1 – Magnetic field perturbations from Juno/MAG measurements during Io-induced radio emission source crossing on 2017 March 27 (Perijove #5 South)**



*Figure S1: Magnetic field perturbations (spherical coordinates) during Io-induced radio emission source crossing that occurs during Perijove #5 South (2017 March 27). Transverse perturbations: (A)  $\delta B_\phi$  and (B)  $\delta B_\theta$ ; Radial perturbations: (C)  $\delta B_r$ ; Compressive perturbations: (D)  $\delta|B|$ . The blue shaded area represents downward current, while the red area represents upward current. Panel (E) shows the polar projection (as seen from the Southern pole) of Juno/UVS data with Juno's trajectory overplotted. The two red point shows the integrated time of the image (indicated on the bottom-right corner of the image). The red ellipse highlight the crossing of interest.*

**Figure S2 – Juno/ measurements during Io-induced radio emission source crossing on 2017 May 29 (Perijove #6 North)**

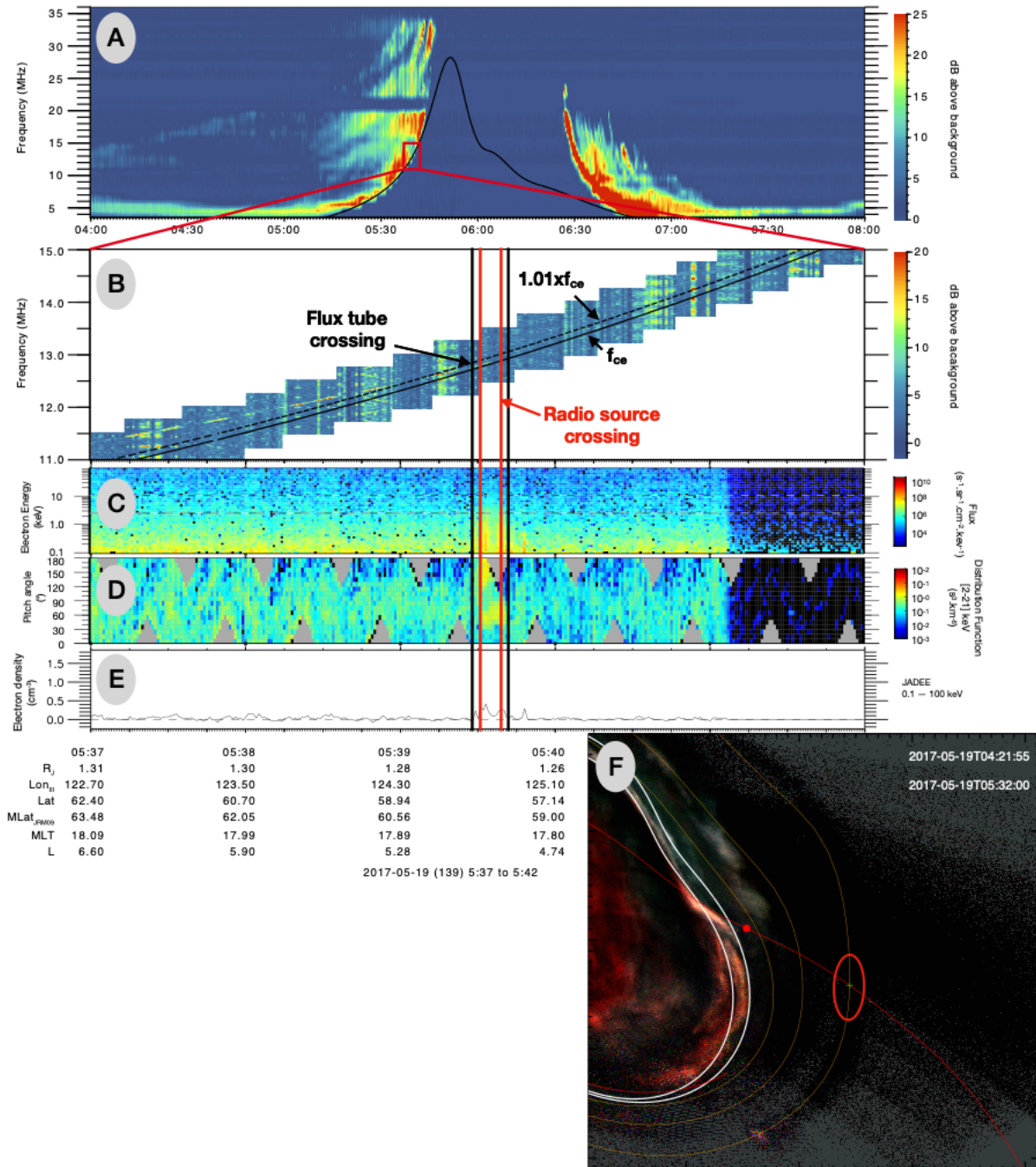
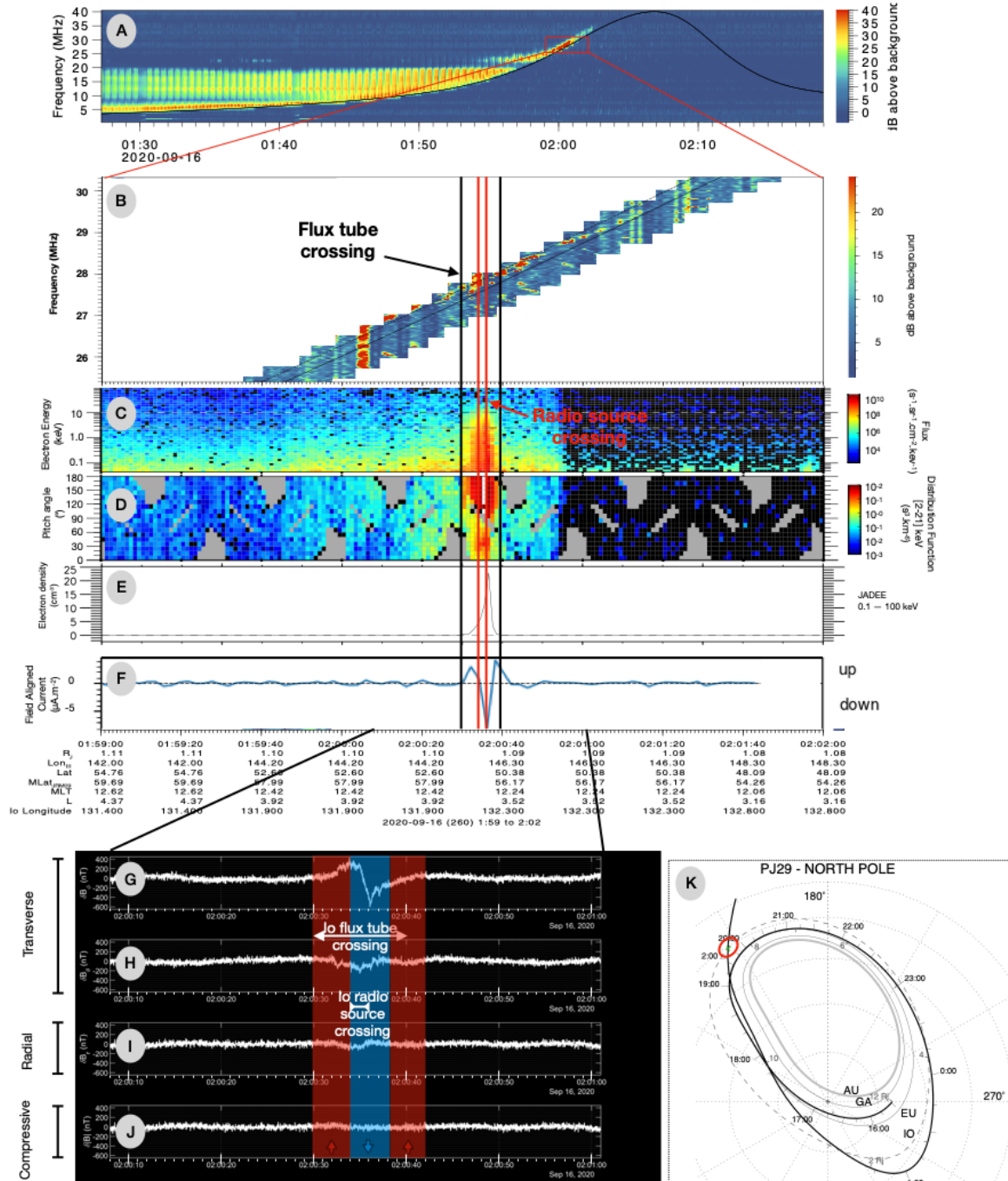


Figure S2: Juno data during Perijove #6 North (2017 May 19), during an Io-induced radio emission source crossing. Panels (A,B) display Juno/Waves data (A) in low-resolution mode and (B) in high-resolution mode. The solid-black lines represent the electron cyclotron frequency derived from the magnetic field measurements of Juno/MAG, and the dashed-black line is  $1.01xf_{ce}$ . Panels (C-E) display Juno/JADE-E measurements: (C) the electron differential number flux (or intensity) of all electrons; (D) the electron distribution function for energy in range [2-21] keV as a function of pitch angle; (E) partial electron density calculated from the JADE-E flux. The vertical solid black lines represent the flux tube crossing as inferred from JADE data, while vertical red lines represent the time interval where growth rate  $> 10^{-4}$  are calculated from JADE measurements. Panel (F) shows the polar projection (as seen from the Northern pole) of Juno/UVS data with Juno's trajectory

overplotted. The two red point shows the integrated time of the image (indicated on the top-right corner of the image). The red ellipse highlights the crossing of interest. Juno/MAG measurements show no significant magnetic field perturbation (potentially due to a very small electron density), and are therefore not shown.

**Figure S3 – Juno/ measurements during Io-induced radio emission source crossing on 2020 September 16 (Perijove #29 North)**



**Figure S3: Juno data during Perijove #29 North (2020 September 16), during an Io-induced radio emission source crossing.** Panels (A,B) display Juno/Waves data (A) in low-resolution mode and (B) in high-resolution mode. The solid-black lines represent the electron cyclotron frequency derived from the magnetic field measurements of Juno/MAG, and the dashed-black line is  $1.01x f_{ce}$ . Panels (C-E) display Juno/JADE-E measurements: (C) the electron

differential number flux (or intensity) of all electrons; (D) the electron distribution function for energy in range [2-21] keV as a function of pitch angle; (E) partial electron density calculated from the JADE-E flux. Panel (F) shows the field aligned currents calculated based on Al Saati et al. (2022)'s method, using magnetic field fluctuations in the azimuthal direction ( $\delta B_\phi$ ) deduced from the Juno/MAG measurements.

The vertical solid black lines represent the flux tube crossing as inferred from JADE data, while vertical solid red lines represent the time interval where growth rate  $> 10^{-4}$  are calculated from JADE measurements.

Panels (G-J): Magnetic field perturbations (spherical coordinates) from Juno/MAG measurements: Transverse perturbations: (G)  $\delta B_\phi$  and (H)  $\delta B_\theta$ ; Radial perturbations: (I)  $\delta B_r$ ; Compressive perturbations: (J)  $\delta |B|$ . The blue shaded area represents downward current, while the red areas represent upward currents.

Panel (K) shows the polar projection of Juno's trajectory (as seen from the Northern pole). The red ellipse highlights the position of Juno at the crossing time. Not enough Juno/UVS data were available for this crossing to build a UV map of context.



**Figure S4 – Juno/ measurements during Io-induced radio emission source crossing on 2017 March 17 (Perijove #5 North)**

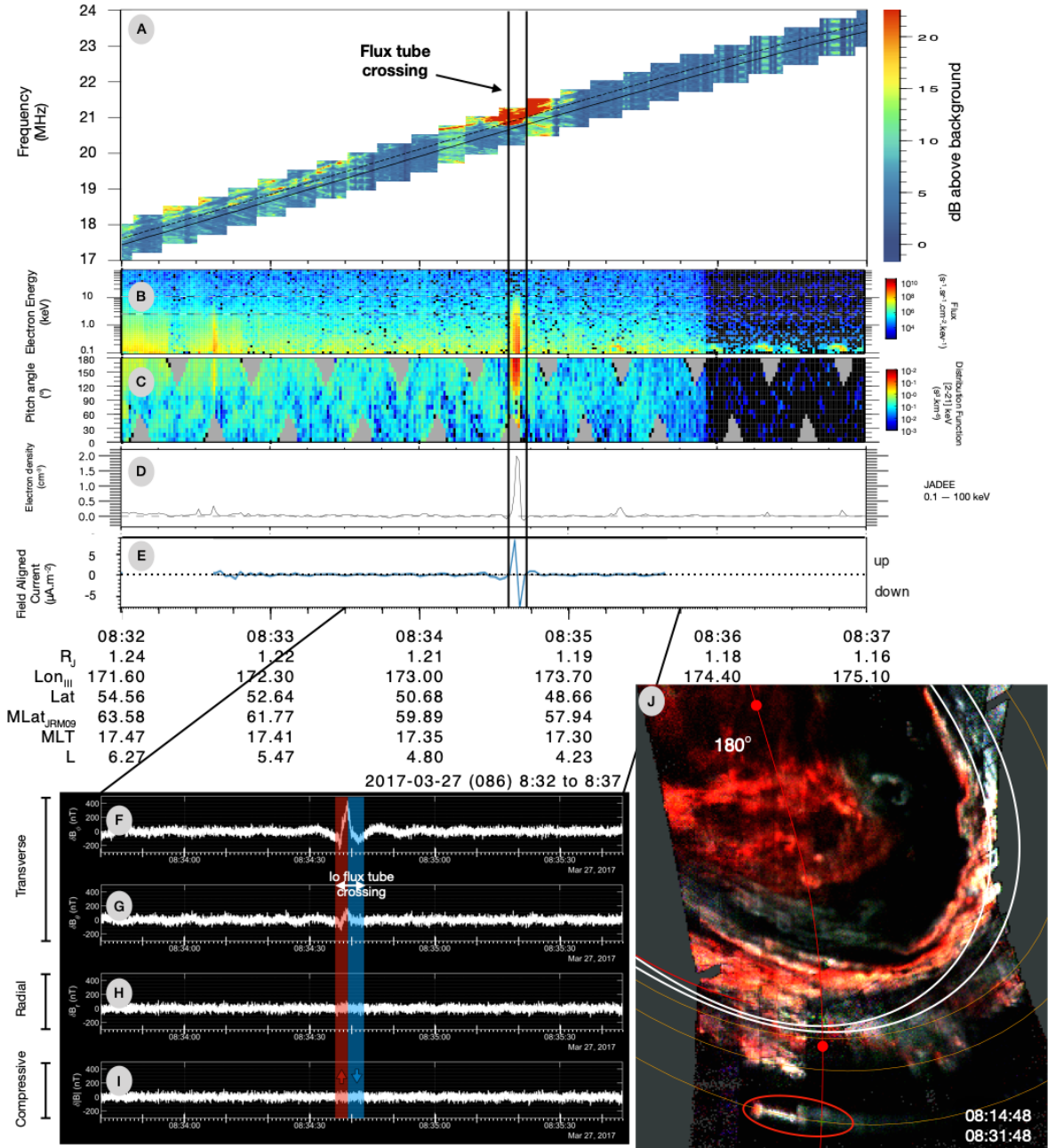
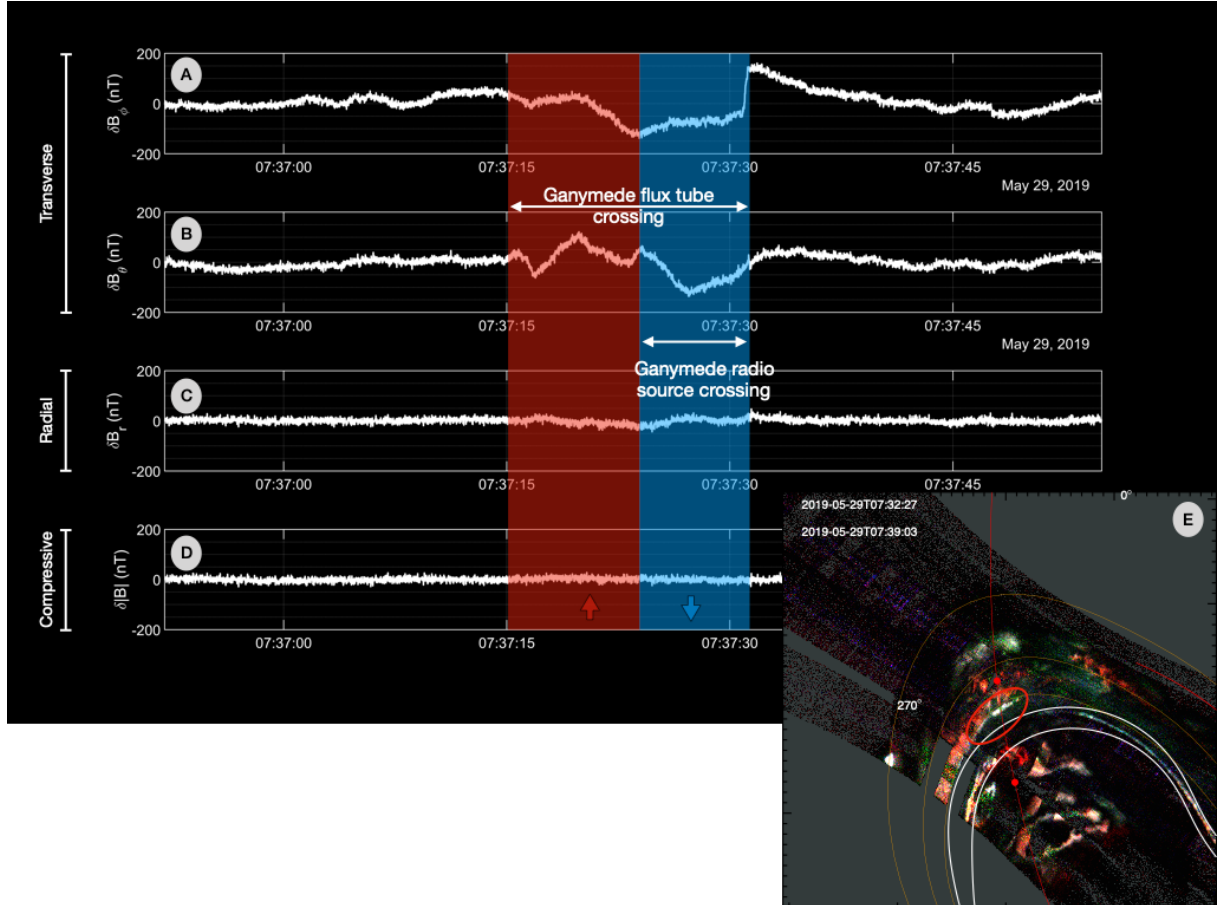


Figure S4: Juno data during Perijove #5 North (2017 March 17), during an Io-induced radio emission source crossing. Panel (A) displays Juno/Waves data in high-resolution mode. The solid-black lines represent the electron cyclotron frequency derived from the magnetic field measurements of Juno/MAG, and the dashed-black line is  $1.01x f_{ce}$ . Panels (B-D) display Juno/JADE-E measurements: (B) the electron differential number flux (or intensity) of all electrons; (C) the electron distribution function for energy in range [2-21] keV as a function of pitch angle; (D) partial electron density calculated from the JADE-E flux. Panel (E) shows the field aligned currents calculated based on Al Saati et al. (2022)'s method, using magnetic field fluctuations in the azimuthal direction ( $\delta B_\phi$ ) deduced from the Juno/MAG measurements. The vertical solid black lines represent the flux tube crossing as inferred from JADE data. Panels (F-I): Magnetic field perturbations (spherical coordinates) from Juno/MAG measurements: Transverse perturbations: (F)  $\delta B_\phi$  and (G)  $\delta B_\theta$ ; Radial perturbations: (H)

$\delta B_r$ ; Compressive perturbations: (I)  $\delta|B|$ . The blue shaded area represents downward current, while the red area represents upward current.

Panel (J) shows the polar projection (as seen from the Northern pole) of Juno/UVS data with Juno's trajectory overplotted. The two red point shows the integrated time of the image (indicated on the bottom-right corner of the image). The red ellipse highlights the crossing of interest.

**Figure S5 – Magnetic field perturbations from Juno/MAG measurements during Ganymede-induced radio emission source crossing on 2019 May 29 (Perijove #20 North)**



*Figure S5: Magnetic field perturbations (spherical coordinates) during Ganymede-induced radio emission source crossing that occurs during Perijove #20 North (2019 May 29). Transverse perturbations: (A)  $\delta B_\phi$  and (B)  $\delta B_\theta$ ; Radial perturbations: (C)  $\delta B_r$ ; Compressive perturbations: (D)  $\delta|B|$ . The blue shaded area represents downward current, while the red area represents upward current. Panel (E) shows the polar projection (as seen from the Northern pole) of Juno/UVS data with Juno's trajectory overplotted. The two red point shows the integrated time of the image (indicated on the top-right corner of the image). The red ellipse highlights the crossing of interest.*