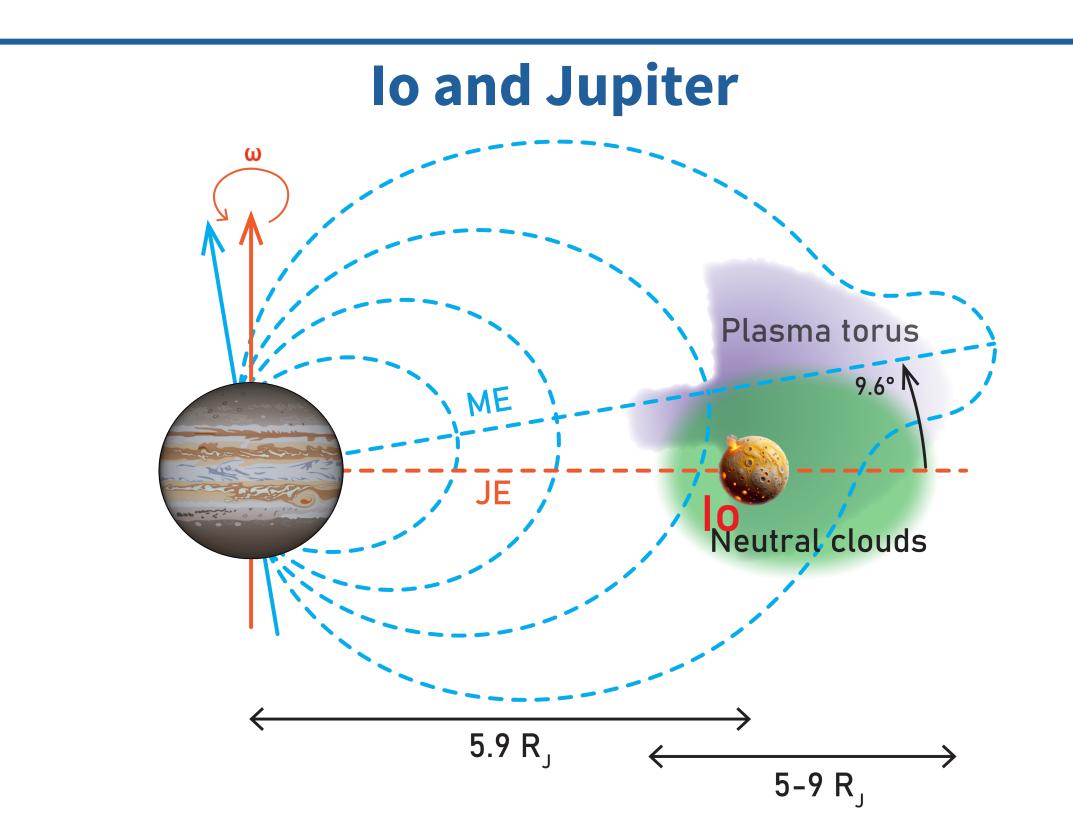
Earth-based monitoring of lo torus: proposition for a Community Project



•The Io Plasma Torus (IPT) is a region of the Jovian Magnetosphere where a dense plasma population is fed by ionization of a neutral cloud of O and SO₂, which ultimately comes from Io's surface and volcanic activity, and feeds the Jovian magnetodisk via outward radial transport.

•Tidal dissipation in Io's interior (Peale et al. 1979) induces volcanism, which in turn contributes to the Ionian atmosphere. The leaks from the atmosphere populate a neutral cloud, which loads the IPT with approx. 1 ton/s of fresh ions.

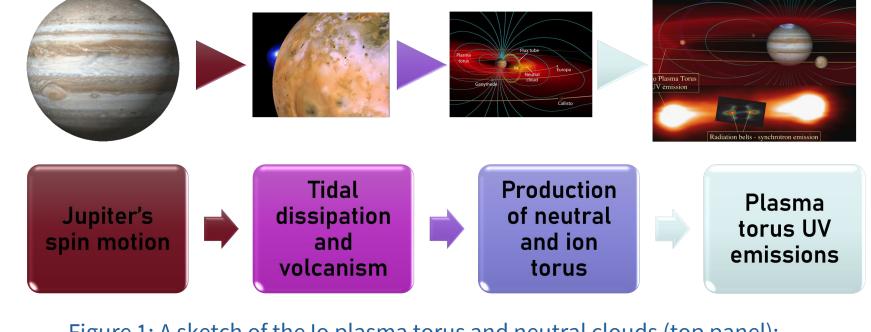


Figure 1: A sketch of the Io plasma torus and neutral clouds (top panel); A scheme of the physical phenomena underlying the Io plasma torus (bottom).

Observations of the IPT

In a over half a century, a variety of observation techniques has been adopted to target the Jovian System:

•Remote sensing from groundbased telescopes, Earth-orbiting missions such as SPRINT-1 and in the future LAPYUTA, and from Jupiter orbiters (e.g., JIRAM and UVS on *Juno*)

•*In-situ* measurements: EM waves, mass spectrometers (Waves, JADE, JEDI on *Juno*). •Radio experiments: BSR, Gravity Science, Radio Occultations.

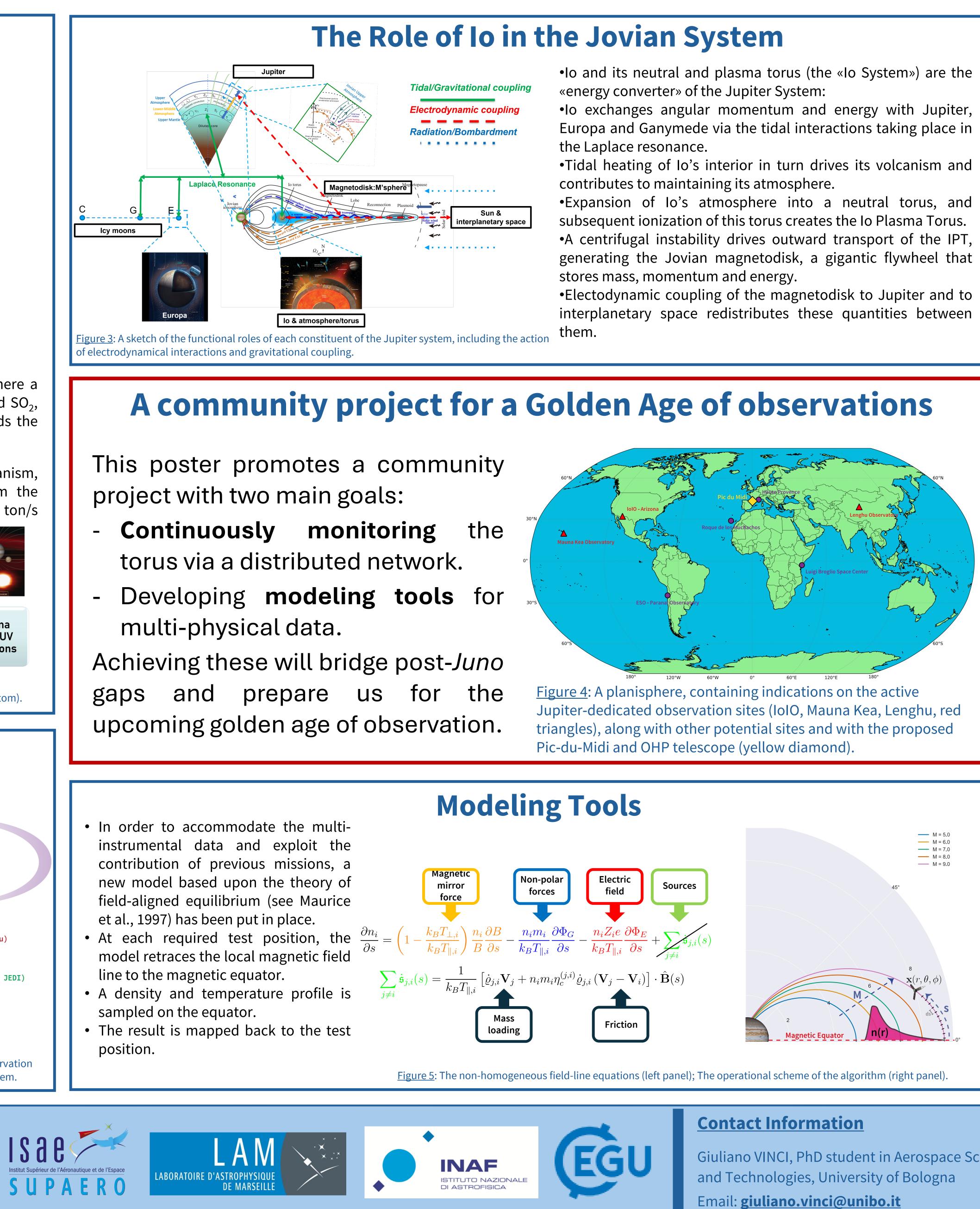
Remote sensing:

JV/IR/Vis. Spectroscopy (HST, Hisaki, IoIO, Lenghu) Radio occultation (GRAV) [n-situ: asma waves (Waves) Plasma spectroscopy(JADE, JEDI)

Figure 2: A simplified sketch of the possibilities of observation which present technologies enable for the Jupiter System.



RADIO SCIENCE AND PLANETARY EXPLORATION



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Recent observations of Io & JS from Juno

The Juno spacecraft has benefitted from two decades of technological developments after the Galileo mission and carries a wealth of modern scientifical instruments, which has given unprecedented insight over the Jupiter System, such as with the characterization of the Main Alfvén Wing of Io.

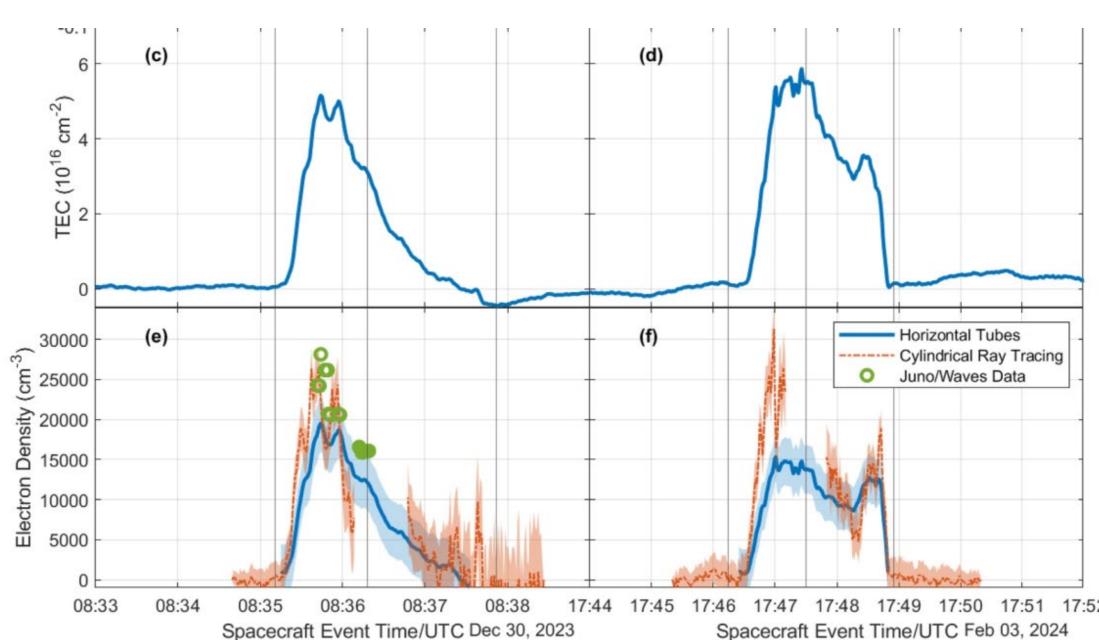
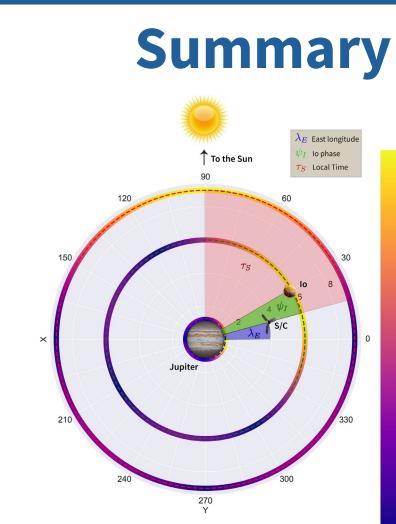


Figure 6: Plots of the electron densities as retrieved from inversion of the total electron content (TEC), measured along a Line of Sight during Radio Occultations of the Alfvén Wing of Io (PJ 57&58), taken from Buccino et al., 2025.

As shown in fig. 7, the more prolonged observation and tracking periods of the Jupiter System lie ahead of us, and complementing these with remote observing facilities will enable the determination of Jupiter System variability over short and long timespans.





Spacecraft Event Time/UTC Feb 03, 2024

Upcoming space missions

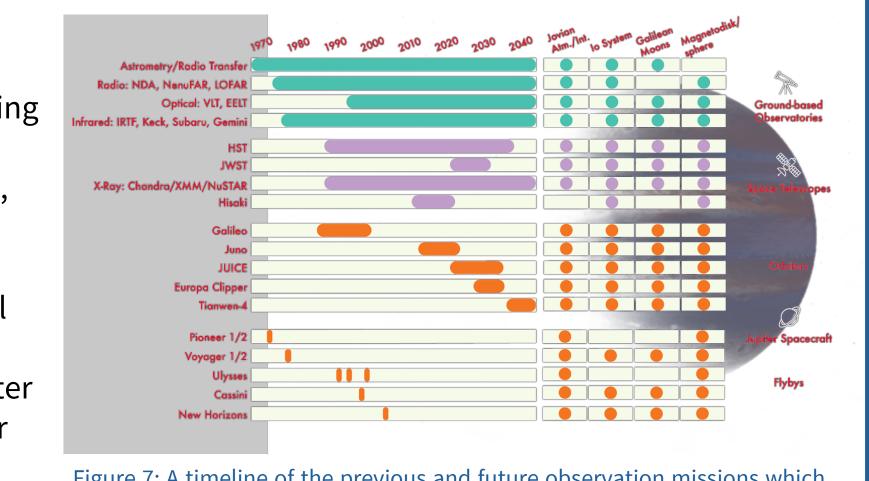


Figure 7: A timeline of the previous and future observation missions which target (or have targeted) Jupiter. Courtesy of Dr. Caitriona Jackman

Summary of objectives for the project

In conclusion, establishing a distributed longitude network is the only feasible way to continuously monitor the Jovian System, bringing within our grasp deeper insights into its daily, seasonal, and decadal physical variations.

This will, however, happen only if proper modeling tools will be available at the time of the observations, requiring a strong community effort.

Figure 8: A sketch depicting the non-latitudinal geometric variables that have or may have an effect on the IPT densities: Solar Time, Longitude, lo Phase.

References

- Full Bibliography
- Virtual poster
- Previous works

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