In-situ characterization of electron properties in Galilean moons-Jupiter circuits

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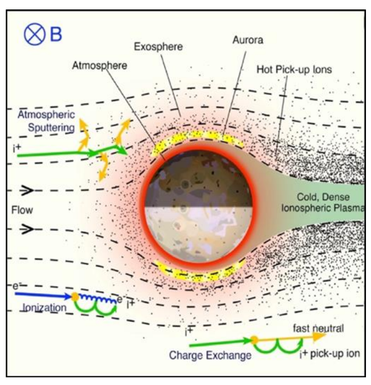
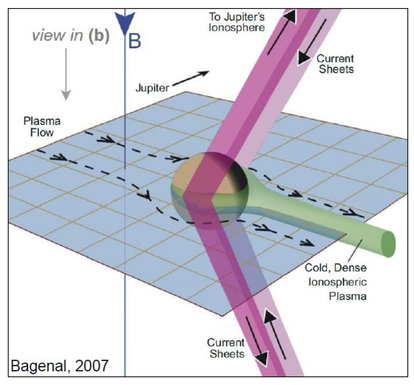
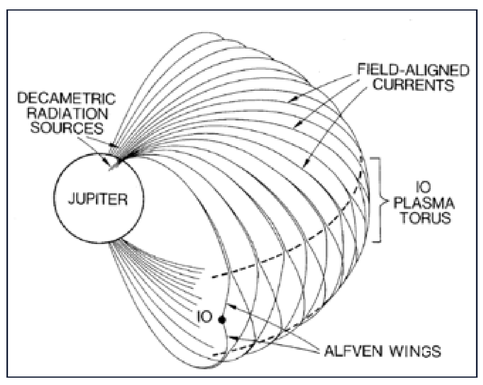
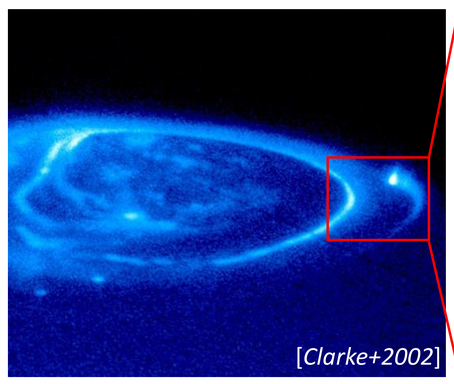
SCIENTIFIC CONTEXT

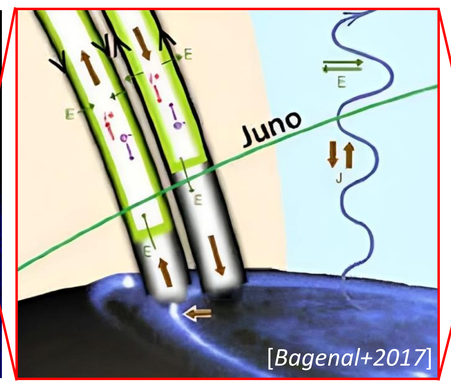
In Jupiter's magnetosphere, the Galilean moons orbit with a Keplerian velocity much slower than the plasma velocity. Thus, the moons disturb the magnetospheric plasma flow, which generates Alfvén waves. These waves propagate away from the moons along the magnetic field lines and can be reflected by density gradient. This creates a current system that links the moons to Jupiter atmosphere.

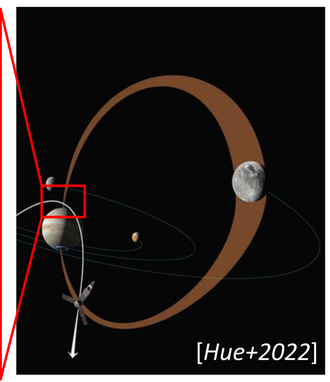








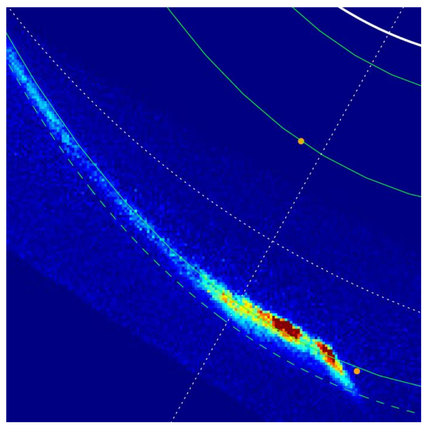




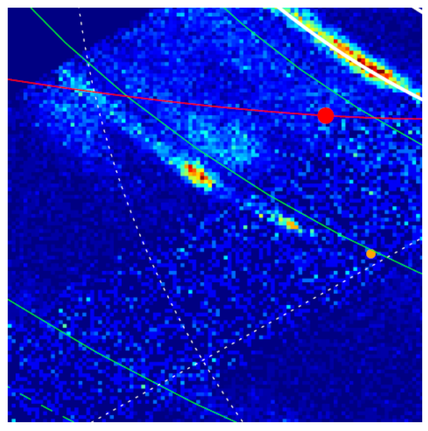
The most visible feature of this coupling is the generation of auroral structures called footprints at the bottom of field lines in Jupiter's ionosphere, created by accelerated electrons. Thanks to its unique polar orbits, Juno crosses the magnetic field lines connected to each moon orbit, enabling accelerated particles to be measured in-situ. In addition, the UVS instrument can remotely observe the moon-induced auroras.

AURORAL OBSERVATIONS with Juno-UVS

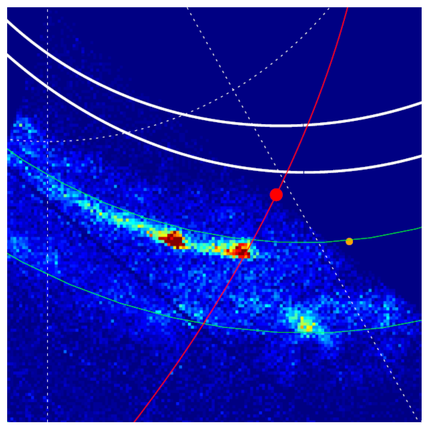
Juno-UVS observations of the Galilean moons footprints



Io – Perijove 15

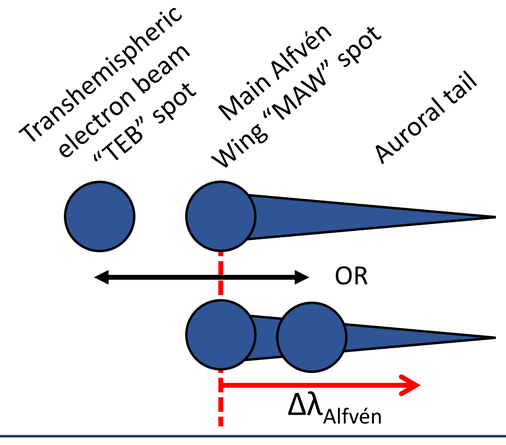


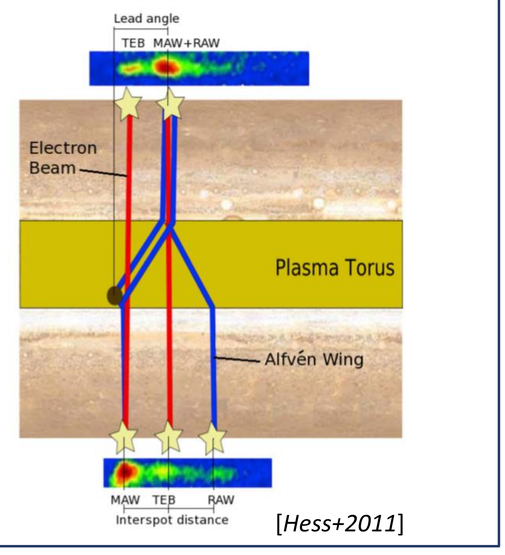
Europa – Perijove 41



Ganymede – Perijove 30

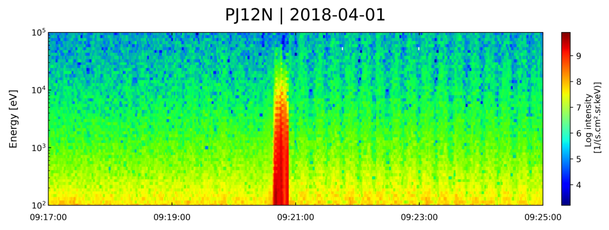
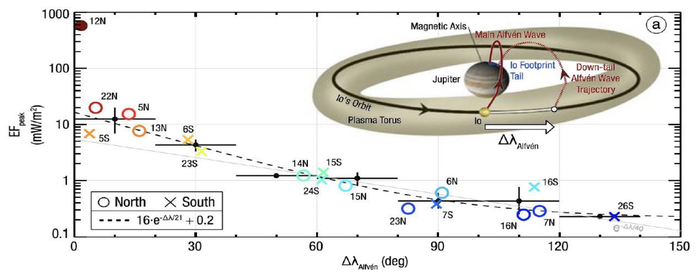
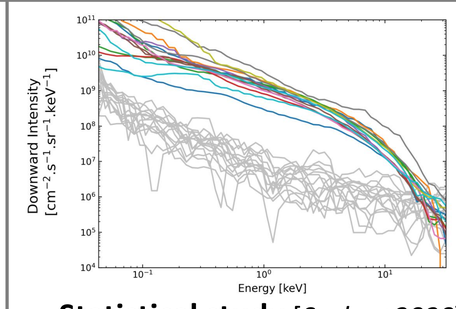
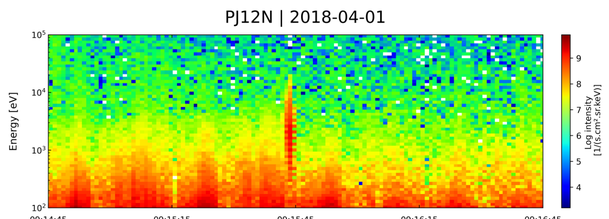
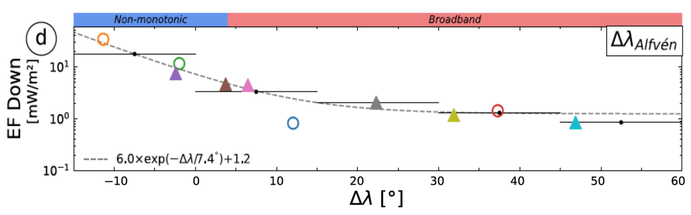
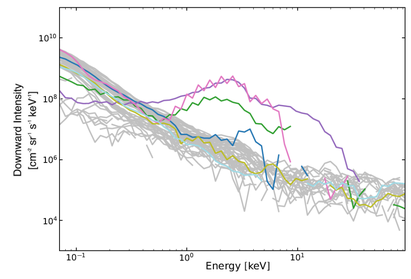
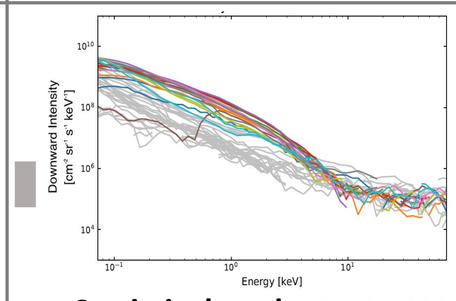
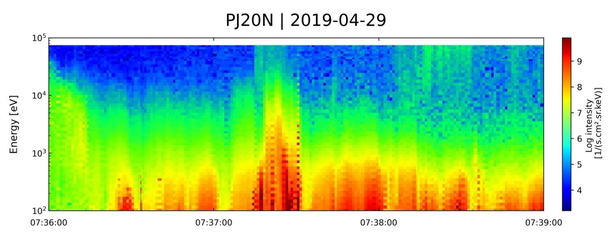
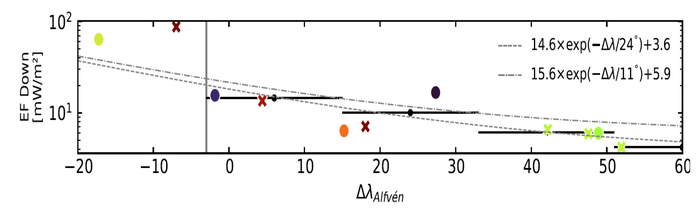
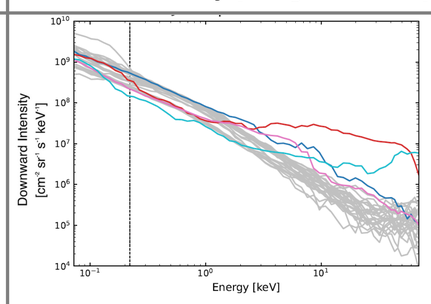
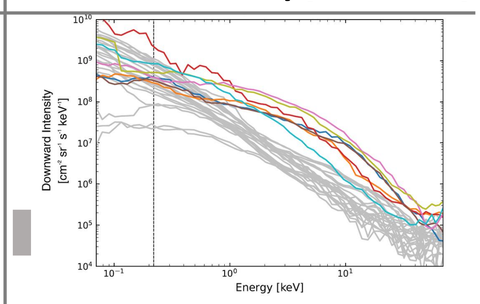
General structure of the footprints





[*Hess+2011*]

IN-SITU ELECTRONS OBSERVATIONS with Juno-JADE

	Typical observations of accelerated electrons	Energy flux evolution with $\Delta\lambda_{Alfvén}$	Energy distribution in the TEB	Energy distribution in the MAW & Tail
Io		 **Statistical study** [*Szalay+2020*]	 No observations reported	 **Statistical study** [*Szalay+2020*]
Europa		 **Statistical study** [*Rabia+2023*]	 **Case study** [*Allegrini+2020*]	 **Statistical study** [*Rabia+2023*]
Ganymede		 **Statistical study** [*Rabia+in prep*]	 **Case study** [*Hue+2022*]	 **Statistical study** [*Rabia+in prep*]
	Observations of sudden increases in electron fluxes	**Exponential decrease of the energy flux consistent with the spatial decay of the auroral tail brightness**	**Non-broadband spectra whose origins are unclear**	**Broadband spectra consistent with Alfvénic acceleration processes**

CONCLUSIONS

Juno's in-situ electron measurements have shown that two different energy distributions exist in the TEB, the MAW and the auroral tail. This was revealed by statistical studies on Europa and Ganymede. These observations may be the result of different acceleration processes or wave-particle interactions still poorly understood in the TEB. Future works may contrast the transition between the two regimes of electron distributions with theoretical studies to figure out how the Juno measurements challenge our understanding of electron acceleration associated with moon-magnetosphere interactions.

OPEN QUESTIONS

TEB
- Can we explain the electron distribution in the TEB with Alfvénic acceleration processes and wave-particle interactions ?
- What are the distributions in Io's TEB ?

Other moons
- Do similar observations exist at Callisto and Enceladus ?

Future work requires theoretical and modeling formalisms to explain these observations.

REFERENCES

- Szalay+2020, *doi: 10.1029/2020GL089267*
- Szalay+2020, *doi:10.1029/2019GL086527*
- Allegrini+2020, *doi:10.1029/2020GL089732*
- Hue+2022, *doi:10.1029/2021GL096994*
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