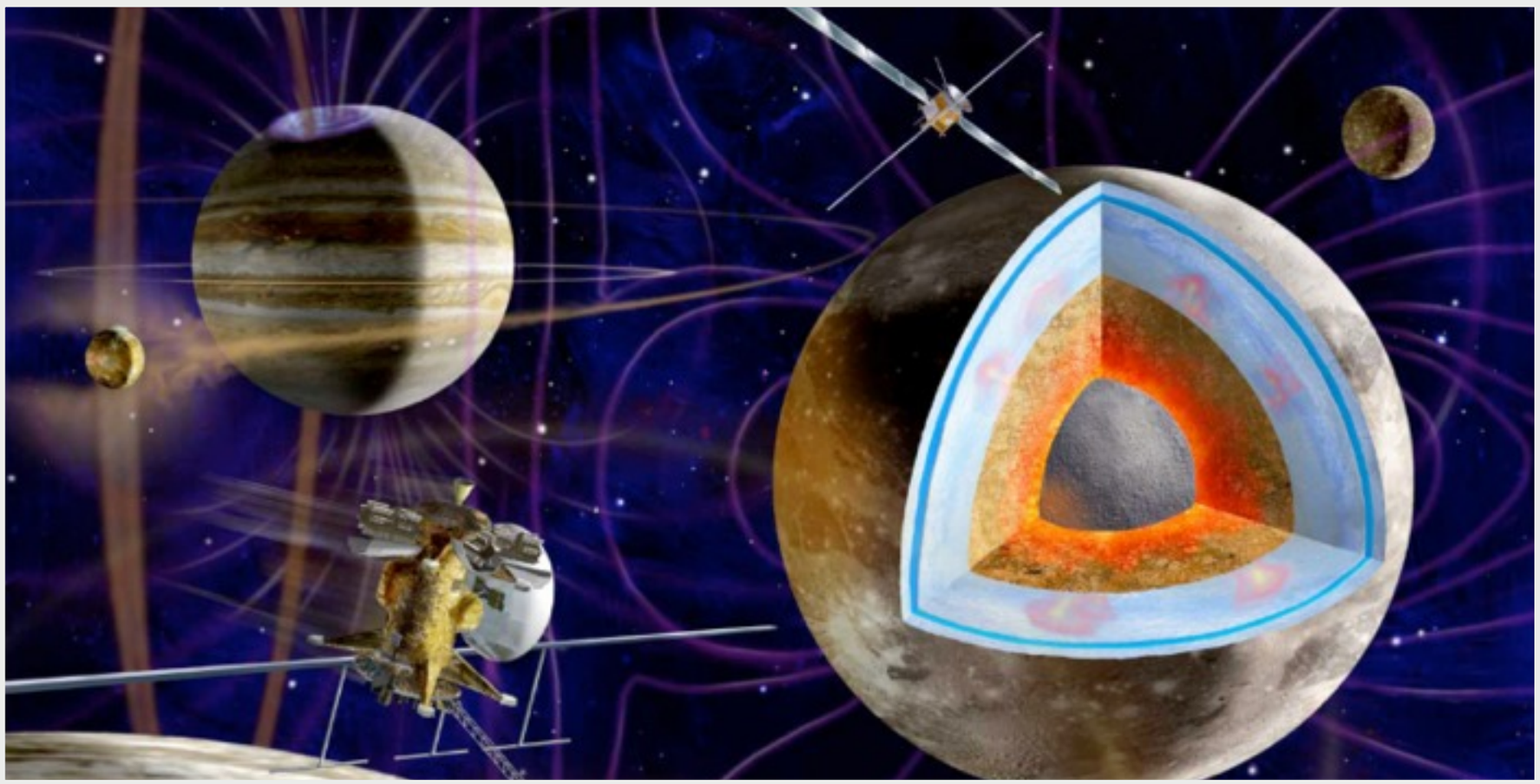
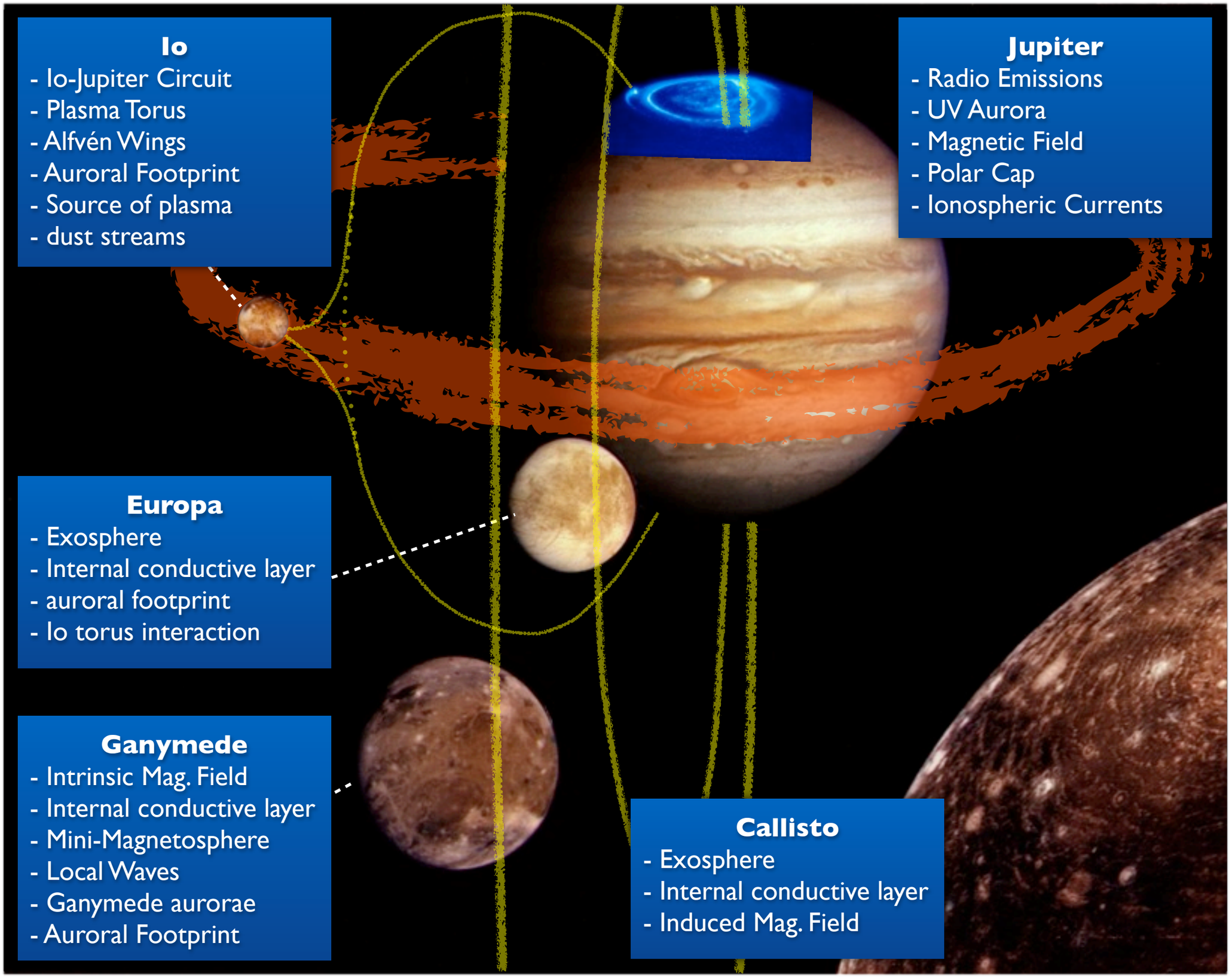
SYNERGISTIC RADIO AND PLASMA WAVE SCIENCE FOR EJSM

B. Cecconi, N. André and the EJSM-EM sensor Study Team



Electrodynamic portrait of the Jovian System



History of Jovian exploration

Spacecraft		*Orbits*	*Radio Instrumentation*	*Maximum frequency*	*Plasma Wave Instrumentation*	*Sensors*
Voyager	~	flyby	total flux, sign of circular polarization	**40.5Mhz**	E only	Electrical: 2 monopoles (10m)
Ulysses	+	flyby (outbound was polar)	**flux, polarization, direction finding**	940kHz	**E+B**	Electrical: 1 dipole (72.5m) 1 axial monopole (7.5m)
Galileo	~	misc orbits	total flux only	5.6MHz	**E+B**	Electrical: 1 dipole (6.6m)
Cassini	+	distant flyby >135Rj	**flux, polarization, direction finding**	16MHz (GP up to 2Mhz)	**E+B**	Electrical: 3 monopoles (10m)
New Horizons	×	distant flyby	*— no Radio & Plasma Waves instrumentation —*			
Juno	~	**polar orbits**	total flux only	**40MHz**	**E+B**	Electrical: 1 dipole (~2m)
EJSM (JGO, JEO?)	?	***Tour + Satellites***	**flux, polarization, direction finding**	**45Mhz**	**E+B**	**TBD *(This study!)***

Electromagnetic Sensors for EJSM

[See also the *EJSM ElectroMagnetic Sensor Study* Poster]

Possible sensor types:

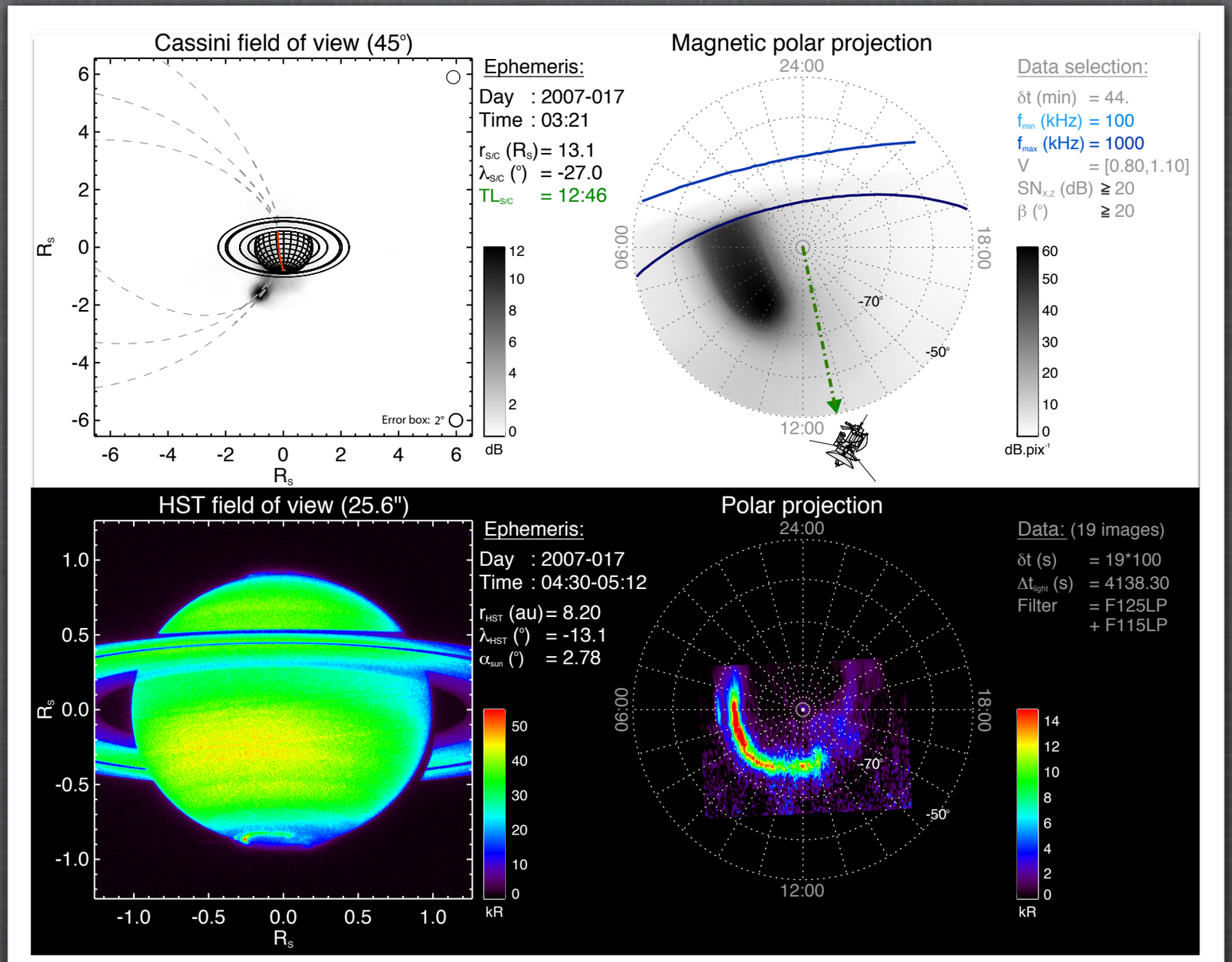
- [a] Electric antenna boom (E-HF + E-BF) — *RPWI-PDD*
  - *long dipole (~6 to 10 m)* — *use SSR?*
  - *triad of short antennas (~1m)*
- [b] Langmuir Probe (plasma + E-BF + E-DC) — *RPWI-PDD*
- [c] Search Coil (B-BF) — *RPWI-PDD*
- [d] High Frequency Magnetic Loop (B-HF) — *not in PDD*
- [e] Rogovski Coil (current) — *not in PDD*
- [f] Association with MAG instrument (B-DC) — *TBD*
- [g] Mutual Impedance Probe (plasma) — ⚠ EMC !

Science optimized sensor selection criteria:

- Size, mass of sensors
- Sensitivity (overall gain, preamplifier sensitivity)
- Interference with other instruments FoV
- Accommodation, risks (momentum, oscillations, planetary protection)
- Radiation tolerance (shielding, instrument design)
- Electromagnetic cleanliness (e.g. prefer passive instrumentation)
- ...

Unique Science Aspects

- **Goniopolarimetry**: [a] or [d], monopole or dipole, (*depending on EM-Sensor Study outcome*)
- **Thermal Noise Spectrometry**: [a] *with long antennas*
- **Dust, nano-dust**: [a] *with long monopole*
- **Plasma waves / waveform** [a] [b] [c] *with long dipole*
- **Local plasma parameters**: density [a] [b], temperature [a] [b], speed [e], S/C potential [b], magnetic field [a] [f], core/halo electron distribution [a]



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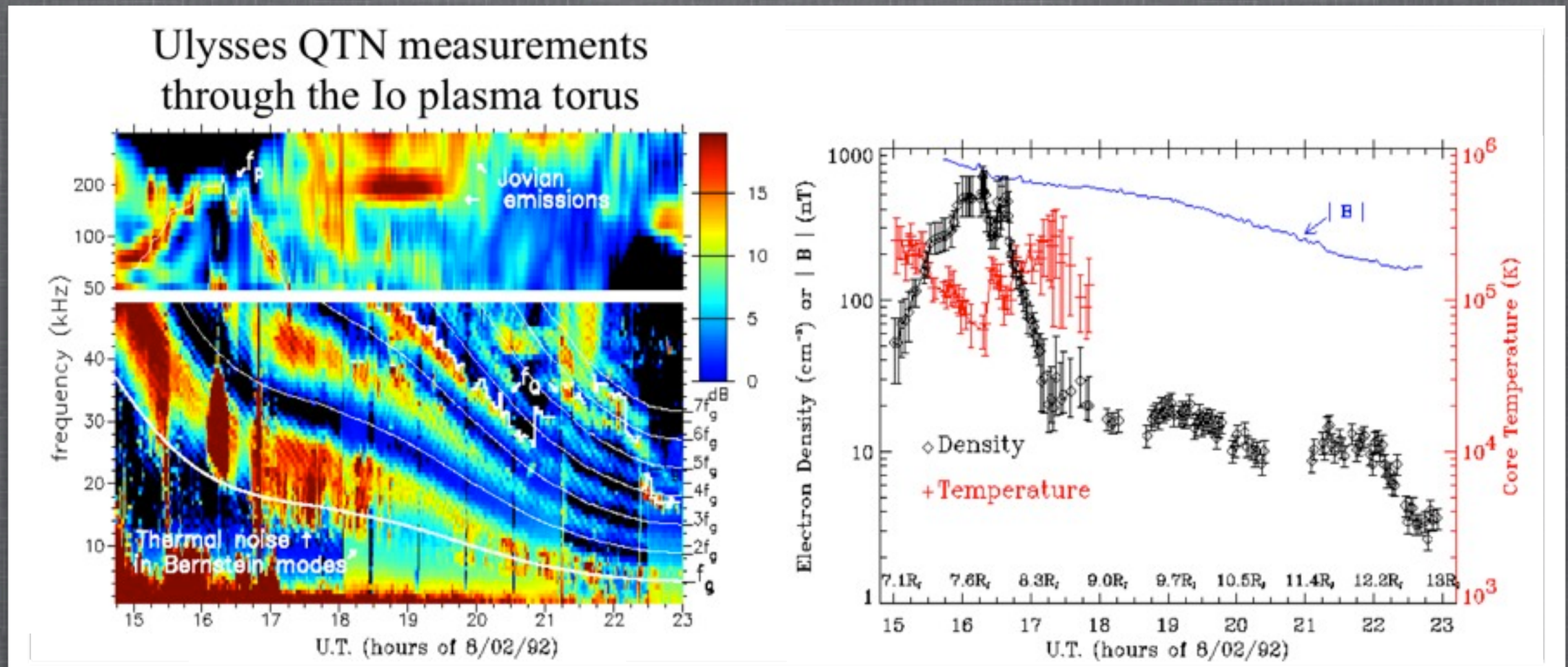

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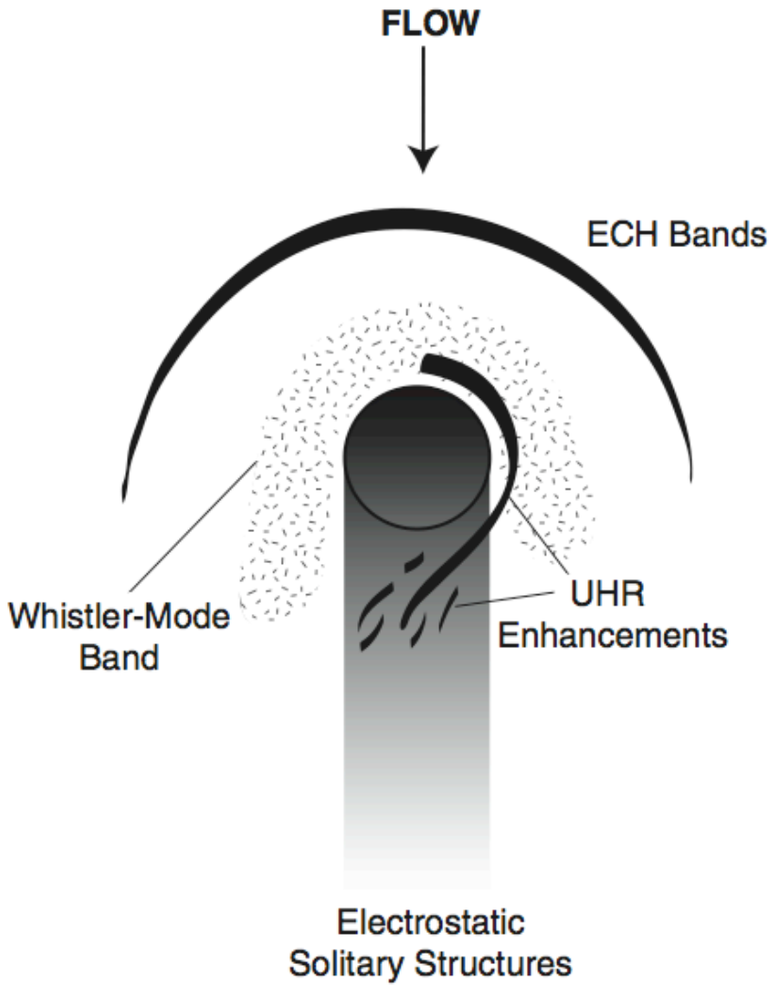
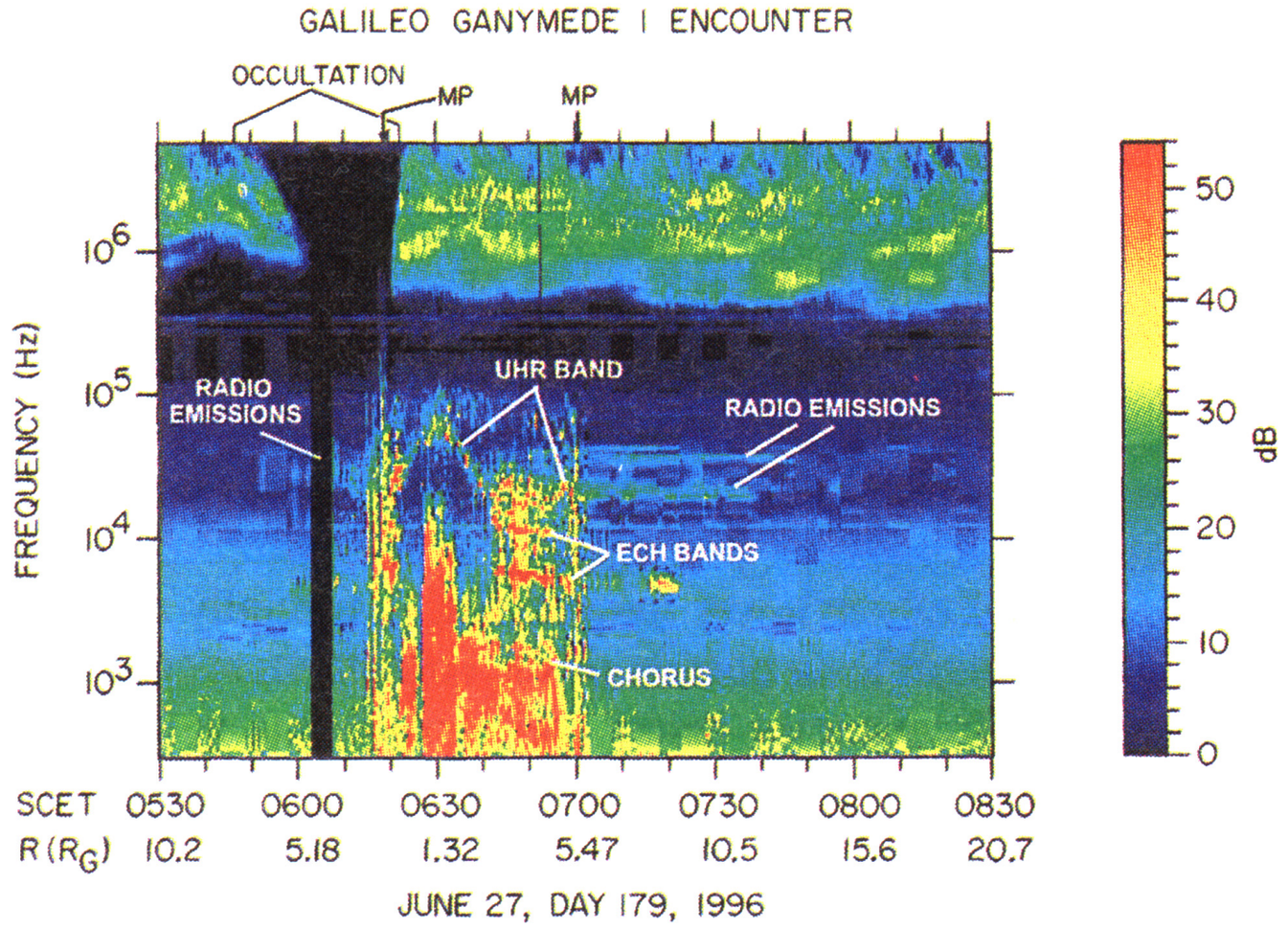




SYNERGISTIC SCIENCE JGO/JEO

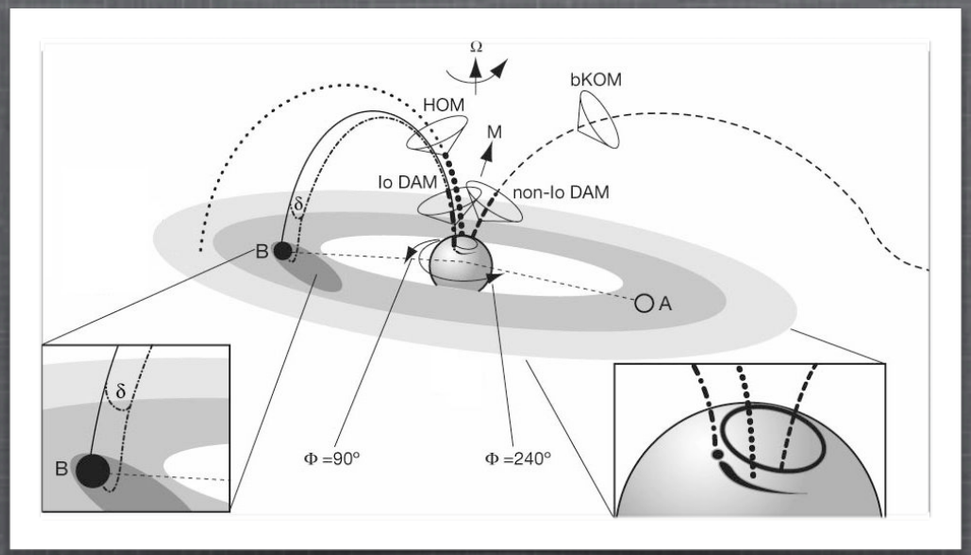
(Cross-Instrument or Cross-Spacecraft)

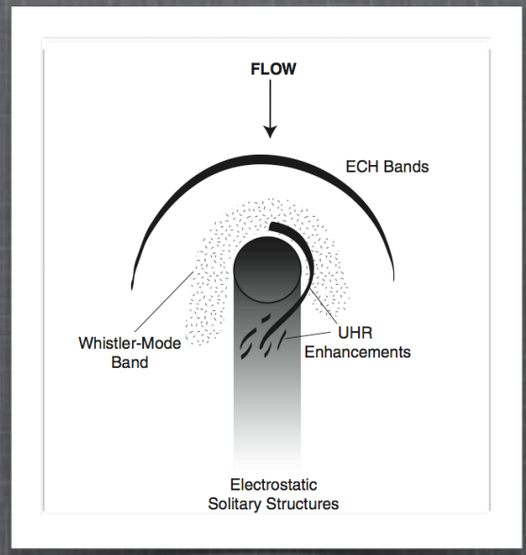
Galilean Satellite Science

- flyby science (local electrodynamic content, induced magnetic response)
- magnetospheric interaction (alfven wings, current, magnetosphere, exosphere, footprints)
- Ganymede magnetosphere (stereo observations)
- magnetospheric context (ENA, UV, IR, Radio, Io torus)

Radio & Plasma Wave Instrumentation provides:
- Unique and continuous radio remote sensing
- Unique and reliable local plasma diagnostic

- Stereo (*radio-in situ*): correlation radio footprint + local electrodynamic content
- Stereo (*radio-radio*): Io radio footprint + Ganymede ? + Europe ? ➟ radio emission microphysics (radio beaming, electron energy and distribution function)



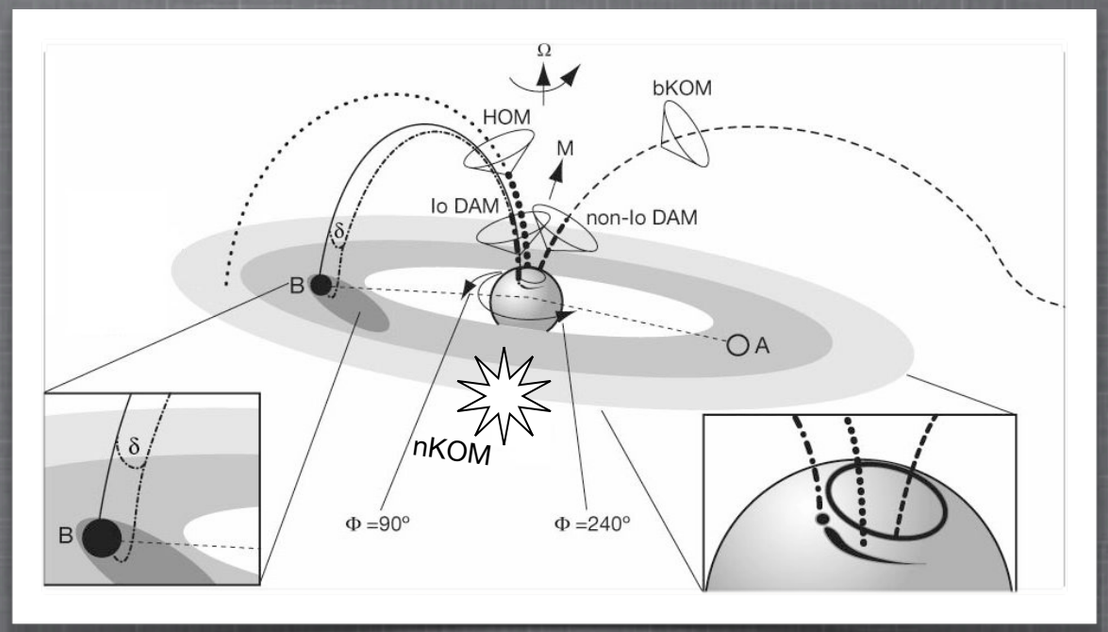


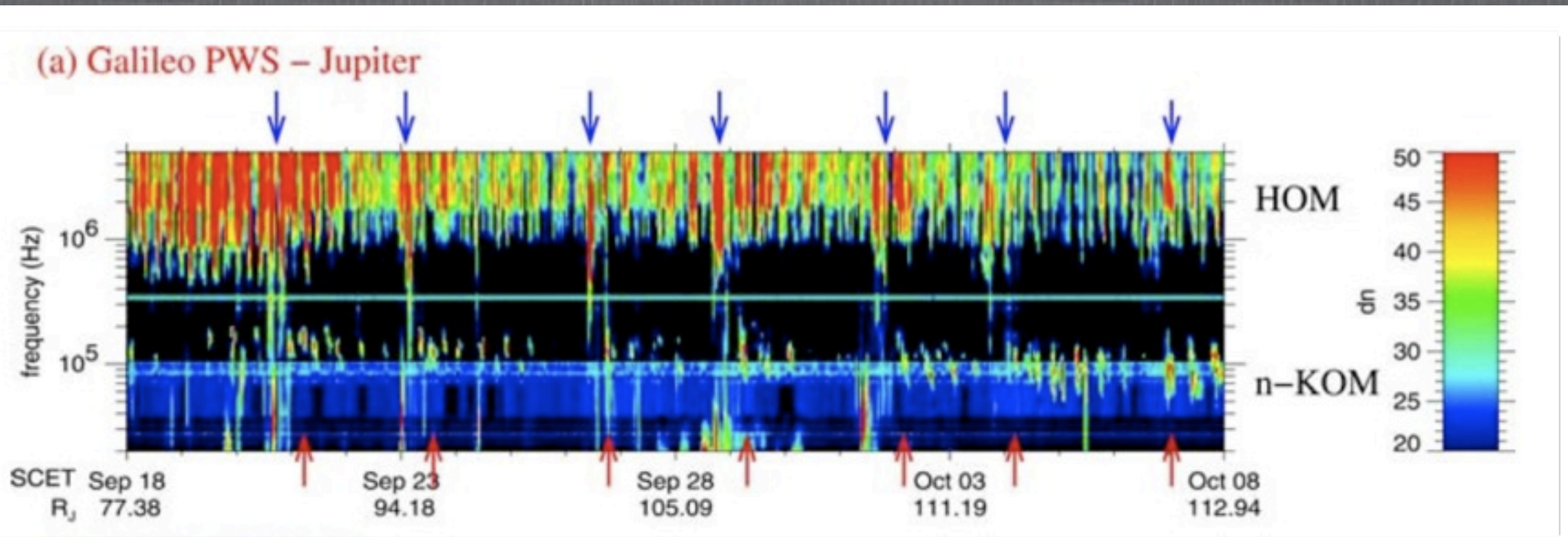
SYNERGISTIC SCIENCE JGO/JEO

(Cross-Instrument or Cross-Spacecraft)

Magnetosphere Science

- Stereo (*radio-radio*):
  both inside magnetophere;
  Solar Wind Spaceweather;
  Io torus Spaceweather
- Latitudinal coupling (*radio & in situ*)
- Plasma wave interactions

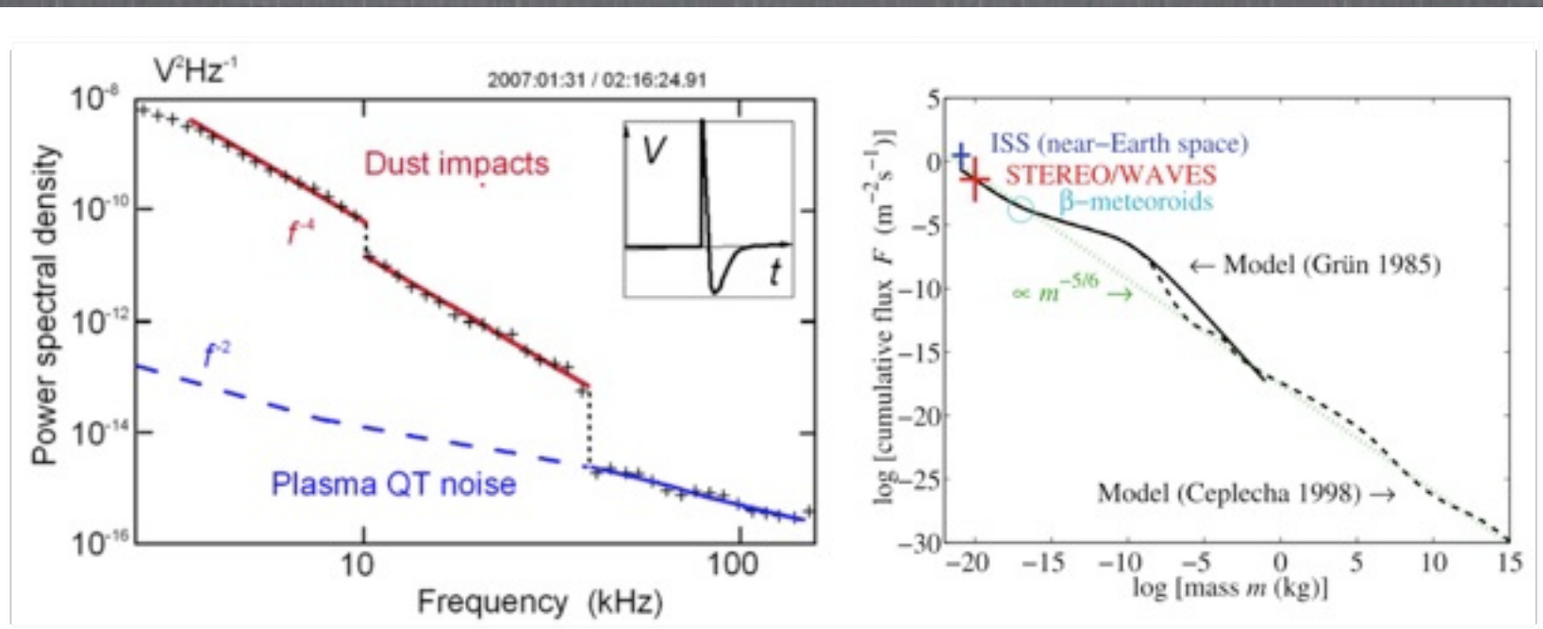




COMPLEMENTARY SCIENCE

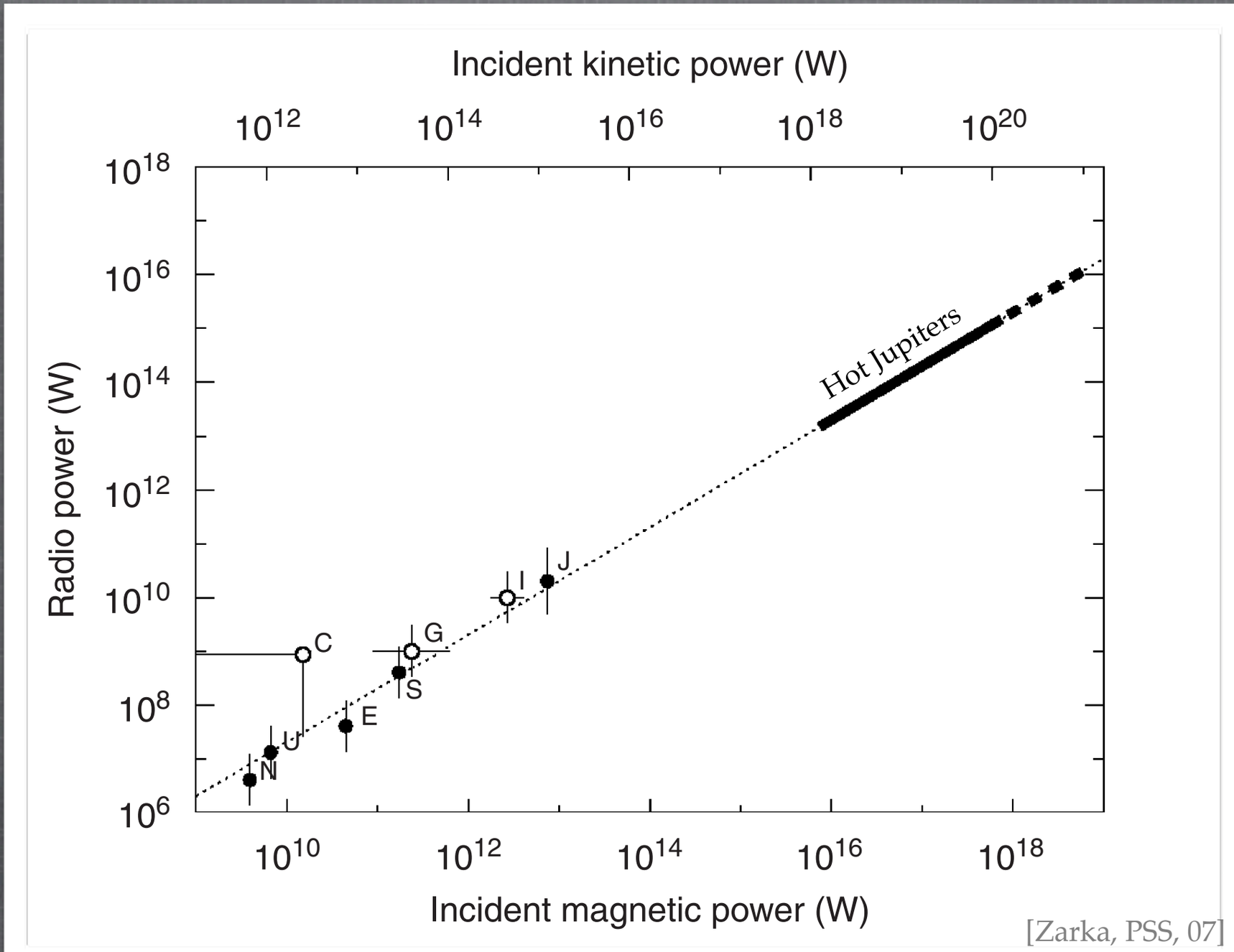
- dust ➟ sputtering ➟ surfaces [Surface]
- radio monitoring ➟ Radar intruments [Surface/Interior]
- calibration reference (plasma density + S/C potential) [plasma particle instruments]
- event triggering: burst mode observation, onboard boundary crossings detection, instrument mode change (cf STEREO, THEMIS) [Engineering]
- current detection ➟ magnetometer data ➟ interior magnetic field (cf ESA/SWARM) [Interior]
- diagnostic of onboard S/C activity/interference [Engineering]
- radio/UV ➟ auroral emission [Atmosphere]
- Ganymede/Io local aurora [Surface/Atmosphere]

Dust detection with STEREO/Waves



BEYOND PLANETOLOGY

"Radio Bode's Law"
astrophysical interest: radio signature of exoplanet



[Zarka, PSS, 07]

RPW instrumentation added value

- Unique jovian system space weather (Solar Wind, Io torus...) via remote sensing and in situ measurements.

- Unique stereoscopic mission concept opportunity.

- Pluri-disciplinary science.

- Passive and reliable local plasma parameters diagnostics necessary for other instruments.

- Strong collaboration/enhanced science return between instrument teams (see MAPS group on Cassini)

- Strong heritage in the community (Cassini, STEREO, Bepi-Colombo/MMO, JUNO, RBSP...)