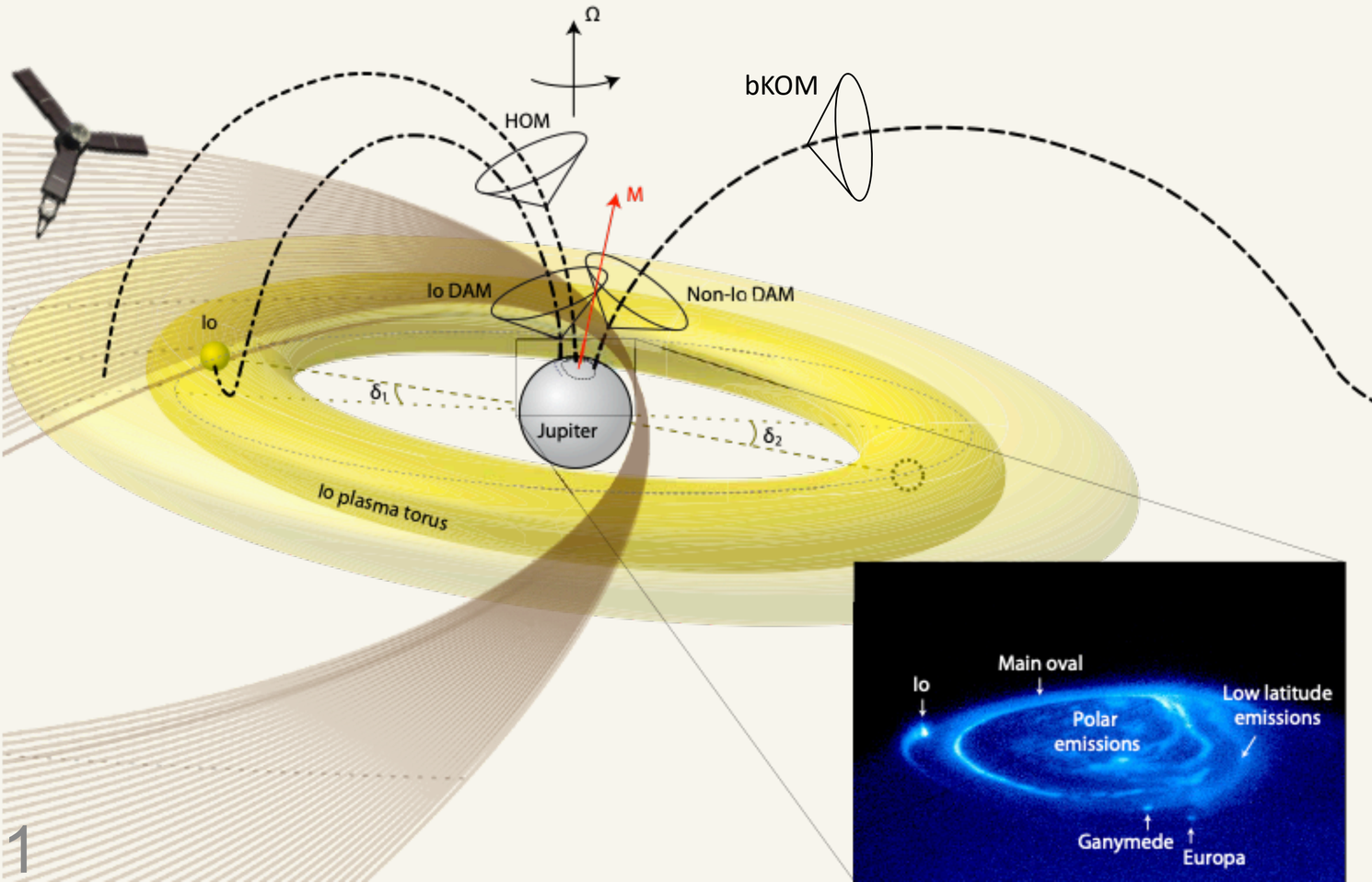
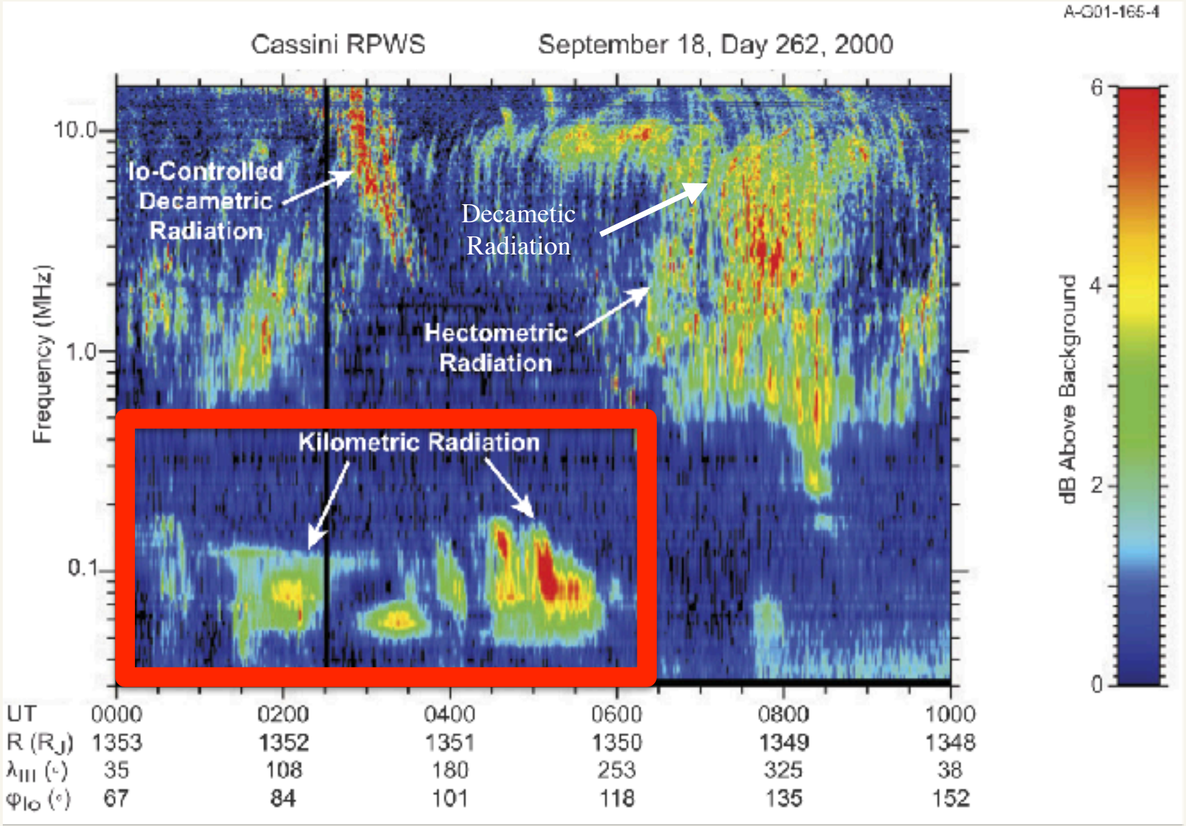
In situ bKOM source crossings with Juno

Collet B, Lamy L, Louis, CK, Hue V, Kim T



- Radio Auroral Emissions generated by CMI
- Fundamental mechanism in plasma physics (wave-plasma instability)
- Jupiter's auroral acceleration region
- In situ electron and radio measurements
- Transfert of energy in a magnetosphere
- Comparative Planetology

Jupiter’s radio spectrum



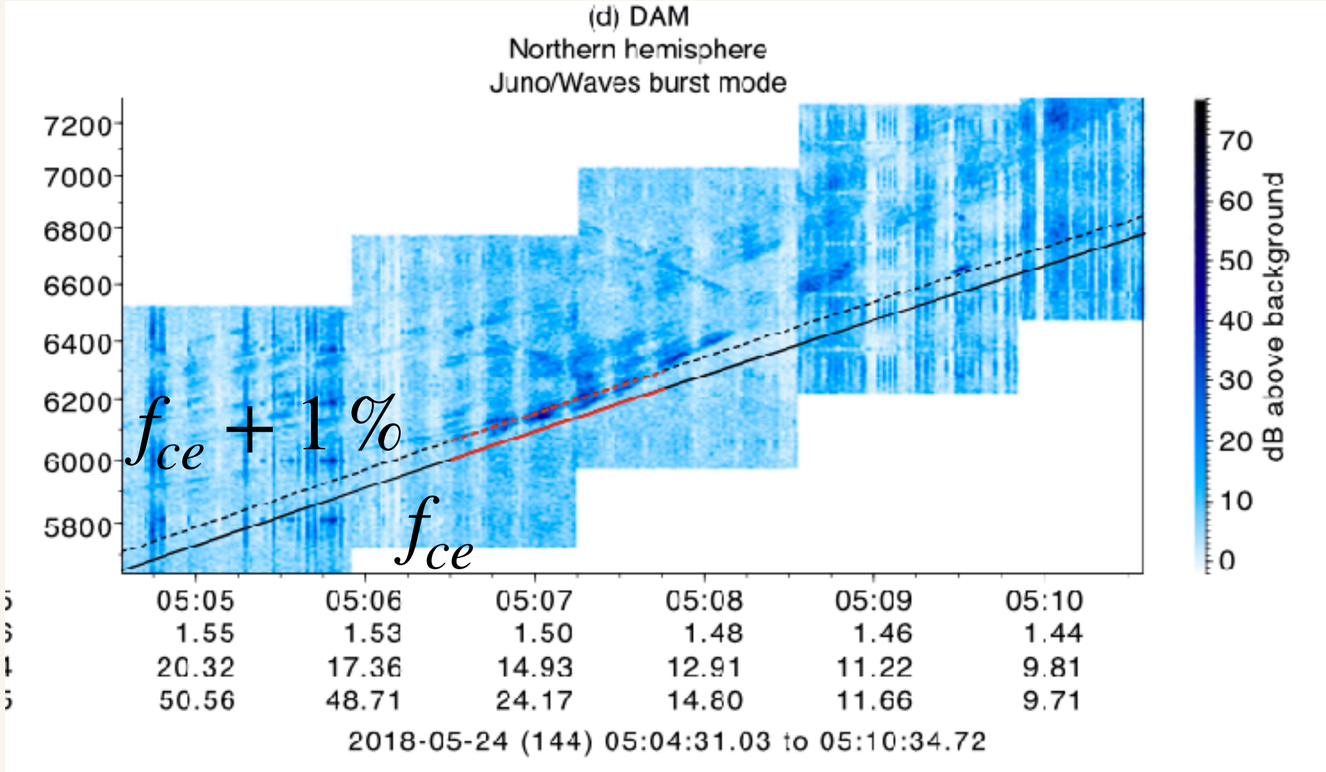
$$\omega = \frac{\omega_{ce}}{\Gamma} + k_{\|} v_{\|}$$

Conditions:

$$\frac{f_{pe}}{f_{ce}} \ll 1 \qquad \frac{\partial F_e}{\partial v_{\perp}} > 0$$

Inversion population

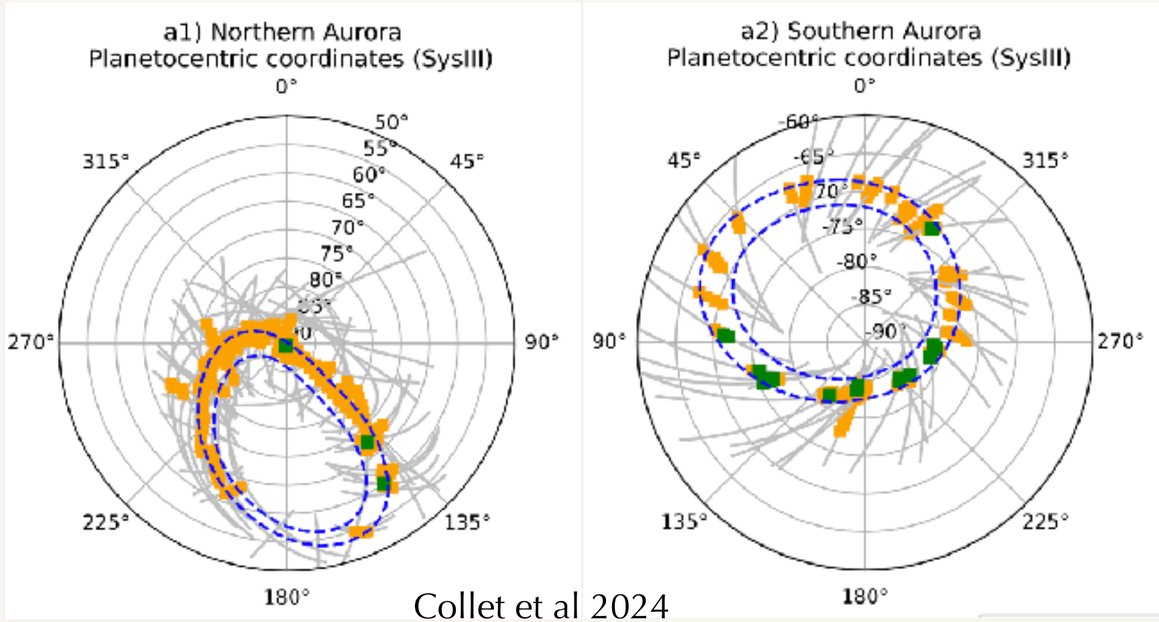
Radio survey : Radio source identification



Louis et al 2019

$$\omega = \frac{\omega_{ce}}{\Gamma} + k_{\|} v_{\|}$$

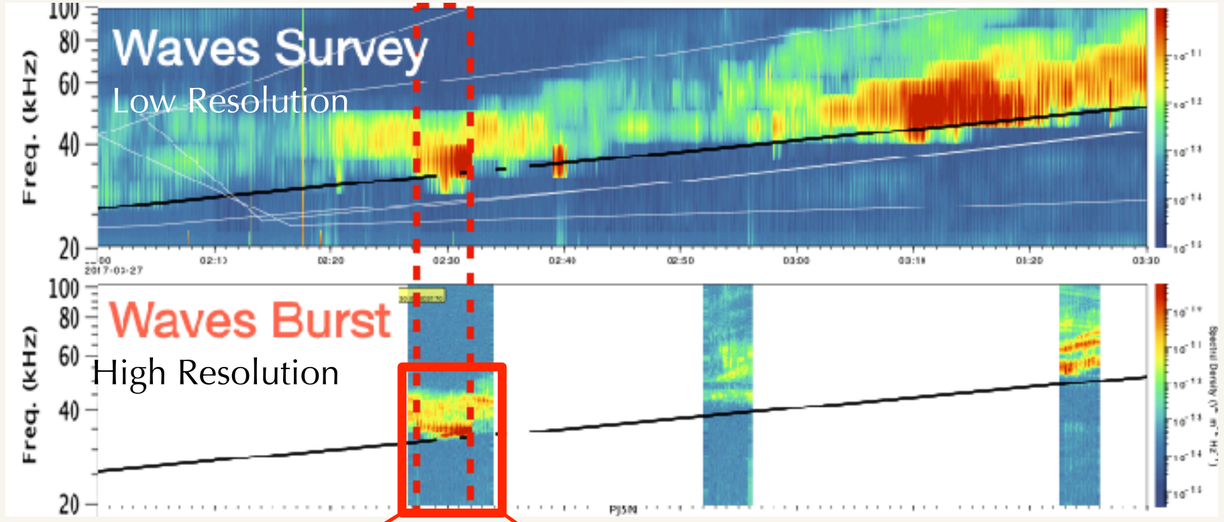
already done for HOM/DAM

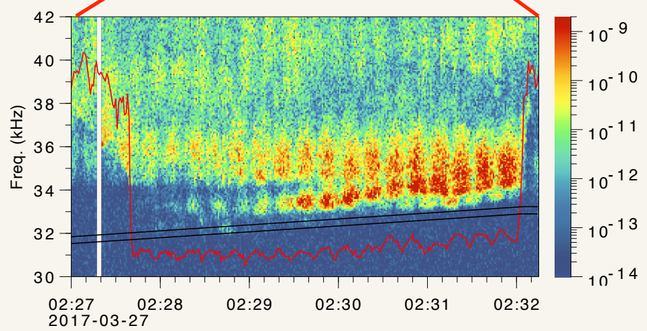


Collet et al 2024

Radio survey : Radio source identification

The case of bKOM source crossings





$$\omega = \frac{\omega_{ce}}{\Gamma} + k_{\|} v_{\|}$$

Requires:

-High Resolution Radio measurements

-High Resolution Electron measurements

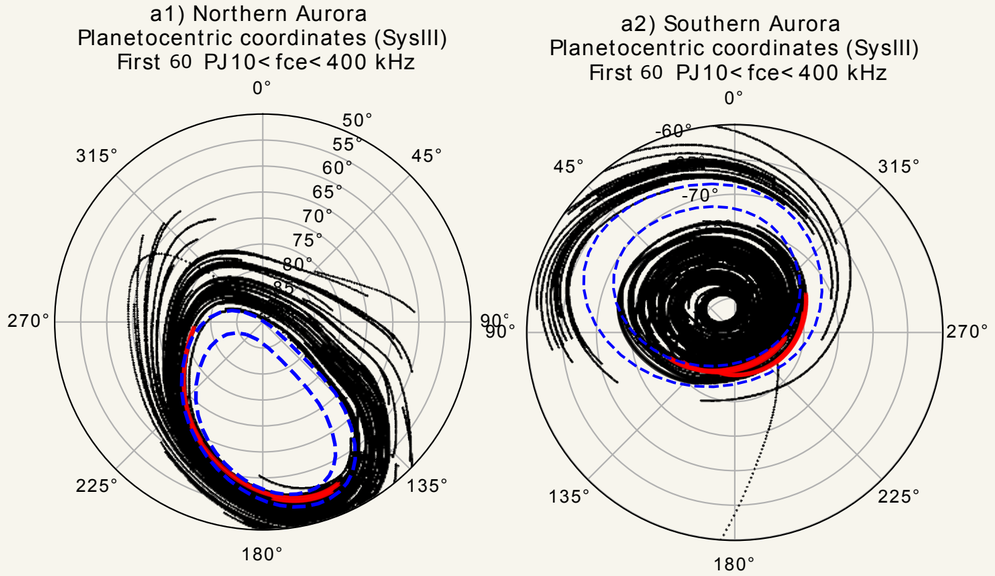
Radio survey : Radio source identification

Only 7 $f \leq f_{ce} + 1\,\%$ **candidates** out of 60 orbis

- $f_{pe}/f_{ce} \sim 10^{-2}\ to\ 10^{-1}$
- Connected to the brightest UV spots
- Partial correlation with Dawn Storms and Solar Wind

PJ	Time	f_{ce} (kHz)	fpe/fce	R (R_J)	MLat (°)	M Shell(R_J)	Dawn storm	Solar wind	FAC
1S	27 August 2016 21:15–22:40	12	0.03 to 0.3	10 to 11	−35 to −30	40 to 50	X	X	
4S	02 February 2017 15:30–17:15	100 to 300	0.01 to 0.07	4 to 6	−59 to −48	30 to 51			↑
5N	27 March 2017 02:00–03:30	30 to 150	0,01 to 0.5	6 to 8,3	33 to 51	22 to 52	X		↑
9N	24 October 2017 10:20–11:30	20 to 30	0,05 to 0.5	8.5	35 to 40	20 to 35	X		↕
11S	07 February 2018 17:30–20:00	30 to 120	0.003 to 0.05	5.5 to 8	−54 to −45	52	X	X	↑ during $f < f_{ce}$
12S	01 April 2018 15:40–18:10	18 to 43	N/A	8 to 10	−49 to −40	50 to 53		X	
7N	10 July 2017 17:15–17:55	15	N/A	10	24 to 28	14 to 19		X	

bKOM



Validation of source crossings ?

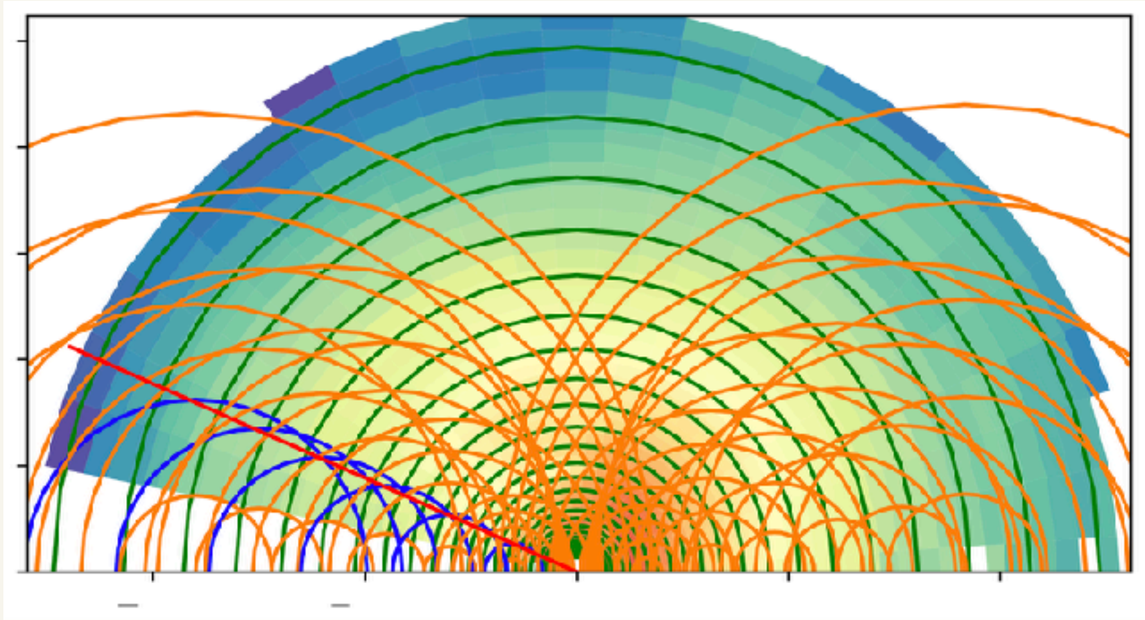
Growth rate analysis

Growth rate

$$\omega_i \propto \oint_{C(v_0, v_r)} \frac{\partial f}{\partial v_\perp}$$

For each second of electron measurements:

- Compute growth rate on many circles
- Keep the circle that gives maximum growth rate
- Determine the type of unstable e-



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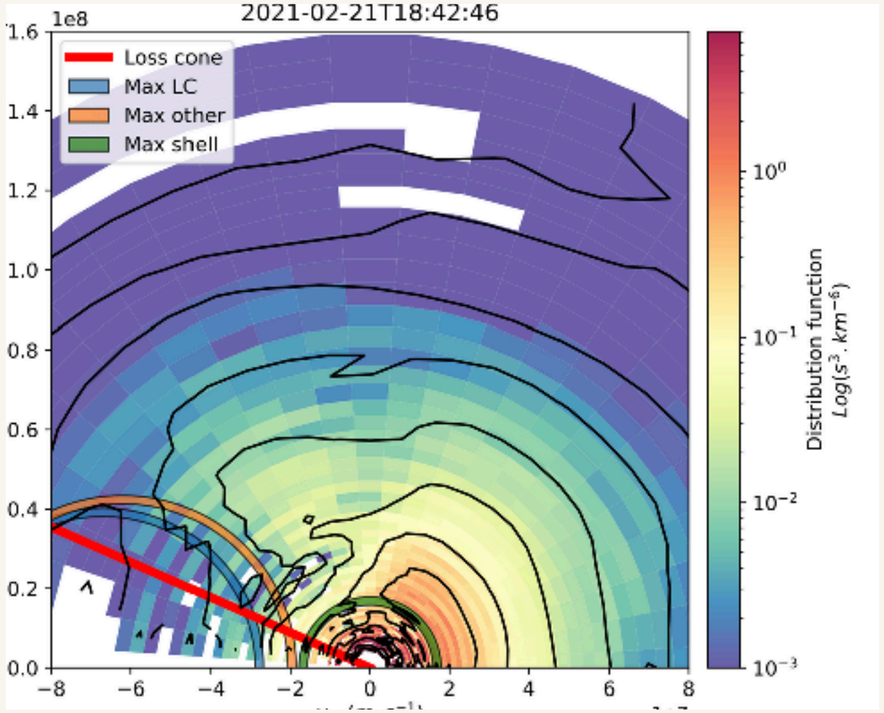
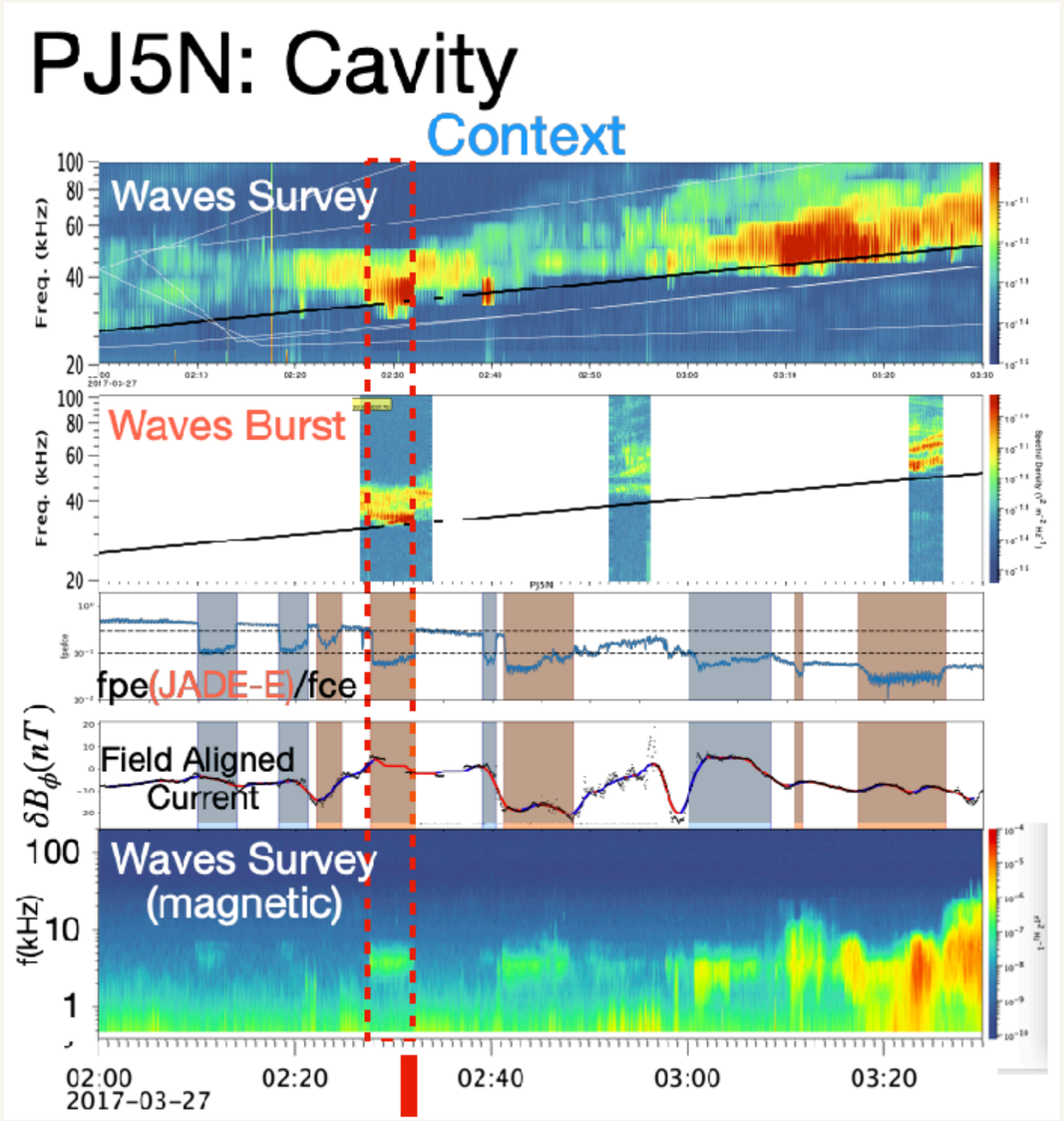


The case of PJ5N
Context

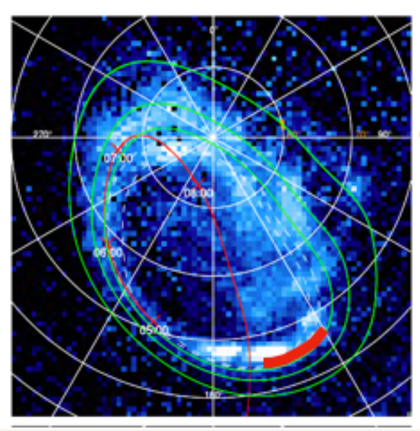


High resolution not available everywhere

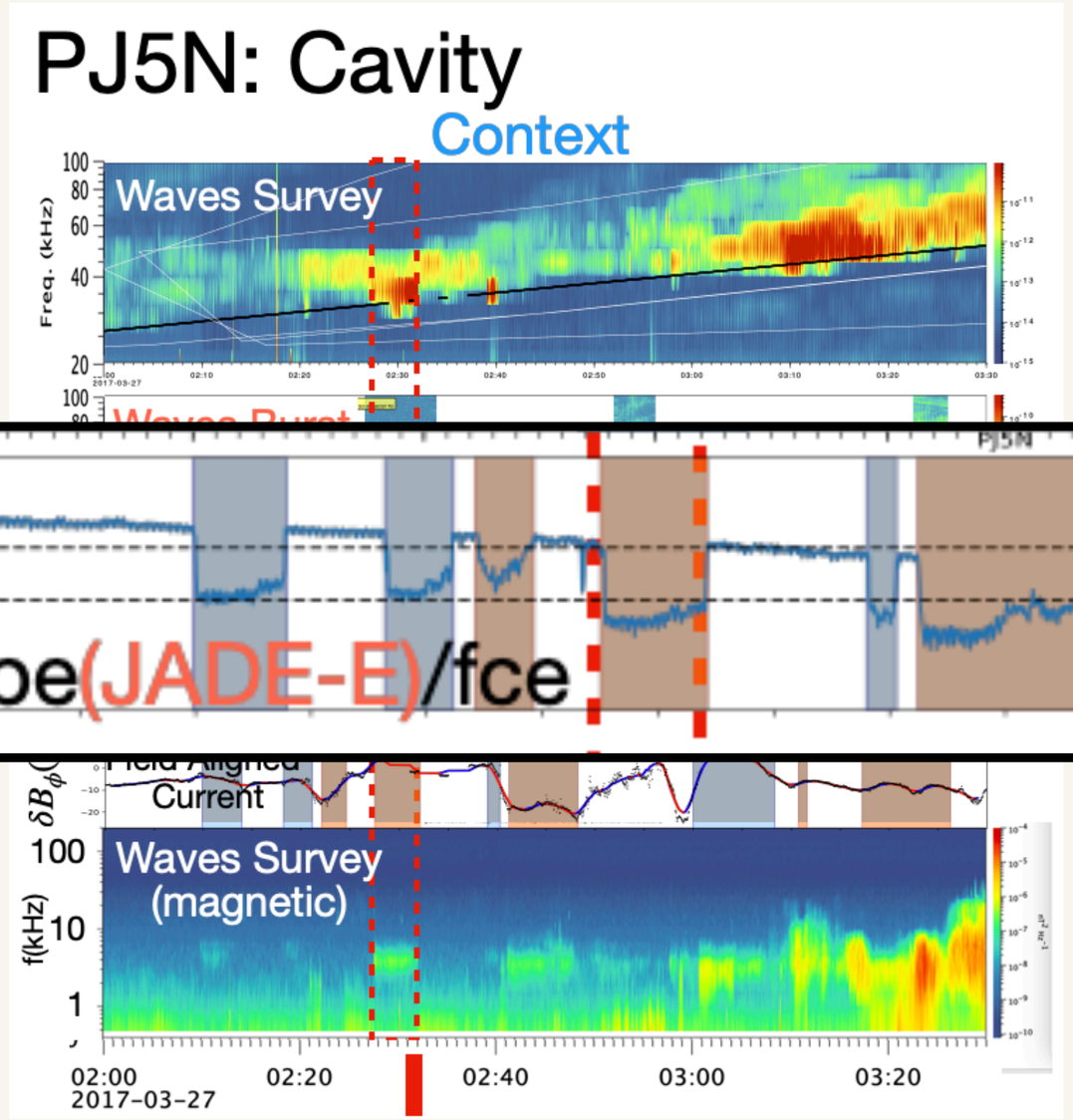
Auroral cavities!

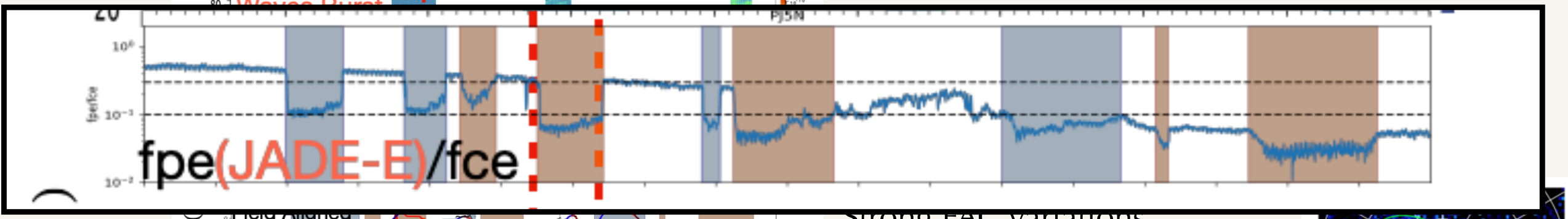
Strong FAC variations

Link with whistler waves ?



The case of PJ5N
Context





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Strong FAC variations

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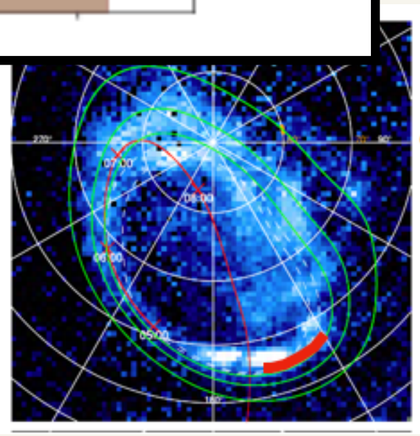
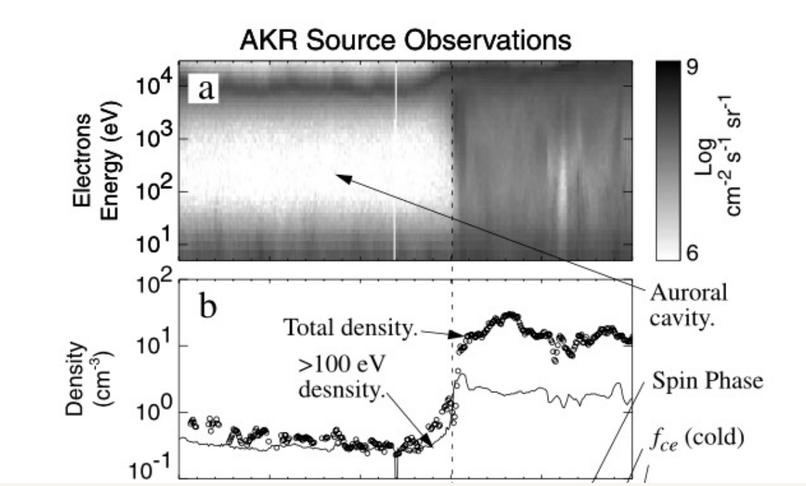


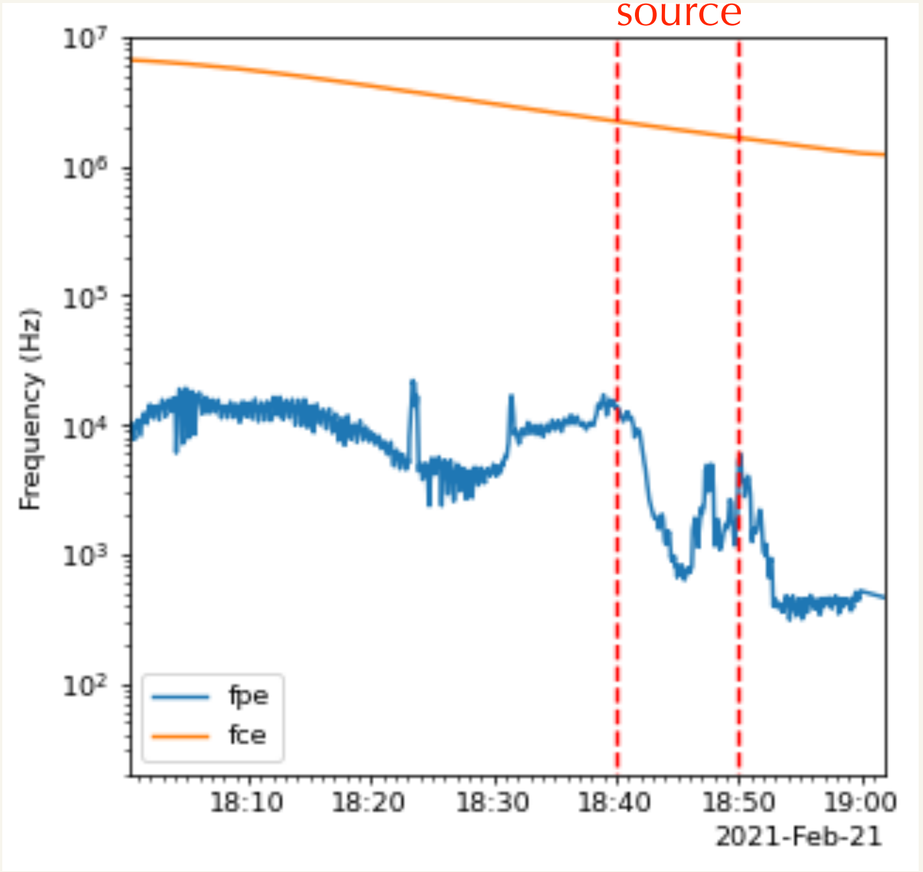
Auroral cavities ?

CMI condition: $\frac{f_{pe}}{f_{ce}} \ll 1$



Earth: need for cavity

Radio source



HOM/DAM: no need

The case of PJ5N Generation

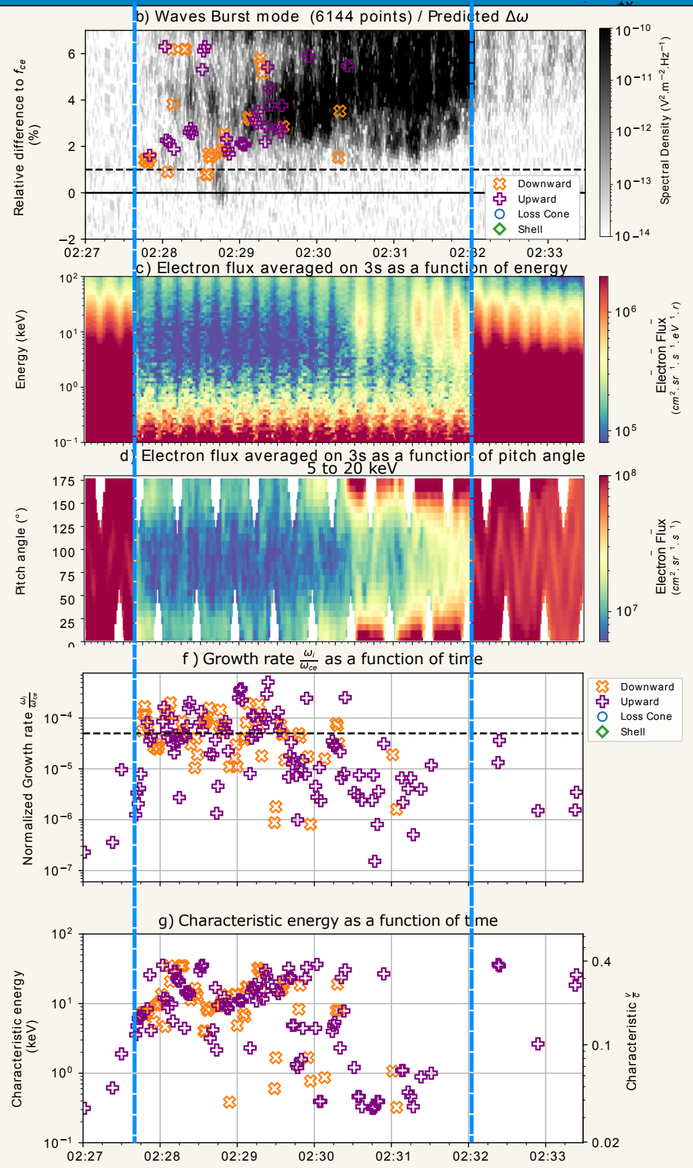
Waves spectra

JADE-E
Energy spectra

JADE-E
Pitch angle spectra

CMI
Growth rate

Characteristic
Energy



7 bKOM candidate sources

- Energy of 1 to 10s keV
- First auroral cavities at Jupiter (3)
- Partial association with Dawn Storms and Solar wind
- Unstable shell and conics
- Connected to Main aurora

(More source crossings needed)

Conclusion

7 bKOM candidate sources

- Energy of 1 to 10s keV
- First auroral cavities at Jupiter (3)
- Partial association with Dawn Storms and Solar wind
- Unstable shell and conics
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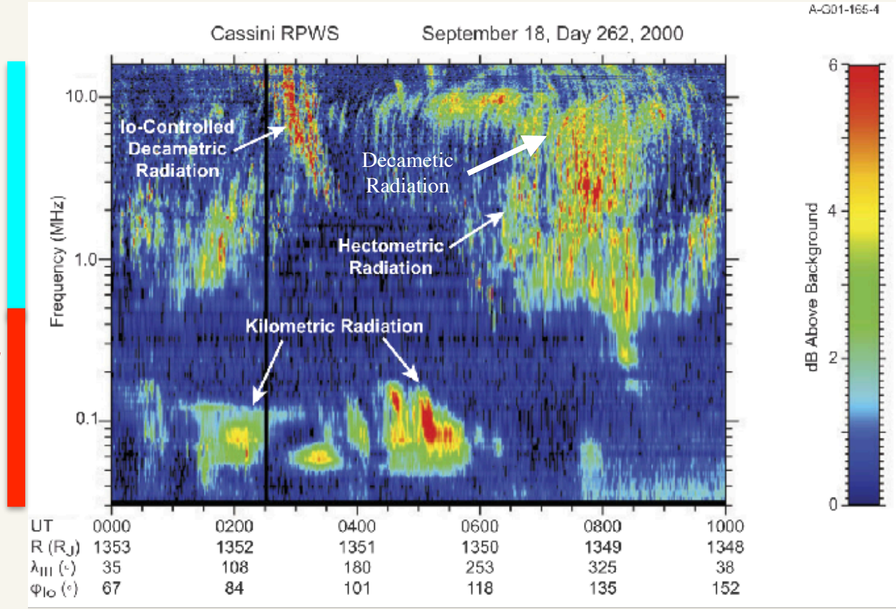
(More source crossings needed)

PJ	Time	f_{ce} (kHz)	fpe/fce	R (R_J)	MLat (°)	M Shell(R_J)	Dawn storm	Solar wind	FAC	Intensity W m^{-2} Hz^{-1}	Lat. size (×10^{3}km)	JADE-E	Waves	Cavities	Unstable population
1S	27 August 2016 21:15–22:40	12	0.03 to 0.3	10 to 11	−35 to −30	40 to 50	X	X		3×10^{-11}	650	LR	Survey	X	N/A
4S	02 February 2017 15:30–17:15	100 to 300	0.01 to 0.07	4 to 6	−59 to −48	30 to 51			†	4×10^{-11}	170	HR	Burst		Shell Conics
5N	27 March 2017 02:00–03:30	30 to 150	0.01 to 0.5	6 to 8.3	33 to 51	22 to 52	X		†	1×10^{-11}	400	HR	Burst		Conics
9N	24 October 2017 10:20–11:30	20 to 30	0.05 to 0.5	8.5	35 to 40	20 to 35	X		‡	1×10^{-11}	450	LR + HR	Survey	X	Conics
11S	07 February 2018 17:30–20:00	30 to 120	0.003 to 0.05	5.5 to 8	−54 to −45	52	X	X	† during $f < f_{ce}$	1×10^{-10}	320	LR	Burst		N/A
12S	01 April 2018 15:40–18:10	18 to 43	N/A	8 to 10	−49 to −40	50 to 53		X		2×10^{-10}	600	None	Survey	N/A	N/A
7N	10 July 2017 17:15–17:55	15	N/A	10	24 to 28	14 to 19		X		5×10^{-11}	500	None	Survey	N/A	N/A



Corot control
Diff. Aurora
fpe/fce 10^-3

Solar W Control
Main Aurora
fpe/fce 10^-2

CMI verified for bKOM and HOM/DAM

Published in Collet et al 2025 GRL

Connection and limit of HOM/DAM/bKOM ?
Generation by >100 keV ?

PJ	Time	f_{ce} (kHz)	fpe/fce	R (R_J)	MLat (°)	M Shell(R_J)	Dawn storm	Solar wind	FAC	Intensity W m^{-2} Hz^{-1}	Lat. size ($\times 10^3$km)	JADE-E	Waves	Cavities	Unstable population
1S	27 August 2016 21:15–22:40	12	0.03 to 0.3	10 to 11	−35 to −30	40 to 50	X	X		3×10^{-11}	650	LR	Survey	X	N/A
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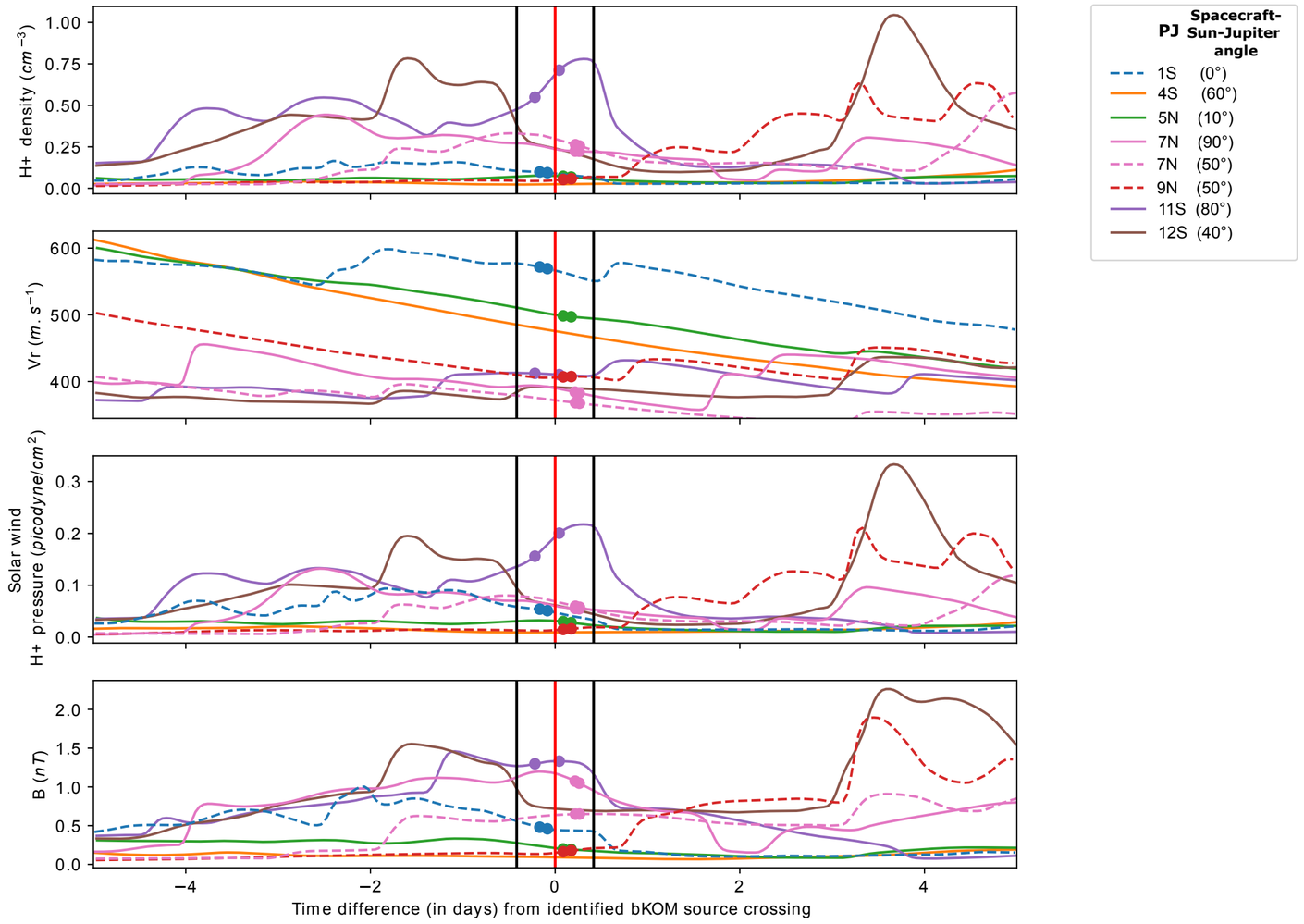
5N	27 March 2017 02:00–03:30	30 to 150	0,01 to 0.5	6 to 8,3	33 to 51	22 to 52	X		↑	1×10^{-11}	400	HR	Burst		Conics
9N	24 October 2017 10:20–11:30	20 to 30	0,05 to 0.5	8.5	35 to 40	20 to 35	X		↕	1×10^{-11}	450	LR + HR	Survey	X	Conics
11S	07 February 2018 17:30–20:00	30 to 120	0.003 to 0.05	5.5 to 8	−54 to −45	52	X	X	↑ during $f < f_{ce}$	1×10^{-10}	320	LR	Burst		N/A
12S	01 April 2018 15:40–18:10	18 to 43	N/A	8 to 10	−49 to −40	50 to 53		X		2×10^{-10}	600	None	Survey	N/A	N/A
7N	10 July 2017 17:15–17:55	15	N/A	10	24 to 28	14 to 19		X		5×10^{-11}	500	None	Survey	N/A	N/A


H+ density (cm^{-3})
1.00
0.75
0.50
0.25
0.00
Vr ($m.s^{-1}$)
600
500
400
Solar wind H+ pressure ($picodyne/cm^2$)
0.3
0.2
0.1
0.0
B (nT)
2.0
1.5
1.0
0.5
0.0
−4
−2
0
2
4
Time difference (in days) from identified bKOM source crossing
PJ
Spacecraft-Sun-Jupiter angle
1S (0°)
4S (60°)
5N (10°)
7N (90°)
7N (50°)
9N (50°)
11S (80°)
12S (40°)

$$\gamma = \frac{\pi^2}{4}\frac{\omega_{pe}^2}{\omega_{ce}^2}\frac{n_h}{1 + n_c\left(\frac{\omega_{pe}}{\omega_{ce}}\frac{1}{2\Delta\omega}\right)^2}\int v^2 sin^2(\theta)\frac{\partial F_e}{\partial v_\perp}$$