



# 9351 - Unveiling the energy flow from Jupiter's magnetosphere to aurora

Cycle: 4, Proposal Category: GO

## INVESTIGATORS

<i>Name</i>	<i>Institution</i>
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Prof. John T. Clarke (CoI) (US Admin CoI)	Boston University
Dr. Luke Moore (CoI)	Boston University
Dr. Oliver King (CoI) (ESA Member)	University of Leicester
Prof. Leigh Fletcher (CoI) (ESA Member)	University of Leicester
Dr. Chihiro Tao (CoI)	National Institute of Information and Com. Technology (NICT)
Dr. Henrik Melin (CoI) (ESA Member)	Northumbria University
Dr. Tom Stallard (CoI) (ESA Member)	Northumbria University
Dr. Glenn S. Orton (CoI)	Jet Propulsion Laboratory

## OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1	JUPITER-SOUTH-1	NIRCam Time Series	(1) JUPITER-AURORA-SOUTH1
	2	JUPITER-SOUTH-2	NIRCam Time Series	(2) JUPITER-AURORA-SOUTH2
	3	JUPITER-NORTH-DAR	NIRSpec IFU Spectroscopy	(3) JUPITER-AURORA-NORTH-DAR
	4	JUPITER-NORTH-IFP	NIRCam Time Series	(4) JUPITER-AURORA-NORTH-IFP

## ABSTRACT

Jupiter's auroras are the brightest in the solar system, revealing where charged particles, energized in the magnetosphere, deposit vast quantities of energy into the atmosphere. Jupiter's auroras in particular are the foundation of our understanding of similar emission from more distant astrophysical objects. However, a pilot program of simultaneous HST and JWST observations of Jupiter's auroras has recently revealed fundamental gaps in our

understanding of how such emissions are generated, demonstrating the power of joint observations to yield new insights into this system. Together with the evolving Juno mission, Cycle 33 presents a golden opportunity to answer the questions raised and piece together the energy flow from magnetosphere to aurora. These observations will answer the following science questions:

1. Are the brightest H3+ emissions in the solar system driven by low energy electrons?
2. Are the satellite footprint emissions driven by Alfvén waves?
3. Are polar auroral flares driven by the solar wind?

Only simultaneous observation with HST, JWST and Juno can answer these questions.

### **OBSERVING DESCRIPTION**

We will obtain NIR images using the long wavelength channel of NIRCcam with the F335M filter and CLEAR pupil aperture stop. This filter covers several intense ro-vibrational R-branch H3+ spectral lines within a strong methane absorption band, providing optimum contrast the planetary disc. We will employ the SUB160P 10" 10" subarray, which covers most of the auroral region, and target planetocentric coordinates selected to maintain the features of interest in the field of view throughout the observation. These will be finalized once the timing is known. We will employ the RAPID readout mode and use 10 groups during each integration time of ~3 s. We will use the maximum 200 integrations per exposure, and the resulting 614 s exposures yield good observation continuity across each observing interval. This set up was successfully used by Program 4566, which saw count rates of 1k-15k s<sup>-1</sup> px<sup>-1</sup> in the Swirl and bright DAR regions with ~1% noise, and no pixels were saturated, even in the strongly limb-brightened region. In order to measure the spatial and temporal variation of the H3+ temperature and density in the DAR simultaneously with the G140L spectral scan, we will obtain NIRSpec IFU spectroscopy of the DAR region with the G395H/F290LP setup. This was successfully used to measure the density and temperature in other regions in Program 4566. We will employ NRSRAPID readout with 2 groups per 32 s integration, and 10 integrations for each 322 s exposure across the observing interval. This setup provides an efficient mode of observation, providing high time resolution and excellent SNR. The IFU 3" 3" field-of-view will be centred on 70°, 150°W and is large enough to cover the DAR and surrounding region.

Proposal 9351 - Targets - Unveiling the energy flow from Jupiter's magnetosphere to aurora

Solar System Targets	#	Name	Level 1	Level 2	Level 3	
	(1)	JUPITER-AURORA-SOUTH1	STD=JUPITER	TYPE=PCENTRIC, LONG=320, LAT=-75, RAD=66854		
	<i>Comments: Southern aurora. Coordinates are placeholders and will be updated once the timing is known.</i> <i>Extended=YES</i>					
	(2)	JUPITER-AURORA-SOUTH2	STD=JUPITER	TYPE=PCENTRIC, LONG=320, LAT=-75, RAD=66854		
	<i>Comments: Southern aurora. Coordinates are placeholders and will be updated once the timing is known.</i> <i>Extended=YES</i>					
(3)	JUPITER-AURORA-NORTH-DAR	STD=JUPITER	TYPE=PCENTRIC, LONG=210, LAT=70, RAD=66854			
<i>Comments: Northern aurora, DAR region. Coordinates are placeholders and will be updated once the timing is known.</i> <i>Extended=YES</i>						
(4)	JUPITER-AURORA-NORTH-IFP	STD=JUPITER	TYPE=PCENTRIC, LONG=190, LAT=67, RAD=66854			
<i>Comments: Northern aurora, for the Io footprint. Coordinates are placeholders and will be updated once the timing is known.</i> <i>Extended=YES</i>						

Proposal 9351 - Observation 1 - Unveiling the energy flow from Jupiter's magnetosphere to aurora

Wed Aug 13 13:00:09 GMT 2025

<b>Observation</b>	<b>Proposal 9351, Observation 1: JUPITER-SOUTH-1</b> <b>Diagnostic Status: Warning</b> Observing Template: NIRCcam Time Series <i>Comments: This observation is to coincide with HST visit 1. The special requirements are set in the HST proposal, which governs the timings for this observation.</i>											
	(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. (JUPITER-SOUTH-1 (Obs 1)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.											
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<i>Comments: Southern aurora. Coordinates are placeholders and will be updated once the timing is known.</i> Extended=YES												
<b>Acquisition</b>	<b>#</b>											<b>Target</b>
	1											NONE
<b>Template</b>	<b>Module</b>											<b>Subarray</b>
	B											SUB160P
<b>Spectral Elements</b>	<b>#</b>	<b>Short Pupil</b>	<b>Short Filter</b>	<b>Long Pupil</b>	<b>Long Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Exposures/Dith</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>
	1	CLEAR	F212N	CLEAR	F335M	RAPID	10	688	1	688	2112.27	

Proposal 9351 - Observation 1 - Unveiling the energy flow from Jupiter's magnetosphere to aurora

Special Requirements

Time Series Observation  
No Parallel Attachments

DEFAULT WINDOW: NOT OCCULTATION OF JUPITER-AURORA-SOUTH1 BY JUPITER FROM JWST  
DEFAULT WINDOW: ANGULAR RATE JUPITER-AURORA-SOUTH1 FROM JWST LESS THAN 0.075

Proposal 9351 - Observation 2 - Unveiling the energy flow from Jupiter's magnetosphere to aurora

Wed Aug 13 13:00:09 GMT 2025

<b>Observation</b>	<p><b>Proposal 9351, Observation 2: JUPITER-SOUTH-2</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRCcam Time Series</p> <p><i>Comments: This observation is to coincide with HST visit 1. The special requirements are set in the HST proposal, which governs the timings for this observation.</i></p>																																		
<b>Diagnostics</b>	<p>(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p> <p>(JUPITER-SOUTH-2 (Obs 2)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.</p>																																		
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## Proposal 9351 - Observation 2 - Unveiling the energy flow from Jupiter's magnetosphere to aurora

### Special Requirements

Time Series Observation  
No Parallel Attachments

DEFAULT WINDOW: NOT OCCULTATION OF JUPITER-AURORA-SOUTH2 BY JUPITER FROM JWST  
DEFAULT WINDOW: NOT ECLIPSE PENUMBRAL PARTIAL OF JUPITER-AURORA-SOUTH2 BY IO FROM JWST  
DEFAULT WINDOW: NOT ECLIPSE PENUMBRAL PARTIAL OF JUPITER-AURORA-SOUTH2 BY EUROPA FROM JWST  
DEFAULT WINDOW: NOT ECLIPSE PENUMBRAL PARTIAL OF JUPITER-AURORA-SOUTH2 BY GANYMEDE FROM JWST  
DEFAULT WINDOW: NOT ECLIPSE PENUMBRAL PARTIAL OF JUPITER-AURORA-SOUTH2 BY CALLISTO FROM JWST  
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DEFAULT WINDOW: ANGULAR RATE JUPITER-AURORA-SOUTH2 FROM JWST LESS THAN 0.075

Proposal 9351 - Observation 3 - Unveiling the energy flow from Jupiter's magnetosphere to aurora

Wed Aug 13 13:00:09 GMT 2025

<b>Observation</b>	<b>Proposal 9351, Observation 3: JUPITER-NORTH-DAR</b> <b>Diagnostic Status: Warning</b> Observing Template: NIRSspec IFU Spectroscopy <i>Comments: This observation is to coincide with HST visit 3. The special requirements are set in the HST proposal, which governs the timings for this observation.</i>																																																																																																																																															
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Proposal 9351 - Observation 3 - Unveiling the energy flow from Jupiter's magnetosphere to aurora

Special Requirements

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Proposal 9351 - Observation 4 - Unveiling the energy flow from Jupiter's magnetosphere to aurora

Wed Aug 13 13:00:09 GMT 2025

<b>Observation</b>	<p><b>Proposal 9351, Observation 4: JUPITER-NORTH-IFP</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRCcam Time Series</p> <p><i>Comments: This observation is to coincide with HST observation 4-6. The special requirements are set in the HST proposal, which governs the timings for this observation.</i></p>																																		
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Special Requirements

Time Series Observation  
No Parallel Attachments

DEFAULT WINDOW: NOT OCCULTATION OF JUPITER-AURORA-NORTH-IFP BY JUPITER FROM JWST  
DEFAULT WINDOW: ANGULAR RATE JUPITER-AURORA-NORTH-IFP FROM JWST LESS THAN 0.075