



2143 - The turbulent magnetized interstellar medium: looking for ambipolar diffusion in the Pleiades

Cycle: 1, Proposal Category: GO

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OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1		NIRCam Imaging	(1) PLEIADES1
	2		NIRCam Imaging	(2) PLEIADES2

ABSTRACT

Magnetic fields and turbulence are two intertwined actors of cosmic evolution at the crossroad of the formation of planets, stars and galaxies. In the interstellar medium, magnetic fields are generally frozen to matter but this property breaks for dynamical timescales shorter than the ion-neutral coupling time through collisions. The resulting ion-neutral drift, known as ambipolar diffusion, is a fundamental process in ISM dynamics, because it is a major channel of turbulent energy dissipation and it redistributes magnetic flux. Observational evidence of its impact on interstellar turbulence have been so far elusive. The JWST offers the opportunity for a breakthrough, which we aim to materialize.

With NIRCAM, we propose to image the diffuse interstellar medium, illuminated by the Pleiades stars, down to physical scales (15 au) that encompass the ambipolar diffusion scale. The fluorescent line emission of H₂ will be the tracer of neutral gas, and PAH emission that of ions. H₂ in the diffuse interstellar medium will be mapped with unprecedented resolution and sensitivity. Our project follows-up Hubble Space Telescope observations that show striations, aligned with the magnetic field orientation, in the Pleiades nebula with structure down to the 0.1" resolution of JWST. The H₂ and PAH maps are expected to show similar but somehow different structure. They will be compared statistically to find evidence of the impact of decoupling of neutrals from ions and magnetic fields, as well as of energy dissipation, on interstellar turbulence. The results promise to fundamentally transform a cornerstone in our understanding of interstellar medium physics and star formation.

OBSERVING DESCRIPTION

We propose to image H₂ and PAH emission from the Pleiades nebula with NIRCAM at two positions, position 1 close and position 2 away from the star Merope. We use the F212N filter, centered on the 1-0 S(1) H₂ line, and the F335M filter that includes the 3.3 and 3.4 micron features and the associated dust continuum. For the subtraction of star light, we image the two positions in the F200W and F277W filters. The observations in the SW and LW channels are done simultaneously. The H₂ and PAH images will be used to statistically characterize and compare the multiscale structure of neutral (H₂) and ionized (PAH) species. Our goal is to detect observational signatures of the expected decoupling of neutrals and ions in interstellar turbulence.

Dithering is performed to mitigate bad pixels and flat field uncertainties by imaging each area of sky with multiple regions of the detectors. We use the standard 6THIGHT dithering pattern. With the dithering, the gap between the two NIRCAM arrays is covered. The field of view of the image at each of the two positions will be 6' x 2.2'. We do not use secondary subpixel dithers because the fine sampling of the point-spread function is not essential to our observations. The emission is extended on angular scales much larger than the field of view. We do not request an OFF position, and will rely on an external noise-less observation to perform dark subtraction. For each of the two positions, we have checked that the brightest stars in

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the camera field-of-view do not saturate the detector, even in the continuum filter F200W. At position 1, the bright star Merope is 20" off to the south-east of the NIRCAM field of view.

The integration time is driven by the sensitivity required to map the H₂ line emission. For the continuum filters, we integrate long enough so that star light may be subtracted without adding significant noise to the H₂ and PAH observations. At each position, the on-source integration time is 10⁴ s for the H₂ and PAH observations, and 4000 s for the continuum observations.

Proposal 2143 - Targets - The turbulent magnetized interstellar medium: looking for ambipolar diffusion in the Pleiades

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	PLEIADES1	RA: 03 46 27.9000 (56.6162500d) Dec: +23 56 52.00 (23.94778d) Equinox: J2000 <i>Comments:</i> <i>Category=ISM</i> <i>Description=[Cold neutral medium, Diffuse interstellar clouds, Interstellar magnetic fields, Reflection nebulae]</i> <i>Extended=YES</i>		
(2)	PLEIADES2	RA: 03 46 51.0000 (56.7125000d) Dec: +23 50 30.00 (23.84167d) Equinox: J2000 <i>Comments:</i> <i>Category=ISM</i> <i>Description=[Cold neutral medium, Diffuse interstellar clouds, Interstellar magnetic fields, Reflection nebulae]</i> <i>Extended=YES</i>			

Proposal 2143 - Observation 1 - The turbulent magnetized interstellar medium: looking for ambipolar diffusion in the Pleiades

Fri May 31 17:00:10 GMT 2024

Observation	<p>Proposal 2143, Observation 1</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRCam Imaging</p>									
Diagnostics	(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.									
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections			Miscellaneous		
	(1)	PLEIADES1	RA: 03 46 27.9000 (56.6162500d) Dec: +23 56 52.00 (23.94778d) Equinox: J2000							
	<p><i>Comments:</i> <i>Category=ISM</i> <i>Description=[Cold neutral medium, Diffuse interstellar clouds, Interstellar magnetic fields, Reflection nebulae]</i> <i>Extended=YES</i></p>									
Template	Module		Subarray			Target Placement				
	ALL		FULL			Module Gap				
Dithers	#	Primary Dither Type		Primary Dithers	Subpixel Dither Type		Dither Size	Subpixel Positions		
	1	FULLBOX		6TIGHT	STANDARD			1		
Spectral Elements	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
	1	F212N	F335M	DEEP8	5	2	12	6	11402.45	57635
	2	F200W	F277W	DEEP2	4	1	6	6	3994.078	57635

Proposal 2143 - Observation 2 - The turbulent magnetized interstellar medium: looking for ambipolar diffusion in the Pleiades

Fri May 31 17:00:10 GMT 2024

Observation	<p>Proposal 2143, Observation 2 Diagnostic Status: Warning Observing Template: NIRCam Imaging</p>									
Diagnostics	(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.									
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections		Miscellaneous		
	(2)	PLEIADES2	RA: 03 46 51.0000 (56.7125000d) Dec: +23 50 30.00 (23.84167d) Equinox: J2000							
	<p><i>Comments:</i> Category=ISM Description=[Cold neutral medium, Diffuse interstellar clouds, Interstellar magnetic fields, Reflection nebulae] Extended=YES</p>									
Template	Module		Subarray			Target Placement				
	ALL		FULL			Module Gap				
Dithers	#	Primary Dither Type		Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions			
	1	FULLBOX		6TIGHT	STANDARD		1			
Spectral Elements	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
	1	F212N	F335M	DEEP8	5	2	12	6	11402.45	57635
	2	F200W	F277W	DEEP2	4	1	6	6	3994.078	57635