



6739 - GQ Lup unveiled: Probing the Evolution of a Circumplanetary Disk

Cycle: 3, Proposal Category: GO

INVESTIGATORS

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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 | GQ Lup NIRSpec | NIRSpec IFU Spectroscopy | (1) V-GQ-LUP |
| | 2 | Reference NIRSpec | NIRSpec IFU Spectroscopy | (2) V-RY-Lup |
| | 3 | GQ Lup MIRI | MIRI Imaging | (1) V-GQ-LUP |
| | 4 | Reference MIRI | MIRI Imaging | (2) V-RY-Lup |

ABSTRACT

GQ Lup hosts a well-known accreting 10-30 MJ companion that interacts with the surrounding circumstellar disk. The companion has been confirmed to harbor a circumplanetary disk (CPD), offering a unique opportunity for comprehensive study across a wide range of wavelengths from

the near- and mid-infrared with JWST to radio frequencies with ALMA. This proposal aims to provide the first empirical insights into the physical properties of a CPD by leveraging observations from NIRSpec, MIRI, and ALMA Band 7. These observations, coupled with radiative transfer models, will be sensitive to the geometry of the CPD, the properties of its grains and the presence of pebbles in optically thick or thin configurations. Moreover, GQ Lup presents a rare chance to investigate planet-disk interactions. Notably, GQ Lup B stands as the sole directly imaged companion with a documented orbit which is interacting with its parent disk at a separation substantial enough to resolve the kinematic perturbations it imparts on the surrounding gas. Through high-resolution observations of ^{12}CO and ^{13}CO , we aim to validate and refine our current modelling of planet disk interaction.

This is a joint ALMA-JWST program (ALMA PID: 2024.1.00780.S)

OBSERVING DESCRIPTION

We will observe the GQ Lup system with both NIRSpec and MIRI imager. The goal is to detect and characterize a forming companion that is hosting a circumplanetary disk. The companion is located 0.7" away from the central star GQ Lup A.

We will first visit the target (GQ Lup A) and subsequently the reference star (RY Lup), necessary to properly remove the PSF. For each visit of a target, we will use both instruments MIRI and NIRSpec. Because wavefront drifts have larger impact at NIRSpec wavelengths, we will adopt the sequence MIRI SCIENCE --> NIRSpec SCIENCE --> NIRSpec REF --> MIRI REF (non-interruptible to be more time-efficient).

For NIRSpec, our observation is similar to PID1270, where the program aimed at a similar companion at similar separation. We will spend enough time on GQ Lup to obtain a SNR of 100 in the case no star were present. The residuals speckles will increase the noise by a factor 2-3 (based on experience with similar programs), meaning that we aim at a SNR of 30-50 in each channel. We will spend less time on the reference as it is not as important to be able to detect faint objects. We include a PA constraint to make sure that no PSF spike points in the same direction as the companion.

For MIRI, we will observe with F1280W, F1500W and F1800W with the SUB64 array. For each filter we will spend roughly 1 min on the target, as this is enough to reach high SNR. We will spend the same amount of time on the reference. Here, BFE will be one of the limiting factors for PSF subtraction, but since science target and reference have similar brightness, we expect to obtain a similar detector response. We verified with the ETC that the star will not saturate.

Proposal 6739 - Targets - GQ Lup unveiled: Probing the Evolution of a Circumplanetary Disk

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|--|----------|--|--|---------------|
| (1) | V-GQ-LUP | RA: 15 49 12.0868 (237.3003617d) Dec: -35 39 5.43 (-35.65151d) Equinox: J2000 | Proper Motion RA: -0.0011595206842507835 sec of time/yr Proper Motion Dec: -0.023328999941440998 arcsec/yr Epoch of Position: 2016 | |
| <p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=Star Description=[T Tauri stars] Extended=NO</p> | | | | |
| (2) | V-RY-Lup | RA: 15 59 28.3865 (239.8682771d) Dec: -40 21 51.25 (-40.36424d) Equinox: J2000 | Proper Motion RA: -10.963 mas/yr Proper Motion Dec: -22.23199994659808 mas/yr Parallax: 0.0065153" Epoch of Position: 2000 | |
| <p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM. Category=Star Description=[T Tauri stars]</p> | | | | |

Fixed Targets

Proposal 6739 - Observation 1 - GQ Lup unveiled: Probing the Evolution of a Circumplanetary Disk

Wed May 21 16:00:55 GMT 2025

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|-----------------------------|---|-----------------------|---|-------------------|-------------------------|--|-------------------------|----------------|----------------------|---------------------------|----------------------------|-------------------------|
| Observation | <p>Proposal 6739, Observation 1: GQ Lup NIRSpec</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec IFU Spectroscopy</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) | V-GQ-LUP | RA: 15 49 12.0868 (237.3003617d) Dec: -35 39 5.43 (-35.65151d) Equinox: J2000 | | | Proper Motion RA: -0.0011595206842507835 sec of time/yr Proper Motion Dec: -0.023328999941440998 arcsec/yr Epoch of Position: 2016 | | | | | | |
| | <p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p>Category=Star Description=[T Tauri stars] Extended=NO</p> | | | | | | | | | | | |
| Template | TA Method | | | | | | HFF Readout Mode | | | | | |
| | NONE | | | | | | false | | | | | |
| Dithers | # | Dither Type | | Size | Starting Point | | Number of Points | | Points | | | |
| | 1 | 4-POINT-DITHER | | | | | | | | | | |
| Spectral Elements | # | Grating/Filter | Readout Pattern | Groups/Int | Integrations/Exp | Leakcal | Dither | Autocal | Total Dithers | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
| | 1 | G395H/F290LP | NRSIRS2RAPID | 30 | 1 | false | true | NONE | 4 | 4 | 1809.022 | |
| Special Requirements | <p>Aperture PA Range 78.97164917 to 103.97164917 Degrees (V3 300.0 to 325.0)</p> <p>Aperture PA Range 198.97164917 to 223.97164917 Degrees (V3 60.0 to 85.0)</p> <p>Sequence Observations 3, 1, 2, 4 (reordered), Non-interruptible</p> | | | | | | | | | | | |

Proposal 6739 - Observation 2 - GQ Lup unveiled: Probing the Evolution of a Circumplanetary Disk

Wed May 21 16:00:55 GMT 2025

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|-----------------------------|---|-----------------------|--|-------------------|-------------------------|---|-------------------------|-------------------------|----------------------|---------------------------|----------------------------|-------------------------|
| Observation | <p>Proposal 6739, Observation 2: Reference NIRSpec</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec IFU Spectroscopy</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) | V-RY-Lup | RA: 15 59 28.3865 (239.8682771d) Dec: -40 21 51.25 (-40.36424d) Equinox: J2000 | | | Proper Motion RA: -10.963 mas/yr Proper Motion Dec: -22.23199994659808 mas/yr Parallax: 0.0065153" Epoch of Position: 2000 | | | | | | |
| | <p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.</i></p> <p><i>Category=Star</i></p> <p><i>Description=[T Tauri stars]</i></p> | | | | | | | | | | | |
| Template | TA Method | | | | | | HFF Readout Mode | | | | | |
| | NONE | | | | | | false | | | | | |
| Dithers | # | Dither Type | | Size | Starting Point | | | Number of Points | Points | | | |
| | 1 | 4-POINT-DITHER | | | | | | | | | | |
| Spectral Elements | # | Grating/Filter | Readout Pattern | Groups/Int | Integrations/Exp | Leakcal | Dither | Autocal | Total Dithers | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
| | 1 | G395H/F290LP | NRSIRS2RAPID | 10 | 1 | false | true | NONE | 4 | 4 | 641.911 | |
| Special Requirements | Sequence Observations 3, 1, 2, 4 (reordered), Non-interruptible | | | | | | | | | | | |

Proposal 6739 - Observation 3 - GQ Lup unveiled: Probing the Evolution of a Circumplanetary Disk

Wed May 21 16:00:55 GMT 2025

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| Observation | <p>Proposal 6739, Observation 3: GQ Lup MIRI</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: MIRI Imaging</p> | | | | | | | | | | |
| Diagnostics | (Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. | | | | | | | | | | |
| Fixed Targets | # | Name | Target Coordinates | | | Targ. Coord. Corrections | | | Miscellaneous | | |
| | (1) | V-GQ-LUP | RA: 15 49 12.0868 (237.3003617d) Dec: -35 39 5.43 (-35.65151d) Equinox: J2000 | | | Proper Motion RA: -0.0011595206842507835 sec of time/yr Proper Motion Dec: -0.023328999941440998 arcsec/yr Epoch of Position: 2016 | | | | | |
| | <p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>Category=Star</i></p> <p><i>Description=[T Tauri stars]</i></p> <p><i>Extended=NO</i></p> | | | | | | | | | | |
| Template | <p>Subarray</p> <p>SUB64</p> | | | | | | | | | | |
| Dithers | # | Dither Type | Starting Point | Number of Points | Points | Starting Set | Number of Sets | Optimized For | Direction | Pattern Size | |
| | 1 | CYCLING | 1 | 4 | | 1 | 1 | | | DEFAULT | |
| Spectral Elements | # | Filter | Readout Pattern | Groups/Int | Integrations/Exp | Exposures/Dith | Dither | Total Dithers | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
| | 1 | F1280W | FASTR1 | 15 | 11 | 1 | Dither 1 | 4 | 44 | 59.584 | |
| | 2 | F1500W | FASTR1 | 15 | 11 | 1 | Dither 1 | 4 | 44 | 59.584 | |
| | 3 | F1800W | FASTR1 | 15 | 11 | 1 | Dither 1 | 4 | 44 | 59.584 | |
| | 4 | F2100W | FASTR1 | 10 | 32 | 1 | Dither 1 | 4 | 128 | 119.508 | |
| Special Requirements | Sequence Observations 3, 1, 2, 4 (reordered), Non-interruptible | | | | | | | | | | |

Proposal 6739 - Observation 4 - GQ Lup unveiled: Probing the Evolution of a Circumplanetary Disk

Wed May 21 16:00:55 GMT 2025

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|-----------------------------|---|--------------------|--|-------------------------|-------------------------|---|-----------------------|----------------------|---------------------------|----------------------------|-------------------------|
| Observation | <p>Proposal 6739, Observation 4: Reference MIRI</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: MIRI Imaging</p> | | | | | | | | | | |
| Diagnostics | (Visit 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. | | | | | | | | | | |
| Fixed Targets | # | Name | Target Coordinates | | | Targ. Coord. Corrections | | | Miscellaneous | | |
| | (2) | V-RY-Lup | RA: 15 59 28.3865 (239.8682771d) Dec: -40 21 51.25 (-40.36424d) Equinox: J2000 | | | Proper Motion RA: -10.963 mas/yr Proper Motion Dec: -22.23199994659808 mas/yr Parallax: 0.0065153" Epoch of Position: 2000 | | | | | |
| | <p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.</i></p> <p><i>Category=Star</i></p> <p><i>Description=[T Tauri stars]</i></p> | | | | | | | | | | |
| Template | <p>Subarray</p> <p>SUB64</p> | | | | | | | | | | |
| Dithers | # | Dither Type | Starting Point | Number of Points | Points | Starting Set | Number of Sets | Optimized For | Direction | Pattern Size | |
| | 1 | CYCLING | 1 | 4 | | 1 | 1 | | | DEFAULT | |
| Spectral Elements | # | Filter | Readout Pattern | Groups/Int | Integrations/Exp | Exposures/Dith | Dither | Total Dithers | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
| | 1 | F1280W | FASTR1 | 15 | 11 | 1 | Dither 1 | 4 | 44 | 59.584 | |
| | 2 | F1500W | FASTR1 | 15 | 11 | 1 | Dither 1 | 4 | 44 | 59.584 | |
| | 3 | F1800W | FASTR1 | 15 | 11 | 1 | Dither 1 | 4 | 44 | 59.584 | |
| | 4 | F2100W | FASTR1 | 10 | 32 | 1 | Dither 1 | 4 | 128 | 119.508 | |
| Special Requirements | Sequence Observations 3, 1, 2, 4 (reordered), Non-interruptible | | | | | | | | | | |