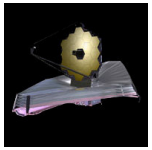

# 5497 - Resolving the Radio Riddle: Unveiling the Origins of Radio Emission in a Red Dwarf and its Wide-Orbit Companion

Cycle: 3, Proposal Category: GO

**INVESTIGATORS**


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|---|---|
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**OBSERVATIONS**

| *Folder* | *Observation* | *Label* | *Observing Template* | *Science Target* |
|---|---|---|---|---|
| GJ1151 | | | | |
| | 1 | Science target | NIRCam Coronagraphic Imaging | (1) G-122-49 |
| | 2 | Reference | NIRCam Coronagraphic Imaging | (2) V-HT-UMa |


**ABSTRACT**

Detection of radio emission due to the electron cyclotron maser instability (ECMI) is likely the only viable way to measure exoplanets' magnetic fields. Because ECMI from exoplanets has not yet been detected we have no empirical knowledge of their magnetic fields. Radio observations of GJ 1151, a 5 Gyr M5 star at 8 parsec, revealed an unexpected ECMI signature. In the absence of known massive planets around GJ 1151 capable of emitting this signature, the emission was originally attributed to star-planet interaction with a short-period planet. Subsequent radial velocity (RV)

measurements excluded this hypothesis, but revealed an RV trend suggestive of a distant gas giant or brown dwarf companion. Is this the coveted radio-emitting exoplanet?

To answer this question, we propose the 'Resolving the Radio Riddle' program to obtain 3 hours of JWST/NIRCam coronagraphy observations of GJ 1151 with the F200W and F444W filters, which would be sensitive to companions down to 3 Mjup from 3-25 AU. The companion is expected to be cool (200K-350 K depending on its mass), making JWST the only instrument capable to detect the companion down to planetary mass regimes. Through combining the proposed NIRCam observations with the available RVs, we will be able to measure the dynamical mass of the companion, and inform evolutionary models that lack observational constraints at these ages. We will for the first time confirm radio emission of a planetary mass companion, provide the first empirical test of dynamo scaling laws that predict exoplanetary magnetic fields, and open up the emerging field of radio astronomy to characterize exoplanets and substellar companions.

**OBSERVING DESCRIPTION**

We will obtain NIRCam dual band coronagrahy osbervations of M5 star GJ1151 in the F200W and F444W filters using MASK335R. We will move directly to the nearby M2 star HT UMA in  a non interruptible sequence to observe a reference PSF using a 9 grid pattern in order to sample the PSF and improve the PSF subtraction. These observations should yield mass limits of 3 jupiter masses at the age of 5Gyr for the host star, enabling the detection of an radio emitting gas giant with a long-term RV trend.

**Fixed Targets**

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (1) | G-122-49 | RA: 11 50 55.2390 (177.7301625d)<br>Dec: +48 22 23.16 (48.37310d)<br>Equinox: J2000 | Proper Motion RA: -1545.069 mas/yr<br>Proper Motion Dec: -962.724 mas/yr<br>Parallax: 0.1243"<br>Epoch of Position: 2016 | |
| *Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.*<br>*Category=Star*<br>*Description=[M stars]*<br>*Extended=NO* | | | | |
| (2) | V-HT-UMa | RA: 11 48 14.6730 (177.0611375d)<br>Dec: +48 31 25.65 (48.52379d)<br>Equinox: J2000 | Proper Motion RA: -8.905 mas/yr<br>Proper Motion Dec: 2.473 mas/yr<br>Parallax: 0.001340"<br>Epoch of Position: 2016 | |
| *Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.*<br>*Category=Star*<br>*Description=[M stars]* | | | | |

## Observation

**Proposal 5497, Observation 1: Science target**

Tue Mar 18 17:00:17 GMT 2025

**Diagnostic Status: Warning**

Observing Template: NIRCam Coronagraphic Imaging

## Diagnostics

(Science target (Obs 1)) Warning (Form): Science observations should be linked to at least one other compatible science observation by an Aperture PA Offset of 1-14 degrees

(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) | G-122-49 | RA: 11 50 55.2390 (177.7301625d)<br>Dec: +48 22 23.16 (48.37310d)<br>Equinox: J2000 | Proper Motion RA: -1545.069 mas/yr<br>Proper Motion Dec: -962.724 mas/yr<br>Parallax: 0.1243"<br>Epoch of Position: 2016 | |

*Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.*
*Category=Star*
*Description=[M stars]*
*Extended=NO*

## Acquisition

| # | Target | Filter | Target Brightness | Readout Pattern | Groups/Int | Integrations/Exp | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SAME | F335M | FAINT | RAPID | 5 | 1 | 1 | 0.304 | 169171.5 |

## Template

| Module | Occulting Mask | Obtain Astrometric Confirmation Images? | Subarray | Dither Pattern |
|---|---|---|---|---|
| A | MASK335R | true | SUB320A335R | NONE |

## Confirmation

| # | Conf. Readout Pattern | Conf. Groups/Int | Conf. Integrations/Exp | Conf. Total Integrations | Conf. Total Exposure Time | Conf. Total Dithers |
|---|---|---|---|---|---|---|
| 1 | RAPID | 3 | 1 | 1 | 32.21 | 1 |

## Spectral Elements

| # | Short Filter | Long Filter | Readout Pattern | Groups/Int | Integrations/Exp | Total Dithers | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
|---|---|---|---|---|---|---|---|---|---|
| 1 | F200W | F444W | DEEP8 | 10 | 46 | 1 | 46 | 9295.176 | |

| | |
|---|---|
| **PSF References** | Reference (Obs 2) (PSF Reference; Filters [F200W/F444W])<br>Additional Justification: false |
| **Special Requirements** | Offset -0.01 arcsec, -0.018 arcsec<br>No Parallel Attachments<br><br>Sequence Observations 1, 2, Non-interruptible |

## Observation

**Proposal 5497, Observation 2: Reference**

Tue Mar 18 17:00:17 GMT 2025

**Diagnostic Status: Warning**

Observing Template: NIRCam Coronagraphic Imaging

## 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-HT-UMa | RA: 11 48 14.6730 (177.0611375d)<br>Dec: +48 31 25.65 (48.52379d)<br>Equinox: J2000 | Proper Motion RA: -8.905 mas/yr<br>Proper Motion Dec: 2.473 mas/yr<br>Parallax: 0.001340"<br>Epoch of Position: 2016 | |

*Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.*
*Category=Star*
*Description=[M stars]*

## Acquisition

| # | Target | Filter | Target Brightness | Readout Pattern | Groups/Int | Integrations/Exp | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SAME | F335M | BRIGHT (ND Square) | SHALLOW4 | 9 | 1 | 1 | 2.26 | 169171.6 |

## Template

| Module | Occulting Mask | Obtain Astrometric Confirmation Images? | Subarray | Dither Pattern |
|---|---|---|---|---|
| A | MASK335R | true | SUB320A335R | 9-POINT-CIRCLE |

## Confirmation

| # | Conf. Readout Pattern | Conf. Groups/Int | Conf. Integrations/Exp | Conf. Total Integrations | Conf. Total Exposure Time | Conf. Total Dithers |
|---|---|---|---|---|---|---|
| 1 | RAPID | 3 | 1 | 1 | 32.21 | 1 |

## Spectral Elements

| # | Short Filter | Long Filter | Readout Pattern | Groups/Int | Integrations/Exp | Total Dithers | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
|---|---|---|---|---|---|---|---|---|---|
| 1 | F200W | F444W | SHALLOW4 | 8 | 3 | 9 | 27 | 1155.116 | |

| | |
|---|---|
| **PSF References** | PSF Reference: true |
| **Special Requirements** | Offset -0.01 arcsec, -0.018 arcsec<br>No Parallel Attachments<br><br>Sequence Observations 1, 2, Non-interruptible |