



2635 - Infrared emission from the magnetar 4U 0142+61: A dusty fallback disk?

Cycle: 1, 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 | | MIRI Low Resolution Spectroscopy | (1) PSR-J0146+6145 |
| | 2 | | NIRCam Time Series | (1) PSR-J0146+6145 |
| | 3 | | NIRCam Imaging | (1) PSR-J0146+6145 |
| | 4 | repeat | NIRCam Time Series | (2) 4U0142+61 |
| | 5 | repeat of obs 4. | NIRCam Time Series | (2) 4U0142+61 |

ABSTRACT

Observations of the magnetar 4U 0142+61 with the Spitzer space telescope have shown a broad infrared excess with a possible silicate spectral feature at 9.7 micron. This result was interpreted as emission from a passive disk surrounding the energetic isolated neutron star. Such disks, predicted by supernova dynamic models, have been long sought after because they can elucidate details of neutron star formation and evolution. Unfortunately, the Spitzer spectrum was of low quality, thus an infrared flux contribution from the neutron star's magnetosphere remains a possibility, leaving the origin of the magnetar's infrared-optical spectrum uncertain. JWST will enable a thorough investigation and clarification of the nature of 4U0142+61's infrared emission. Taking advantage of the NIRCam subarray time-series mode, we also propose to investigate the pulsations of emission from this slowly spinning neutron star to quantify the contribution of the magnetosphere and separate the magnetospheric

emission from the disk emission.

OBSERVING DESCRIPTION

This JWST project has two parts - spectroscopy and time series + imaging observations.

For the spectroscopy, we will employ the MIRI Low Resolution Spectroscopy with the 0.5 arcsec x 4.7 arcsec slit. Two dither positions ('along slit nod' dither type) will be used with FAST readout. The goal is to investigate a suspected silicate feature at 9.7 micron and look for other dust/PAH emission features in the source spectrum.

An acquisition image will be obtained in the F560W filter (FASTGRPAVG readout) which will detect the magnetar in 44 s with S/N=43.

For the time-series observations we will use the NIRCam SUBP64P subarray with SHALLOW4 readout pattern (0.25 sec time resolution) in order to detect pulsations from the magnetar (rotation period 8.7 sec) in the infrared (F410M) and optical (F070W). Obtaining these two bands in one visit is important because magnetars can show long-term flux variations. We also ask for a short acquisition image in the F335M band (DEEP8 readout) as recommended in the JWST documentation.

To cover the wavelength gap between the MIRI/LRS and NIRCam/time-series observations, and obtain a multi-band photometry, we propose a very short NIRCam imaging exposure with F140M and F250M filters (Full array) with a standard 3 point dither.

In order to enable contemporaneous coverage (needed because of magnetar variability), we use GROUP OBSERVATION Timing Special Requirement, linking all 3 observations to be carried out within one day.

Proposal 2635 - Targets - Infrared emission from the magnetar 4U 0142+61: A dusty fallback disk?

| Fixed Targets | # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---------------|-----------|---|---|---------------------------|---------------|
| | (1) | PSR-J0146+6145 | RA: 01 46 22.2100 (26.5925417d) Dec: +61 45 3.80 (61.75106d) Equinox: J2000 <i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> <i>Category=Star</i> <i>Description=[Neutron stars]</i> | Epoch of Position: 2015.5 | |
| (2) | 4U0142+61 | RA: 01 46 22.3940 (26.5933083d) Dec: +61 45 3.23 (61.75090d) Equinox: J2000 <i>Comments:</i> <i>Category=Star</i> <i>Description=[Neutron stars]</i> <i>Extended=NO</i> | | | |

Proposal 2635 - Observation 1 - Infrared emission from the magnetar 4U 0142+61: A dusty fallback disk?

Fri Feb 17 16:01:14 GMT 2023

| | | | | | | | | |
|------------------------------|---|------------------------|---|-----------------------------------|---------------------------|----------------------------|---------------------------|---|
| Observation | <p>Proposal 2635, Observation 1</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: MIRI Low Resolution 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) | PSR-J0146+6145 | RA: 01 46 22.2100 (26.5925417d) Dec: +61 45 3.80 (61.75106d) Equinox: J2000 | Epoch of Position: 2015.5 | | | | |
| | <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=[Neutron stars]</i></p> | | | | | | | |
| Acquisition | # | Target | Filter | Readout Pattern | Groups/Int | Integrations/Exp | Total Integrations | Total Exposure Time ETC Wkbk.Calc ID |
| | 1 | SAME | F560W | FASTGRPAVG | 4 | 1 | 1 | 44.401 63247 |
| Template | Subarray | | | Obtain Verification Image? | | | | |
| | FULL | | | true | | | | |
| Dithers | # | Dither Type | No. Spectral Steps | Spectral Step Offset | No. Spatial Steps | Spatial Step Offset | | |
| | 1 | ALONG SLIT NOD | | | | | | |
| Pointing Verification | # | Readout Pattern | Groups/Int | Integrations/Exp | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID | |
| | 1 | FASTGRPAVG | 4 | 1 | 1 | 44.401 | 63247 | |

Proposal 2635 - Observation 1 - Infrared emission from the magnetar 4U 0142+61: A dusty fallback disk?

| Spectral Elements | # | Readout Pattern | Groups/Int | Integrations/Exp | Total Integrations | Exposures/Dith | Total Dithers | Total Exposure Time | ETC Wkbk.Calc ID |
|--|----------------------|-----------------|------------|------------------|--------------------|----------------|---------------|---------------------|------------------|
| | Special Requirements | 1 | FASTR1 | 50 | 7 | 14 | 1 | 2 | 1975.828 |
| Group Observations 1, 2, 3 within 1 Days | | | | | | | | | |

Proposal 2635 - Observation 2 - Infrared emission from the magnetar 4U 0142+61: A dusty fallback disk?

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| Observation | <p>Proposal 2635, Observation 2</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRCам Time Series</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 | | | |
| | (1) | PSR-J0146+6145 | RA: 01 46 22.2100 (26.5925417d) Dec: +61 45 3.80 (61.75106d) Equinox: J2000 | | | Epoch of Position: 2015.5 | | | | | | |
| | <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=[Neutron stars]</i></p> | | | | | | | | | | | |
| Acquisition | # | Target | Subarray | Filter | Readout Pattern | Groups/Int | Integrations/Exp | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID | | |
| | 1 | SAME | SUB32TATS | F335M | DEEP8 | 65 | 1 | 1 | 19.286 | 63241 | | |
| Template | Module | | | | | Subarray | | | | | | |
| | B | | | | | SUB64P | | | | | | |
| Spectral Elements | # | Short Pupil | Short Filter | Long Pupil | Long Filter | Readout Pattern | Groups/Int | Integrations/Exp | Exposures/Dith | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
| | 1 | CLEAR | F070W | CLEAR | F410M | SHALLOW4 | 10 | 800 | 1 | 800 | 2008.448 | |
| Special Requirements | <p>Time Series Observation</p> <p>No Parallel Attachments</p> <p>Group Observations 1, 2, 3 within 1 Days</p> | | | | | | | | | | | |

Proposal 2635 - Observation 3 - Infrared emission from the magnetar 4U 0142+61: A dusty fallback disk?

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| Observation | <p>Proposal 2635, Observation 3</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRCcam 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) | PSR-J0146+6145 | RA: 01 46 22.2100 (26.5925417d) Dec: +61 45 3.80 (61.75106d) Equinox: J2000 | | Epoch of Position: 2015.5 | | | | | |
| | <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=[Neutron stars]</i></p> | | | | | | | | | |
| Template | Module | | | | Subarray | | | | | |
| | B | | | | SUB400P | | | | | |
| Dithers | # | Primary Dither Type | | Primary Dithers | | Subpixel Dither Type | | Dither Size | | Subpixel Positions |
| | 1 | NONE | | | | STANDARD | | | | 7 |
| Spectral Elements | # | Short Filter | Long Filter | Readout Pattern | Groups/Int | Integrations/Exp | Total Integrations | Total Dithers | Total Exposure Time | ETC Wkbk.Calc ID |
| | 1 | F140M | F250M | RAPID | 10 | 1 | 7 | 7 | 127.674 | |
| Special Requirements | Group Observations 1, 2, 3 within 1 Days | | | | | | | | | |

Proposal 2635 - Observation 4 - Infrared emission from the magnetar 4U 0142+61: A dusty fallback disk?

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| Observation | <p>Proposal 2635, Observation 4: repeat Diagnostic Status: Warning Observing Template: NIRCam Time Series</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) | 4U0142+61 | RA: 01 46 22.3940 (26.5933083d) Dec: +61 45 3.23 (61.75090d) Equinox: J2000 | | | | | | | | | |
| | <i>Comments:</i> Category=Star Description=[Neutron stars] Extended=NO | | | | | | | | | | | |
| Acquisition | # | Target | Subarray | Filter | Readout Pattern | Groups/Int | Integrations/Exp | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID | | |
| | 1 | 2 4U0142+61 | SUB32TATS | F335M | DEEP8 | 65 | 1 | 1 | 19.286 | 130489 | | |
| Template | Module | | | | | Subarray | | | | | | |
| | B | | | | | SUB64P | | | | | | |
| Spectral Elements | # | Short Pupil | Short Filter | Long Pupil | Long Filter | Readout Pattern | Groups/Int | Integrations/Exp | Exposures/Dith | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
| | 1 | CLEAR | F070W | CLEAR | F410M | SHALLOW4 | 10 | 800 | 1 | 800 | 2008.448 | |
| Special Requirements | Time Series Observation No Parallel Attachments | | | | | | | | | | | |

Proposal 2635 - Observation 5 - Infrared emission from the magnetar 4U 0142+61: A dusty fallback disk?

Fri Feb 17 16:01:14 GMT 2023

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|-----------------------------|--|--------------------|---|-------------------|------------------------|---------------------------------|-------------------------|---------------------------|----------------------------|---------------------------|----------------------------|-------------------------|
| Observation | <p>Proposal 2635, Observation 5: repeat of obs 4.</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRCam Time Series</p> | | | | | | | | | | | |
| Diagnostics | (Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. | | | | | | | | | | | |
| Fixed Targets | # | Name | Target Coordinates | | | Targ. Coord. Corrections | | | Miscellaneous | | | |
| | (2) | 4U0142+61 | RA: 01 46 22.3940 (26.5933083d) Dec: +61 45 3.23 (61.75090d) Equinox: J2000 | | | | | | | | | |
| | <p><i>Comments:</i> <i>Category=Star</i> <i>Description=[Neutron stars]</i> <i>Extended=NO</i></p> | | | | | | | | | | | |
| Acquisition | # | Target | Subarray | Filter | Readout Pattern | Groups/Int | Integrations/Exp | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID | | |
| | 1 | 2 4U0142+61 | SUB32TATS | F335M | DEEP8 | 65 | 1 | 1 | 19.286 | 130489 | | |
| Template | Module | | | | | Subarray | | | | | | |
| | B | | | | | SUB64P | | | | | | |
| Spectral Elements | # | Short Pupil | Short Filter | Long Pupil | Long Filter | Readout Pattern | Groups/Int | Integrations/Exp | Exposures/Dith | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
| | 1 | CLEAR | F070W | CLEAR | F410M | SHALLOW4 | 10 | 800 | 1 | 800 | 2008.448 | |
| Special Requirements | <p>Time Series Observation No Parallel Attachments</p> | | | | | | | | | | | |