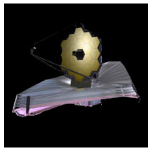

# 3231 - Panchromatic Phase Curve of the Highest-S/N Hot Neptune

Cycle: 2, Proposal Category: GO

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**OBSERVATIONS**

| *Folder* | *Observation* | *Label* | *Observing Template* | *Science Target* |
|---|---|---|---|---|
| Observation Folder | | | | |
| | 1 | Phase Curve | NIRSpec Bright Object Time Series | (1) LTT9779 |


**ABSTRACT**

Planets are complex three dimensional objects whose temperature, chemistry, and clouds vary throughout their atmospheres. Phase curve spectroscopy provides great insight into the atmospheric structure of giant exoplanets, but such observations are sorely lacking for Neptune-size exoplanets.

We propose to measure the spectroscopic thermal phase curve of hot Neptune LTT 9779b with NIRSpec/G395H (3-5 micron) to measure the planet's global thermal and molecular structure via two day-side eclipse spectra, one transmission spectrum, and longitudinally-resolved emission spectra via a full-orbit phase curve. Our program will (i) measure the planet's global molecular abundances to a precision of <0.5 dex and its C/O ratio to better than 10% at the day-side, night-side, terminator, and at intermediate longitudes, (ii) measure cloud properties at all longitudes to compare to the ubiquitous night-side clouds and patchy terminators seen in hot Jupiters, and (iii) provide the definitive hot-Neptune benchmark against which to compare the next generation of models of small exoplanet atmospheric circulation, chemistry, clouds, and global thermal structure.

LTT 9779b is the single best exo-Neptune for these studies because it has: (1) a broadband phase curve and SED already measured with Spitzer; (2) a short, 19-hour orbital period that permits a full-orbit JWST phase curves in a Small program; (3) a hot day-side and bright star that yield high S/N; and (4) a complementary Cycle 1 NIRISS/SOSS phase curve at 1-2.6 micron. However, our simulations show that a combined NIRISS+NIRSpec analysis is necessary to usefully measure the planet's global atmospheric properties.


**OBSERVING DESCRIPTION**

The basic format for our observations is time series spectroscopy during one planet orbit using NIRSpec/G395H's ``BOTS'' (Bright Object Time Series) mode. The 1.6"x1.6" BOTS captures the entire 3--5um spectrum and minimizes both readout times and pointing-induced, time-variable slit losses. We will bracket the phase curve with eclipses: the planet is hidden from view during eclipse, allowing us to correct low-order stellar variability and detector systematics. Our observation consist of near-continuous spectroscopy of the system, interrupted only by detector overheads.

We will perform offset target acquisition using a star 24" away. Both science and offset stars have precise Gaia DR3 astrometry. Our acquisition target is faint enough (Vega J=12.8) that the ETC predicts NIRSpec's Wide-Angle Target Acquisition mode will result in only a single saturated pixel, in line with the instrument handbook's guidelines. AO imaging and Gaia show no stellar companions within 2" down to Delta K_s < 7 mag.

TESS and Spitzer observed our target's transits so we know its orbital perio, and Spitzer shows that the secondary eclipse occurs at an orbital phase of 0.5. These published observations eliminate any meaningful uncertainties in the scheduling times, allowing efficient and accurate scheduling with JWST. APT verifies that LTT~9779b is visible for four months per year; with P~0.79 days this means that >100 observing windows are available for this system. We will schedule our observations in a one-hour, phase-constrained window using these ephemerides. We will then observe the entire phase curve, including transit and a second eclipse.

**Fixed Targets**

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (1) | LTT9779 | RA: 23 54 40.5408 (358.6689200d)<br>Dec: -37 37 41.64 (-37.62823d)<br>Equinox: J2000 | Proper Motion RA: 247.634 mas/yr<br>Proper Motion Dec: -69.75199999033066 mas/yr<br>Epoch of Position: 2016.0 | |
| *Comments: Main science target.*<br><br>*LTT9779 = Gaia DR3 2307504062045842688.  double-checked on 2024/08/29*<br>*Category=Star*<br>*Description=[Exoplanet Systems, G dwarfs]* | | | | |
| (2) | LTT9779-ACQUISITION-TARGET | RA: 23 54 42.0704 (358.6752933d)<br>Dec: -37 37 51.74 (-37.63104d)<br>Equinox: J2000 | Proper Motion RA: 17.708 mas/yr<br>Proper Motion Dec: -14.234 mas/yr<br>Epoch of Position: 2016.0 | |
| *Comments: Acquisition Target.*<br><br>*All parameters taken from Gaia DR3 2307509873137050624, double-checked on 2024/08/29*<br>*Category=Star*<br>*Description=[K giants]* | | | | |

## Observation

**Proposal 3231, Observation 1: Phase Curve**

Thu Aug 29 19:00:18 GMT 2024

**Diagnostic Status: Warning**

Observing Template: NIRSpec Bright Object Time Series

## Diagnostics

(Phase Curve (Obs 1)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure.

(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 1:1) Informational (Form): Visit schedulable, but most scheduling windows are when JWST is pointed in direction of greatest micrometeoroid impact risk. This is likely due to scheduling special requirements.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
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*Comments: Main science target.*

*LTT9779 = Gaia DR3 2307504062045842688. double-checked on 2024/08/29*
*Category=Star*
*Description=[Exoplanet Systems, G dwarfs]*

## Acquisition

| # | Target | TA Method | Subarray | Filter | Readout Pattern | Groups/Int | Integrations/Exp | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 LTT9779-ACQUISITION-TARGET | WATA | SUB32 | F110W | NRSRAPID | 3 | 1 | 1 | 0.08 | 141812 |

## Template

| Subarray |
|---|
| SUB2048 |

## Spectral Elements

| # | Grating/Filter | Readout Pattern | Groups/Int | Integrations/Exp | Exposures/Dith | Total Dithers | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
|---|---|---|---|---|---|---|---|---|---|
| 1 | G395H/F290LP | NRSRAPID | 7 | 10276 | 1 | 1 | 10276 | 74362.068 | 141812 |

## Special Requirements

Phase 0.218042 to 0.244345 with period 1.5841282 Days and zero-phase 2459043.310602 HJD
Time Series Observation
No Parallel Attachments