TrExoLiSTS: Transiting Exoplanets List of Space Telescope Spectroscopy

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December 23, 2022

Abstract

We present the STScI WFC3 project webpage, Transiting Exoplanets List of Space Telescope Spectroscopy (TrExoLiSTS). It tabulates existing observations of transiting exoplanet atmospheres, available in the MAST archive made with HST WFC3 using the stare or spatial scan mode. A parallel page is available for all instruments aboard JWST using the spectral Time Series Observation (TSO) mode. The webpages include observations obtained during primary transits, secondary eclipses and phase curves. TrExoLiSTS enables quick identification of complementarity between programs in terms of targets and or wavelength coverage, which can help to simplify proposal preparation, and to eliminate duplicate or redundant efforts. Reference for the quality of the HST WFC3 visits taken more than 1.5 years ago are made available via diagrams of the direct image, white light curve, and drift of the spectral time series across the detector. Future improvements to the webpage will include expanding the program query to other HST instruments and references for the quality of JWST visits.

Introduction

Over the past two decades, spectroscopic observations of transiting exoplanet atmospheres with the *Hubble Space Telescope* (*HST*) have been steadily increasing, covering primary transits, secondary eclipses, and phase curves. Thanks to the availability of a drift scanning mode, the infrared channel of the Wide Field Camera 3 (WFC3) has become a leading instrument, capable of delivering high signal-to-noise observations that are sensitive to absorption

from water in exoplanet atmospheres (Deming et al. 2013, Edwards et al. 2022). With multiple community efforts aimed toward establishing a diverse and statistically large sample of compositional constraints of exoplanet atmospheres, a need for a catalog of archived *HST* observations has emerged. While the Mikulski Archive for Space Telescopes (MAST[1]) records HST and JWST observations, a list of every spectroscopic time series observation of a transiting exoplanet is not available to the community. This requires the users to either search MAST by a planet name, program or an instrument. To address the need for an exoplanet catalog and help reduce target duplication and redundant effort in proposal preparation, the WFC3 team has established a webpage, TrExoLiSTS: Transiting Exoplanets List of Space Telescope Spectroscopy. It provides a summary of time-series observations of transiting exoplanets that are archived on the MAST. TrExoLiSTS is organized in a table format and is equipped with a search bar, allowing quick identification of targets by name, coordinates or program identifier e.g., GO, DD; PI name. TrExoLiSTS can be accessed at `https://www.stsci.edu/~WFC3/trexolists/trexolists.html`. With the launch of the *James Webb Space Telescope* (*JWST*) and first observations of transiting exoplanets, TrExoLiSTS includes archived observations made using the Time-Series Observing (TSO) mode with each instrument of the *JWST* and is available at a separate webpage at `https://www.stsci.edu/~nnikolov/TrExoLiSTS/JWST/trexolists.html`.

Methods

The contents of TrExoLiSTS is produced using public *HST* and *JWST* program information provided by the Space Telescope Science Institute (STScI). Lists of programs are obtained from the following sources:

- *HST* TAC Programs: `https://www.stsci.edu/ftp/presto/ops/program-lists/HST-TAC.html`

- *HST* Mid-Cycle Approved Programs: `https://hst-docs.stsci.edu/hsp/hst-mid-cycle-approved-programs`

- *HST* Director's Discretionary Programs: `https://www.stsci.edu/ftp/presto/ops/program-lists/HST-DD.html`

- *JWST* First Image Observations: `https://www.stsci.edu/jwst/science-execution/approved-programs/webb-first-image-observations`

- *JWST* Guaranteed Time Observation Programs: `https://www.stsci.edu/jwst/science-execution/approved-programs/guaranteed-time-observations`

- *JWST* Director's Discretionary Early Release Science Programs: `https://www.stsci.edu/jwst/science-execution/approved-ers-programs`

- *JWST* General Observer Programs in Cycle 1: `https://www.stsci.edu/jwst/science-execution/approved-programs/cycle-1-go`[2]

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[1] `https://archive.stsci.edu/`

[2] Future cycles will be included using a modification of this link accordingly.

In addition to the listed sources, we also included *JWST* commissioning programs 1541 (NIRISS, PI: Espinoza), 1118 (NIRSpec, PI: Proffitt), 1442 (NIRCam, PI: Schlawin), and 1033 (MIRI, PI: Kendrew).

A custom algorithm has been developed to identify programs that include time-series observations of transiting exoplanets to parse target and observing parameters. To achieve these goals, the algorithm first downloads the public submissions made via the Astronomers Proposal Tool (APT, Roman et al. 2004) along with the visit files that describe the status of the observations. Identification of appropriate programs has been performed by a search for key words in their APT submission. A future improvement of this step is envisioned to include a Machine Learning algorithm that identifies programs that focus on time-series spectroscopy of transiting exoplanets. All selected programs are then parsed following the characteristics in the structure of the APT files for each observatory. Information regarding target coordinates, instrument settings, and observing details are obtained and saved in a table, which is provided on the TrExoLiSTS webpage in machine readable format.

TrExoLiSTS content is structured as follows:

- Program identifier hyperlinked with the relevant public information for the observing program, provided by STScI

- Target name, including alternative names[3] hyperlinked to exo.MAST, (Mullally et al. 2019)

- Right Ascension and Declination

- Instrument: UVIS or IR for *HST* WFC3 and NIRCam, NIRISS, NIRSpec and MIRI for *JWST*, respectively

- Dispersive Element for *HST* WFC3: G280, G102 or G141; or Mode for *JWST*: SOSS, BOTS+PRISM, GRISMR+F322W2, GRISMR+F444W, LRS, MRS, etc.

- Phase Start/End, planet orbital phase between which observation has started

- Observing mode: stare or scan

- Scan rate in arcsec per second

- Visit identifier

- Date/Time Start/End: date and time of the observation start/end

- Orbits for *HST* and Duration in hours for *JWST*, obtained from the APT and visit files, respectively

- Status, Archived or Failed; scheduling window for upcoming observations is envisioned to be included in a future version of the list

- Name of the PI

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[3]When available in the APT submission

A: *HST* WFC3

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Welcome to the WFC3 team's Trexolists! This table contains observations of transiting exoplanets made with HST/WFC3 in the ultraviolet and infrared channel using the stare or spatial scan mode. Please use the search bar below to look for targets that may have already been observed by a previous program.

Link to download table: Trexolists.txt
Last update: 2021-12-23

Program identifier	Target name	Right Ascension	Declination	Instrument	Dispersive Element	Phase Start	Phase End	Observing Mode	Scan Rate	Visit identifier	Date/Time Start	Date/Time End	Orbits	Status	PI name	Proprietary Period (Months)	Direct image	White light curve	XY drift map
11495	WASP-3/USNO-B1.01256-0285133	18:34:31.6300	+35:39:41.52	WFC3/IR	G102	0.94459	0.94831	Stare	0.000	04	Jun 13 2010 05:48:53	Jun 13 2010 13:09:04	5	Archived	Haswell	0	N/A	N/A	N/A
11622	GJ-436	11:42:11.0941	+26:42:23.65	WFC3/IR	G141	0.94180	0.94380	Forward	0.990	01	May 01 2012 21:21:25	May 02 2012 02:45:15	4	Failed	Knutson	12	Yes	Yes	Yes

B: *JWST*

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Welcome to TrExoLiSTS! This table contains time series observations of transiting exoplanets made with all instruments on the JWST. Please use the search bar below to look for targets that may have already been observed by a previous program.

Link to download table: Trexolists.txt
Last update: 2022-12-09

Program identifier	Target name	Right Ascension	Declination	Instrument	Mode	Phase Start	Phase End	Observing Mode	Scan Rate	Visit identifier	Date/Time Start	Date/Time End	Duration, hr	Status	PI name	Proprietary Period (Months)	Target Acquisition	White light curve	XY drift map
1033	L168-9	23:20:06.8620	-60:03:56.63	MIRI	LRS	0.91616	0.94589	Stare	0	5	May 29 2022 08:22:33	May 29 2022 12:50:19	4.97	Archived	Kendrew	0	N/A	N/A	N/A
1177	WASP-80	20:12:40.0319	-02:08:39.97	MIRI	LRS	0.95093	0.96454	Stare	0	1	Sep 24 2022 01:32:48	Sep 24 2022 07:51:31	7.90	Archived	Greene	12	N/A	N/A	N/A

Figure 1: Example of the current version of the catalogue for A: *HST* WFC3 and B: *JWST*.

- Proprietary Period in Months

In addition to the listed parameters, three additional columns provide hyperlinks to WFC3 Direct Image or *JWST* Target Acquisition, White Light Curve, and XY drift map of the spectra on the detector. These products are currently available only for *HST* WFC3 IR observations via products from the WFC3's Quicklook project (Bourque et al. 2017, Stevenson et al. 2019). Placeholders have been included for *JWST*, envisioning a future inclusion of equivalent products for *JWST* observations. TrExoLiSTS includes a user-friendly interface for easier navigation through the content and a search bar allowing quick identification of program details.

TrExoLiSTS is currently available at two separate addresses for each observatory:

- *HST* WFC3: `https://www.stsci.edu/~WFC3/trexolists/trexolists.html`

- *JWST*: `https://www.stsci.edu/~nnikolov/TrExoLiSTS/JWST/trexolists.html`

Figure 1 visualizes the look of the top portions of the *HST* WFC3 and *JWST* webpages.

Future improvements of TrExoLiSTS are envisioned with the goal to increase the contents of the catalog and improve the functionality of the webpage. Multiple transits and eclipses of exoplanets have been observed at ultraviolet and optical wavelengths using the Space Telescope Imaging Spectrograph (STIS). These observations are highly complementary to existing and planned *JWST* observations, covering longer wavelengths, and would make TrExoLiSTS a comprehensive catalog. Ideally, the *HST* and *JWST* TrExoLiSTS webpages should be merged in a joint webpage with improved functionality, including sorting and filtering. With the development of a Quicklook tool for *JWST* time-series observations,

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Quicklook products that include white light curves, maps of the time-series, and figures detailing the locations of the time series of spectra on the detector should be included as references for the data quality.

Summary

TrExoLiSTS has been designed with the goal to support users during proposal preparation of programs focused on atmospheric characterization of transiting exoplanets that use *HST*, *JWST*, and other missions. The catalog can be employed to identify target lists, which can help enable observers to craft proposals to include complementary targets and wavelength coverage for comprehensive atmospheric characterization of transiting exoplanets.

References

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