Time Series Observations of WASP-43b

1. Introduction

WASP-43b is a well-studied hot Jupiter transiting its K-type host star. We will use it in these hands-on exercises to:

1) assess observability with JWST
2) determine a good set of readout / exposure parameters to observe a transit
3) have a look at an example APT program that observes transits of WASP-43b with three of the four science instruments on JWST

For the exercises in this hands-on we will assume that WASP-43b has a period of p ~ 0.81347437 days, a transit duration of T_{14} ~ 1.1592 hours, and a transit mid-point of T_c ~ 2455934.792239 HJD [see e.g. https://exoplanetarchive.ipac.caltech.edu].

The transit properties of exoplanet systems can be found in the literature, or from databases such as the NASA Exoplanet Archive or the Exoplanets Data Explorer.

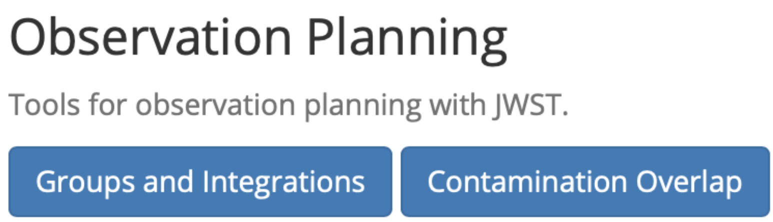
Tip: Exo.MAST (https://exo.mast.stsci.edu/) provides an easy interface to exoplanet information and existing observations in the MAST archive.

2. Target Observability and Spectral Contamination – ExoCTK (5 min)

Use the Exoplanet Characterization Tool Kit (ExoCTK; https://exoctk.stsci.edu) to get the visibilities and spectral contamination plots for WASP-43 for NIRISS SOSS observations.

You can access this calculator under “Observation Planning” > “Contamination Overlap”. This calculator computes the visibility of the target for all available spectroscopic TSO modes on JWST; the contamination calculator is currently only available for NIRISS SOSS. The visibility calculator in ExoCTK uses the JWST General Target Visibility Tool, so these tools should return the same results.

Can WASP-43 be observed with NIRISS SOSS without significant spectral contamination by nearby sources?



3. Get Exposure Parameters – PandExo (5 min)

The JWST Exposure Time Calculator (ETC) can be used to calculate signal to noise ratio and exposure times for TSOs. However, it is not optimized for such observations, in which each integration is a separate exposure. Multiple integrations aren't aimed at increasing the SNR in TSOs, instead they provide the time cadence over the transit or eclipse observation. PandExo (Pandeia + Exoplanets = PandExo; https://exoctk.stsci.edu/pandexo/) was developed on top of the ETC engine code to provide optimised calculations for TSOs.

Use PandExo to estimate good exposure parameters for transit observations of WASP-43b using the NIRSpec Bright Object Time Series (BOTS) template, complementing the wavelength range covered by NIRISS SOSS. Use the default properties and models for WASP-43b (constant value for $(R_p/R_*)^2$), as well as the following instrument settings:

Instrument: NIRSpec
Filter/Disperser: F290LP/G395H
Subarray: SUB2048
Saturation limit: 80% full well
Noise floor: constant 20 ppm

Remember to use the recommended duration for transit/eclipse:
$T_{total} = 0.75\text{ h} + \max(1\text{ h}, T_{14}/2) + T_{14} + \max(1\text{ h}, T_{14}/2) + 1\text{ h}$

What is the recommended number of groups per integration? How many integrations for the full observation (out of and in transit)? What is the predicted precision of the transit measurements?

4. APT Review (5 min)

Examine the provided APT example file (TSO_Example.aptx). Exposures parameters for time series observations were estimated using ExoCTK, target acquisition parameters using the JWST ETC (workbook 31454).

There are example transit observations with NIRISS SOSS, NIRSpec BOTS (F290LP/395H) and MIRI LRS (slitless), covering (with some wavelength gaps) the spectral range from ~ 0.6 to ~ 12 micron.