Rocky Worlds DDT: HST Data Analysis Report for TOI-198, Visits 5-10

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HST observed Visits 5-10 of the program for TOI-198 (PID 18235) between July 30, 2026 and August 17, 2026. Visits 1 and 2 were designed to measure the NUV-Optical spectral energy distribution of TOI-198. Visits 5 and 6 were designed to provide spectral coverage for TOI-198 in the NUV and optical. Visits 7-10 were designed to measure the Lyman-α emission of TOI-198. These observations are fundamental to constraining the high-energy output of this host M dwarf in the UV, which can be applied to planetary models of atmospheric escape, as well as photochemistry if a planetary atmosphere is present. Along with this data analysis report, we also produce high-level science products (HLSPs) that are hosted on MAST.

More details about the observing modes, technical justifications and decisions are available in the RWDDT Scheduling Report for TOI-198 (J. Debes et al., 2026)[1]. The observing log of the visits discussed in this report is shown in Table 1.

Table 1: Observations log of this data analysis report.

Visit	Dataset	Mode	Start Date & Time	Exposure time (s)	Status
5	OFTA05010	STIS/G230L	2026-08-17 11:09:26	1987.197	Pass
6	OFTA06010	STIS/G430L	2026-07-30 12:26:24	800.0	Pass
	OFTA06020	STIS/G750L	2026-07-30 12:51:31	210.0	Pass
	OFTA06030	STIS/G750L Flat	2026-07-30 13:18:51	50.0	Pass
7	OFTA07010	STIS/G140M	2026-08-01 02:09:06	1962.195	Pass
8	OFTA08010	STIS/G140M	2026-08-05 23:35:22	1962.199	Pass
9	OFTA09010	STIS/G140M	2026-08-12 18:26:05	1962.174	Pass
10	OFTA10010	STIS/G140M	2026-08-12 20:00:01	1962.180	Pass

1 Data quality

We did not receive any AlertObs notifications for the visits reported here. We do not observe any significant effects of jitter pointing trends in these visits. We present the time series of jitter vectors in Figures 9 to 14. Despite these AlertObs notifications, we deemed Visits 3 and 4 successful, since the amount of data lost was not significant enough to impact the scientific objectives of the program. We did not request a repeat for the orbit lost in Visit 3.

[1] Available on the Rocky Worlds DDT website.

2 Data Reduction

2.1 Spectral analysis

The STIS/CCD data obtained with the G750L grating exhibit fringing patterns that require manual correction (Figure 1). We followed the de-fringing tutorial[2] of the `stistools` package to perform this correction.

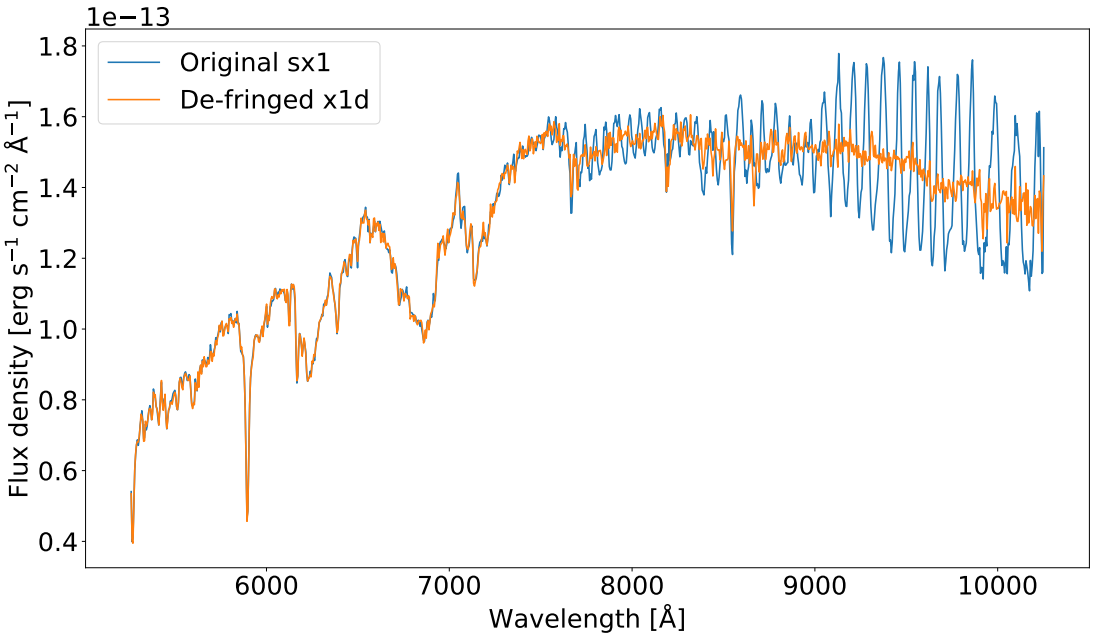

Figure 1: STIS/G750L spectrum of TOI-198, before and after de-fringing.

2.2 Time-series analysis

All UV observations of TOI-198 in the RWDDT program were executed in photon-counting mode, or `TIME-TAG`. The Rocky Worlds Utils codebase possesses a dedicated time-series analysis tool that enables the user to create flux-calibrated light curves integrated over user-defined wavelength ranges at any temporal resolution within the precision of the STIS and COS instruments. For the RWDDT program, we produced light curves with a temporal resolution of 5 s for all `TIME-TAG` observations. For every non-Lyα observation, we integrate fluxes in the entire wavelength available and mask out ranges with geocoronal contamination. We do not perform corrections for telescope breathing or other systematic effects.

3 Lyman-α reconstruction

We measure the Lyman-α blue wing integrated flux with an SNR of $\sim$6.4 per successful exposure, and $\sim$12.6 in the red wing. Since the intrinsic Lyman-α stellar emission is partially absorbed by the ISM, we need to reconstruct it in order to accurately

[2]Available in `https://stistools.readthedocs.io/en/latest/defringe_guide.html`.

estimate the stellar UV output. We refer the reader to the Lyman-α reconstruction section in the GJ 3929 Data Analysis Report (L. Dos Santos et al., 2025)[3] for a description of the methodology.

We present the results of the reconstruction in Figure 2 and Table 2. While we were able to constrain the stellar emission parameters, our fit could not constrain the temperature of the ISM.

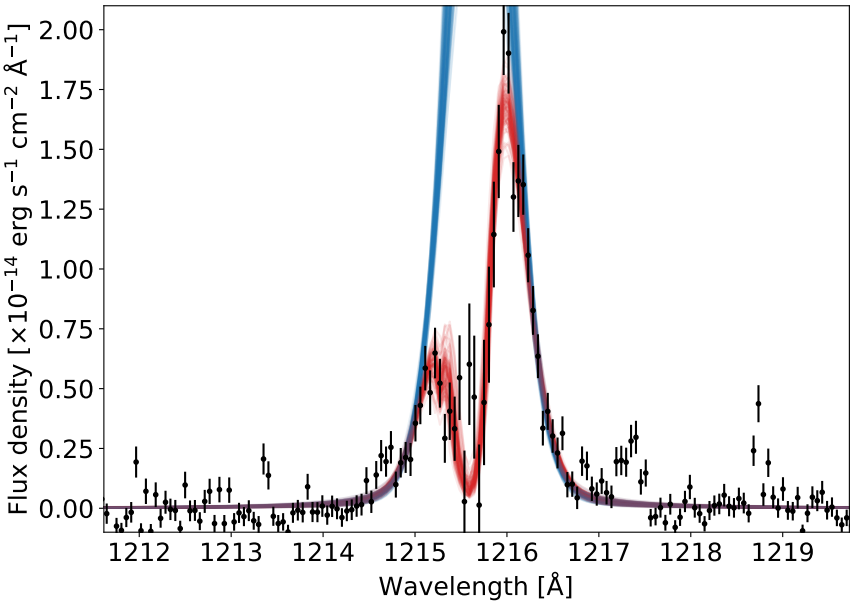

Figure 2: Co-added Lyman-α spectrum of TOI-198. The blue curves represent a family of models of the intrinsic stellar emission randomly drawn from the posterior sample distribution fit to the data. The red curves represent the same models, but with ISM absorption included.

Table 2: Stellar Lyman-α emission and ISM fit parameters and their uncertainties.

	Parameter	Unit	Prior	Posterior confidence interval
Host star	log amplitude	$\mathrm{erg\,s^{-1}\,cm^{-2}\,\AA^{-1}}$	U(-15, -9)	$-14.36^{+0.18}_{-0.30}$
	Lorentzian FWHM	$\mathrm{km\,s^{-1}}$	U(5, 100)	$21.4^{+9.6}_{-9.7}$
	Gaussian FWHM	$\mathrm{km\,s^{-1}}$	U(10, 250)	178^{+20}_{-19}
ISM	log H I column density	$\mathrm{cm^{-2}}$	U(15, 20)	$-18.01^{+0.19}_{-0.20}$
	Temperature	K	U(1000, 15000)	Unconstrained
	Radial velocity	$\mathrm{km\,s^{-1}}$	U(-30, 0)	$-17.2^{+6.1}_{-7.4}$

4 Combined science products

4.1 Spectrum of TOI-198

We utilized the HSLA codebase (R. Sankrit et al., 2025) to co-add and abut all the final-stage HST observations obtained in this program to produce a high-fidelity spectral energy distribution (SED) of TOI-198, which we present in Figure 3.

[3] Available on the Rocky Worlds DDT website.

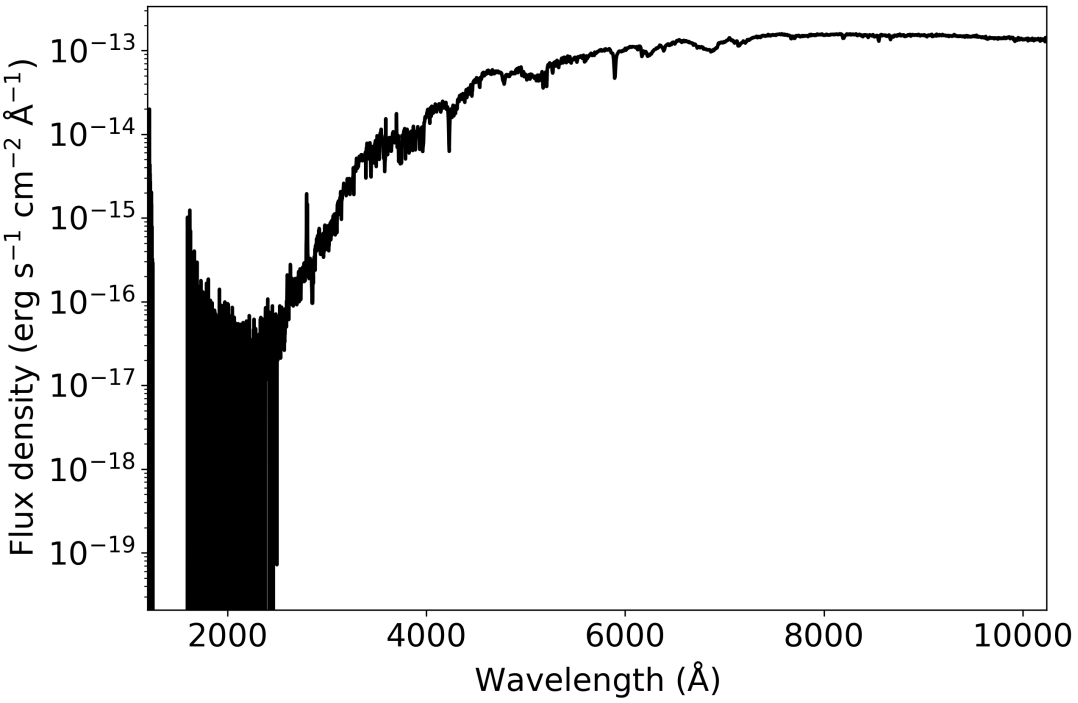

Figure 3: Full spectral energy distribution of TOI-198 in quiescent state as observed in the program thus far.

4.2 Light curves

We present the resulting light curves of the HST observations of TOI-198 in Figures 4 to 8.

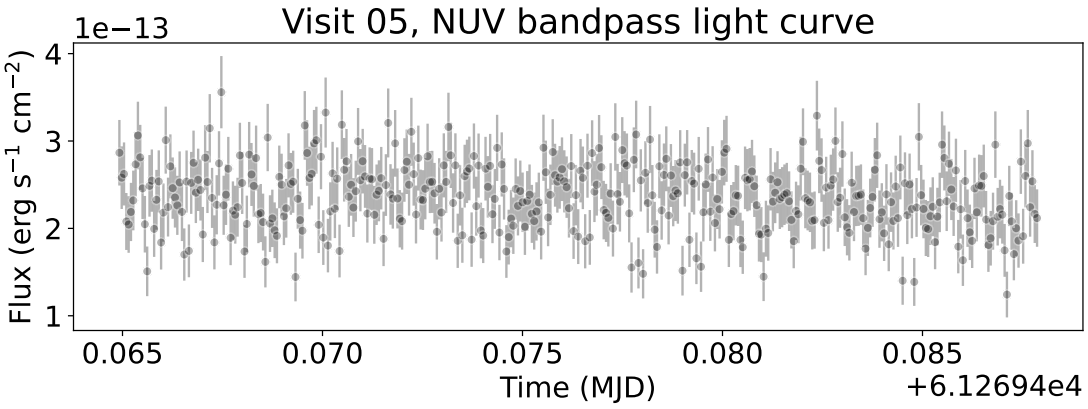

Figure 4: Light curves of Visit 5. NUV continuum corresponds to wavelengths [1700, 3150] Å.

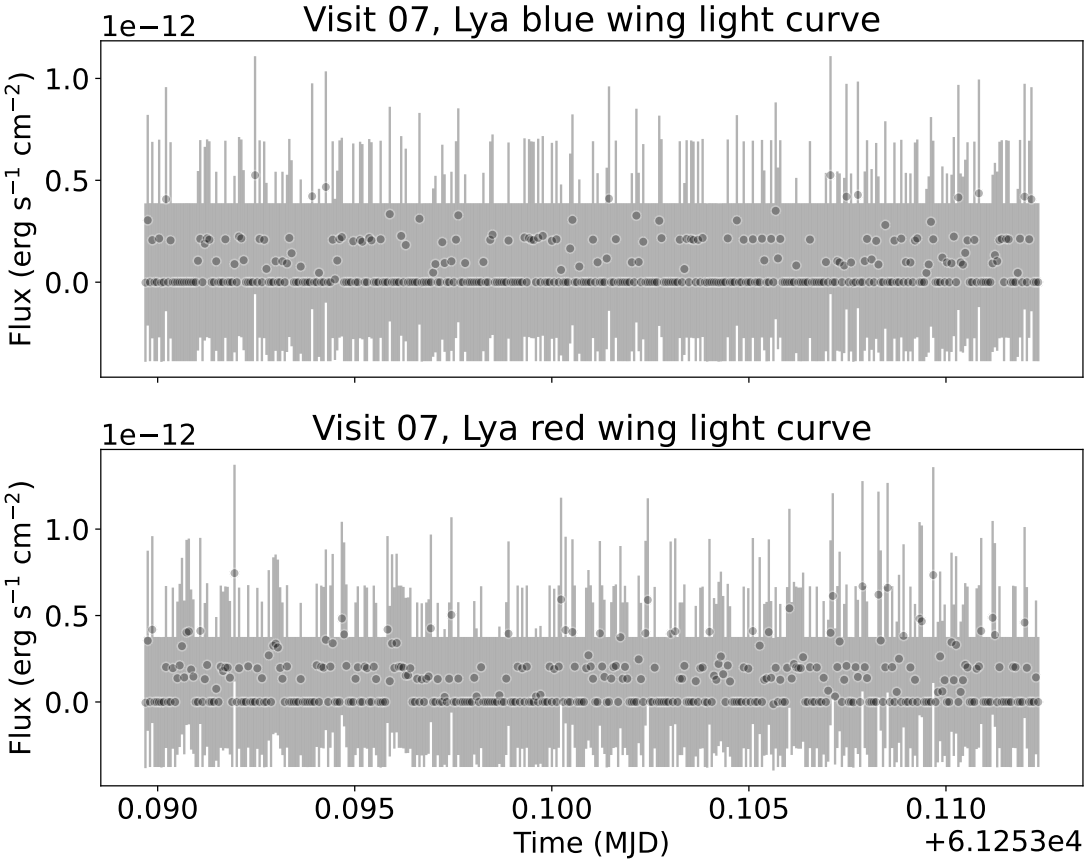

Figure 5: Light curves of Visit 7. The Lyman-α blue and red wings are defined as the wavelength ranges [1214.4, 1215.4] Å and [1216.0, 1217.0] Å, respectively.

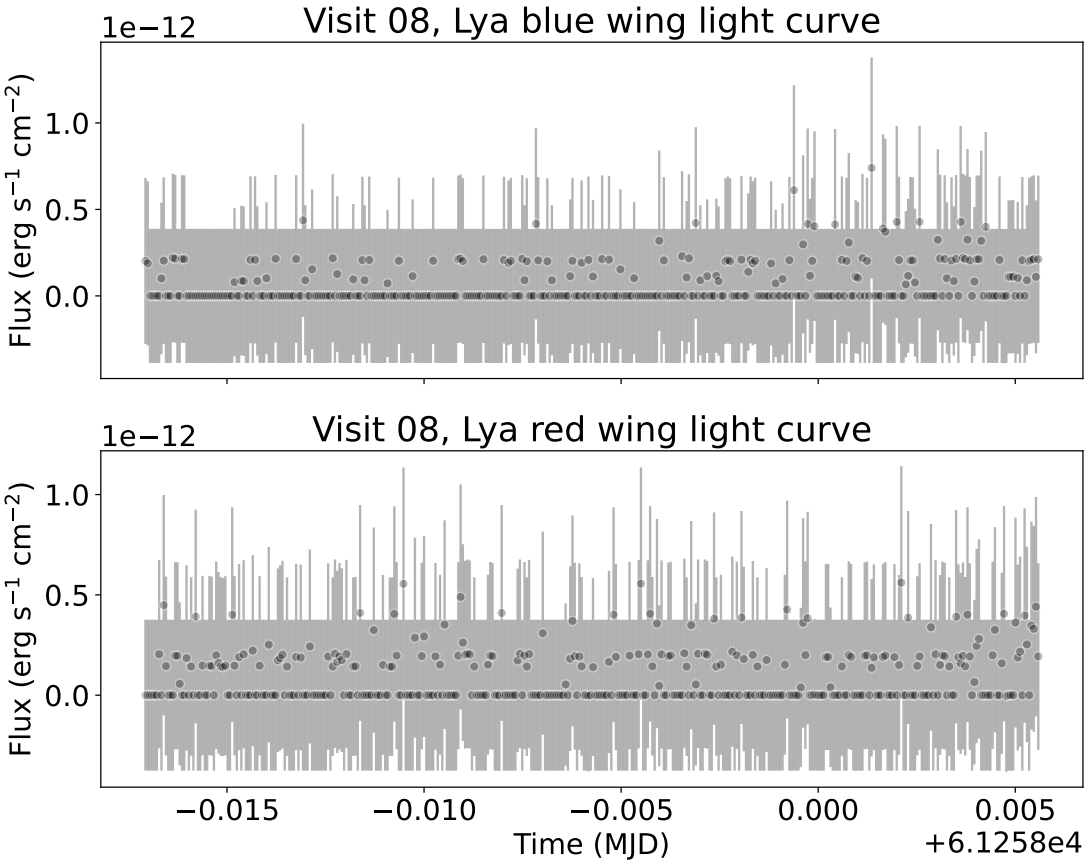

Figure 6: Same as Figure 5, but for Visit 8.

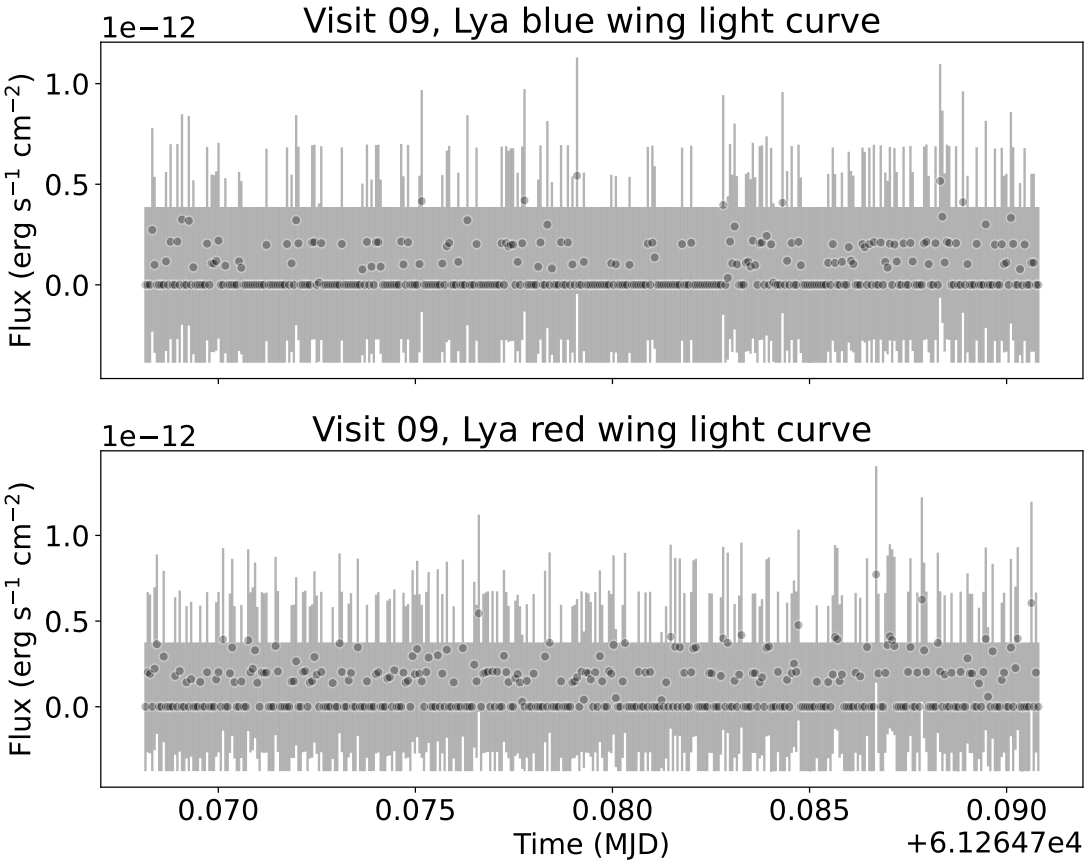

Figure 7: Same as Figure 5, but for Visit 9.

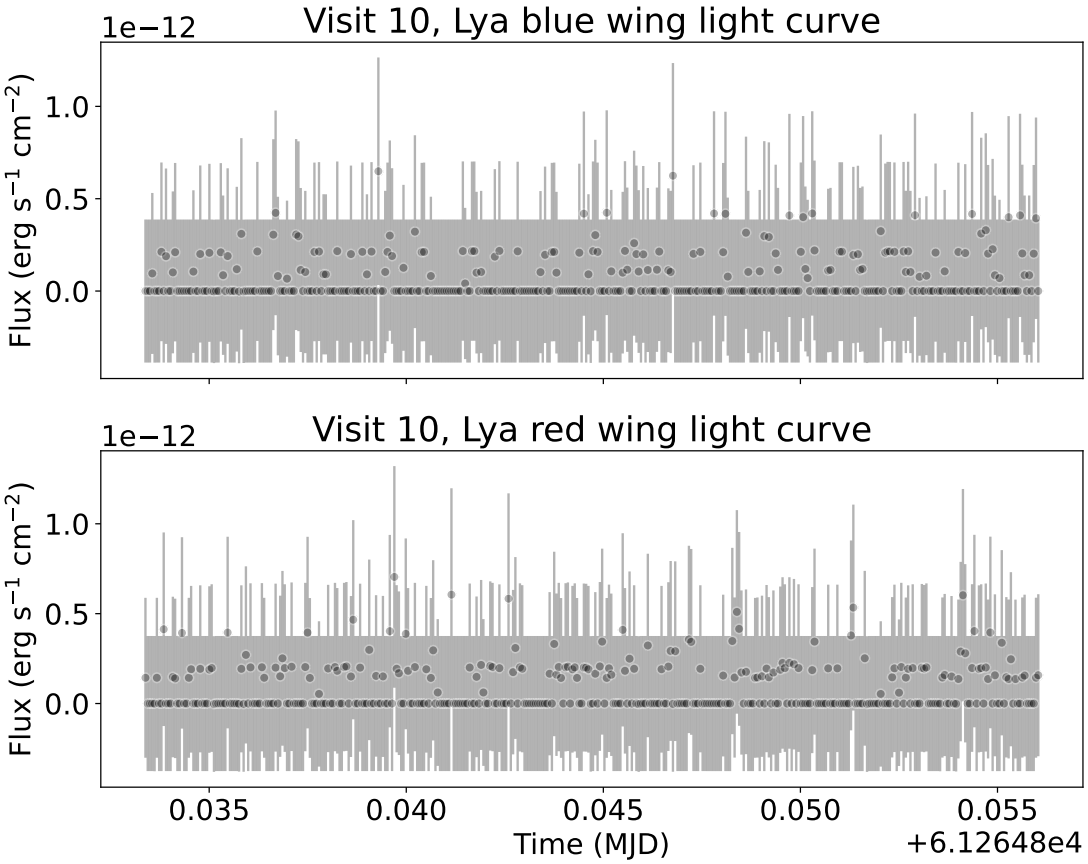

Figure 8: Same as Figure 5, but for Visit 10.

Appendix

We present below the HST pointing jitter vectors of the visit in this report. We do not observe any significant trends that could potentially affect the quality of the observations.

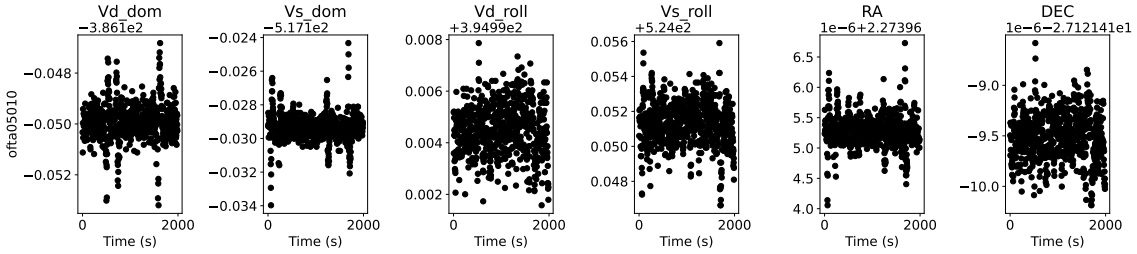

Figure 9: Jitter vectors for exposures in Visit 5.

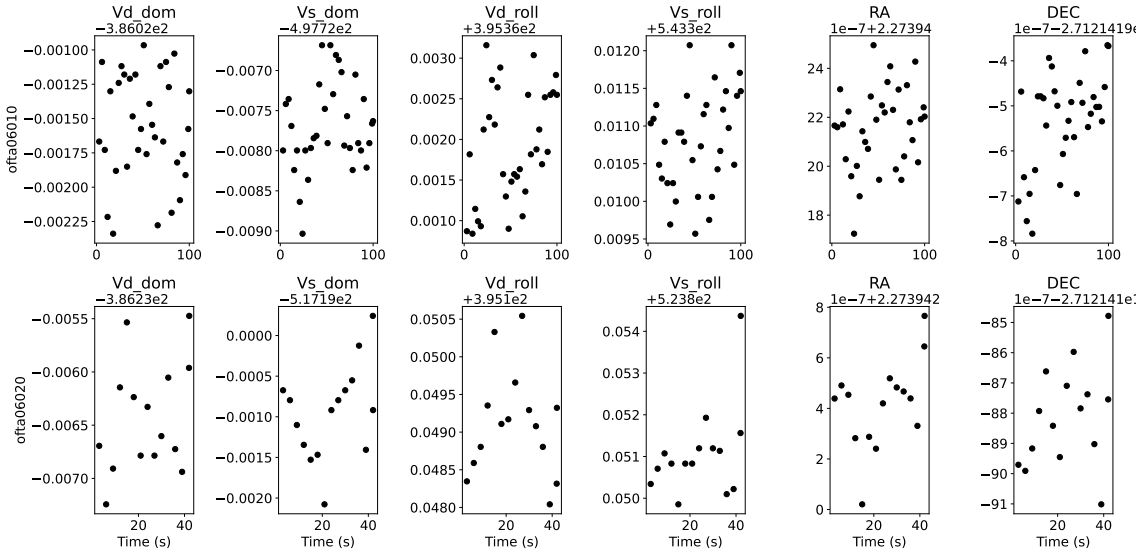

Figure 10: Jitter vectors for exposures in Visit 6.

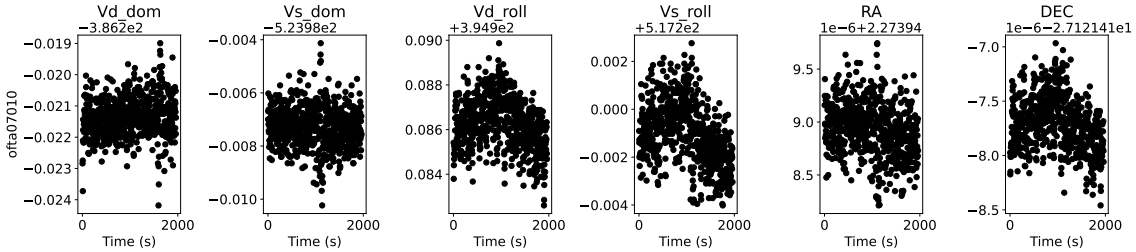

Figure 11: Jitter vectors for exposures in Visit 7.

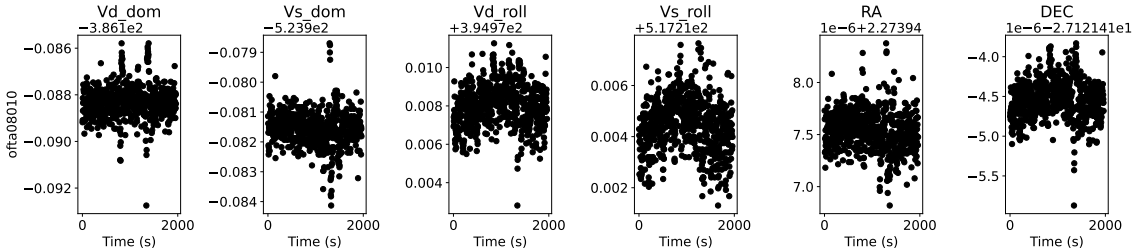

Figure 12: Jitter vectors for exposures in Visit 8.

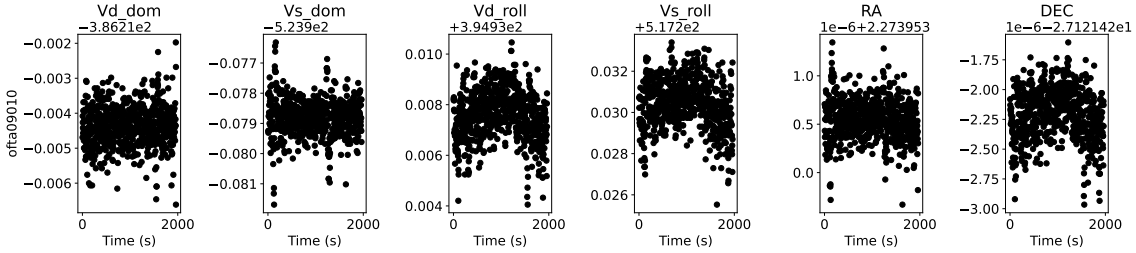

Figure 13: Jitter vectors for exposures in Visit 9.

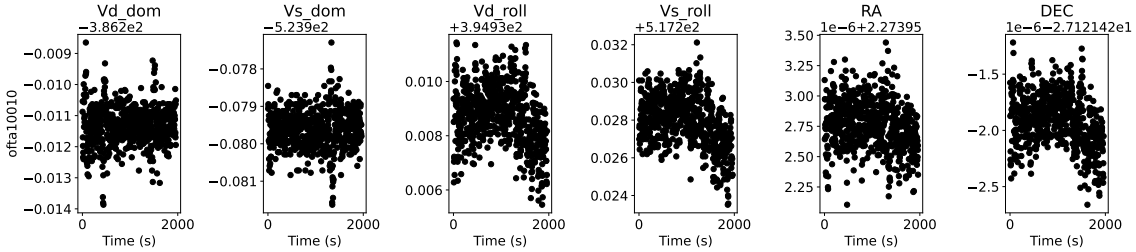

Figure 14: Jitter vectors for exposures in Visit 10.

References

Debes, J., Dos Santos, L., Espinoza, N., & Diamond-Lowe, H. 2026, Rocky Worlds DDT: HST Scheduling Report for TOI-198,, RWDDT Scheduling Reports

Dos Santos, L., Debes, J., Espinoza, N., & Diamond-Lowe, H. 2025, Rocky Worlds DDT: HST Data Analysis Report for GJ 3929,, RWDDT Data Analysis Reports

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