Money, Money, Money

Thematic Areas (Check all that apply):

☐ (Theme A) Key science themes that should be prioritized for future JWST and HST observations
☐ (Theme B) Advice on optimal timing for substantive follow-up observations and mechanisms for enabling exoplanet science with HST and/or JWST
☒ (Theme C) The appropriate scale of resources likely required to support exoplanet science with HST and/or JWST
☐ (Theme D) A specific concept for a large-scale (∼500 hours) Director's Discretionary exoplanet program to start implementation by JWST Cycle 3.

Summary: Human society has yet to achieve the post-scarcity phase where all of our survival needs are met and we can freely pursue our passions and curiosity in life. Confounding factors such as offsets between data sets require careful handling to reveal the true properties of the planets being studied, and we are still at a point in developing data reduction methods where multiple reductions are commonly used to verify results. Additionally, the modeling needed to interpret exoplanet spectra often requires as much work, if not more, than obtaining an initial reduced spectrum. Therefore an appropriate level of funding is key to ensure the success of this large-scale DDT exoplanet program. Based on the median JWST cycle 1 funding level of ∼$10k/hr, a large-scale (∼500 hours) DDT program would require ∼$5M in funding support for the exoplanet community. This funding should be available through archival proposals.

Why is funding needed?

The funding is needed for both data reduction and model interpretation. The current default JWST pipeline is inadequate for transiting exoplanet TSO observation. All published JWST exoplanet papers to date used custom-made data reduction pipelines. There has not yet been a standard "plug-and-play" reduction pipeline that takes in raw JWST exoplanet TSO data and outputs a planetary spectrum free of systematics and with well-understood noise properties. Including multiple data reductions is currently the most commonly used practice to verify results from JWST as the community actively continues to develop best practices to address systematics. In addition, correcting for offsets between different datasets has been a significant obstacle in synthesizing the final planet spectrum as shown in the ERS and various GO programs (Moran et al. 2023).

The work does not stop at the reduced planetary spectra. Interpretation of the spectra with models will be what actually determines the scientific gain we will obtain from this DDT program. Our current exoplanet atmospheric models are still in their infancy, having never been stress-tested against high-quality spectra for irradiated planets. An intense era of model development is now needed.

The data analysis and model interpretation also can not be decoupled from each other. All of the ERS and cycle 1 results so far require back-and-forth between the two. Having one group reducing the data and another separate group performing the modeling is not ideal for producing robust scientific results. The ERO observation of WASP-96b is an example where the original press release spectrum was produced back in July 2022, but it took 10 months (until May 2023) for two papers over the result to be published. These efforts were led by two non-US-based investigators (Radica et al. 2023; Taylor et al. 2023) who received no JWST funding. During this 10-month period, the spectrum changed compared to the press release version, and significant modeling effort was required. This 500-hr DDT program is at a much larger scale compared to the ERO program and insufficient funding support would significantly inhibit the involvement of US-based investigators.