

The TRAPPIST-1 JWST Community Initiative

1. Context

An ambitious JWST program targeting TRAPPIST-1 represents a unique opportunity to make the field of comparative exoplanetology enter the realm of temperate Earth-sized planets. Nevertheless, such a program will inevitably face numerous challenges both from an observational and a theoretical point of view. Considering these challenges, the limited lifetime of JWST combined to the unfavorable position of the star in the sky for the telescope, the probably large delay between the end of the JWST mission and the launch of another space-based facility of similar or superior instrumental potential, the division of this ambitious program in several sub-programs carried out by independent teams, without any global coordination, is certainly not optimal as it would inevitably result in useless competitive efforts, delays between the publications of the results of one team and the decision by another team to complement them with other observations, missed opportunities, and eventually a non-optimal scientific return. Such an ambitious study that could require up to 1000hr on the largest-ever space-based telescope that could be fully operational for less than 6 years, makes necessary to move from a 'competing small teams' approach to a community-driven one. It requires the support and contribution of a large interdisciplinary community gathering all the expertise and resources required to (1) constantly optimize a well-defined sequential structure for the study, and to ensure (2) a strong coordination between all the teams involved on every aspect of its preparation and implementation, both on the observational (e.g. study of the instrumental limitations, data analysis techniques, complementary space-based and ground-based observations) and theoretical levels (e.g. model developments and comparison, retrieval techniques, inferences).

2. Goals

The TRAPPIST-1 JWST Community Initiative aims to maximize the scientific return of the study of the TRAPPIST-1 system with JWST by:

- Gathering all interested scientists into a large multi-disciplinary community that will work together on a single large effort, while keeping their basic scientific freedom (to lead their own proposals, to publish their own independent papers, to collaborate with the colleagues of their choice, etc.);
- Setting-up and developing a website that will gather all relevant data and publications on the system (e.g. Spitzer photometry, high-res spectra, transit & occultation ephemerides);
- Defining and constantly optimizing a sequential structure for the study of the system with JWST, and coordinating on every aspect of its preparation and implementation, both on the observational and theoretical levels;
- Assessing the relevance and possibility of a major JWST Legacy program devoted to the study of TRAPPIST-1, and possibly implementing it.

3. Organizational structure

The Initiative is supervised by a Board composed of scientists of complementary expertise that aims (1) to develop and provide the Initiative members with the required coordination mechanisms/tool (See Sect. 4), (2) to constantly evaluate the complementarity of the different JWST proposals and their capacity to result into an optimal study of the system with JWST, (3) to review globally the progress of the Working Groups (see below), (4) to manage the

promotion of the Initiative, (5) to ensure that all members abide to the Initiative's code of conduct (see Section 5). The Board has thus mostly an advisory and moderator role, not a decisional one. Nevertheless, it could decide to reject from the Initiative a member whose behavior is obviously not in line with its code of conduct.

The scientific activities of the Initiative are currently structured in four separate Working Groups (WGs):

- *WG 1 – Assessing GTO observations* - The aim of this WG is to combine models from multiple groups to assess the possible scientific output of the GTO observations and the kind of complementary observations that could be proposed in Cycle 1 for planets b, d, e, f (the other planets are not part of GTOs). The science assessment will look at what models/environmental characteristics could be discriminated with the planned GTO observations and more extensive observations, including the significance of a null result.
- *WG2 - Complementary Observations* – This WG aims to organize the ground- and space-based observations that would complement and optimize the JWST ones: transit timing/TTVs, RVs, stellar variability (to help constraining the atmospheric evaporation + photospheric + chromospheric models but also the stellar contamination analyses including how active, how spotted, and periodicities). It also aims to develop an online tool providing the most up-to-date transit/occultation ephemerides for all planets based on TTV analysis, and an online database grouping all TRAPPIST-1 data & publications that could be useful to prepare and analyze JWST observations.
- *WG3 – Planetary Environments and Evolution* – This WG will work on anticipated/predicted system-wide trends in atmospheric characteristics to help justify observing the entire sequence of 7 planets, rather than just one or two. This is envisioned to be an interdisciplinary group focused on atmospheres, but taking into account the modification of atmospheres via atmospheric loss as well as replenishment by outgassing. Specific questions to be addressed include: What can geophysics tell us about the possible atmospheric compositions of the planets, considering different bulk compositions and outgassing scenarios? One of its output will be a table listing possible atmospheric scenarios for the planets and the observations required to falsify these hypotheses, eventually resulting into a global and sequential plan for the atmospheric characterization of the planets.
- *WG4 - JWST Synthetic Data Generation and Analysis* – This WG is interested in synthetic JWST data generation and analysis to support observation planning.

This structure is by essence flexible and evolutionary, and will adapt to the evolution of the global study of TRAPPIST-1. Each WG will work by teleconferences and internet exchanges (emails, Slack, etc). In the long term, some workshops could also be organised to optimize the efficiency of the WGs.

4. Tools

The main tools put at disposal of the Initiative members is a website <https://nexss.info/community/trappist-1> where interested scientists can sign up to join the Initiative and to choose the WG(s) to which they would like to contribute. This website will include:

- Contact information for all Initiative members, for the Board and for the WGs.
- An online transit/occultation ephemerids tool that will be regularly updated basing on the latest TTV results.
- Access to an online data and publication database relative to TRAPPIST-1.

In addition to the website, the Initiative will provide to its members private Slack channels where members will be able to post their proposals and publication intentions, their proposals, a draft of their publications, communicate within a WG, etc.

5. Code of Conduct

All Initiative members must:

- Agree that their PI will post all TRAPPIST-1 JWST observing proposals and JWST proposal intentions developed as part of this Initiative on the dedicated private Slack channel.
- Agree to consider the Board suggestions.
- Agree to consider collaboration with other Initiative members.
- Agree to share results that support planning and interpretation of JWST observations of TRAPPIST-1 - even if preliminary - within the Initiative.
- Agree to coordinate their JWST proposals and resulting publications with other Initiative members under basic rules of deontology, i.e. taking into account the original credit and scientific merit of the contributions.
- Agree to ask for a maximal proprietary period of 3 months for their TRAPPIST-1 JWST data, and to consider sharing their data with other Initiative members as soon as they are available to them.
- Agree to always act in a courteous and constructive manner.

NB: For proposals developed outside the Initiative but containing TRAPPIST-1 components, posting of information on the proposal is welcomed, although completely optional, and only with the outside PI's consent.

Here is an example of what abiding to this code of conduct could look like:

Dr. Yog-Sothoth has the idea to observe 4 transits of planet d with NIRISS to search for the molecular signature of CO. She mentions on the dedicated Slack channel her will to propose these observations and, later, posts there her proposal.

Helped by the contributions of the WGs, the Board finds that Dr. Yog-Sothoth's proposal will bring a valuable contribution to the study of the system, but suggests to propose the observation of 6 transits instead of 4 to optimize the level of possible scientific inference brought by the data. Dr. Yog-Sothoth considers the Board's recommendations, judges them valuable, and decides to follow them.

Dr. Chtulhu reads Dr. Yog-Sothoth's proposal and finds that the results of his own theoretical work on the effect of clouds on the transmission signature of CO would strengthen the proposal. He contacts Dr. Yog-Sothoth that agrees with Dr. Chtulhu's arguments and decides to collaborate with him and to include him in her proposal.

The requested JWST time is granted to Dr. Yog-Sothoth, and the observations are performed.

Dr. Nyarlathotep is interested in doing a global analysis of all transits of planet d observed by JWST so far to study the homogeneity of the stellar chord transited by the planet and the impact of stellar contamination, and asks Dr. Yog-Sothoth to have a direct access to her data.

Dr. Yog-Sothoth agrees and provides Dr. Nyarlathotep with the data. Both Dr. Yog-Sothoth's and Dr. Nyarlathotep's teams analyze the data on their sides, and describe their results in two

different papers. During her analysis, Dr. Yog-Sothoth notices that the signature of CO is firmly detected, and informs directly the Initiative of this result so to make possible taking it into account in the next round of JWST proposals.

Dr. Yog-Sothoth and Dr. Nyarlathotep discuss their results and agree to coordinate the dates of their publications, and that Dr. Yog-Sothoth's paper will go out first, to give her the credit of the idea of the observations.

And here is an example of what it SHOULDN'T look like:

Dr. Azathoth finds that Dr. Yog-Sothoth's observations could lead to a high-impact result that would be beneficial to his career. He waits for the data to be public, makes a quick analysis of them, and publishes his results without informing the Initiative, scooping Dr. Yog-Sothoth in the process.