# Thermal Emission from the Earth-sized Exoplanet TRAPPIST-1 b using the JWST

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Not even one year after its first data release, the James Webb Space Telescope (JWST) has already proven its exceptional performances for exoplanetary science (Ahrer et al. 2023, Bouwman et al. *submitted*, Feinstein et al. 2023). Among the 55 exoplanetary systems observed by the JWST as part of Guaranteed Time Observations (GTO) and Cycle 1 Guest Observer (GO) programs one system stands out, the TRAPPIST-1 system. With more than 200 hours of guaranteed time (including GTO and GO programs), the TRAPPIST-1 system is an exquisite target for the JWST. It is composed of a red dwarf star orbited by seven Earth-sized, temperate planets, three of them being in its habitable zone (Gillon et al. (2017)). Considering their transiting nature, the infrared brightness and the small size of their host star, these planets are extremely promising candidates for the first thorough atmospheric characterization of temperate terrestrial worlds with the JWST (Gillon et al. (2020)). Among the eight JWST programs focused on TRAPPIST-1, three are dedicated to the observations of the thermal emission of the two inner planets through their secondary eclipses -when the planet passes behind the star as seen from the observer. Indeed, the decrease in (thermal) flux that occurs during the secondary eclipse of the planet is a direct measurement of the planet's day- side brightness temperature.

Here we show the results from two of these three programs. The observations consist in five secondary eclipses of TRAPPIST-1 b observed with the Mid Infrared Instrument (MIRI) at 15 microns taken as part of GTO 1177 (PI: Green) and 1 secondary eclipse of TRAPPIST-1 b at 12.8 microns taken as part of GTO 1279 (PI: Lagage), 4 more to come in Nov 2023. Remarkably, at 15 microns, we detect the secondary eclipse in each of the five separate observations. **This is the first detection of thermal emission or any electromagnetic radiation from an exoplanet as small as Earth and as cool as some planets in our Solar System.** These measurements imply a blackbody brightness temperature consistent with re-radiation of the TRAPPIST-1 star's incident flux from only the dayside hemisphere of the planet. The most straightforward interpretation is that there is little to no planetary atmosphere redistributing radiation from the host star on TRAPPIST-1 b. However, the first measurement of the day side emission of the planet at 12.8 microns is in tension with this interpretation. In this talk, we present these results and discuss possible atmosphere and surface scenarios that could explain these measurements. Knowing if TRAPPIST-1 b, the innermost planet of the system, has an atmosphere will result in major implications for the system's outer and potentially habitable planets.

## References:

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