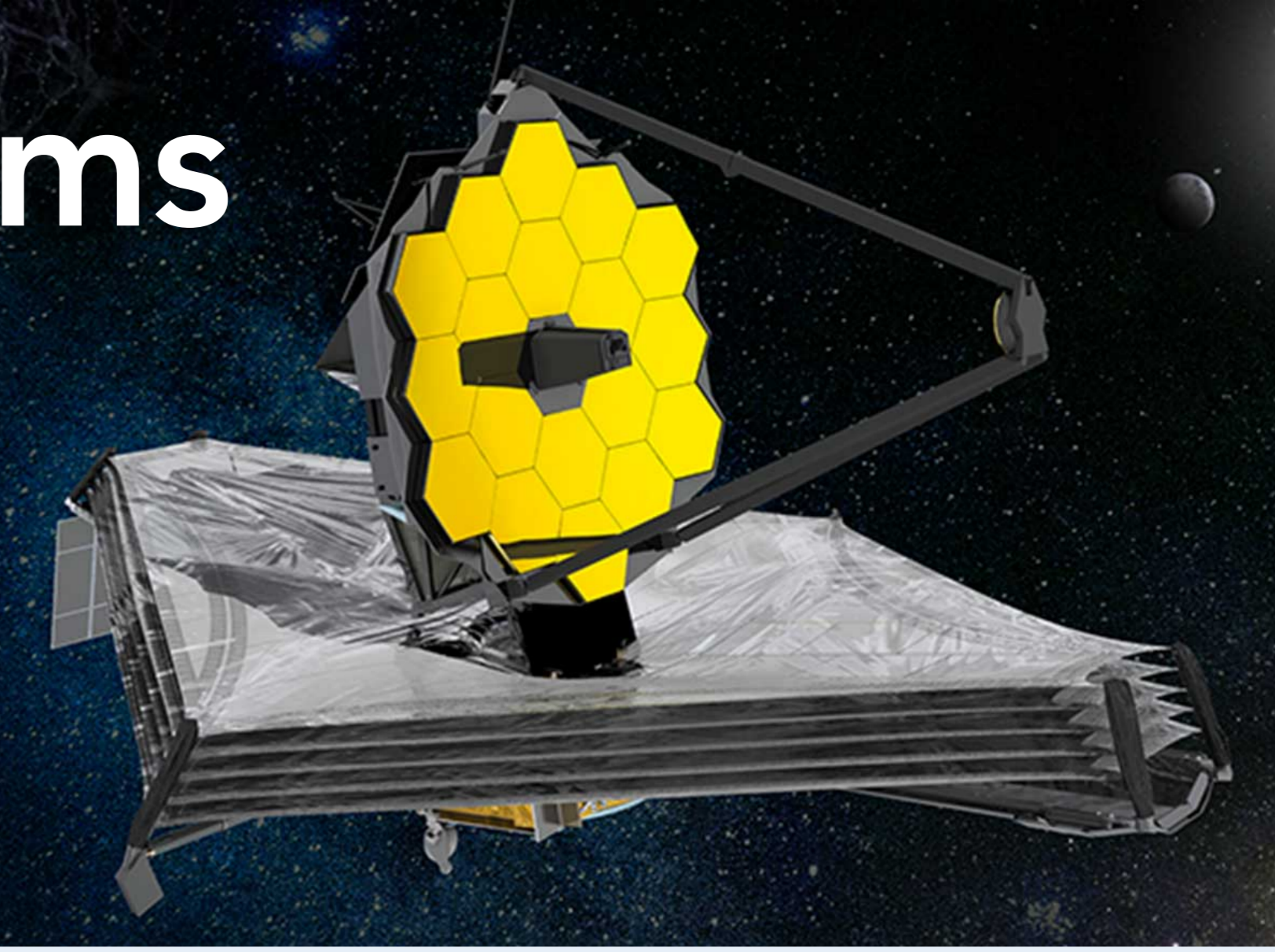


Observation of directly imaged systems with JWST/MIRI coronagraphs



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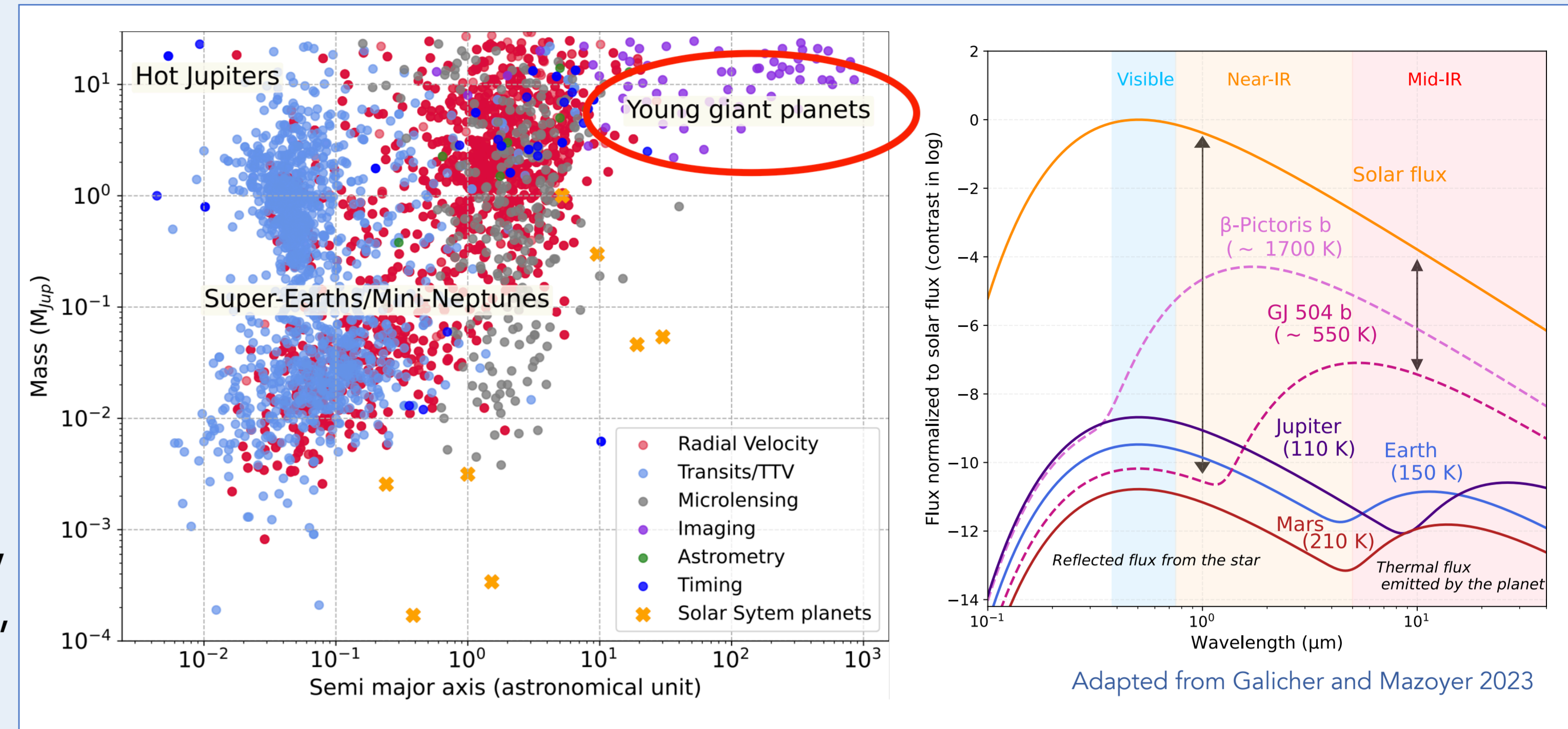
Direct imaging at mid-IR wavelengths

Long-period planets, massive and located in young systems
→ **Unique population**

Mid-IR wavelengths range :

- Favorable star/planet contrast, giving access to cooler, older planets.
- Relevant for the atmospheric characterization : evidence of clouds, disequilibrium chemistry, access to NH₃ and many others molecules,
- It enables more precise measurement of the planet's temperature and radius.

Before JWST, observations were limited to ground-based instruments at wavelengths shorter than 5 μm.

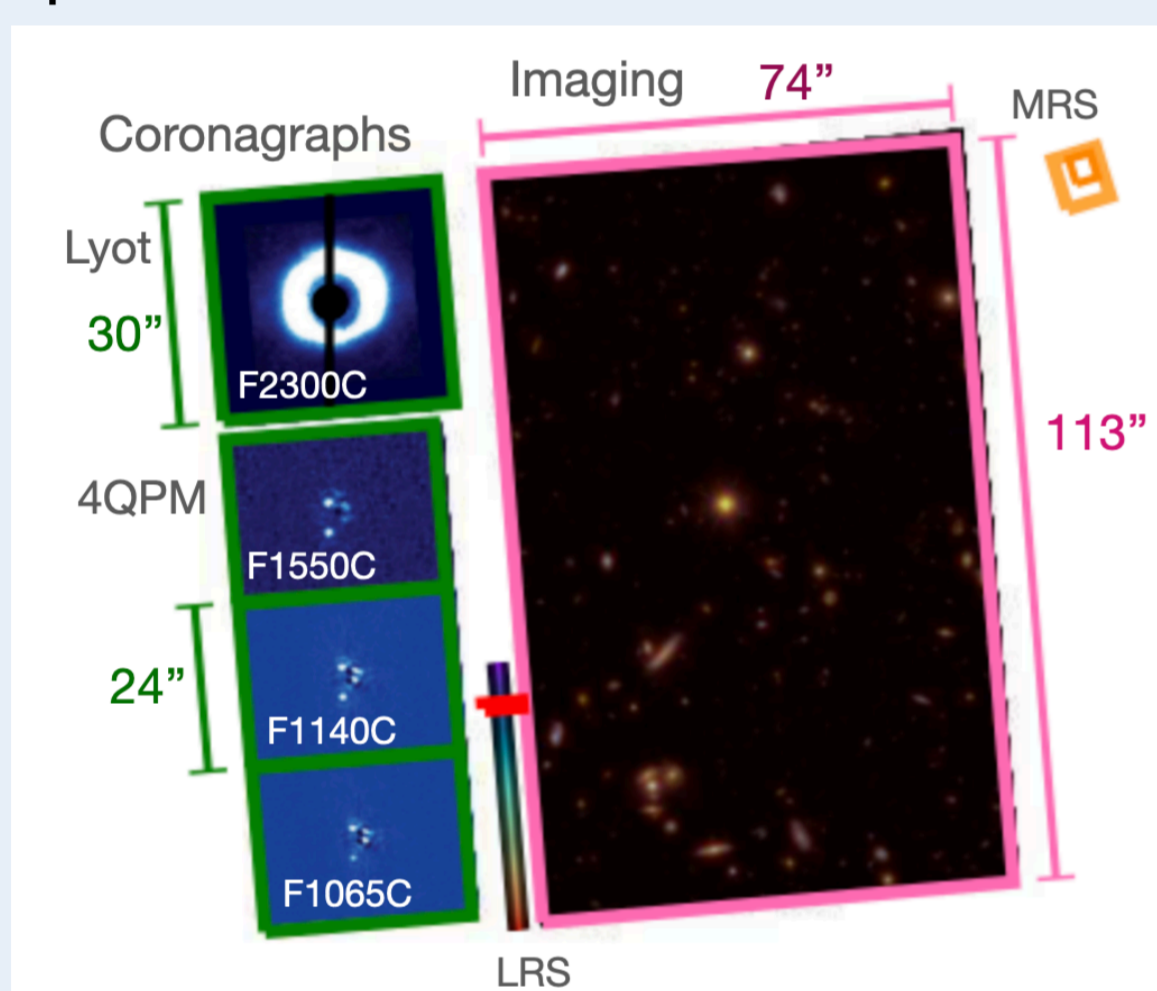


MIRI Coronagraphs

Three Four Quadrant Phase Mask (4QPM) and one Lyot Mask coronagraphs.

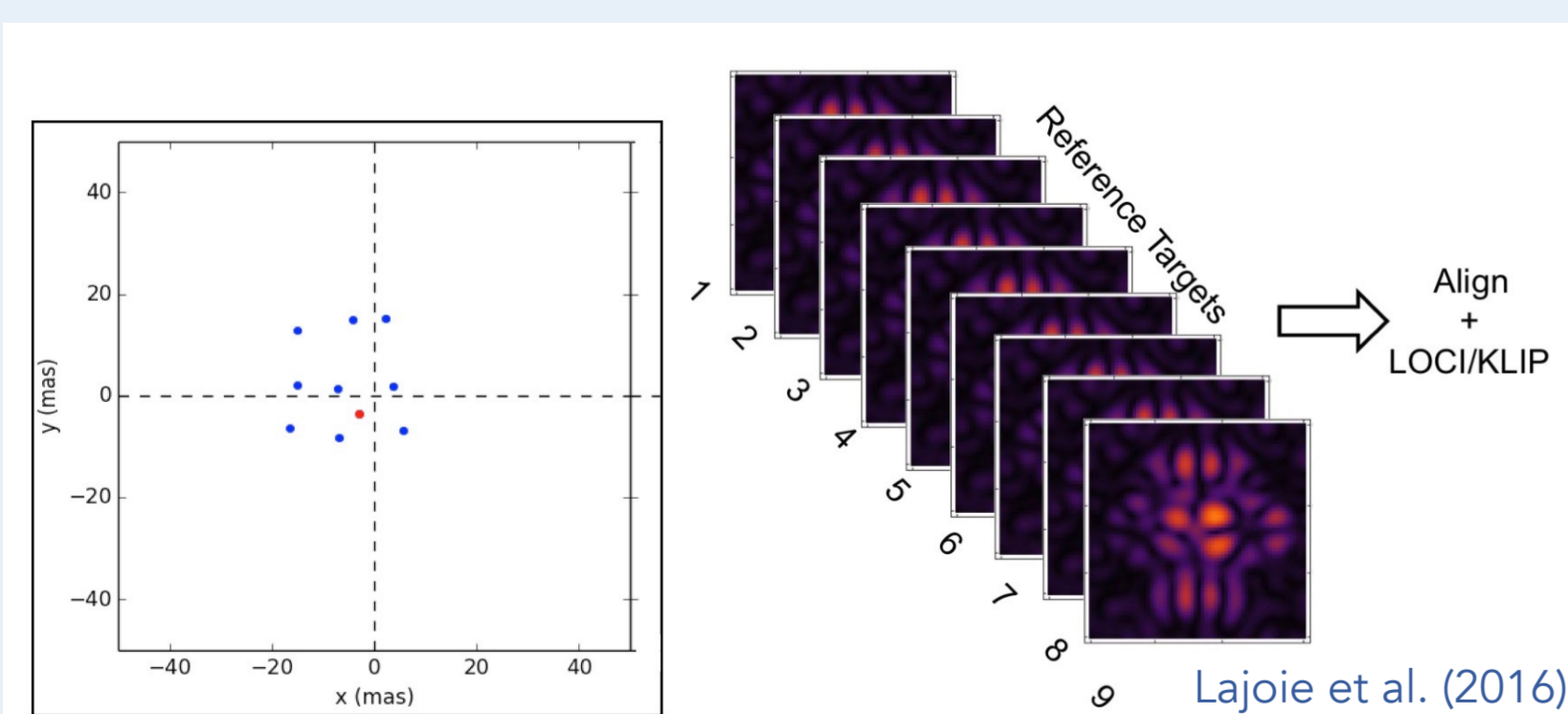
Performances : Boccaletti et al. 2022

- Contrast : 2×10^{-5} à 4×10^{-5}
- Background limited at almost all separations $> 1''$



Observing methods

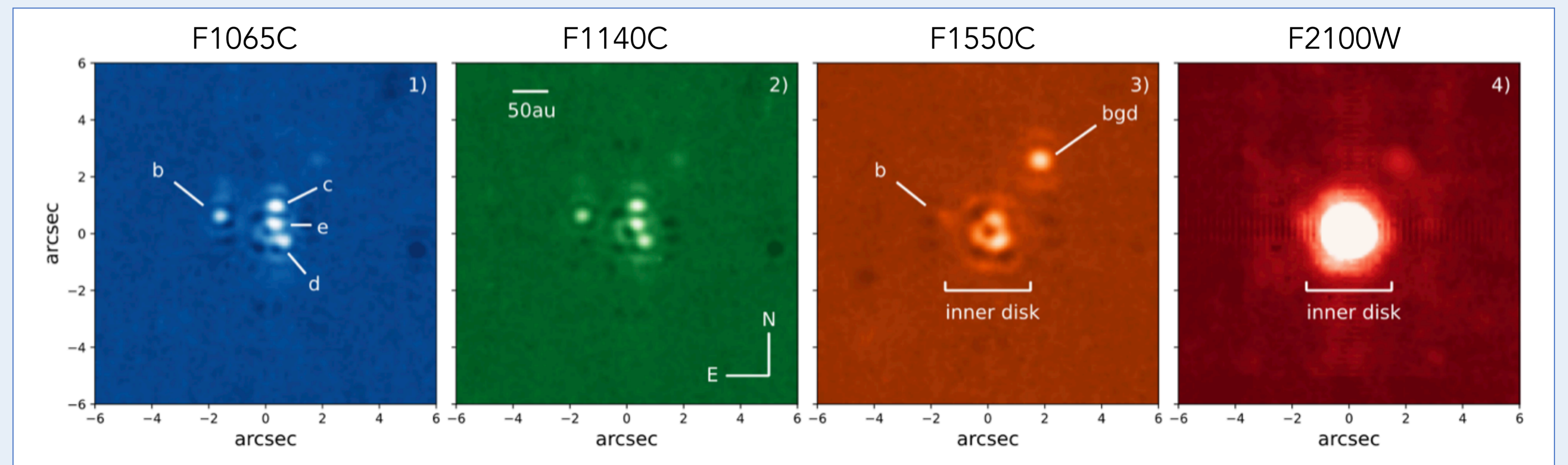
- Background observation is required to eliminate straylight.
- Observations of a reference star (RDI) with the 9 Small Grid Dither method.
- RDI must be optimized for each system, depending on its architecture.
- The use of a library of reference star observations is a promising avenue for JWST observation (e.g. observations of GJ 504 b).



Exo-MIRI GTO Results

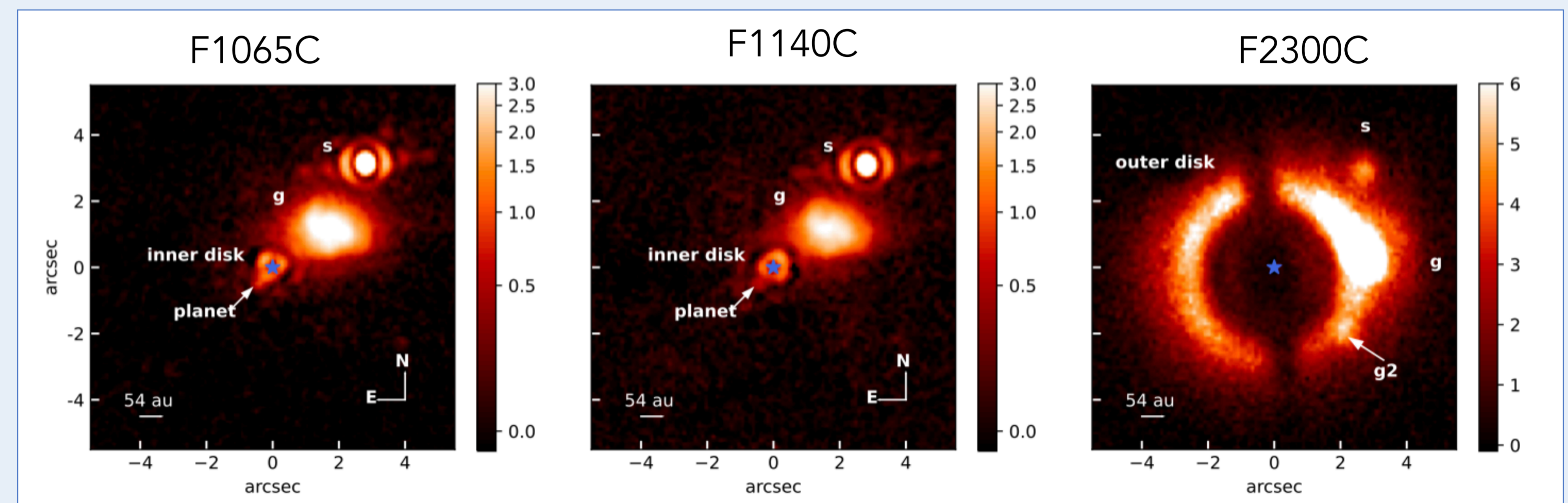
HR 8799

Boccaletti et al. 2024



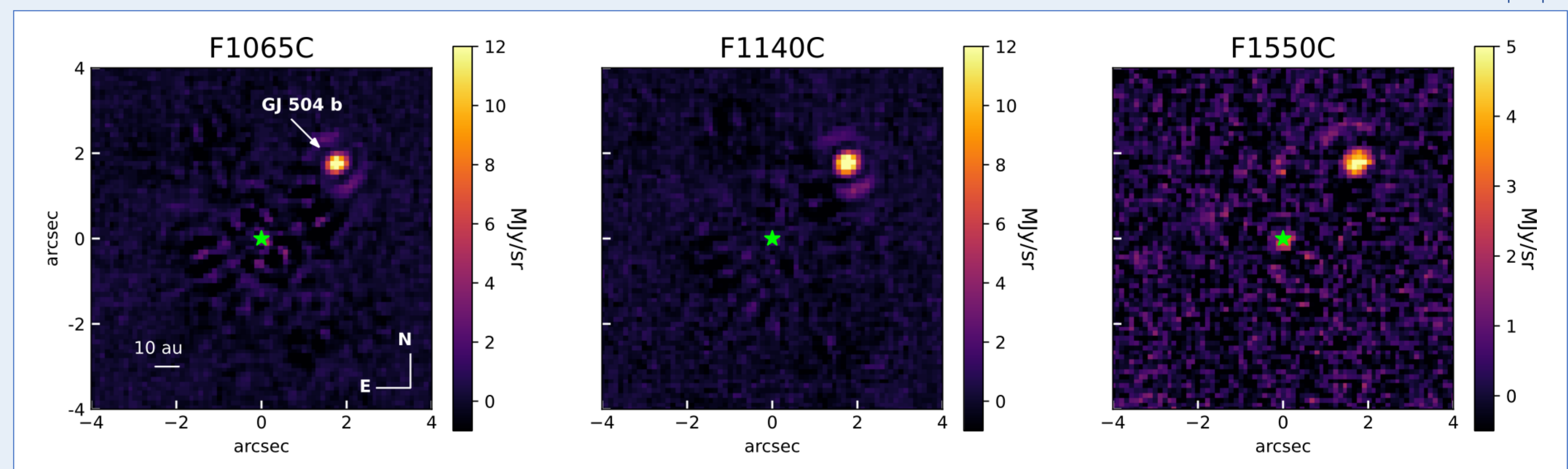
HD 95086

Mâlin et al. (subm)



GJ 504

Mâlin et al. (in prep)



- ★ JWST/MIRI provides the first mid-infrared images of exoplanets, and offers new insights into the structure of these systems.
- ★ Each planet is detected and, more unexpectedly, the emission from the inner disk is also observed, along with many background objects.
- ★ Mid-IR photometry is already improving atmospheric characterization. Atmospheric parameters are measured with lower uncertainties and are more consistent with evolutionary models.
- ★ Follow-up observation with **MIRI/MRS** will provide spectroscopic data to help to conclude on their atmospheric composition, which can be linked with the formation and evolution pathway of these planets (Mâlin et al. 2023, Patapis et al. 2022).

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