ESCAPE Project

"The JWST/MIRI view of HR 2562 b and κ And b"

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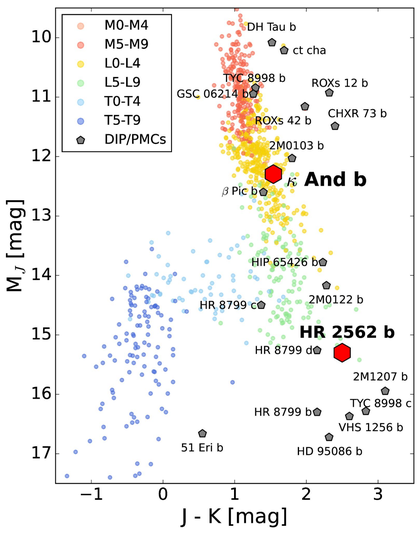
Why JWST/MIRI for directly imaged exoplanets?

- Probes deep atmospheric layers inaccessible at shorter wavelengths
- Highly sensitive to clouds and molecular features
- Breaks key degeneracies in T_{eff} and radius
- NIR + MIR together trace **>85% of the planetary bolometric flux**

Targets overview



	HR 2562 b	κ And b
T_{eff} [K]	1200-1700	1680-2150
log(g)	4 - 5	3.5 - 5.5
R [R_{Jup}]	0.56 - 1.22	1.0 - 1.6
Sp. Type	L4 - T3	L0/L2
Age [Myr]	250 - 750	47^{+27}_{-40}
Mass [M_{Jup}]	<18.5	13 - 50

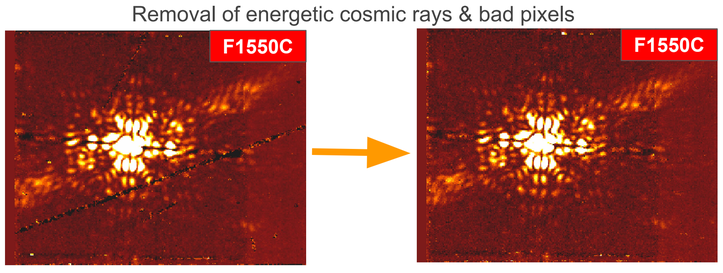
New improvements in data reduction

GTO program 1241 (PI: M. Ressler)
JWST/MIRI coronagraph: F1065C - F1140C - F1550C

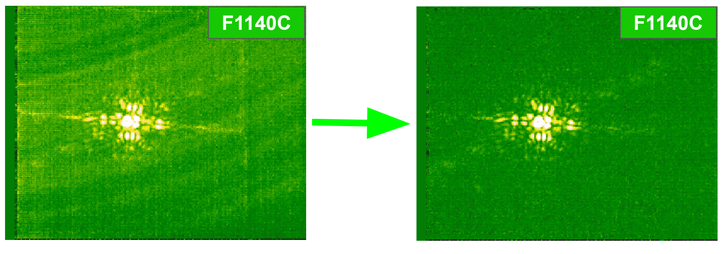
We developed **custom reduction techniques** to correct **energetic cosmic rays and bad pixels**, improve **background subtraction** and **noise suppression** (spaceKLIP; *subtract_background_godoy*; [1,2]), and remove **390 Hz detector fringing** across all three filters.

Example of these improvements applied in three different filters

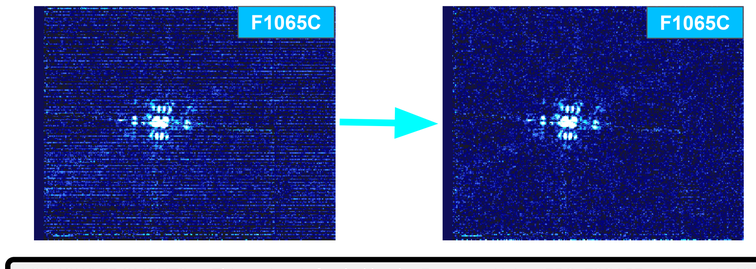
Removal of energetic cosmic rays & bad pixels



Improving the background subtraction



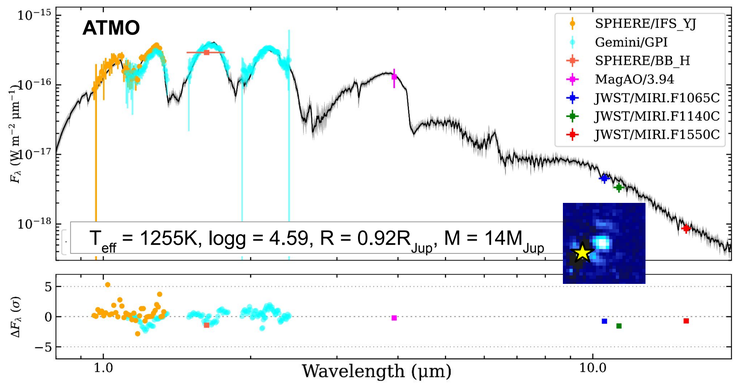
Removing the detector fringing



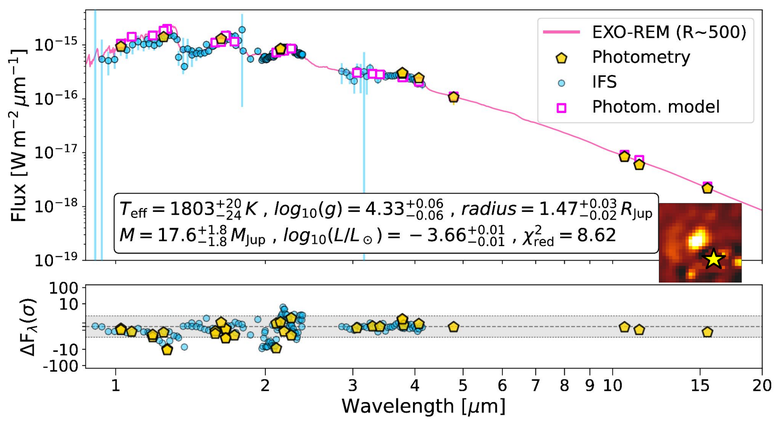
Atmospheric characterization

Direct-imaging constraints on planetary properties rely on **photometry, spectroscopy**, and **atmospheric + evolutionary modeling** (e.g., [3–5])

HR 2562 b – Best-fit cloudless atmosphere with advanced sedimentation

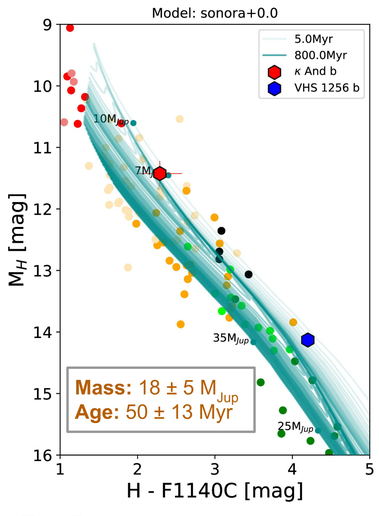


κ And b – Spectrum best matched by a cloudy atmospheric model



Age and mass of κ And b a decade of debate

We resolve long-standing debates on the age and mass of κ And b (e.g., [6–8]) by jointly using **color–magnitude isochrones** and **evolutionary tracks informed by atmospheric modeling** (e.g., [9, 10]).

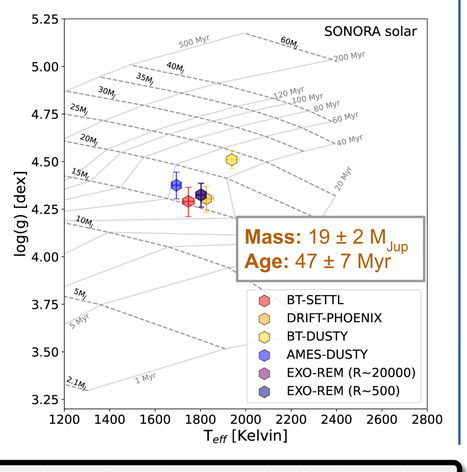


Top figure:

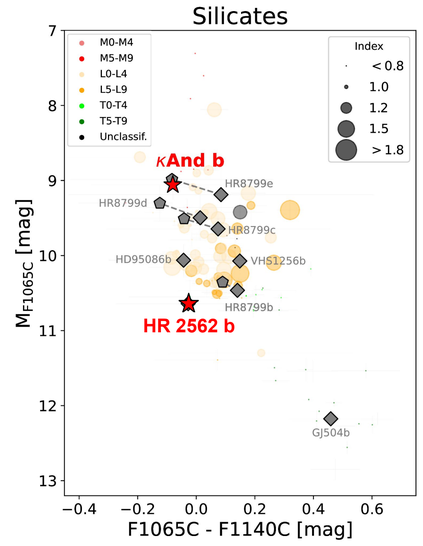
- H-band and F1140C-band shaped by different species
- Direct estimates of mass and age (requires only isochrones)

Bottom figure:

- T_{eff} + radius + log(g) from fitted atmospheric models
- Evolutionary tracks + atm. models results give us mass and age
- Indirect method to derive the age and mass



Identifying, qualitatively, potential species in the atmospheres



Left figure: Colored circles are known field brown dwarfs with measured atmospheric species in MIR ([11]).

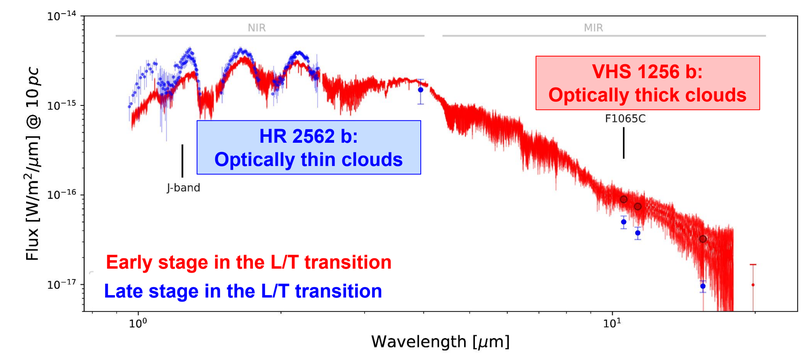
- **HR 2562 b** is at the lower limit (~1250K) of has silicates.
- **κ And b** is at the top limit (~1700K) but greatly possible, of having silicates.

Results and remarks

JWST/MIRI enables a major leap in the characterization of directly imaged exoplanets.
By combining MIRI with near-infrared observations, we significantly refine key physical parameters.
For κ And b, the precision on T_{eff}, radius and log(g) improves by ~20%, ~30%, and ~70%.

- **HR 2562 b - key results**

➔ Cloud-free atmosphere with advanced sedimentation
➔ Planetary-mass object at the end of the L/T transition
➔ Benchmark comparison with VHS 1256 b: similar properties, contrasting atmospheric regimes



- **κ And b - key results**

➔ Young companion with a dusty atmosphere
➔ Physical parameter precision improved by **20–70%**
➔ Age of **47 Myr**, consistent with Columba (42 Myr; [12])
➔ Mass of **17 M_{Jup}**, near the deuterium-burning limit

New constraints in key parameters of HR 2562 b and κ And b

	T_{eff} [K]	log(g)	R [R_{Jup}]	Mass[M_{Jup}]	Age [Myr]
HR 2562 b	1255 ± 14	4.59 ± 0.05	0.92 ± 0.02	8< M <18.5	–
κ And b	1791 ± 69	4.35 ± 0.07	1.42 ± 0.06	17.3± 1.8	47 ± 7

HR 2562 b : Godoy et al. 2024 A&A 689A, 185G
κ And b : Godoy et al. 2025 A&A702A, 4G

REFERENCES — [1]: Kammerer et al. 2022, SPIE 1218E..3NK; [2]: Carter et al. 2023ApJ 951L 20C ; [3]: Samland et al. 2017 A&A, 603, A57, 29 ; [4]: Carter et al. 2023 ApJ, 951L, 20C ; [5]: Denis et al. 2025 A&A, 696, A6, 19 ; [6]: Carson et al. 2013 ApJ, 763L, 32C ; [7]: Jones et al. 2016 ApJ, 882L, 3J; [8]: Stone et al. 2020 AJ, 160, 262S ; [9]: Bonnefoy et al. 2014 A&A, 562A, 111B ; [10]: Godoy et al. 2025 A&A, 689A, 185G ; [11]: Suárez & Metchev 2022 MNRAS, 513, 5701S ; [12]: Bell et al. 2015 MNRAS, 454, 593

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