JWST / Early Release Science

1. HIP 65426 b - Carter et al. (2022)
   https://arxiv.org/pdf/2208.14990.pdf

2. VHS1256 b - Miles et al. (2022)
   https://arxiv.org/pdf/2209.00620.pdf

COBREX

1. HIP65426, first mid-infrared image of an exoplanet!

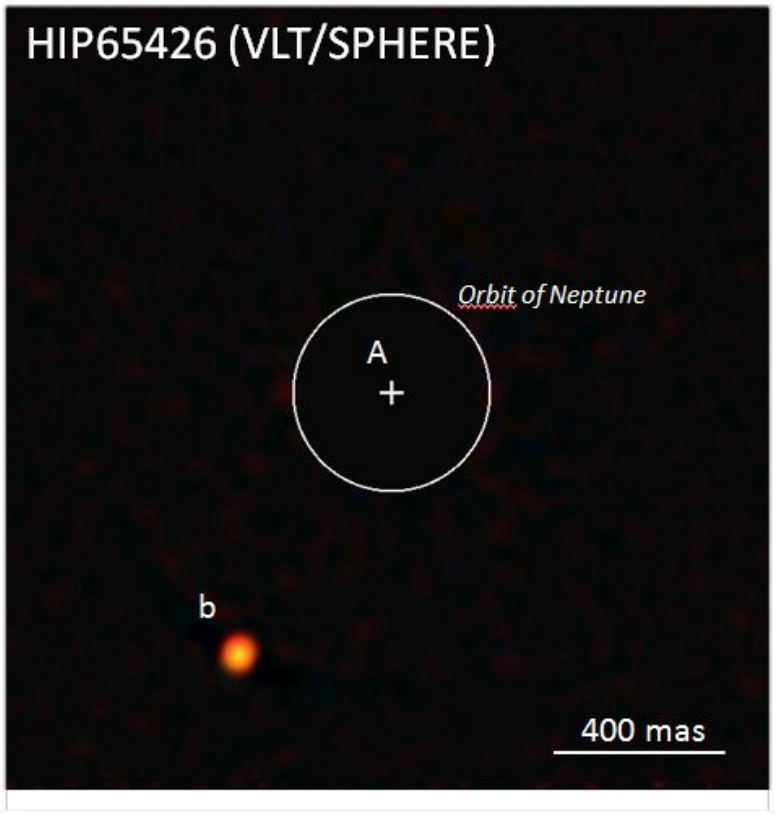
First exoplanet discovered by SPHERE at VLT

HIP65426, A2V, 111.4pc, LCC member, 14 Myr,
No IR excess; fast-rotator (300 m/s)

IRDIS DBI (H23, K12) & IFS (YJ, YJH)
May 30th, 2016, June 26th, 2016
Feb 7th and 9th, 2017

HIP65426 b:
Separation = 830 mas (92 au)
ΔH2 = 11 ± 0.1 mag
Mass = 6-12 M_{Jup}
Teff = 1300 – 1600 K
and R = 1.5 ± 0.1 R_{Jup}

a warm-dusty planet
Chauvin et al. 2017 - ESO-ANN17041



1. HIP65426, first mid-infrared image of an exoplanet!

A warm, dusty giant orbiting a young, Sco-Cen member

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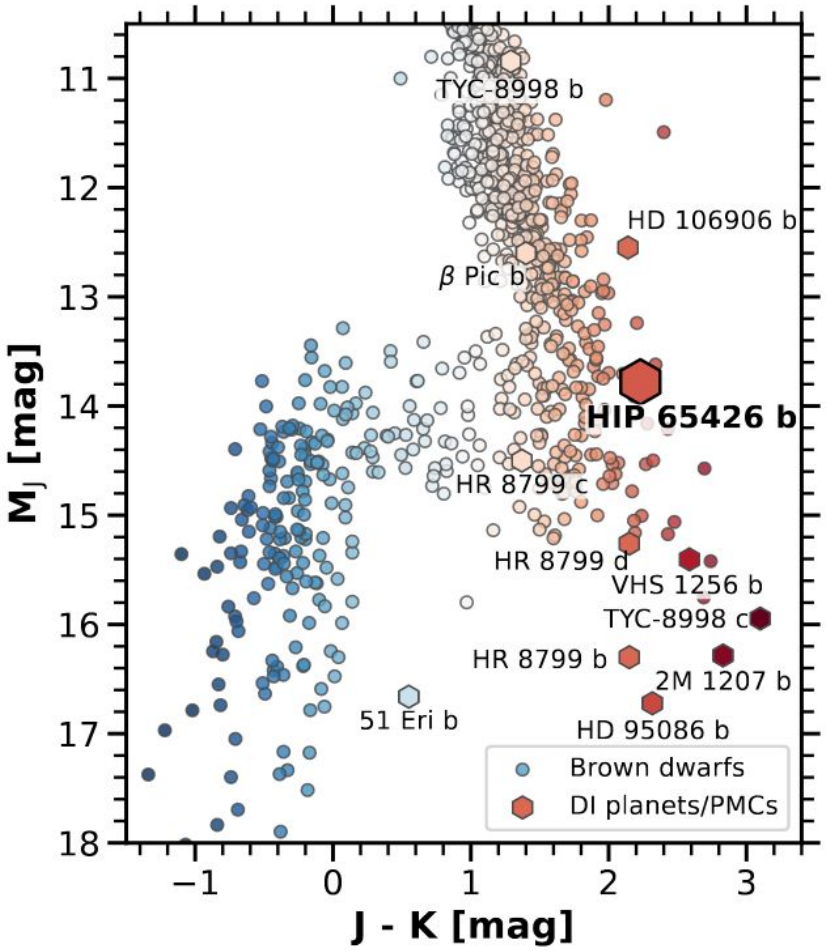

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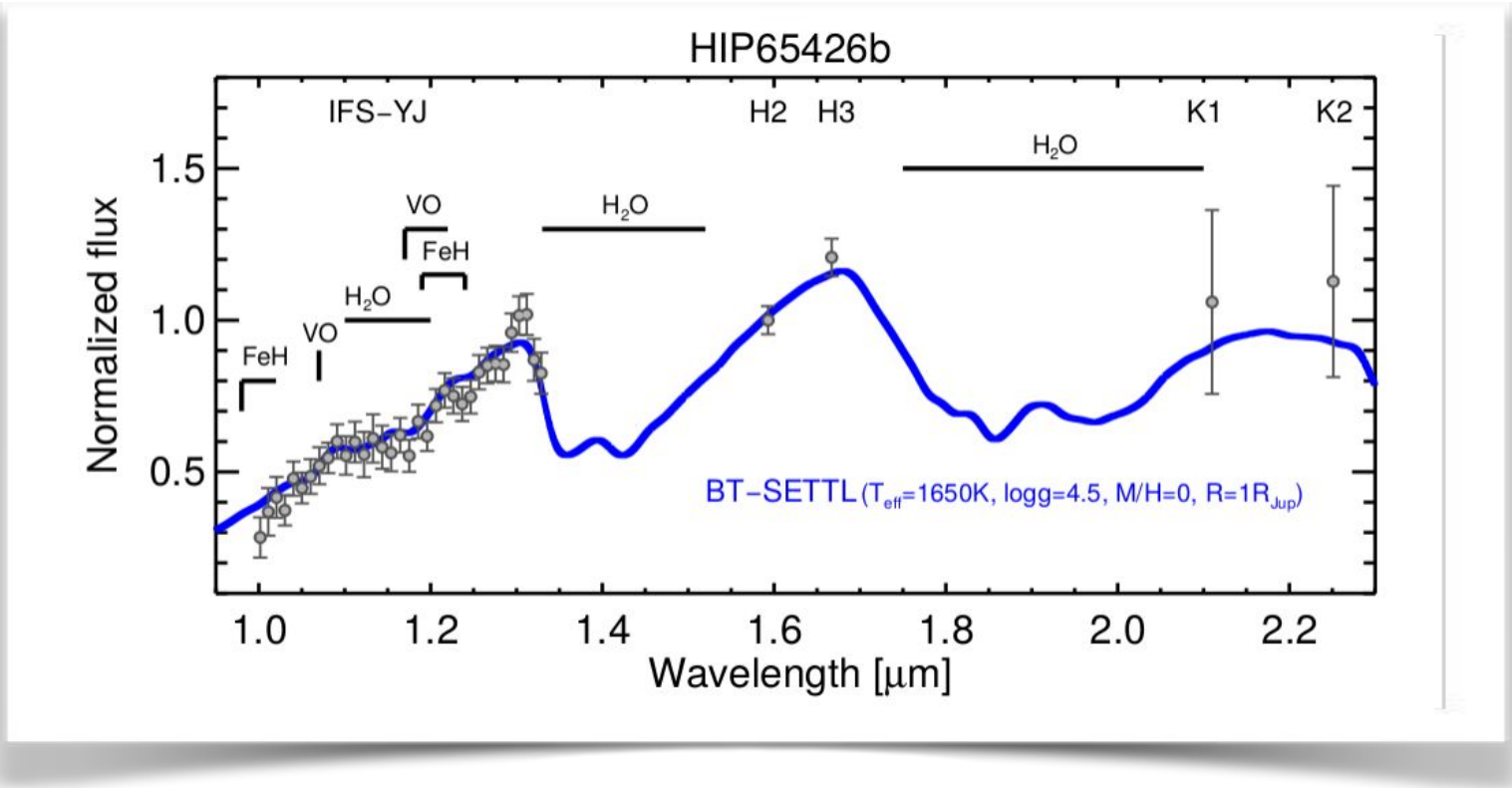
A warm, dusty giant orbiting a young, Sco-Cen member

Empirical study: dusty/young L5-L7 dwarf,
Synthetic models (Exo-REM, BT-Settl): - Teff=1600K, log(g)=4.0-5.0, R=1-1.3R_{Jup}
- Thick clouds composed of silicate grains



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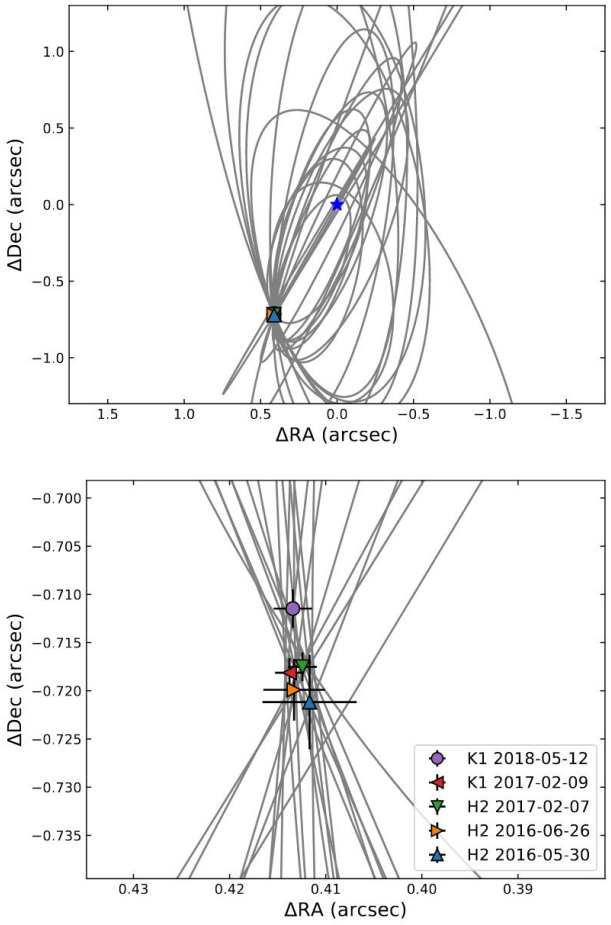
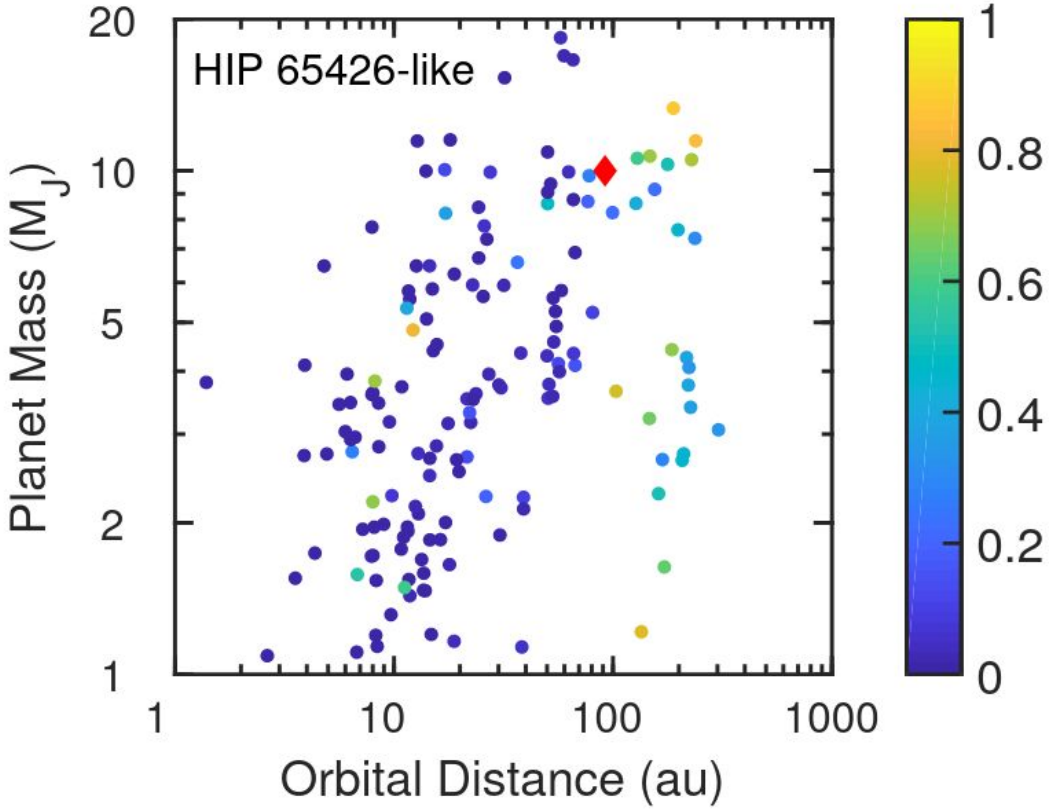
Eccentric orbit & presence of an inner planet?





Cheetham et al. 2018 - moderate eccentricity
Marleau et al. 2019 - planet - planet scattering event

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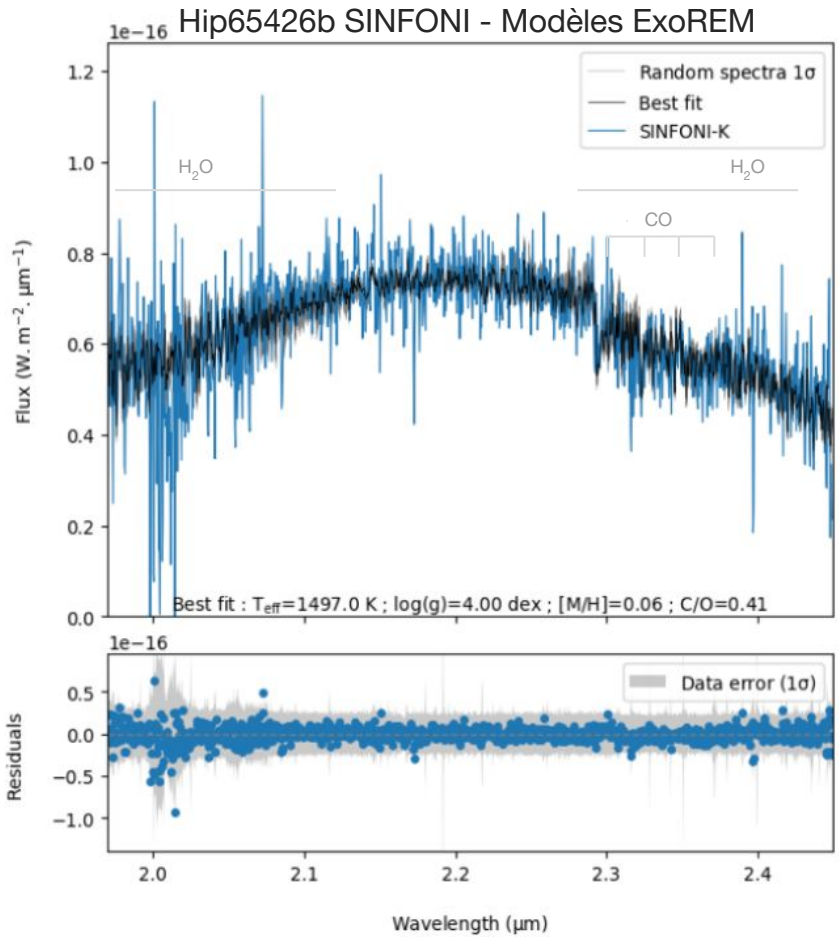
First % ration measurement at medium-resolution



- HIP65426 b: 8 M_{Jup} at 92 au, L5-type, Teff = 1497 ± 80 K, log(g) < 4.20, clouds (Si), Fe/H = 0.05 ± 0.20, C/O < 0.45 RV, v.sin(i), *ecc*~0.35, & C-isotopologues

  > Formation by core accretion (enriched in H2O/CO2 ice) followed by a planet-planet scattering event (JWST ERS target)

  Petrus et al. 2021

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ERS Target for the NIRCam and MIRI coronographic modes

Filter	$\lambda_{\rm mean}$ (μm)	$W_{\rm eff}$ (μm)	Mask	Readout	$N_{\rm groups}$	$N_{\rm ints}$	$t_{\rm exp}$ (s)	$N_{\rm dithers}$	$N_{\rm rolls}$	$t_{\rm total}$ (s)
HIP 65426										
F250M	2.523	0.179	MASK335R	DEEP8	15	4	1235.892	1	2	2471.784
F300M	3.067	0.325	MASK335R	DEEP8	15	4	1235.892	1	2	2471.784
F356W	3.580	0.769	MASK335R	DEEP8	15	2	617.946	1	2	1235.892
F410M	4.084	0.436	MASK335R	DEEP8	15	2	617.946	1	2	1235.892
F444W	4.397	0.979	MASK335R	DEEP8	15	2	617.946	1	2	1235.892
F1140C	11.307	0.608	FQPM1140	FASTR1	101	41	1002.102	1	2	2004.204
F1550C	15.514	0.703	FQPM1550	FASTR1	250	60	3609.341	1	2	7218.682
HIP 68245										
F250M	2.523	0.179	MASK335R	MEDIUM8	4	4	166.852	9	1	1501.669
F300M	3.067	0.325	MASK335R	MEDIUM8	4	4	166.852	9	1	1501.669
F356W	3.580	0.769	MASK335R	MEDIUM8	4	2	83.426	9	1	750.835
F410M	4.084	0.436	MASK335R	MEDIUM8	4	2	166.852	9	1	750.835
F444W	4.397	0.979	MASK335R	MEDIUM8	4	2	83.426	9	1	750.835
F1140C	11.307	0.608	FQPM1140	FASTR1	52	10	126.791	9	1	1141.116
F1550C	15.514	0.703	FQPM1550	FASTR1	100	19	459.706	9	1	4137.356

Table 1. Target and reference exposure settings. Background observations were also performed for the MIRI F1140C and F1550C filters with parameters identical to two exposures of a single roll or dither of the target and reference observations, respectively (see Section 2.1). Filter mean wavelengths ($\lambda_{\rm mean}$) and bandwidths ($W_{\rm eff}$) are taken from `spaceKLIP` (see Section 2.2). See https://jwst-docs.stsci.edu/understanding-exposure-times for further detail on *JWST* exposure settings.

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Coronographic images in mid-infrared :)

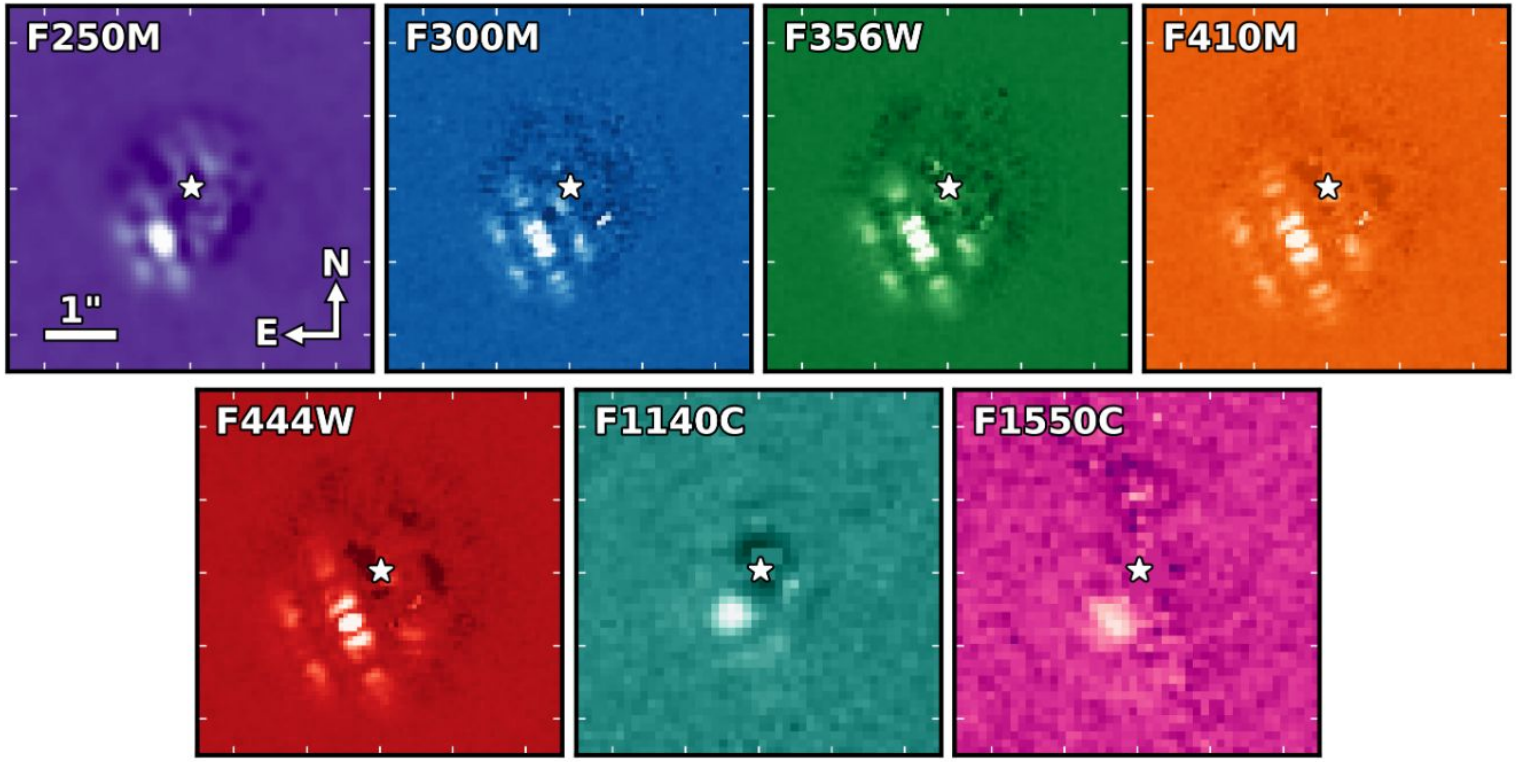
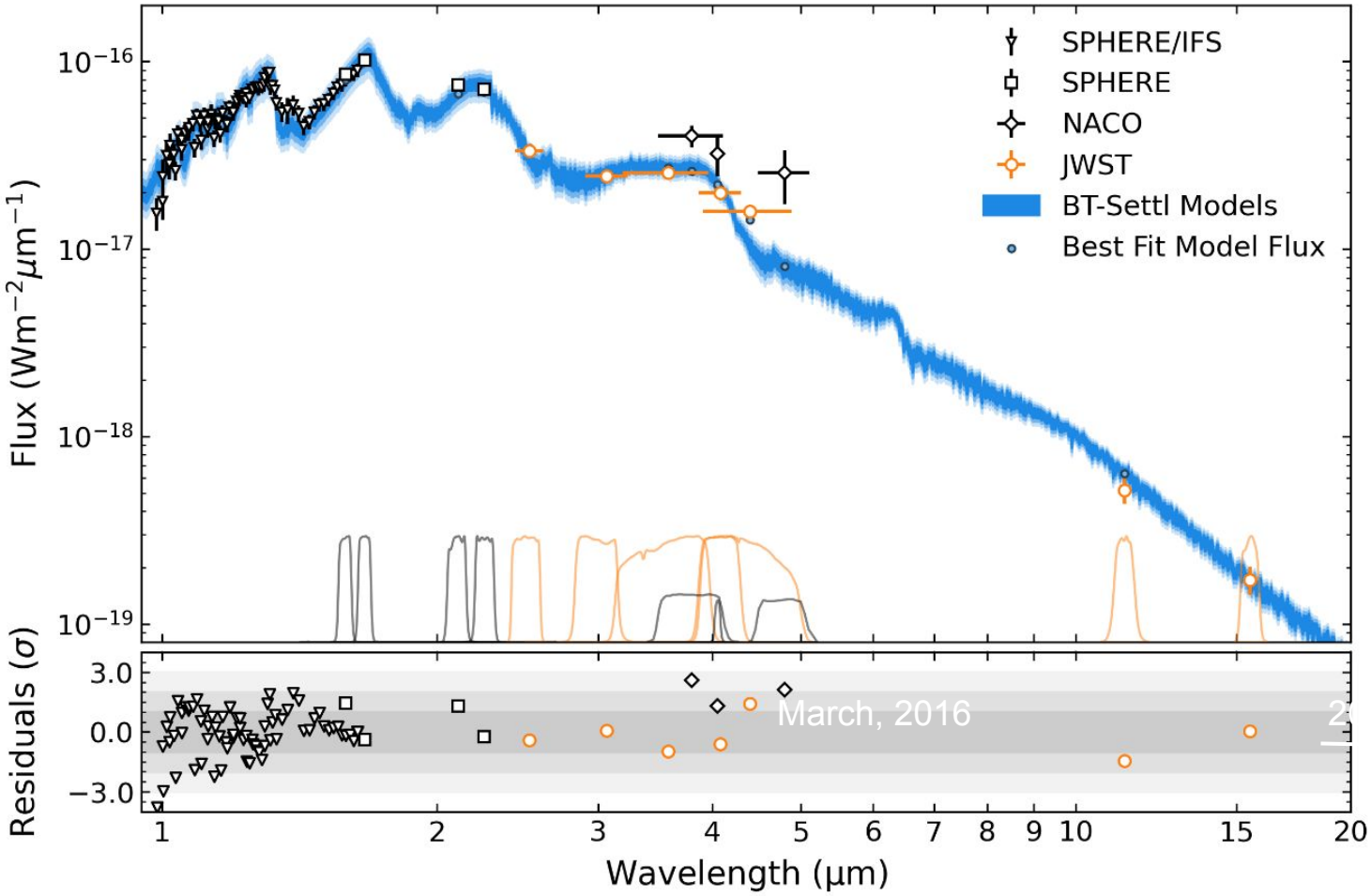


Figure 8. Images of the exoplanetary companion, HIP 65426 b, in all seven NIRCam and MIRI filters used in our observations. Each image is produced following an ADI+RDI KLIP subtraction of the residual stellar PSF. The measured position of the star is marked (white stars), and the orientation and pixel scales of all images are marked in the top left panel.

1. HIP65426, first mid-infrared image of an exoplanet!

Spectral energy distribution up to 15.5 microns!



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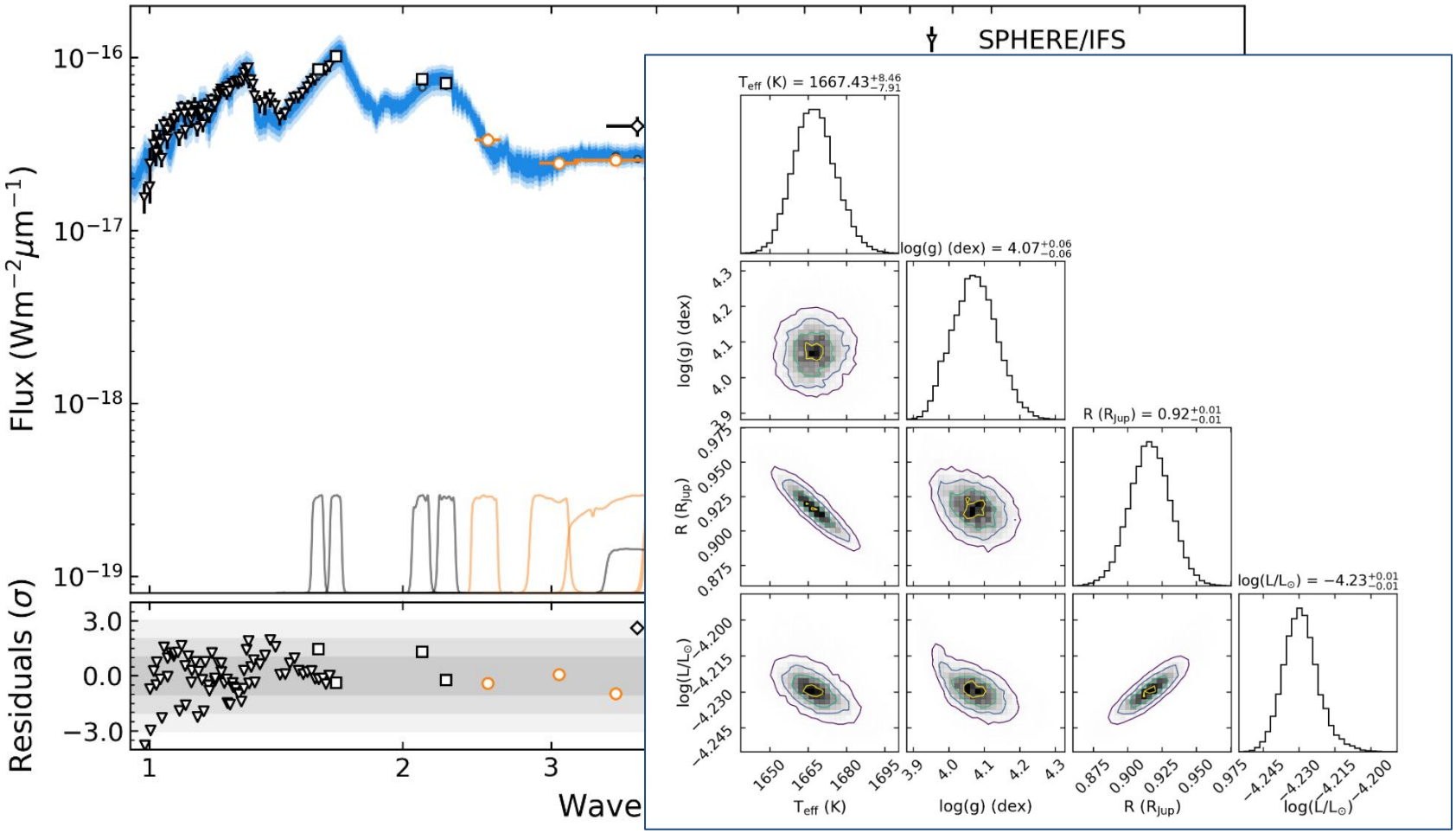

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Evolutionary models predictions

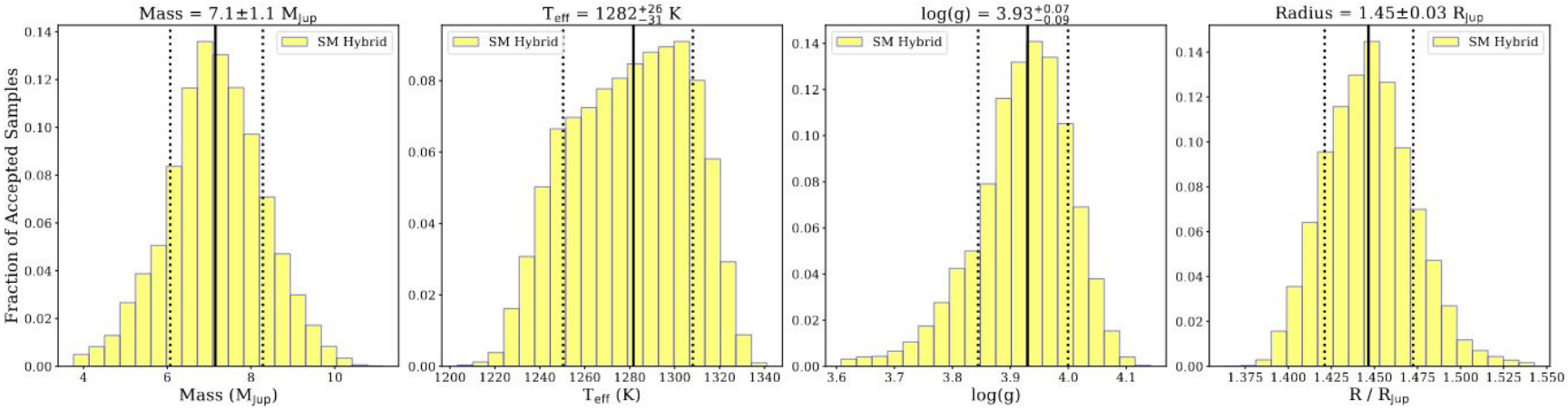


Figure 10. Histograms of the final sets of accepted model properties for the hybrid cloud grid from Saumon & Marley (2008). The median value for each property is shown as a solid black line, with the 68% confidence region falling between the two dotted black lines.

Discrepancy (known) between:

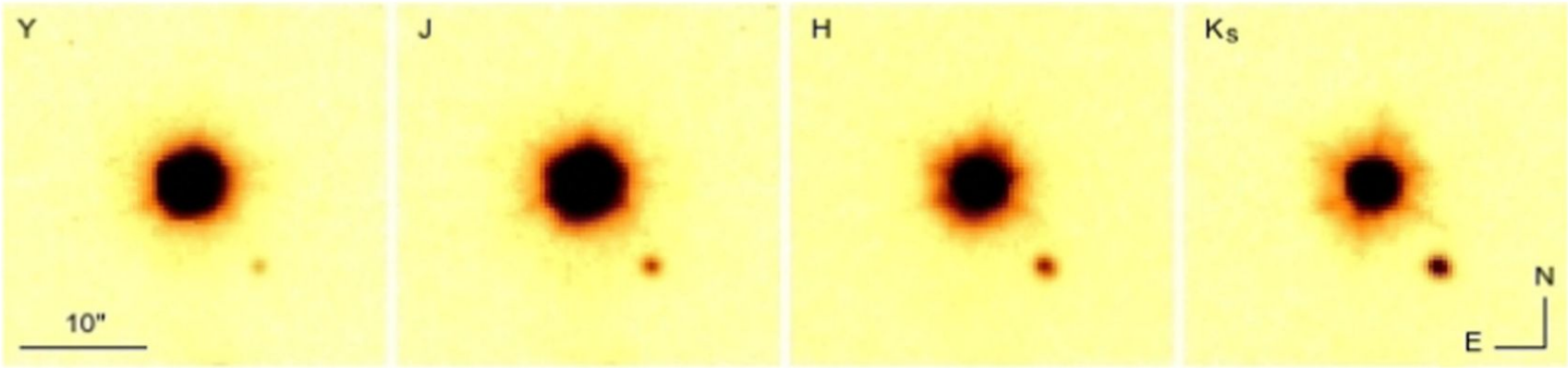
- atmospheric models: hotter, more contracted, 1600K, log(g)=4.1, R = 1.0 RJup
- evolutionary models: cooler, more inflated,1300K, log(g)=3.9, R = 1.45 RJup

2. VHS1256 b, first mid-infrared spectrum of young planetary mass companion!

A wide orbit planetary mass companion to a low-mass binary

A (150 - 300 Myr) triple system VHS J125601.92–125723.9.
This system is composed of:

- a nearly equal-flux binary ("AB"), low-mass, at 22.2pc,
- and a wide, possibly planetary-mass companion ("b").
  Mass of 19±5 MJup and temperature of 1240±50K



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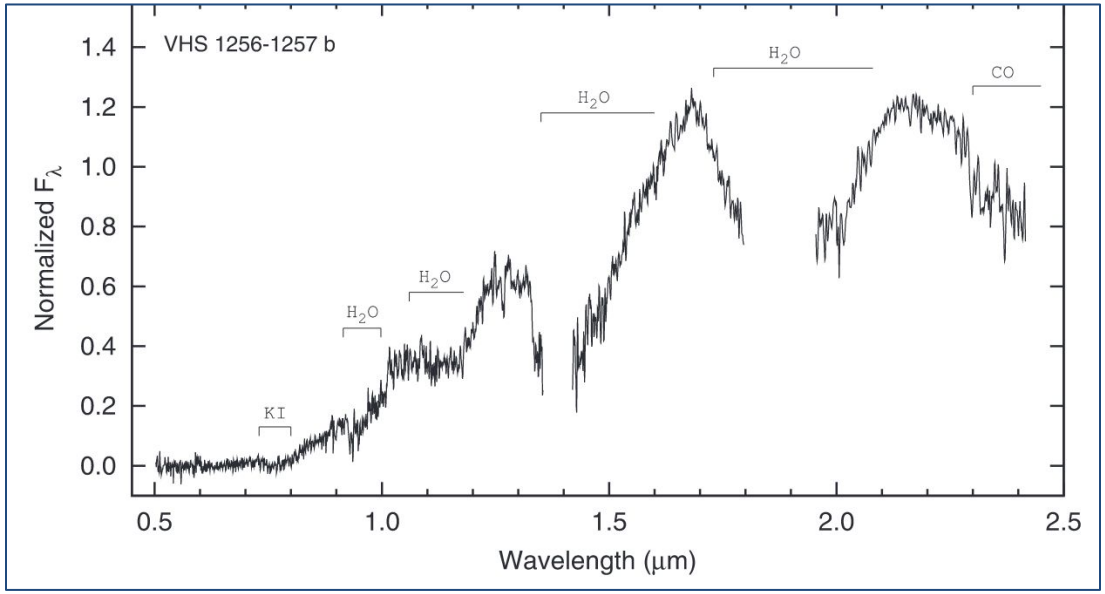

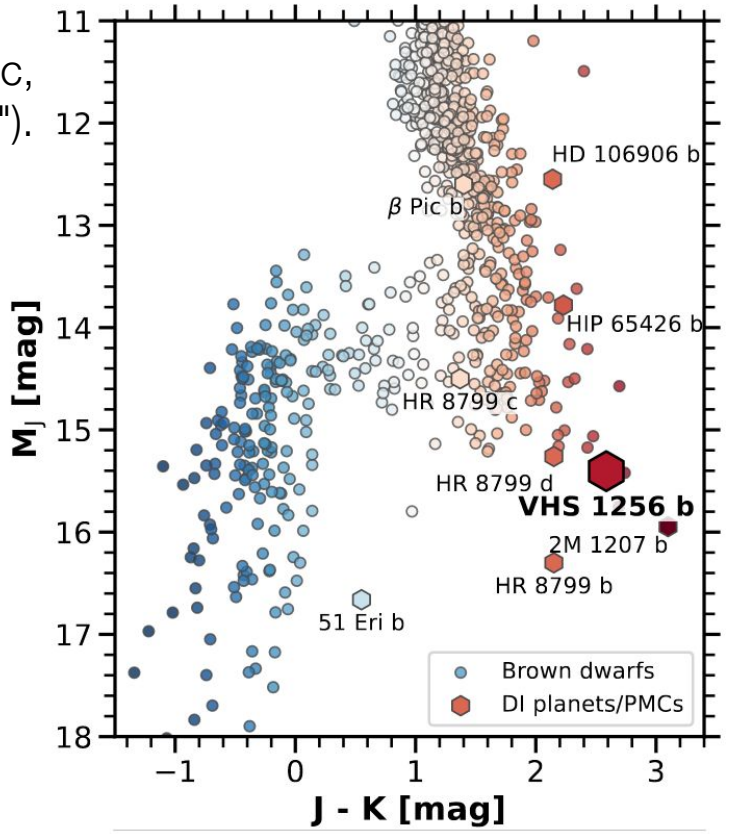

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Table 1. Observations of VHS 1256 b with *JWST*

Instrument	Mode	Wavelength	Subarray	Readout	Resolving Power	Exposure Time (s)
NIRSpec	G140H/F100LP	0.97 - 1.89	FULL	NRSIRS2RAPID	∼1000	1283.82
NIRSpec	G235H/F170LP	1.66 - 3.17	FULL	NRSIRS2RAPID	∼2700	1283.82
NIRSpec	G395H/F290LP	2.87 - 5.27	FULL	NRSIRS2RAPID	∼2700	1283.82
MIRI	Channel 1, Short A	4.9 – 5.74	FULL	FASTR1	3,320 – 3,710	1576.22
MIRI	Channel 1, Medium B	5.65 - 6.63	FULL	FASTR1	3,190 – 3,750	1576.22
MIRI	Channel 1, Long C	6.53 - 7.65	FULL	FASTR1	3,100 – 3,610	1576.22
MIRI	Channel 2, Short A	7.51 - 8.76	FULL	FASTR1	2,990 – 3,110	1576.22
MIRI	Channel 2, Medium B	8.67 - 10.15	FULL	FASTR1	2,750 – 3,170	1576.22
MIRI	Channel 2, Long C	10.01 - 11.71	FULL	FASTR1	2,860 – 3,300	1576.22
MIRI	Channel 3, Short A	11.55 - 13.47	FULL	FASTR1	2,530 – 2,880	1576.22
MIRI	Channel 3, Medium B	13.29 - 15.52	FULL	FASTR1	1,790 - 2,640	1576.22
MIRI	Channel 3, Long C	15.41 - 18.02	FULL	FASTR1	1,980 – 2,790	1576.22
MIRI	Channel 4, Short A	17.71 - 20.94	FULL	FASTR1	1,460 – 1,930	1576.22
MIRI	Channel 4, Medium B	20.69 - 24.44	FULL	FASTR1	1,680 – 1,770	1576.22
MIRI	Channel 4, Long C	23.22 - 28.1	FULL	FASTR1	1,630 – 1,330	1576.22

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NIRSPec/MIRI spectrum from 1 to 20 microns

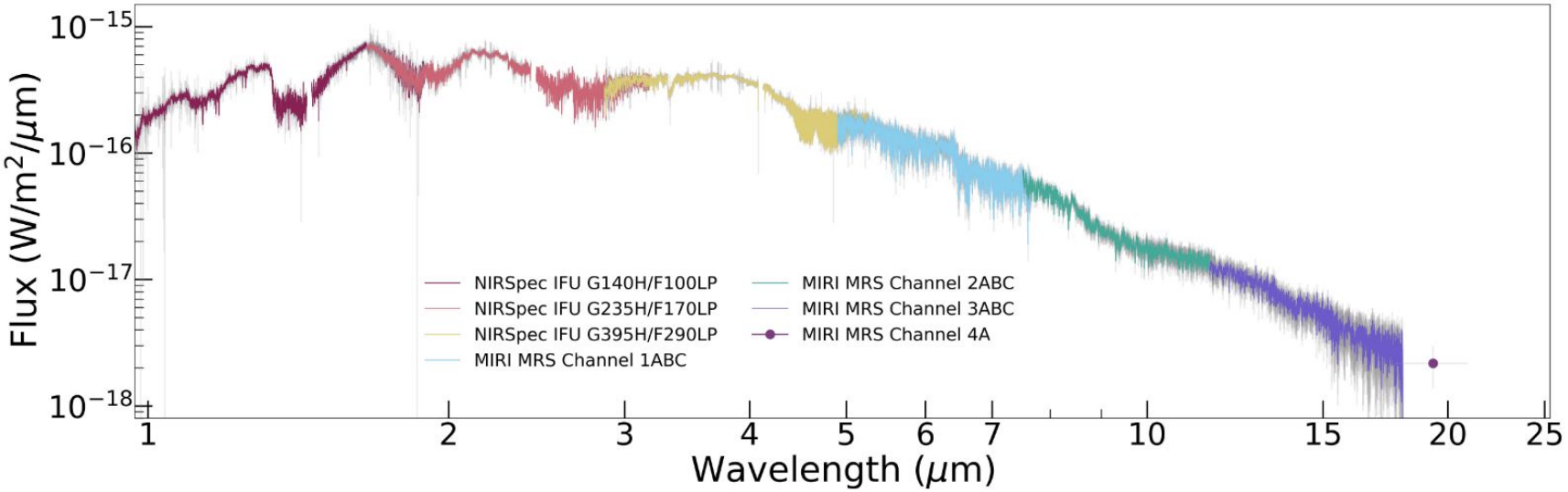

Figure 2. The full spectrum of VHS 1256 b using *JWST*'s NIRSpec IFU and MIRI MRS observation modes. Bandpasses are highlighted with different colors and error bar are displayed in grey. A single photometric point for MIRI MRS Channel 4A is shown because there is little to no signal in the MIRI MRS 4B, and 4C channels. Error bars are plotted in a light grey.

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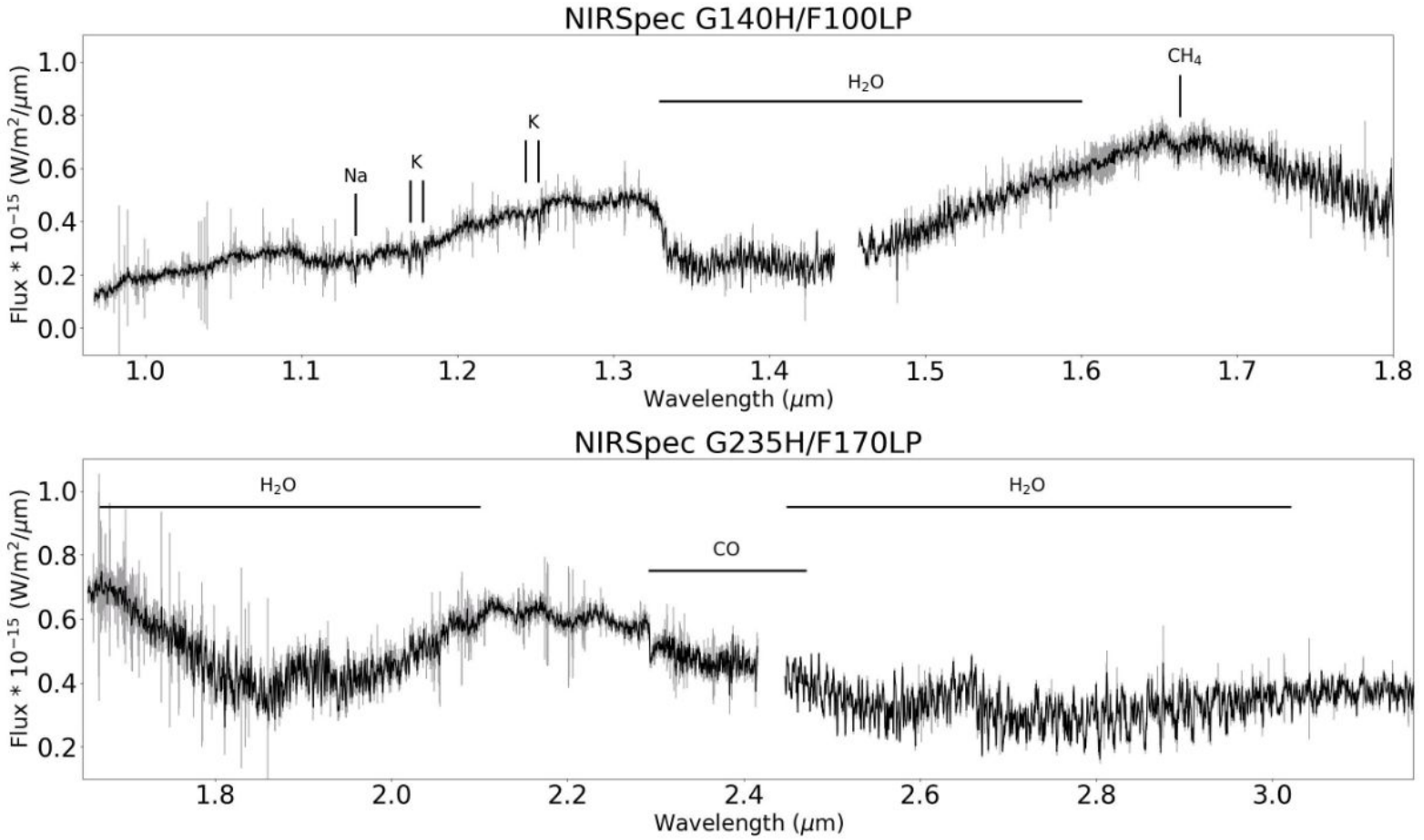

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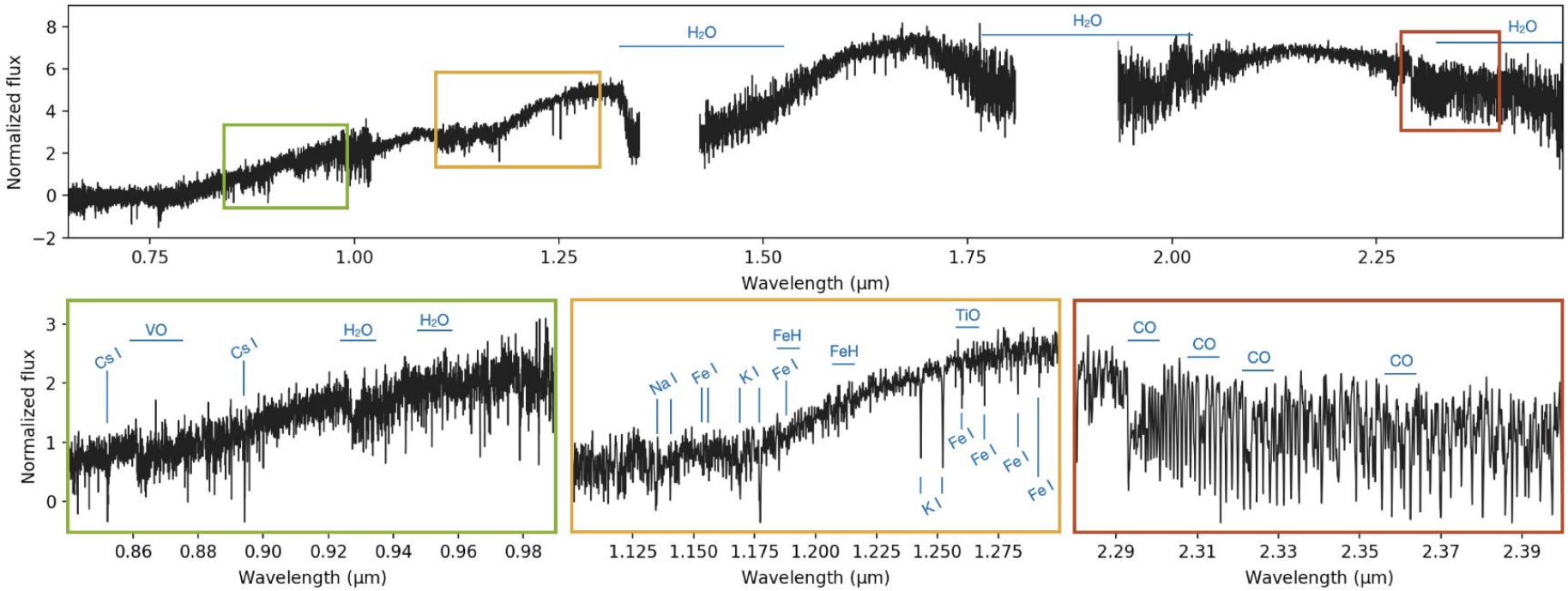
X-Shooter comparison

- Important fringing/wriggles problem with NIRSPec!
- No CH4 detection at 1.6um



Petrus et al. 2022

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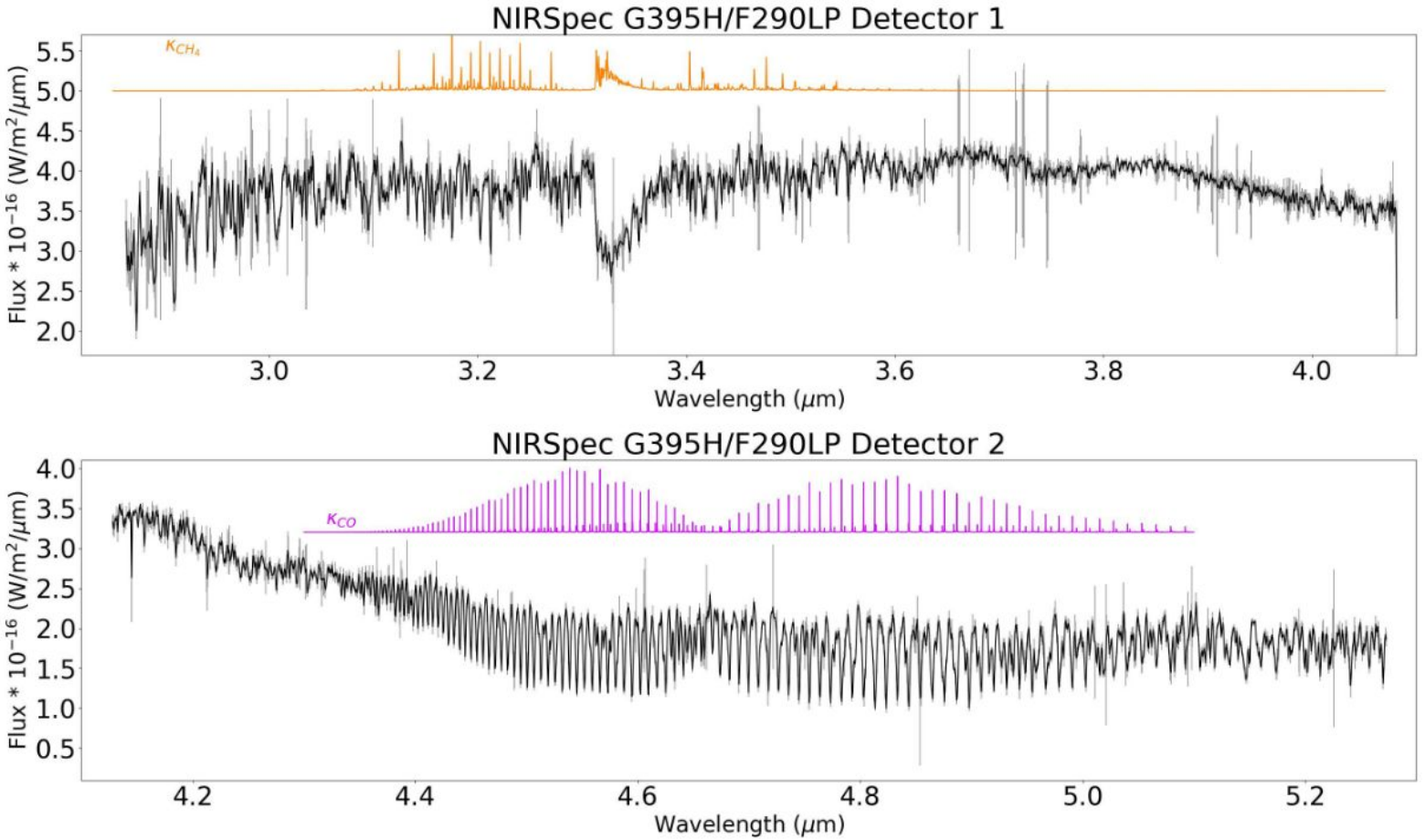

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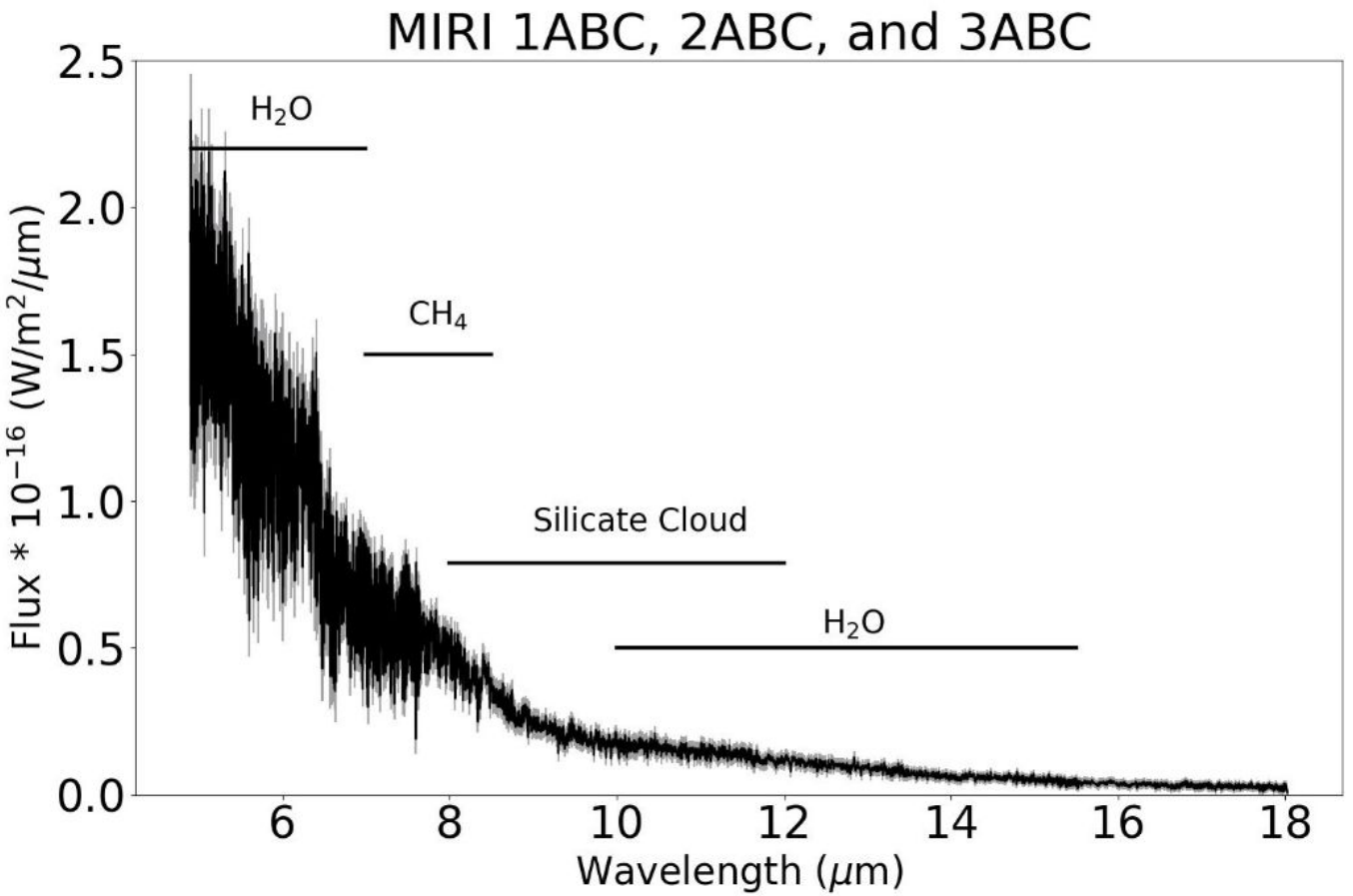

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Do we see clouds?

- First direct detection of silicate feature absorption
- If true, direct proof of the presence of clouds!

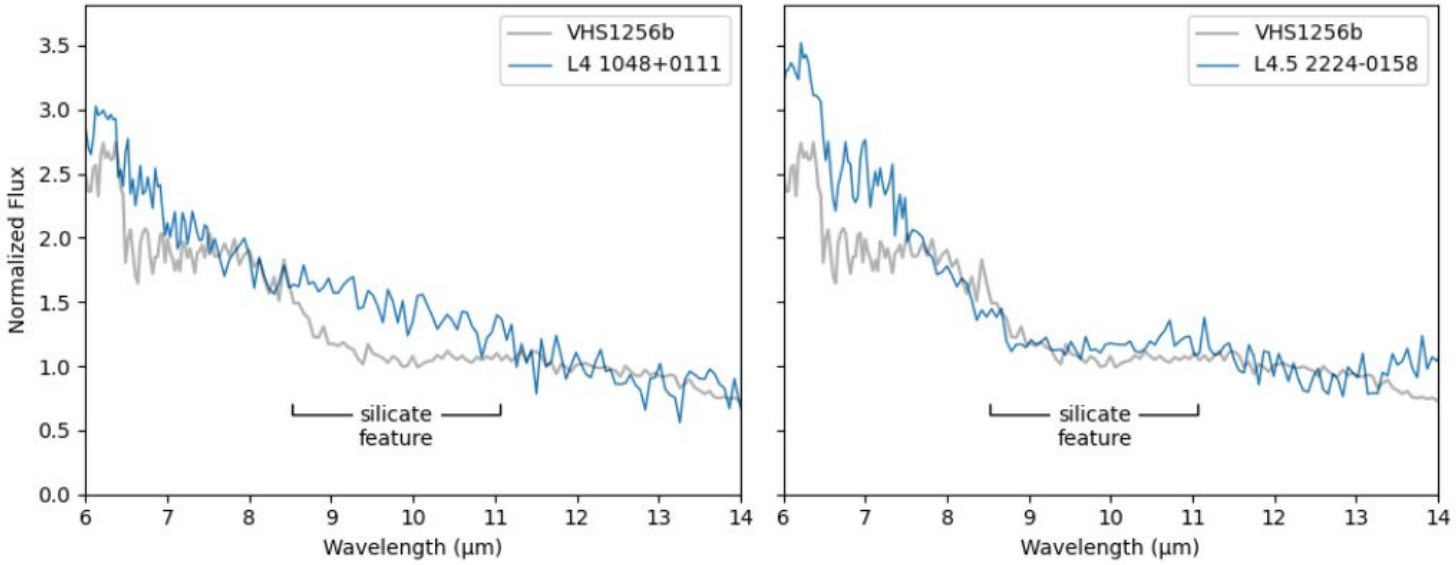

Figure 11. The *JWST*/MIRI spectrum of VHS 1256 b is a good match to the *Spitzer* spectrum of 2M2224-0158, which has a prominent silicate absorption feature. 2M1048+0111, which does not have a prominent silicate feature, is shown for comparison. (2M2224-0158 and 2M1048+0111 spectra from Suárez & Metchev (2022).

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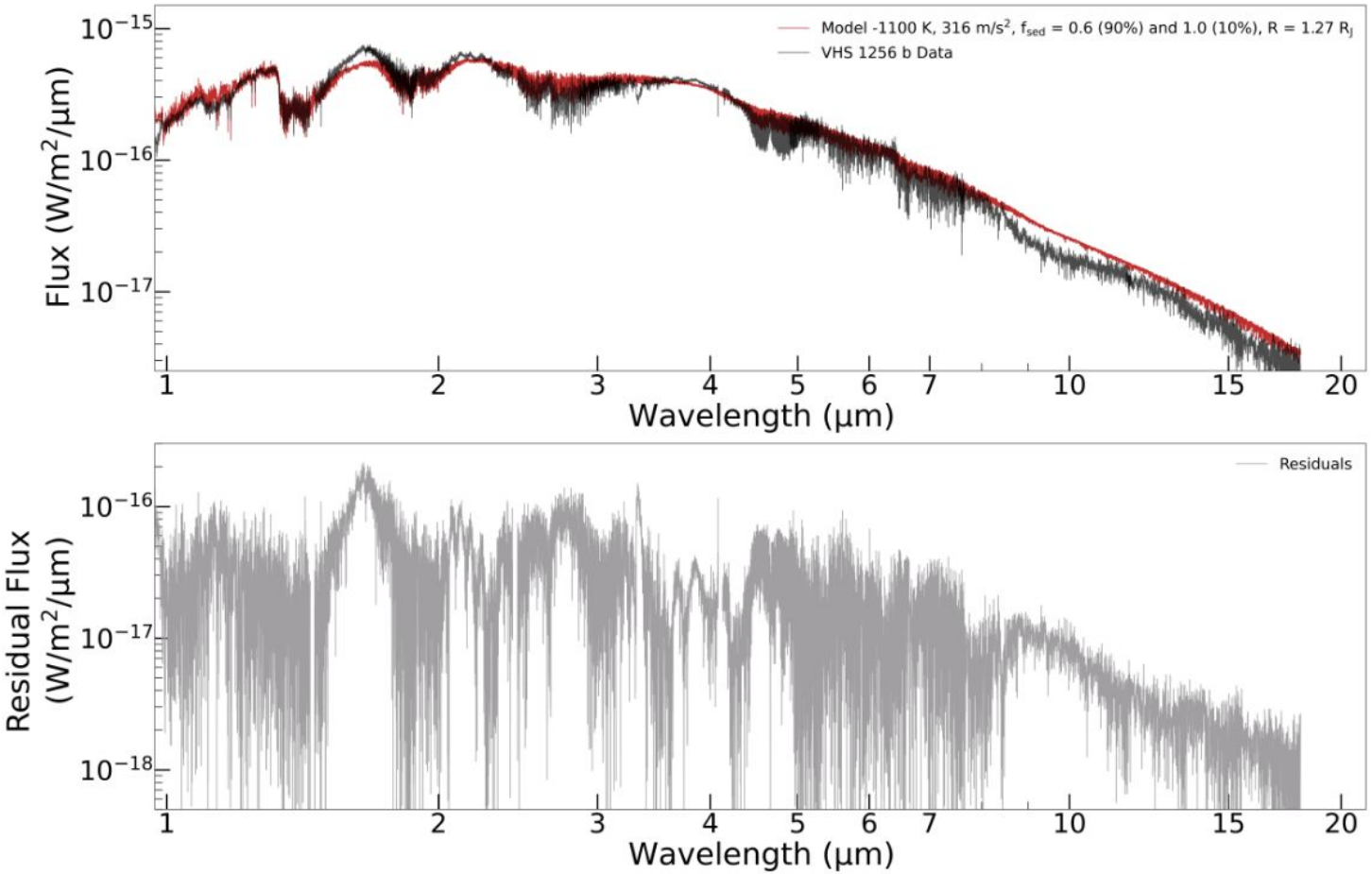
Atmosphere model analysis



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Evolutionary model analysis