Extending Gaia to the Unseen Population of Ultracool Y Brown Dwarfs with HST

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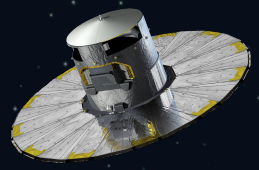
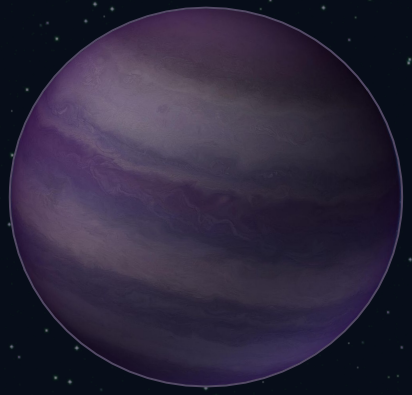
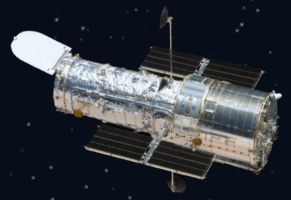
CRAQ Meeting

May 11, 2023

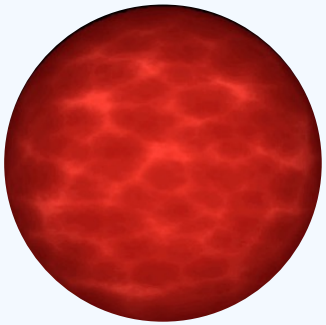






Stars, planets and so much more

STARS ← → **PLANETS**

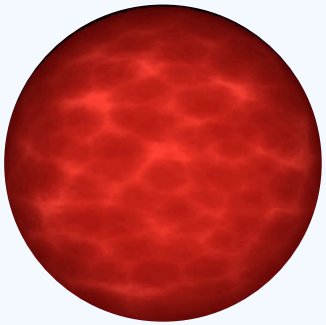
M	L	T	Y	Jupiter
				
2200 – 3000 K	1400 – 2200 K	600 – 1400 K	< 600 K	125 K

Brighter
Hotter
More massive
←

Fainter
Colder
Less massive
→

Y Brown Dwarfs as Giant Planet Analogs

STARS ← → **PLANETS**

M	L	T	Y	Jupiter
				
2200 – 3000 K	1400 – 2200 K	600 – 1400 K	< 600 K	125 K

5–30 M_{Jup}
W0855: 250K
~30 known

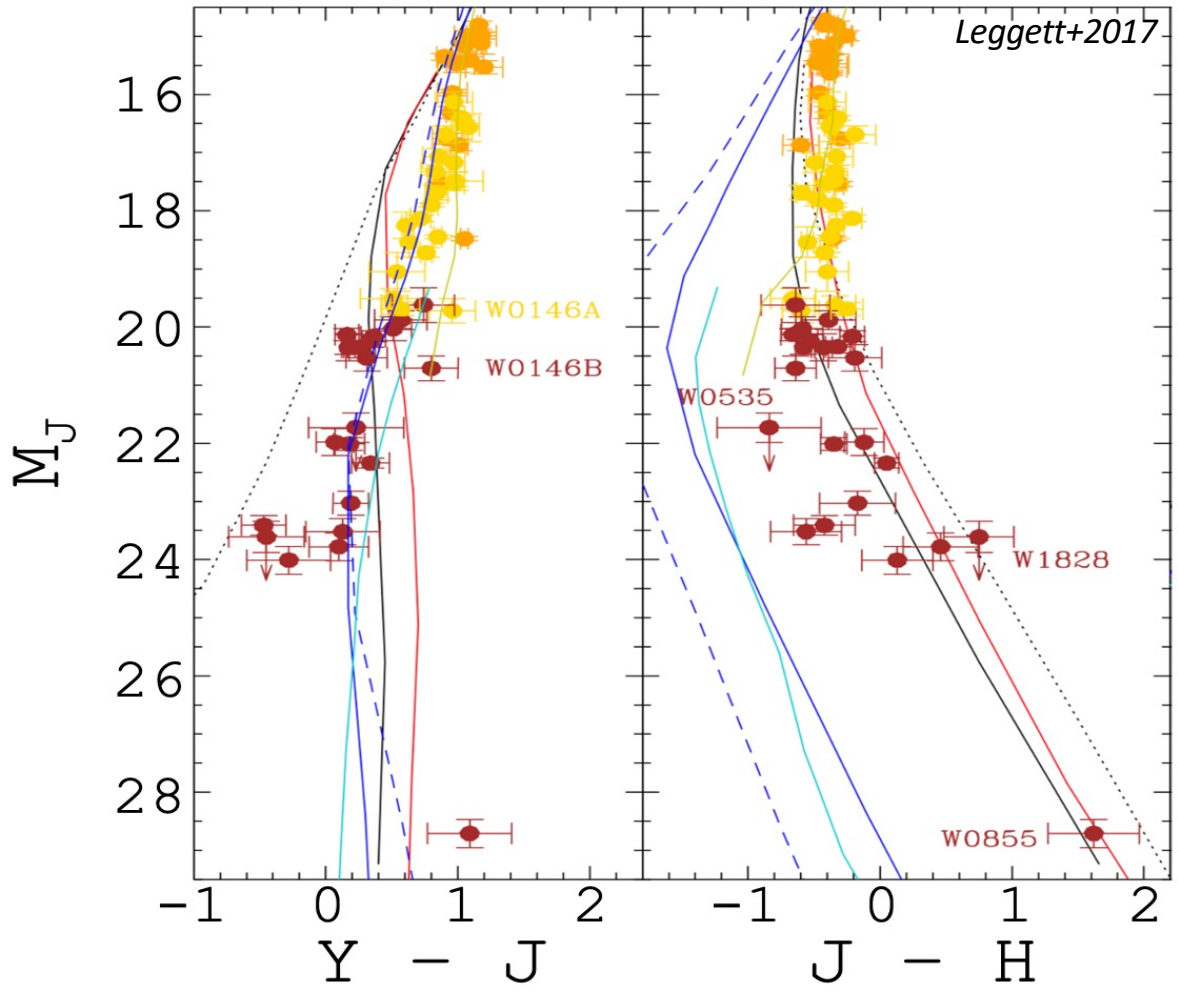
Brighter
Hotter
More massive
←

Fainter
Colder
Less massive
→

The Y dwarf CMD chaos

HOTTER

COLDER



- Mid-Ts
- Late-Ts
- Y dwarfs

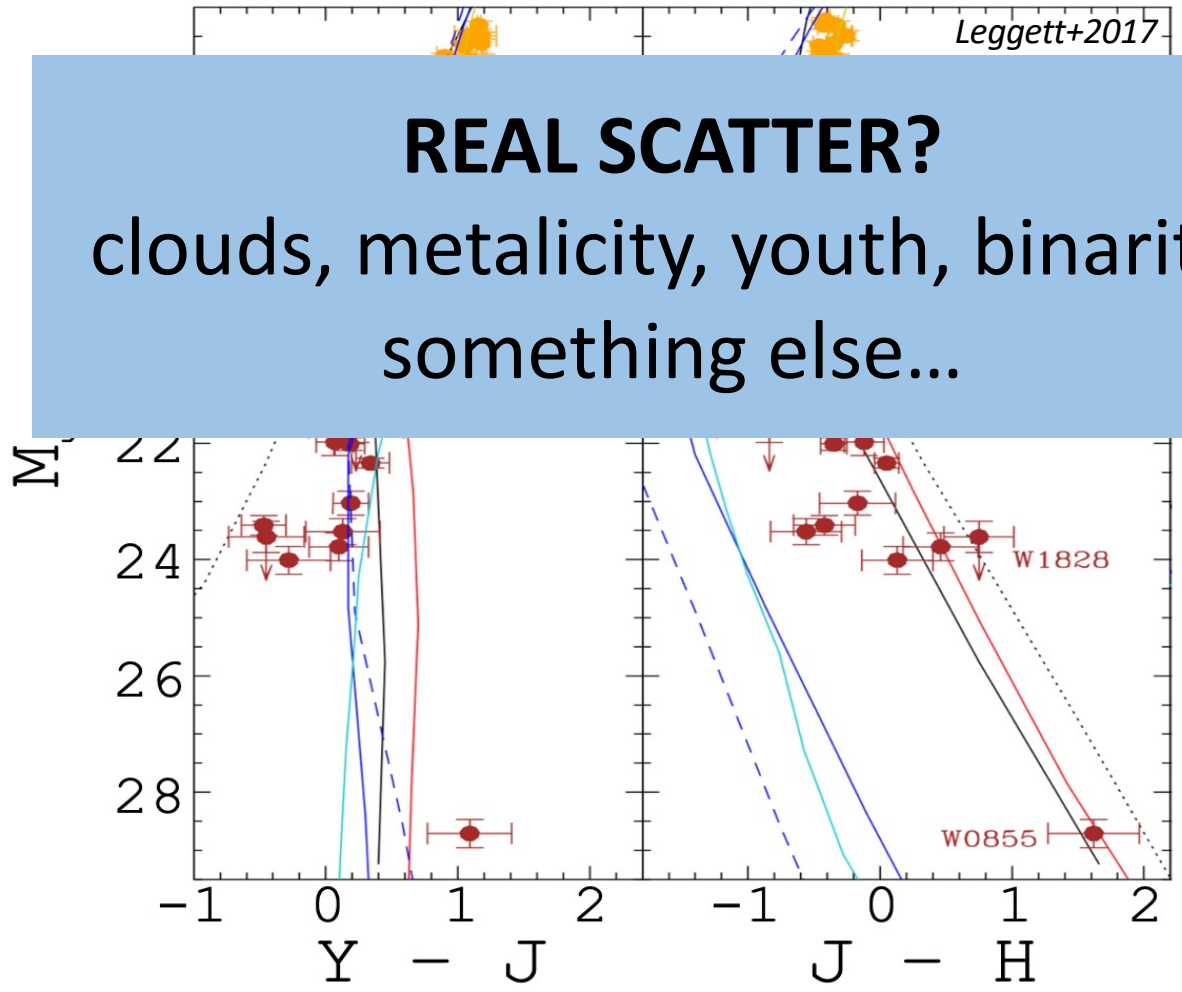
BLUER

REDDER

The Y dwarf CMD chaos

HOTTER

COLDER



REAL SCATTER?

clouds, metalicity, youth, binarity, something else…

Mid-Ts

ate-Ts

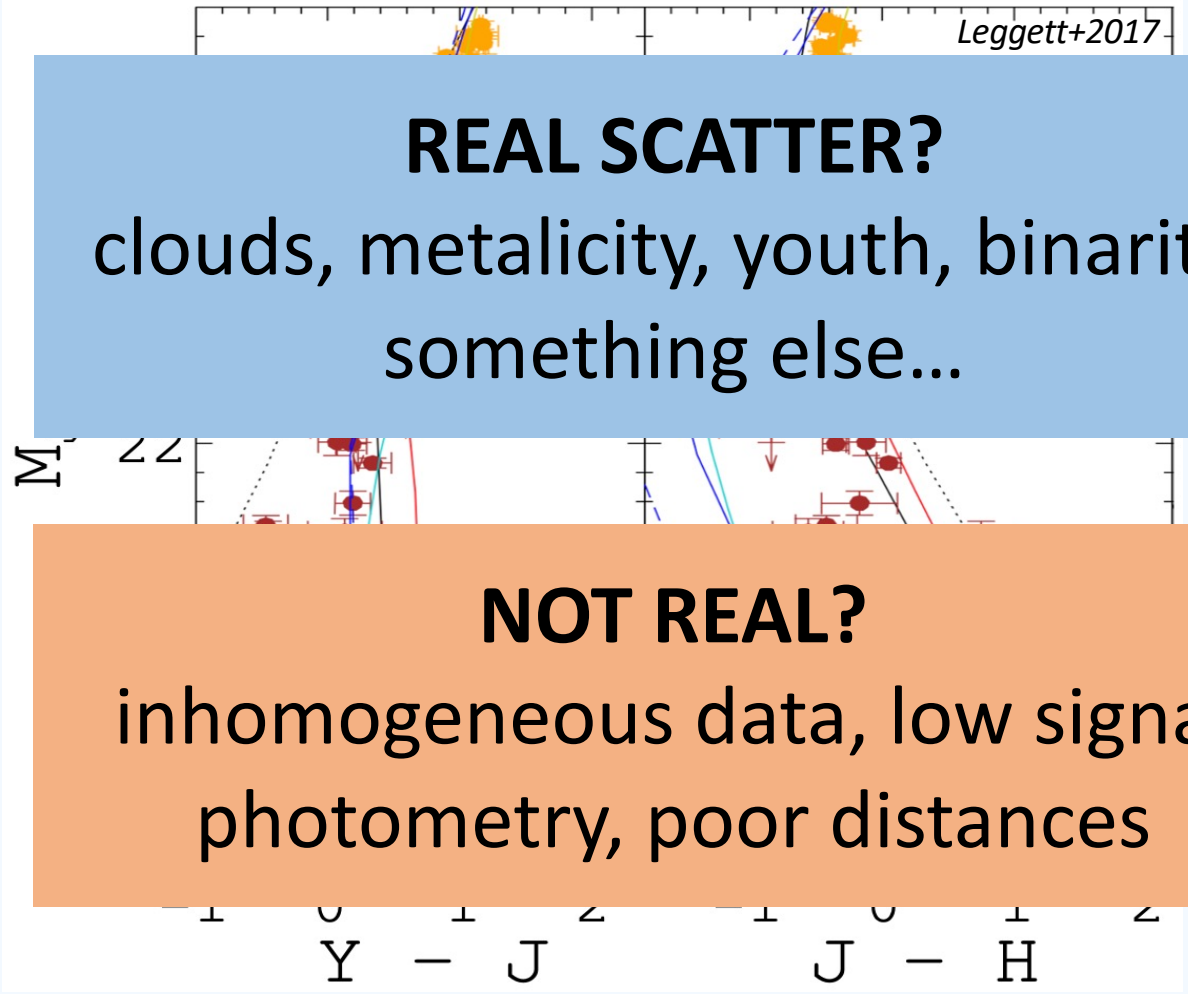
dwarfs

BLUER

REDDER

The Y dwarf CMD chaos

HOTTER



Mid-Ts
ate-Ts
dwarfs

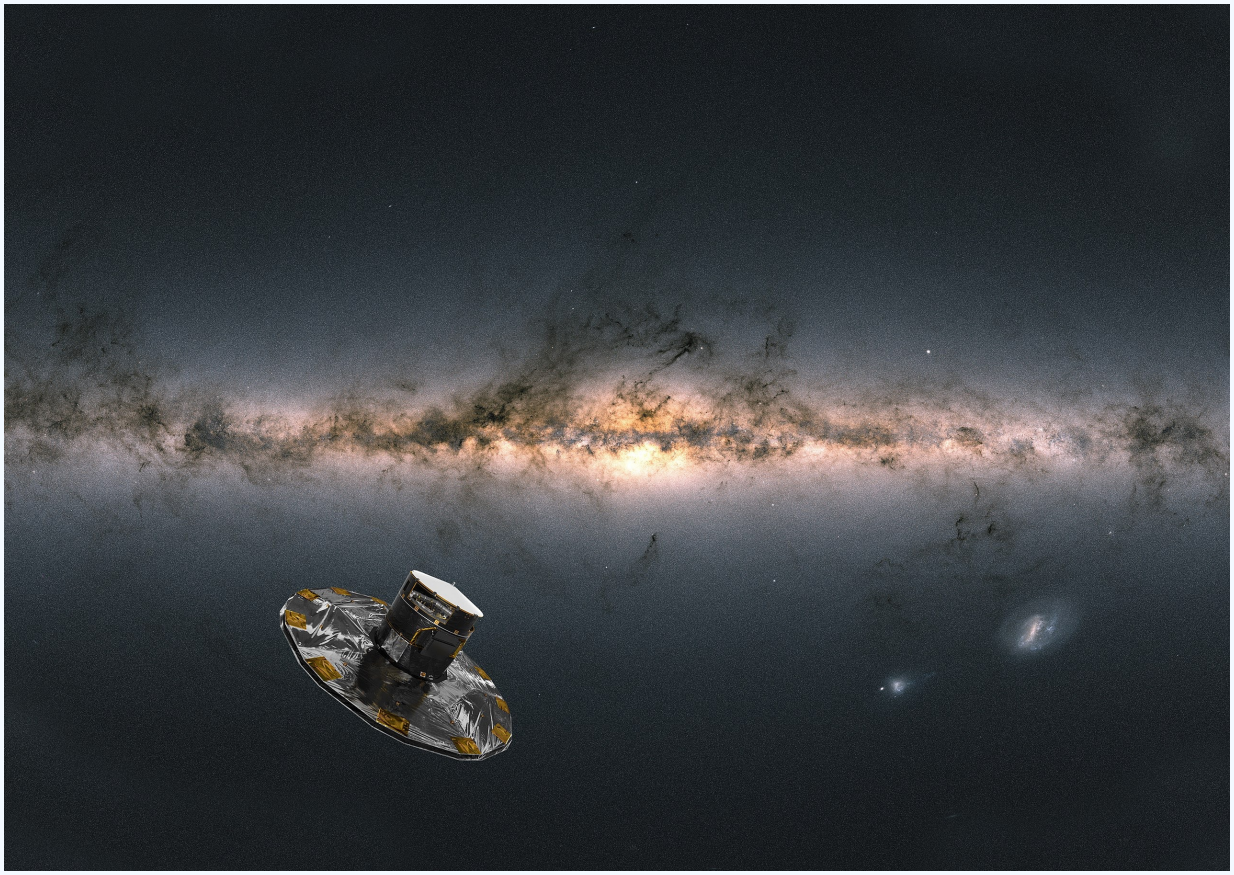
REAL SCATTER?
clouds, metalicity, youth, binarity, something else…

NOT REAL?
inhomogeneous data, low signal photometry, poor distances

COLDER

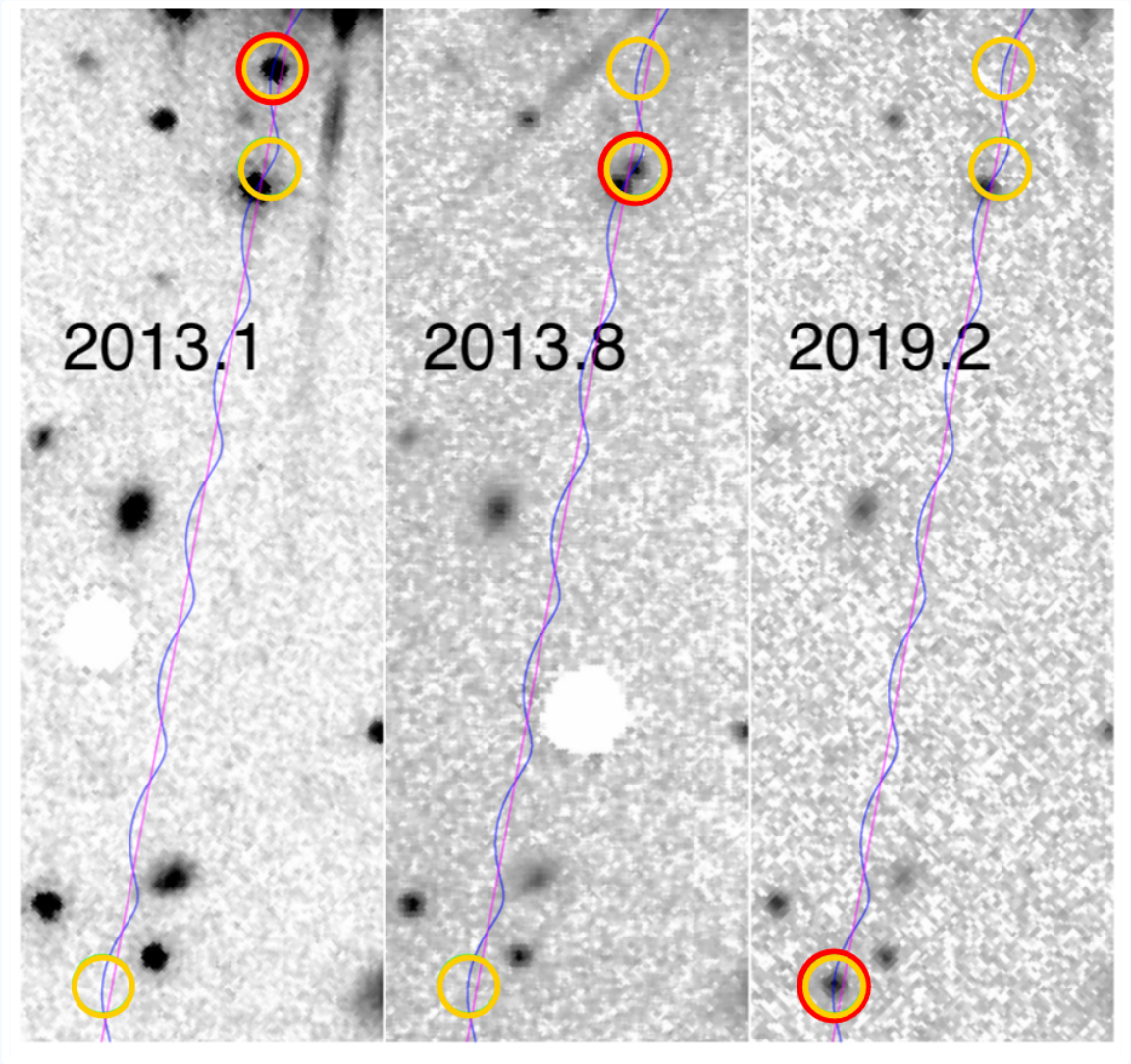
BLUER ← → REDDER

Can’t get far without distances



Gaia is awesome! But not for brown dwarfs ☹

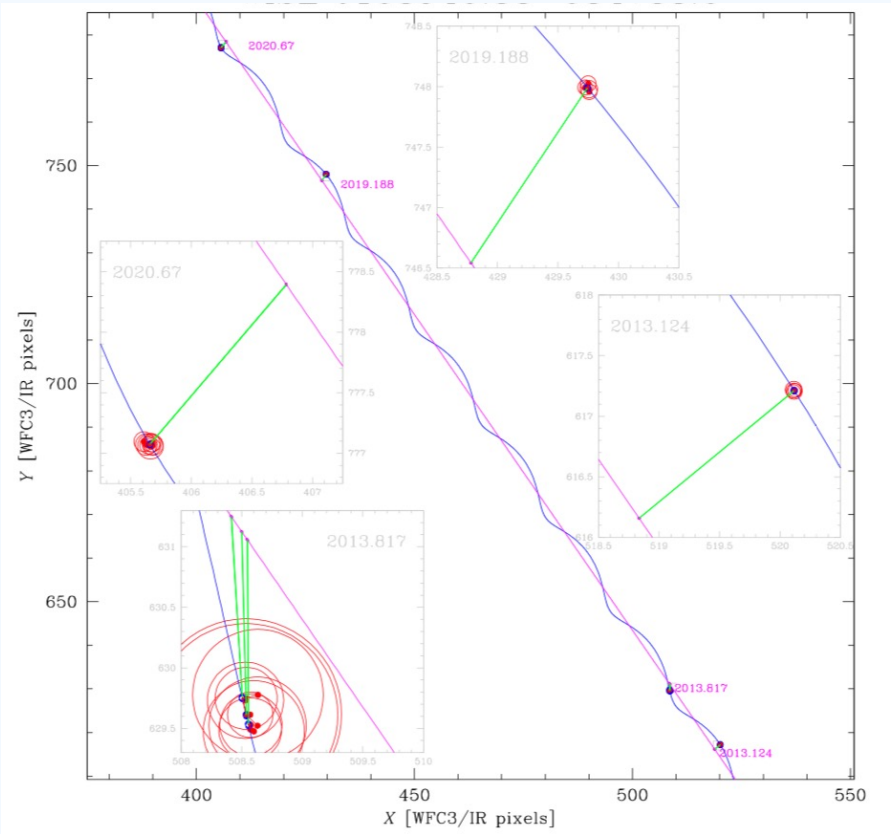
Combining HST and Gaia Astrometry

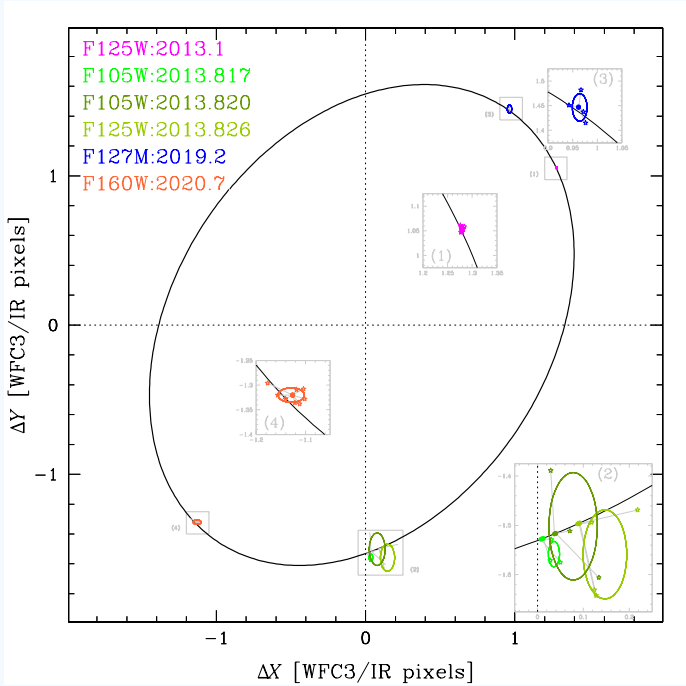


Fontanive et al. 2021

Combining HST and Gaia Astrometry

New astrometric method registering positions of stars in multi-epoch HST images to Gaia ⟶ **Gaia-like astrometric solutions for Y dwarfs**
(sub-mas precisions on parallaxes and proper motions, <1% uncertainties)



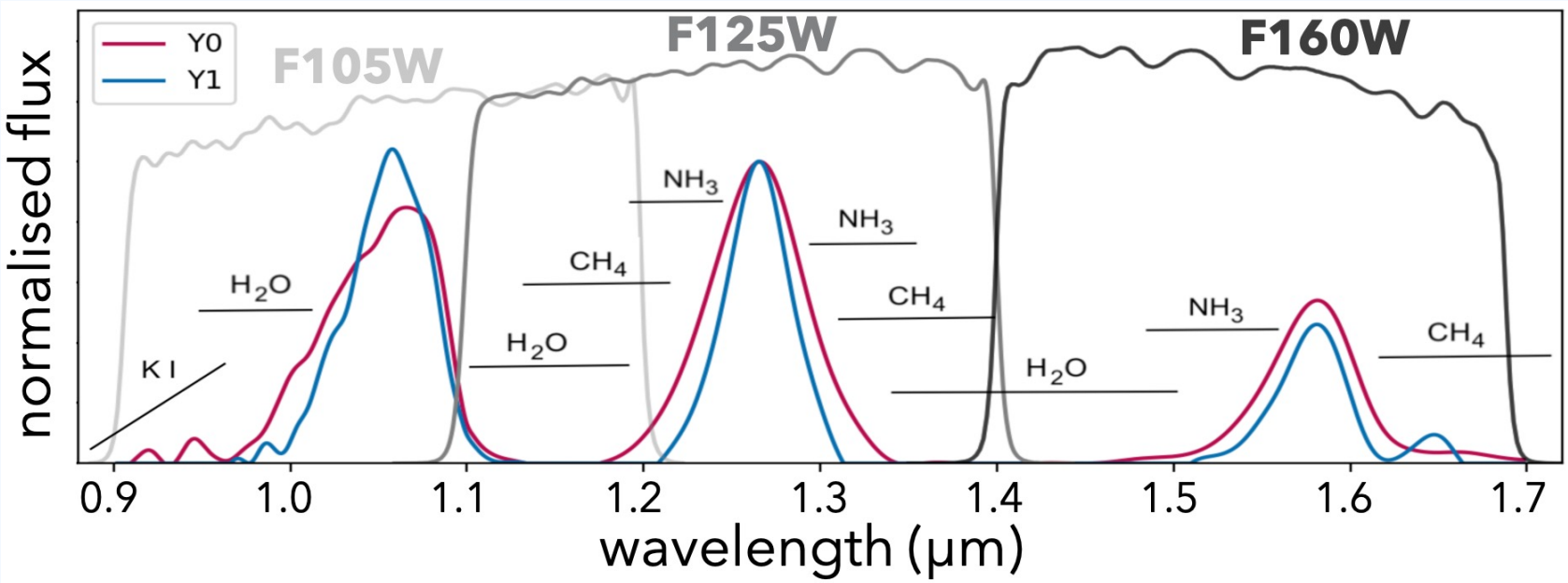


Bedin & Fontanive 2018, 2020
Fontanive et al. 2021

New HST Program

<u>26-orbit HST program (PI Fontanive, GO 15201</u>):

- Precises fluxes in 3 WFC3 filters for 20 Y dwarfs
- All epochs and baselines needed for astrometric solutions

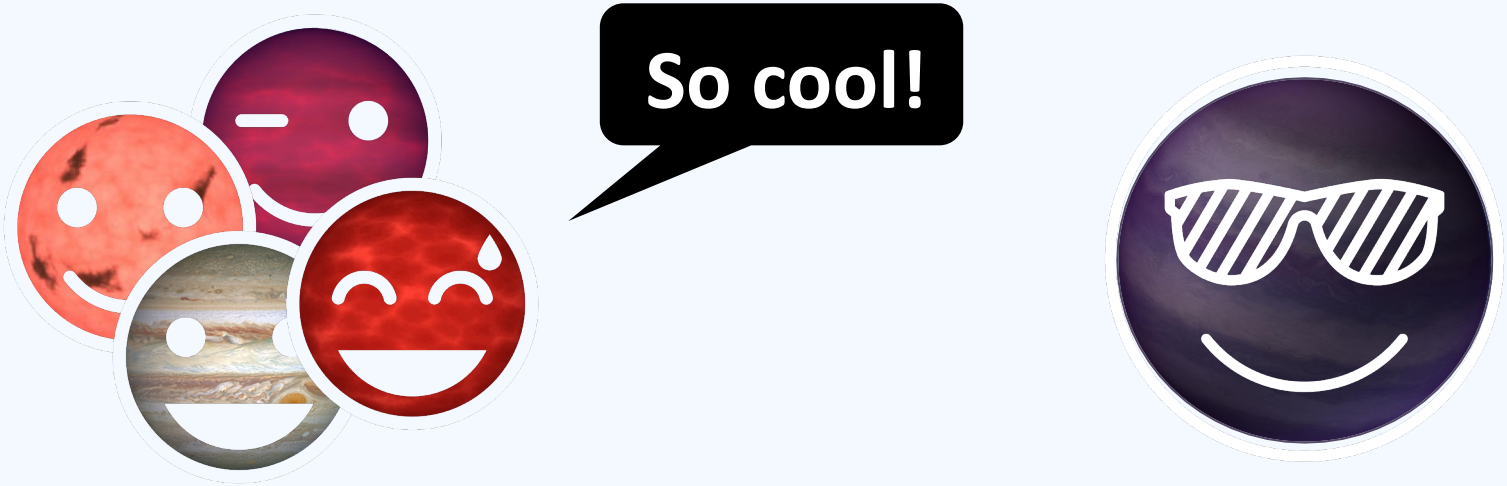


Future Goals

- New distances and proper motions

  volume density, IMF ⟶ *formation processes*
- Magnitudes and colours in the NIR

  clean CMD ⟶ *atmospheric effects*



AoT returns…

Astronomy on Tap is back in Montréal!

Talk to me to get involved in the organisation, give a talk, or help out at the events

Next event on June 6th (in French)