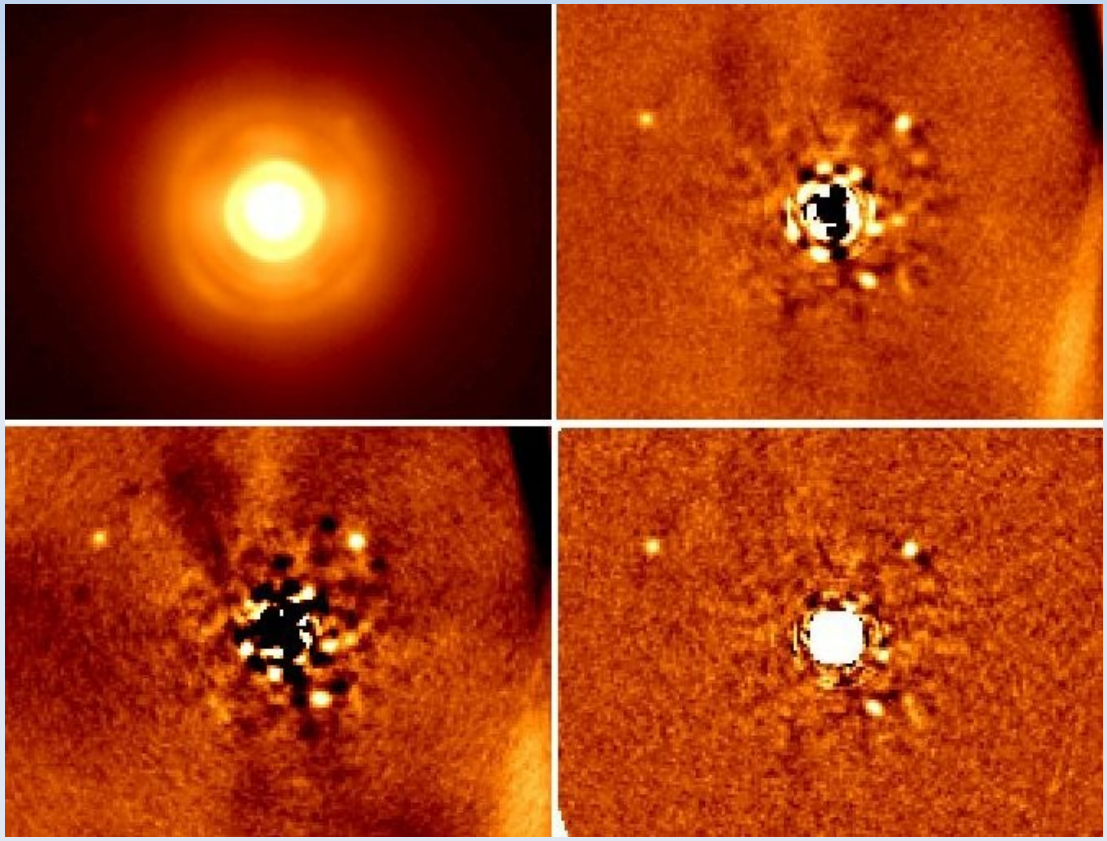
From Adaptive Optics to Exoplanet characterization

Philippe Delorme, IPAG



With AM *Lagrange., G. Chauvin* (**Exoplanets, Adaptive Optics**)

T. Forveille, X. Delfosse. (**Brown Dwarfs**)

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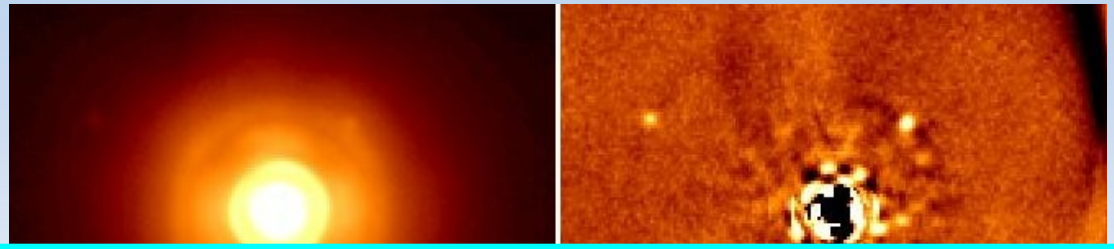
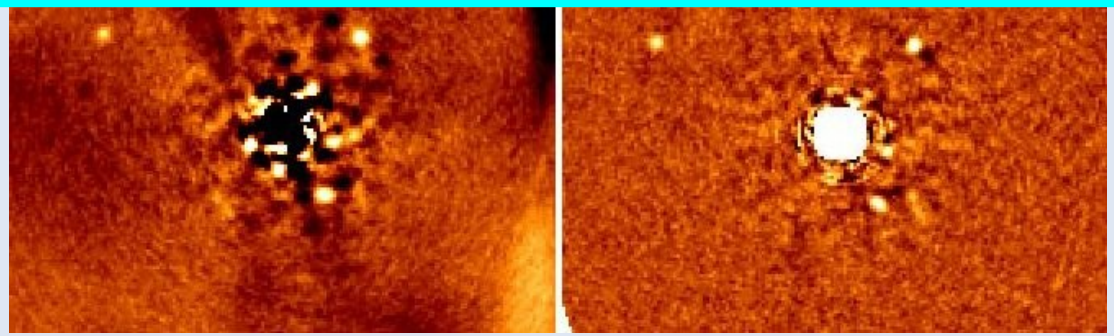


The challenge of extracting physics from dots



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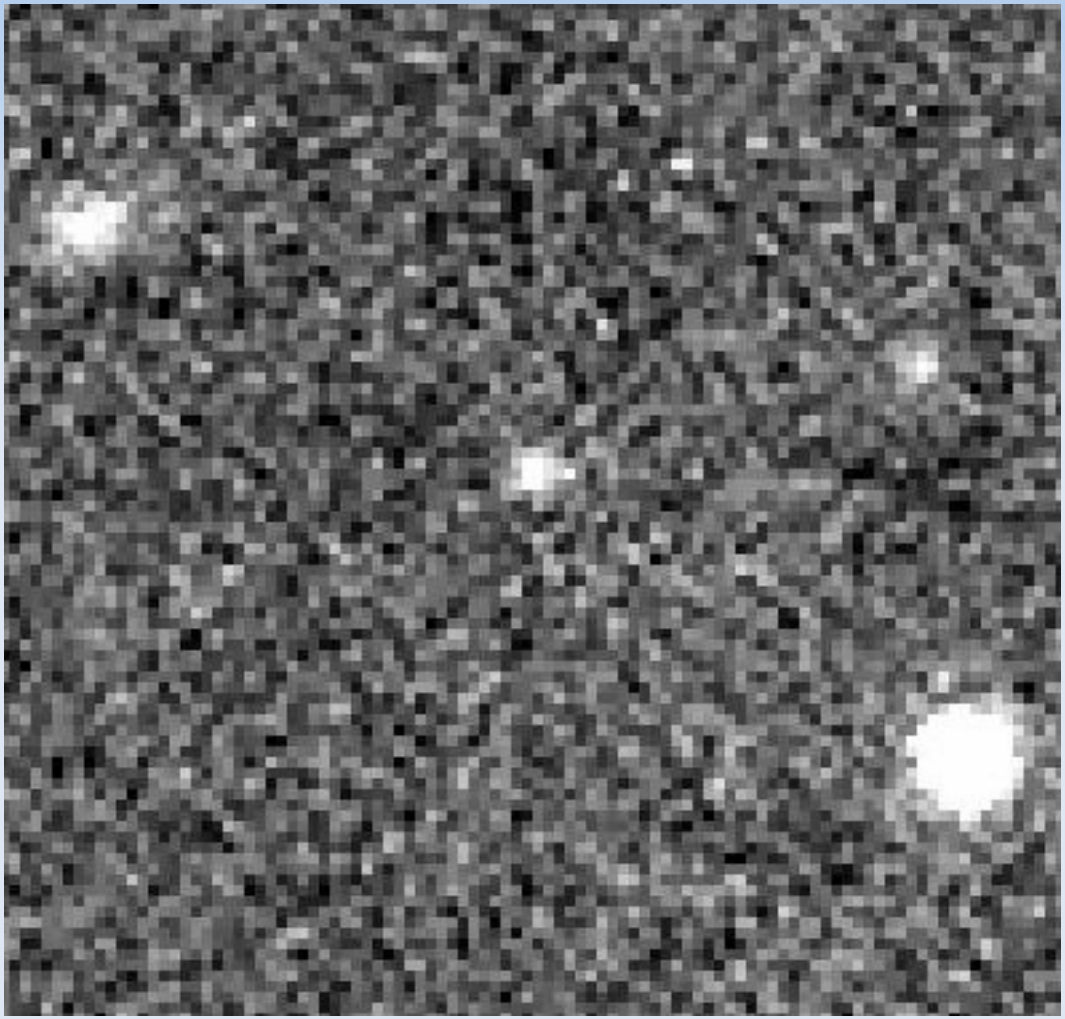
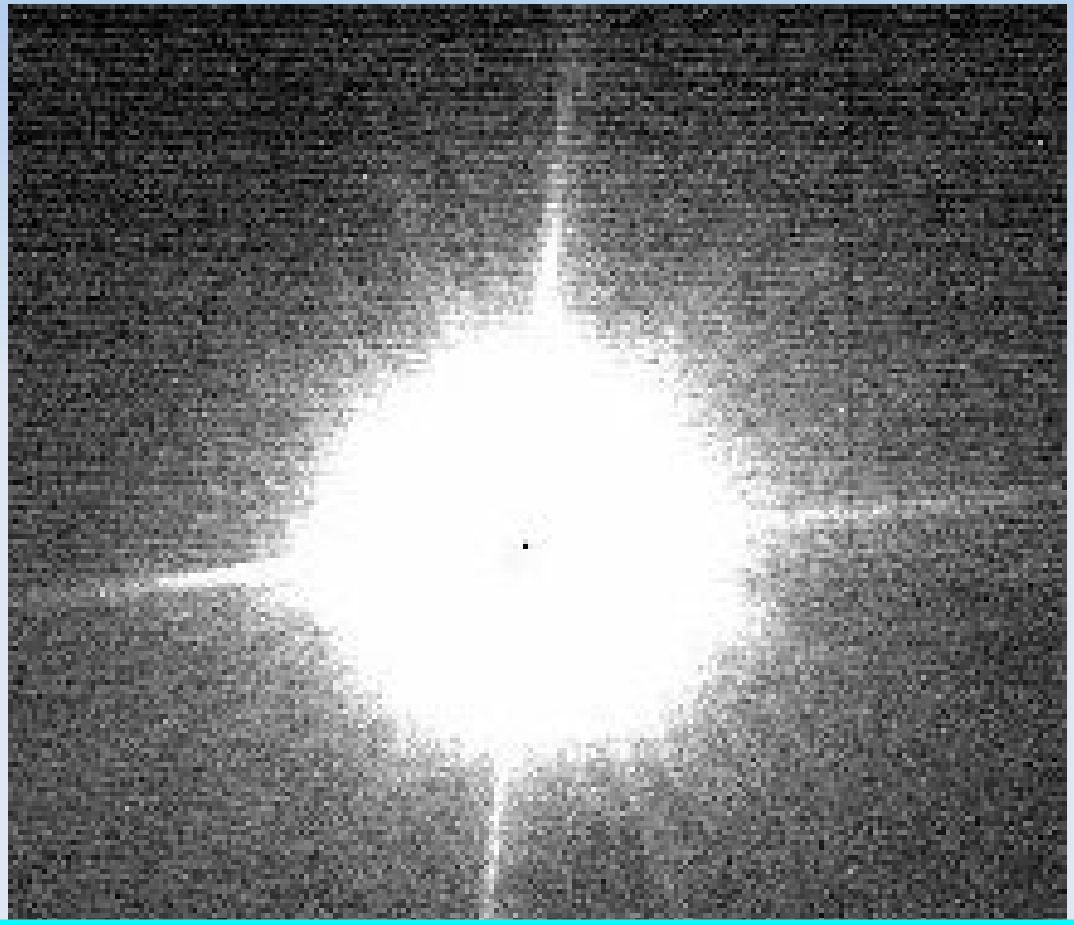
Detecting exoplanets by AO imaging

Main issue:



Detecting exoplanets by AO imaging

Main issue:



Need to remove the central star !

Exoplanet atmospheres

- Some information from transmission spectra of transiting irradiated hot-Jupiters.
- Some photometric information on HR8799 late L to early T planets. Low resolution spectra of 2M1207, Ldwarf and HR8799b.

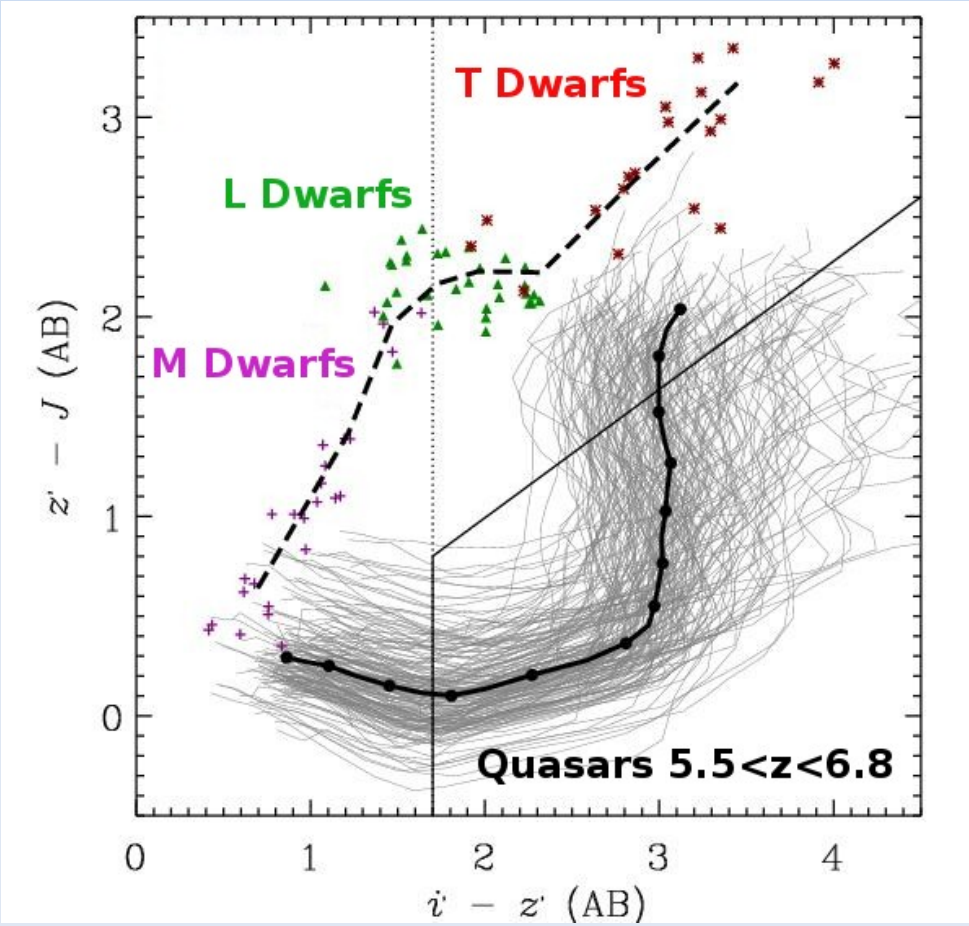
→ SPHERE should discover 1-5M_{Jup} T-Type exoplanets *but models are not tested in this range.*

What will SPHERE exoplanets' atmospheres look like?

Perhaps we have an answer now!

CFBDS:a wide field survey for brown dwarfs at CFHT

=> 800 square degrees in i' and z', up to z'=22.5 in 5mn exposure time
=> more than 30 000 000 astrophysical sources.

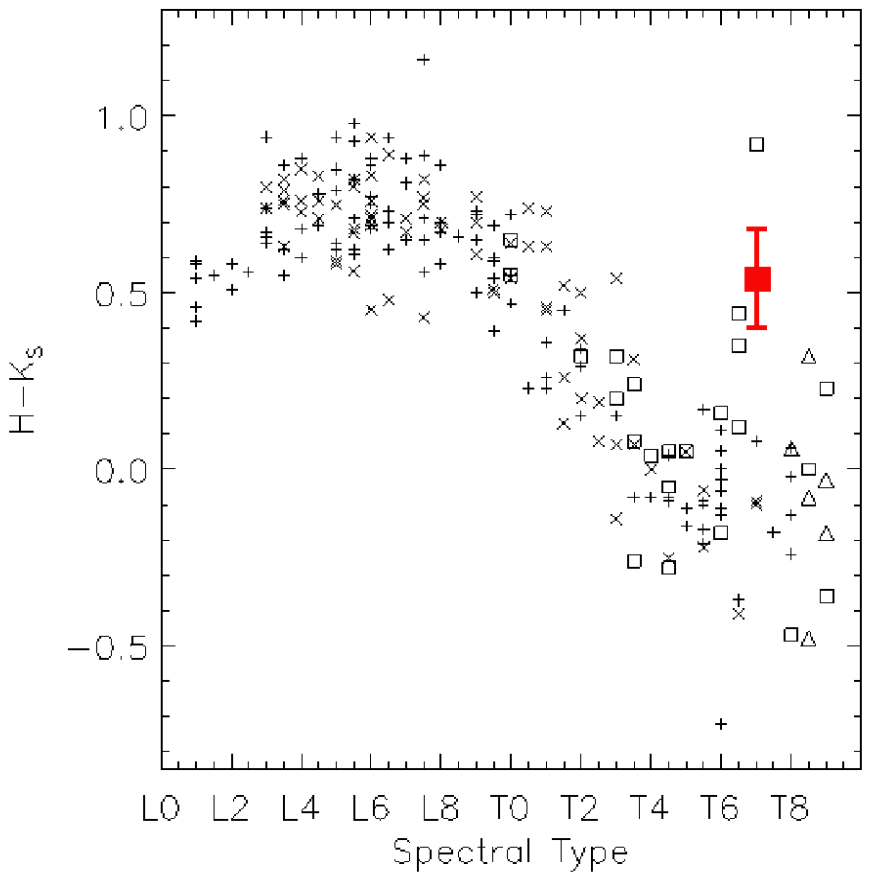


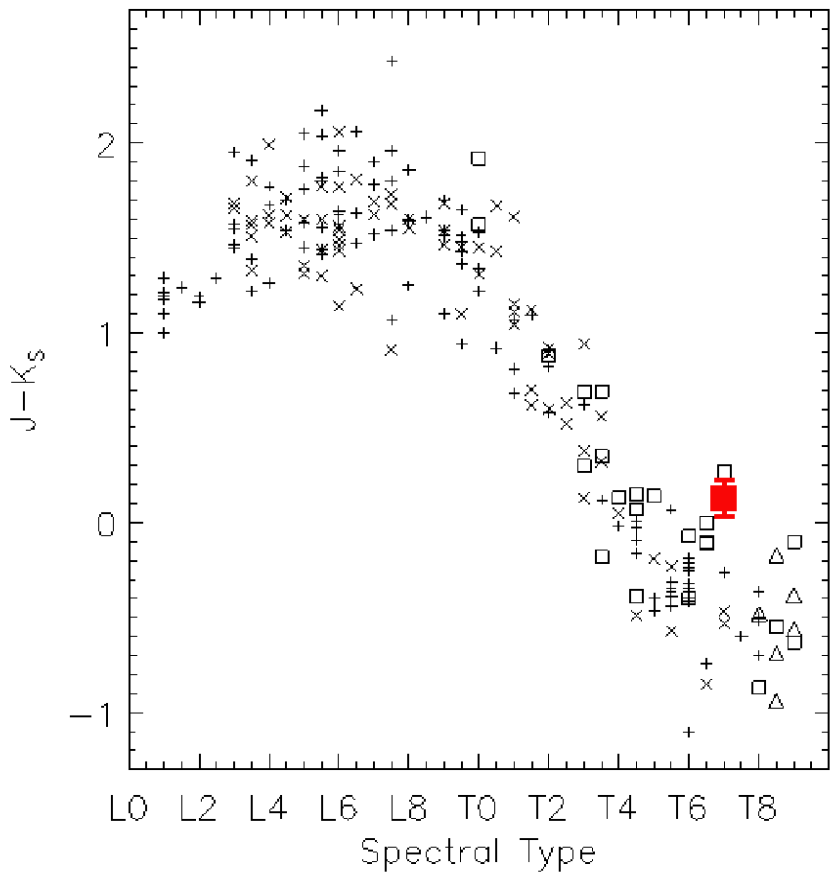
Selection of very red point-sources.
~50 nights of NIR follow-up (NTT-3.6m)

>300 L and T dwarfs
Quasars collaboration
~20 quasars, redshift >6

From Delorme et al, A&A, 2008b,

Atypical red colours

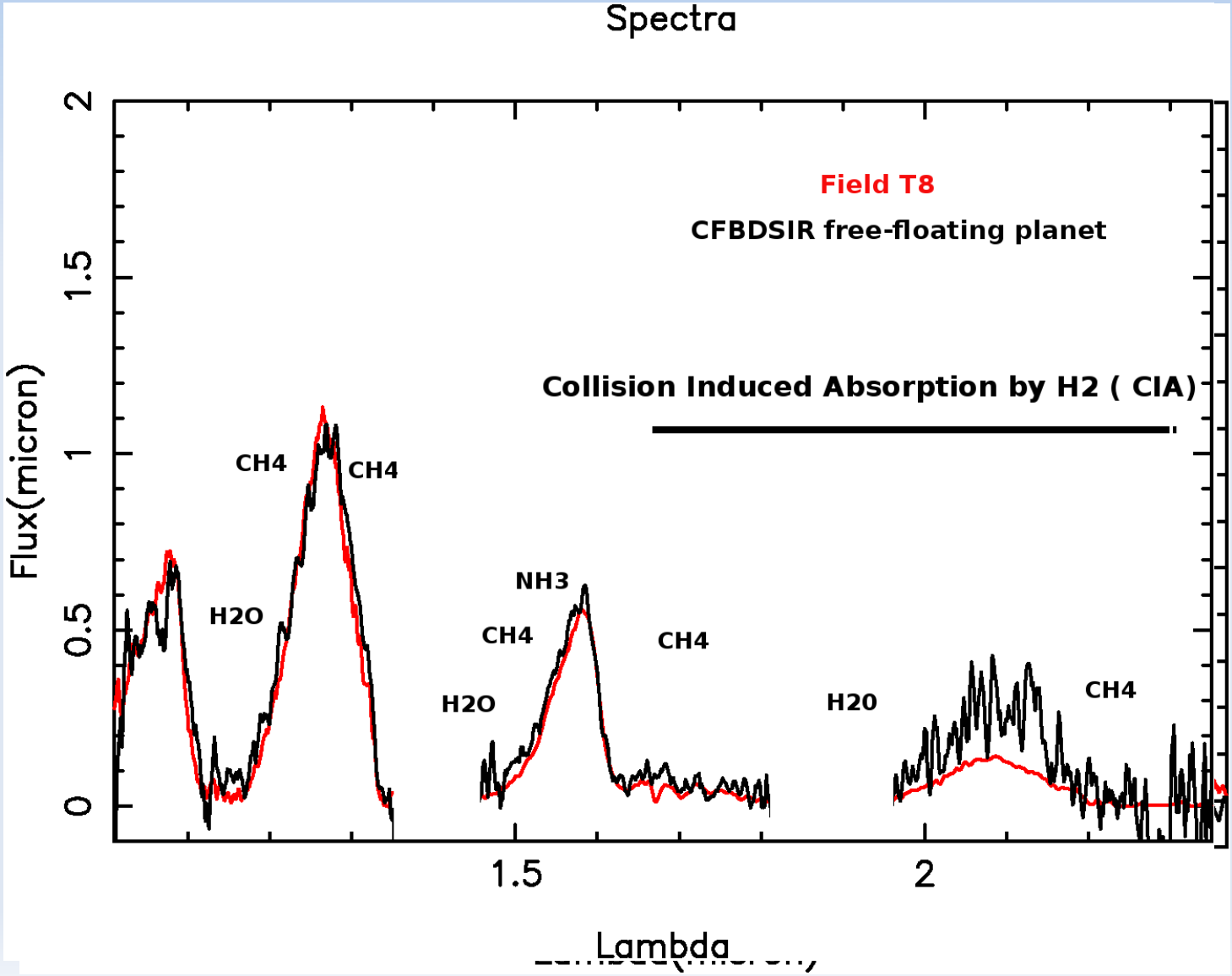




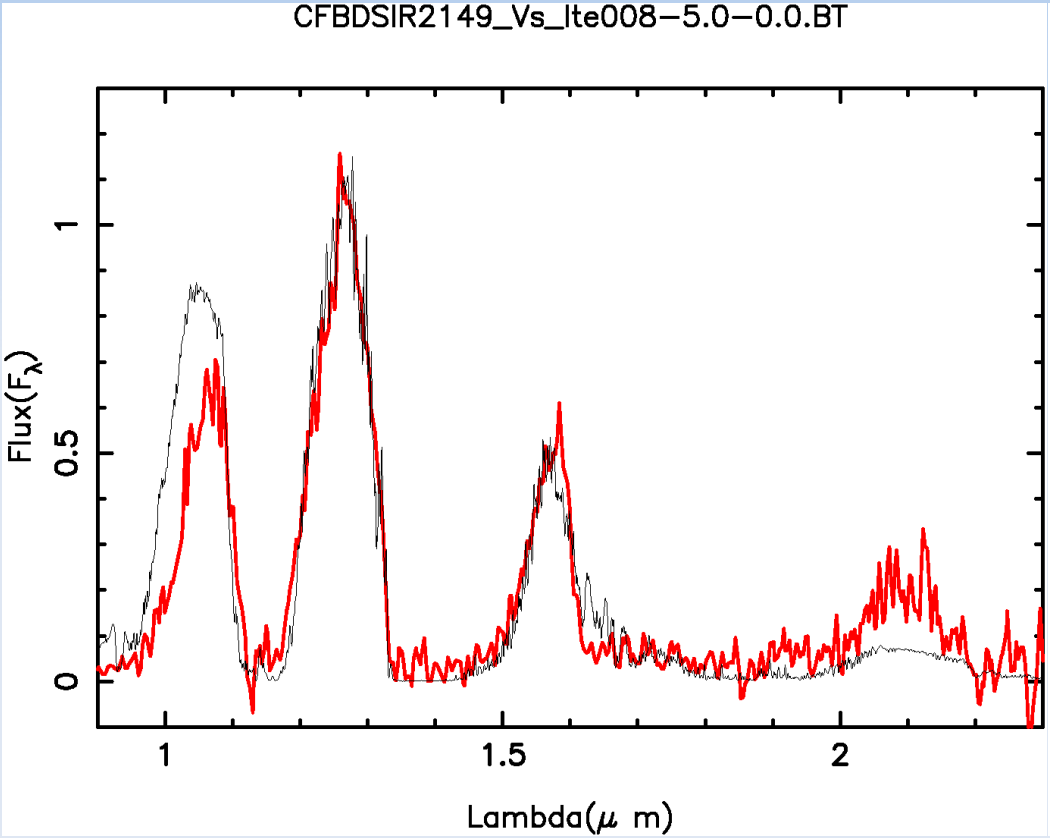
CFBDSIR2149 against **known brown dwarfs**

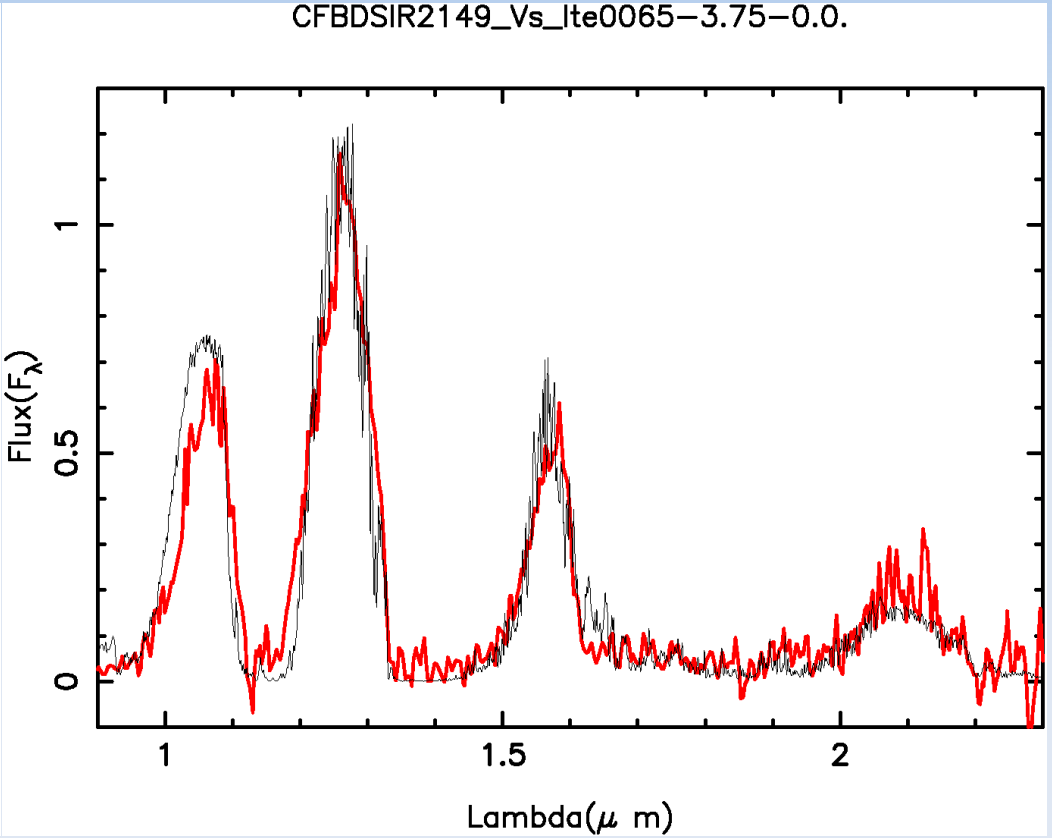
Compare with field brown dwarfs

Comparison with a T8 BD



A low gravity object ?





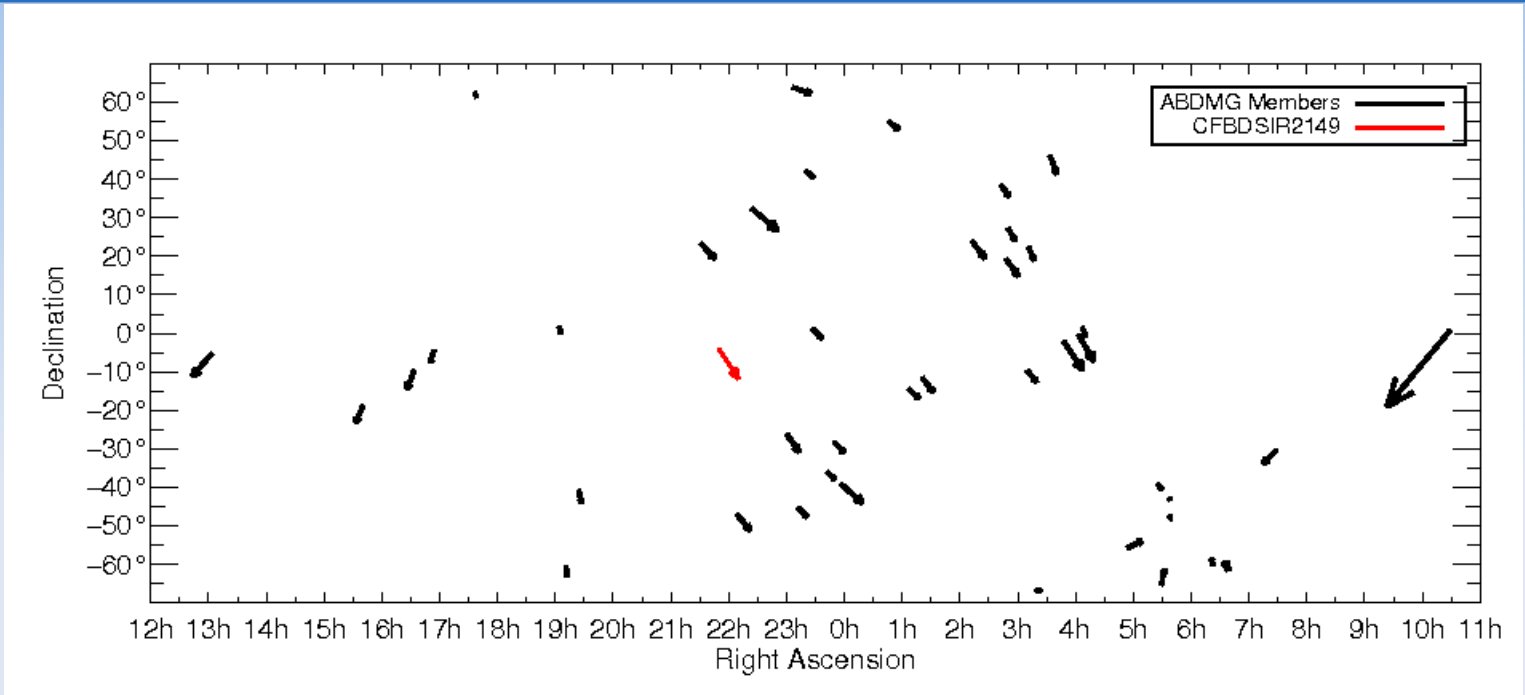
Field gravity model

Observed spectrum

Low gravity model

Observed spectrum

An AB Doradus member ?

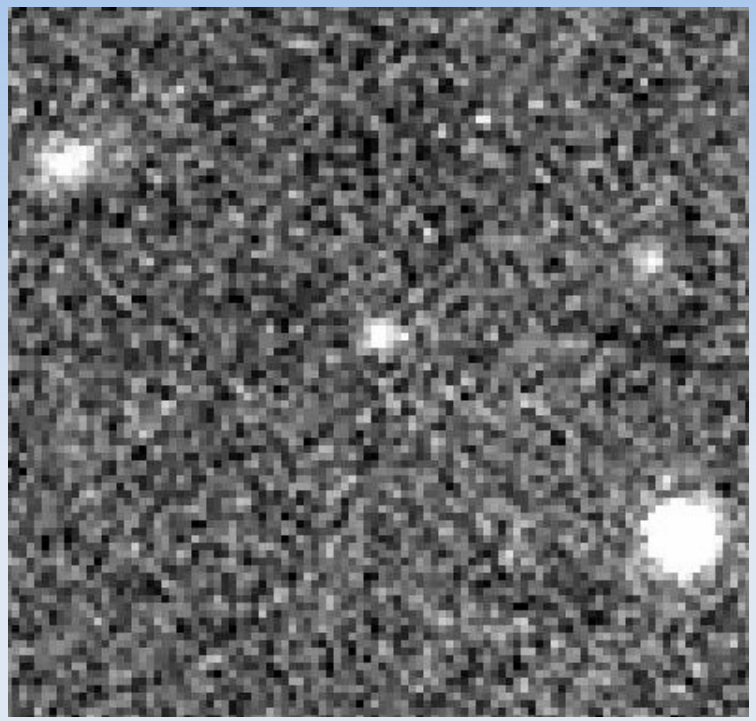


- Bayesian kinematic analysis using 2D proper motion and weak photometric distance constraints :

  = > **87% chance to belong to AB-Doradus** (as well as 6% to Beta Pictoris and 7%the field)

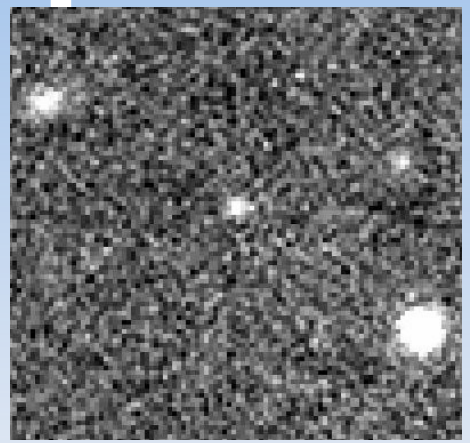
  Takes the much higher field star density into account in the prior.

A free-floating planet?



- Brown dwarf candidate confirmed **with a weird photometry.**
- **X-shooter** spectra from 0.8 to 2.5 micron and find low gravity features. *Did we miss other FFP?*
- Proper motion much more **compatible with AB Doradus** than with the field

What to do with a free-floating planet ? Step 1



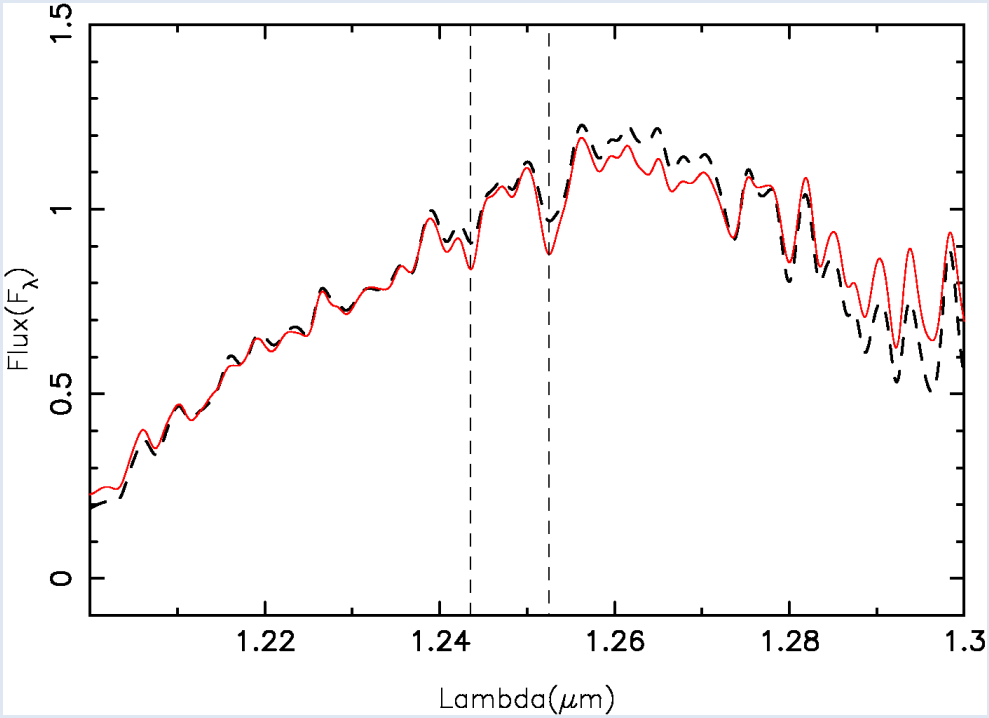
- **Test planetary evolution and atmosphere models !**
- Get the parallax. Derive the absolute flux**.** ***Radius issue?***
- Accurate proper motion :confirm whether it belongs to young moving group. **Get the age !**
- **Check** if **planetary models** are overluminous <=>*Are exoplanet imagers capabilities estimation ok?*
- Use spectra, age and absolute luminosity to understand where models got it wrong.

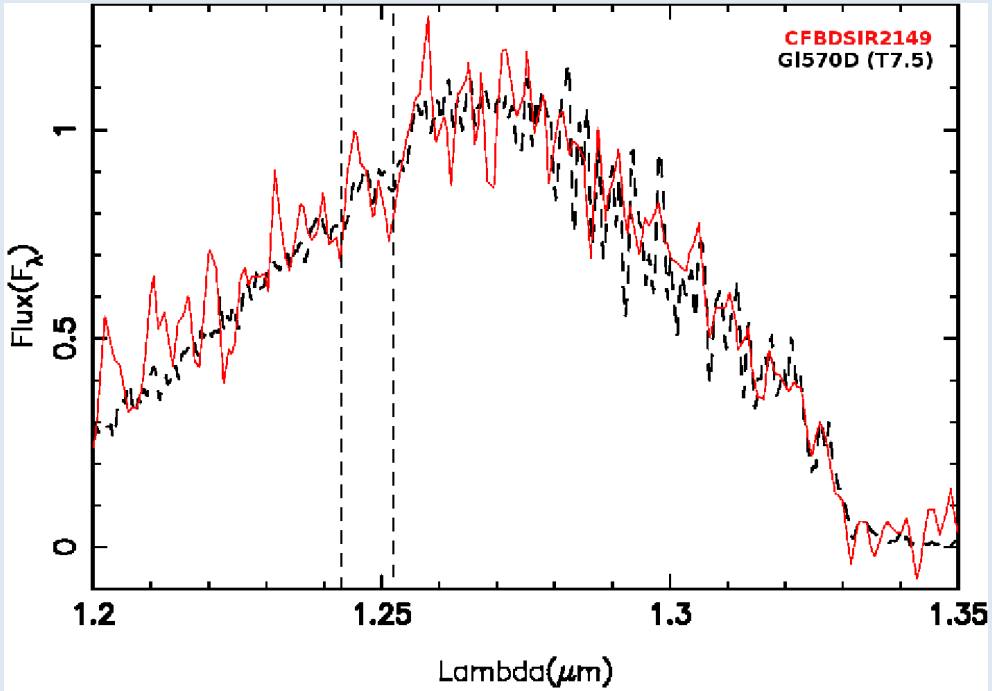
What to do with a free-floating planet ? Step 2

- **Identify low gravity (planetary-mass) features :**

  K-band flux enhancement

  Potassium doublet (need more SNR !). Others?



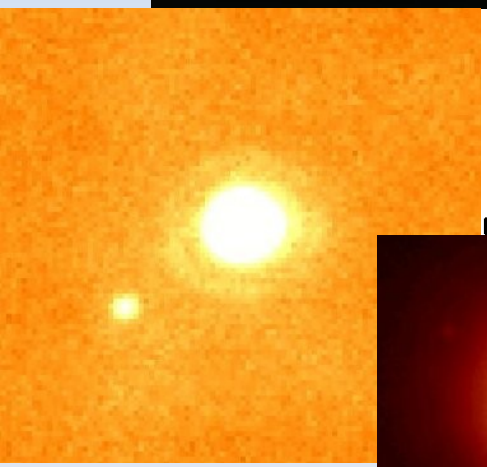


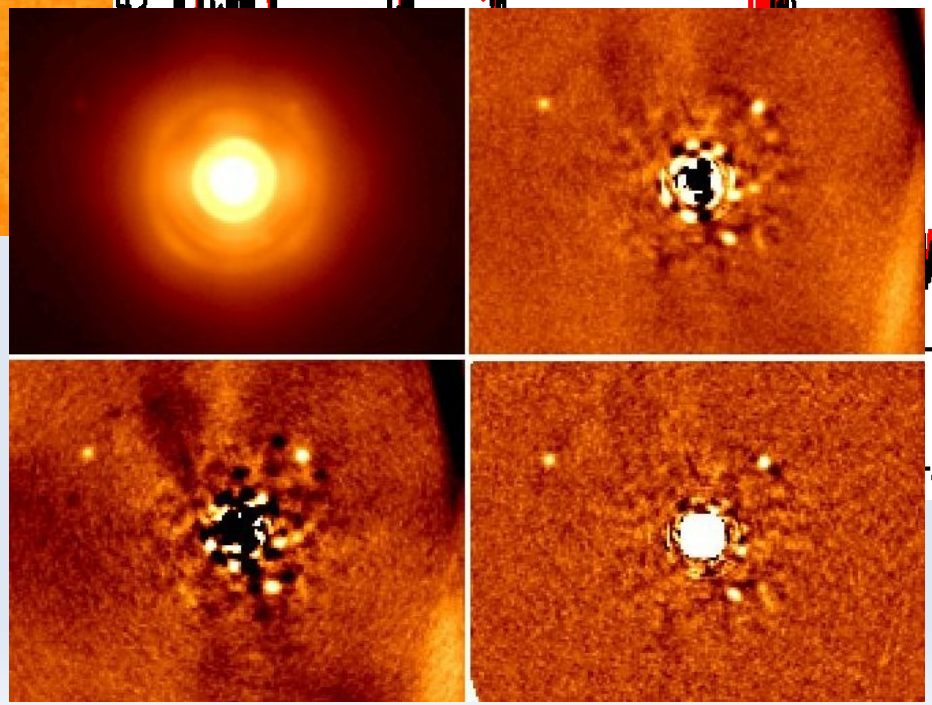
What to do with a free-floating planet ? Step 3

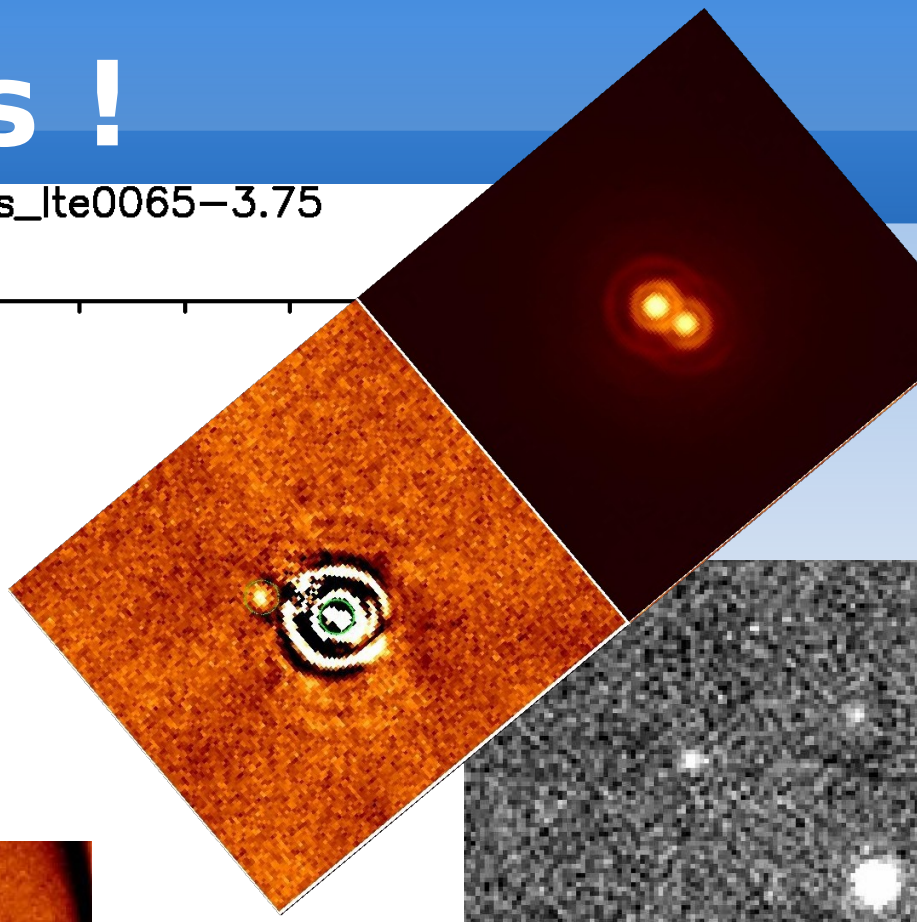
- ***Find exoplanets*** with the same mass/age range ***with SPHERE***

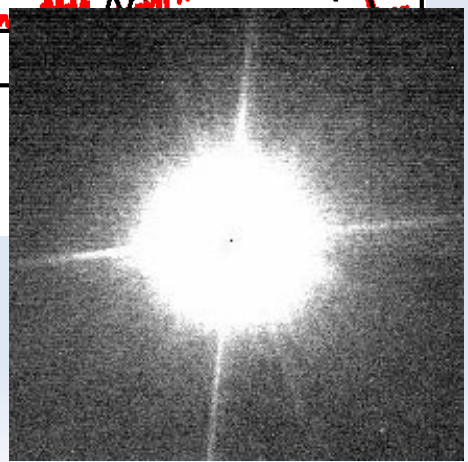
- ***Use*** the high S/N high resolution spectra of ***CFBDSIR2149 as a benchmark to understand*** the photometry and the low resolution spectra, and therefore ***the physics of the exoplanets.***

Thanks !







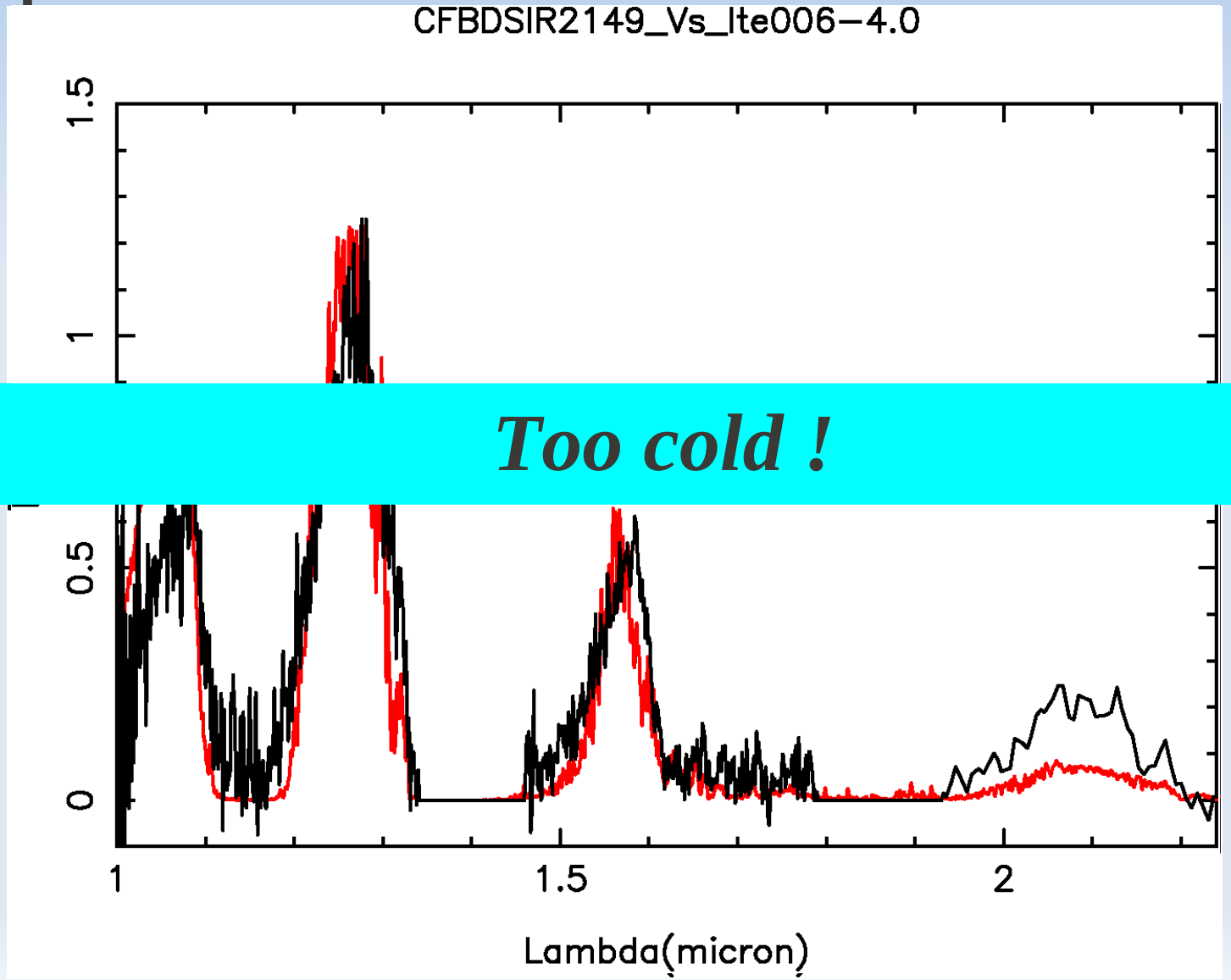


CFBDSIR2149_Vs_lte0065−3.75

ron)

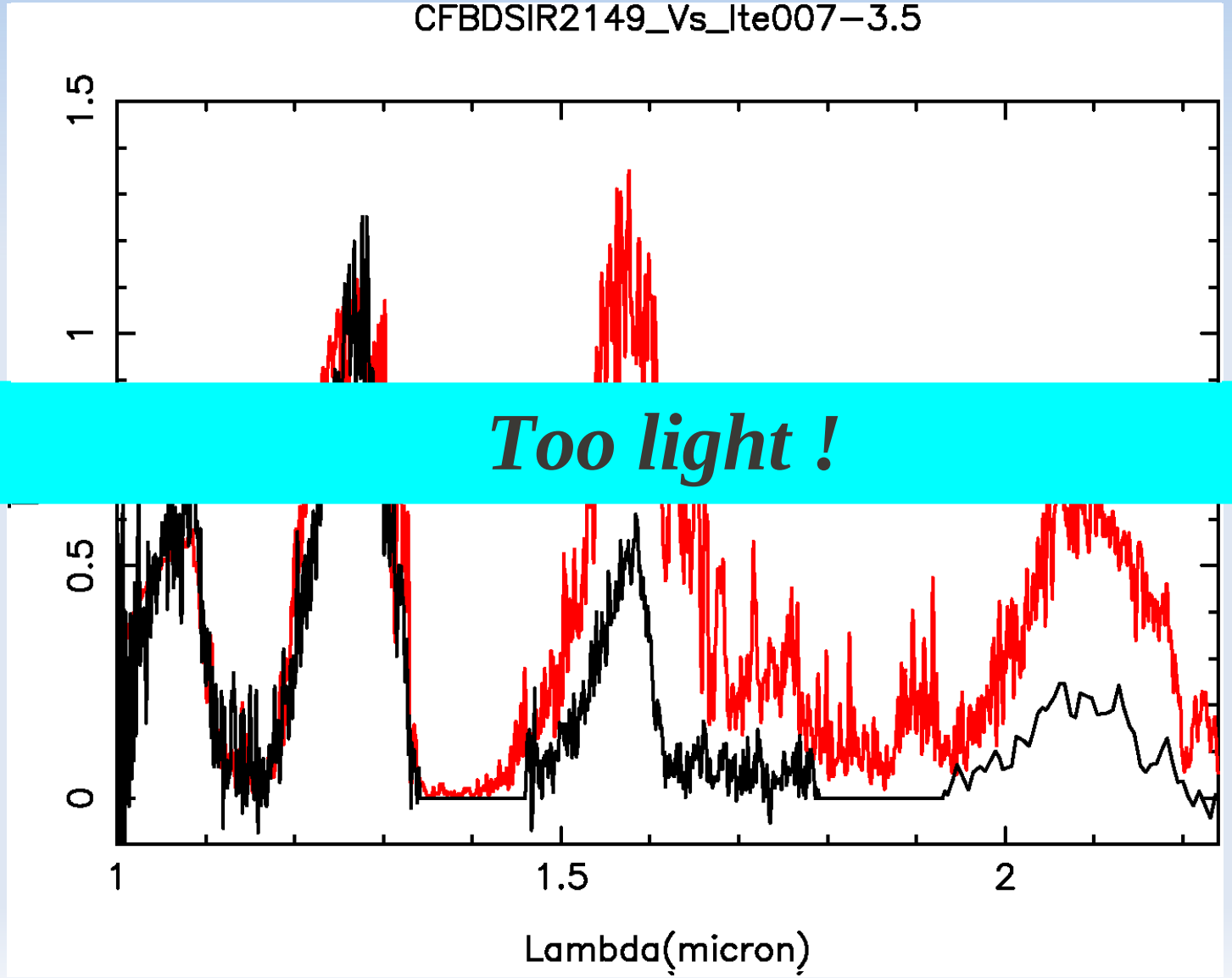
Deriving Teff from models

- Compare your spectra to model spectra and look at **temperature** sensitive molecular features.



Deriving log g from models

- Compare your spectra to model spectra and look at **gravity** sensitive molecular features.



A planetary mass object with temperature in the liquid-water range

=> **Teff=370+/-40K**

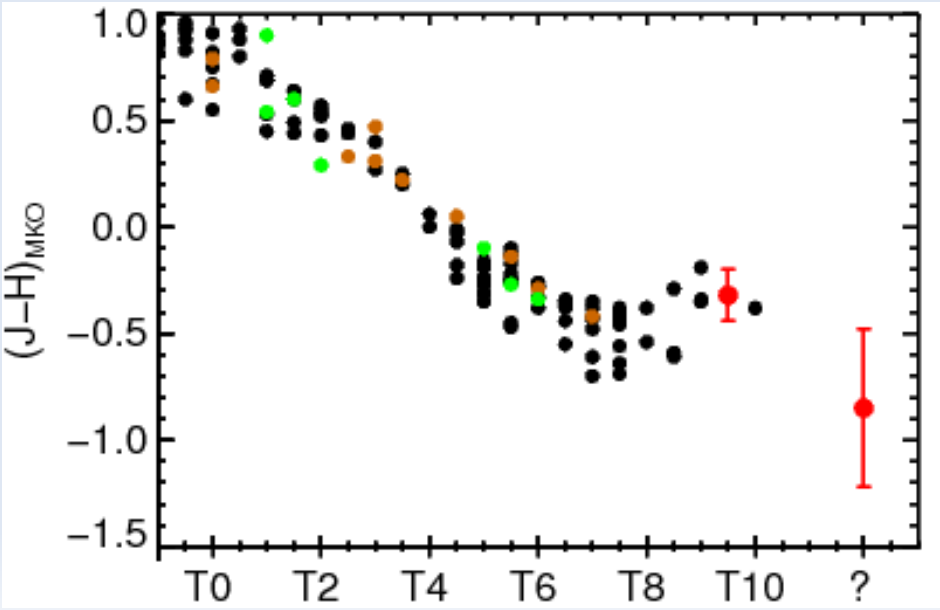
T dwarf or Y dwarf?

Press release *Keck, ESO,CFHT, CNRS, March 2011*

Planetary Mass?

6 Mj if age 1Gyr

14Mj if age 5Gyr



From Liu, Delorme

=> **Atyp**

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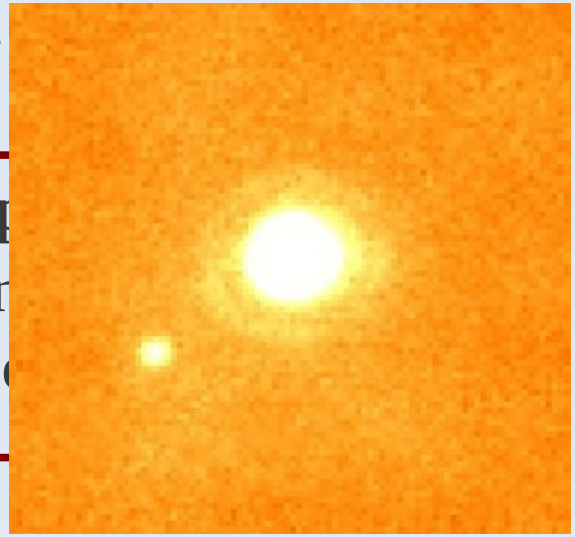
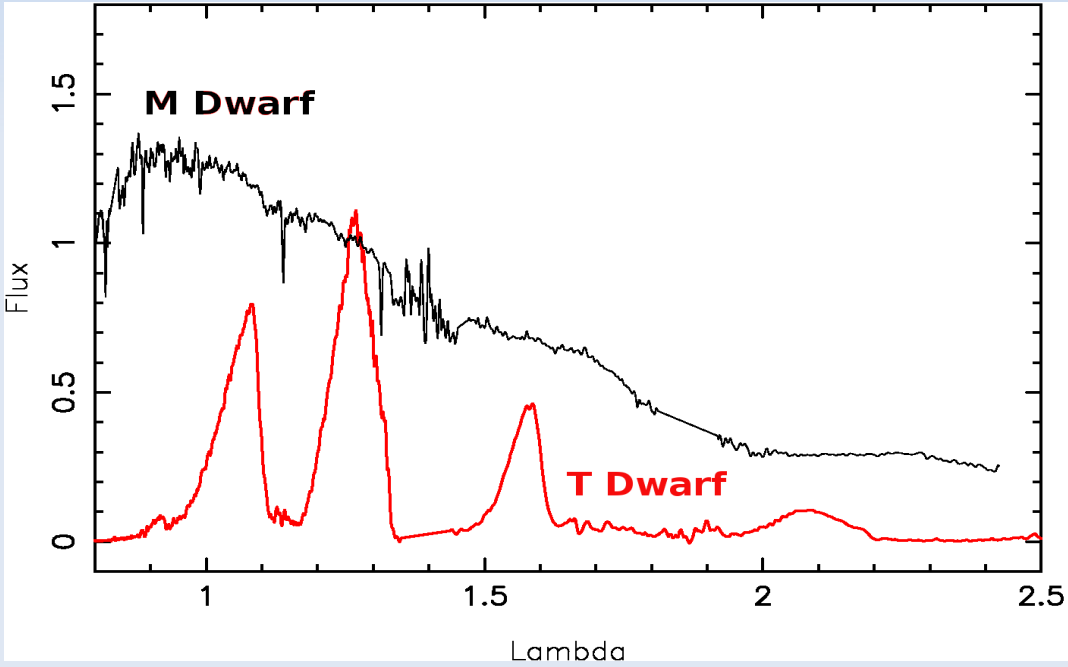


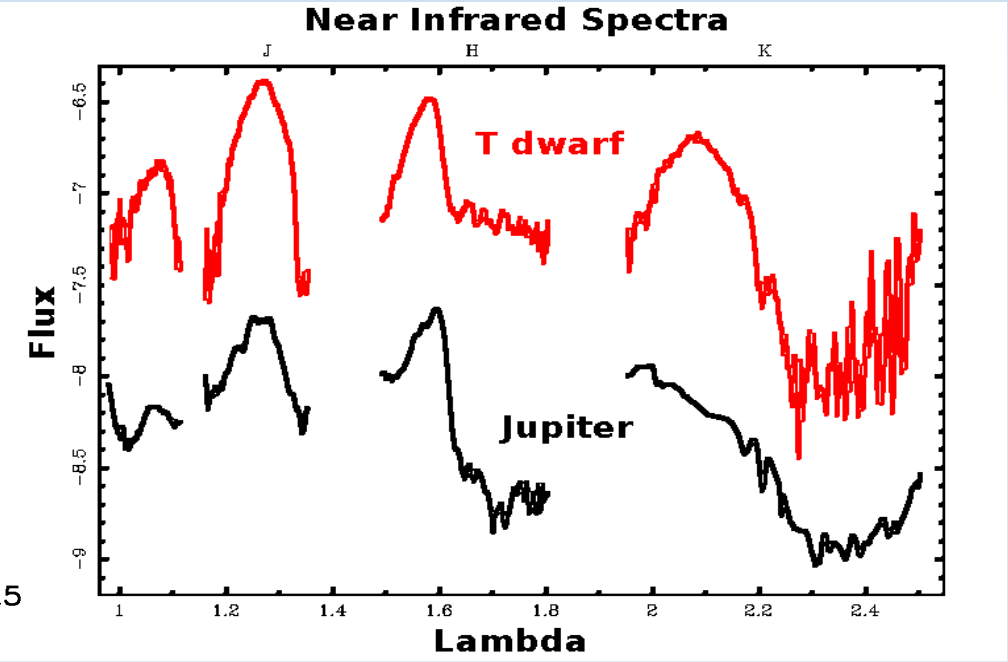
Cool Atmospheres

- **50 T dwarfs NIR spectra**

  => *A diversity in temperature, metallicity and* ***gravity***

- ***Linking stellar and planetary atmospheres physics***





=> ***Jovian-like features*** *appear between ~500K and 100K.*

=> ***Y dwarfs****, missing links between stars and planets.*

=> ***Exoplanets*** *: Low gravity M, L, T, Y spectral types*