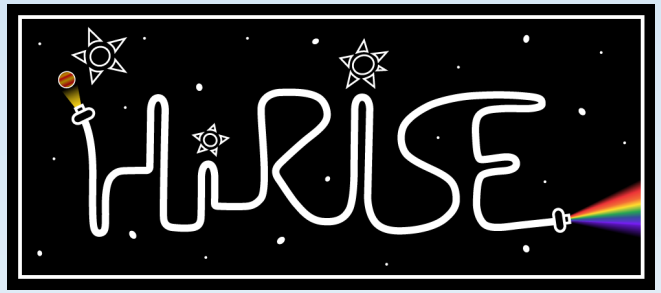


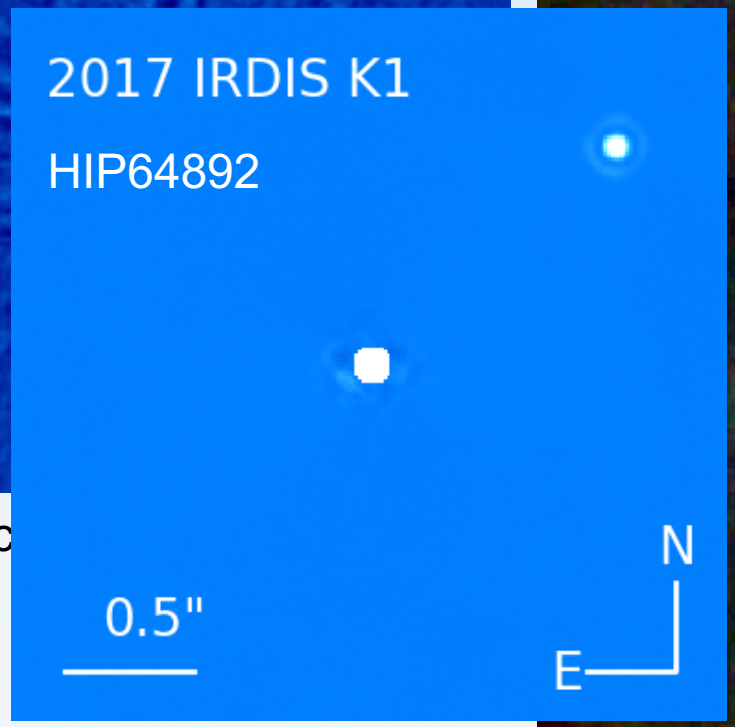
Characterisation of giant planets at high spectral resolution: recent results from VLT/HiRISE and perspectives for the ELT

Allan Denis & Arthur Vigan

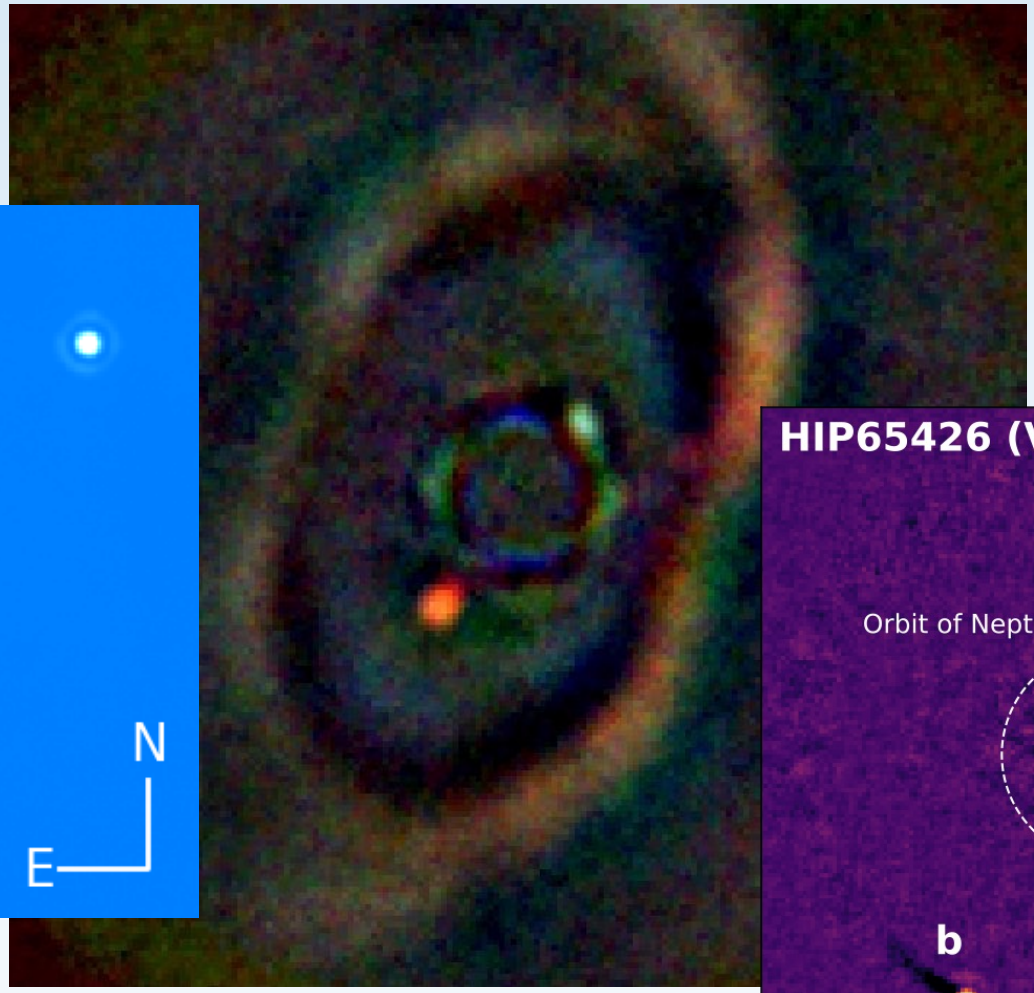
on behalf of the HiRISE consortium

Imaging of planetary systems

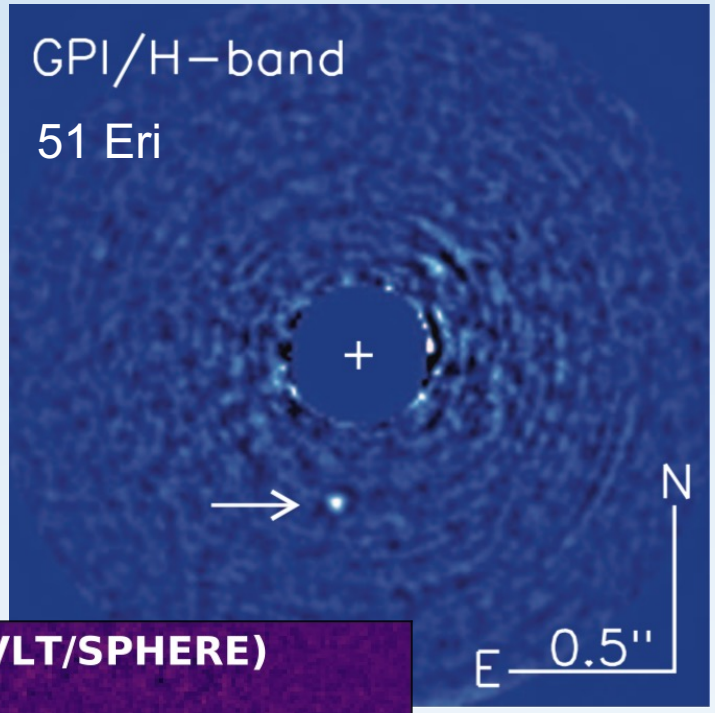
Konopac



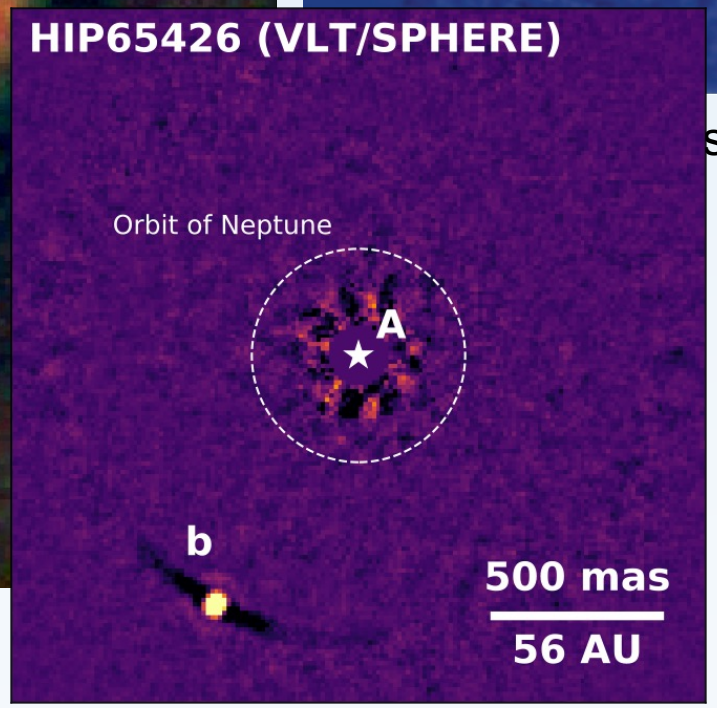
Cheetham et al. 2018



PDS 70 - Keppler et al. (2018)

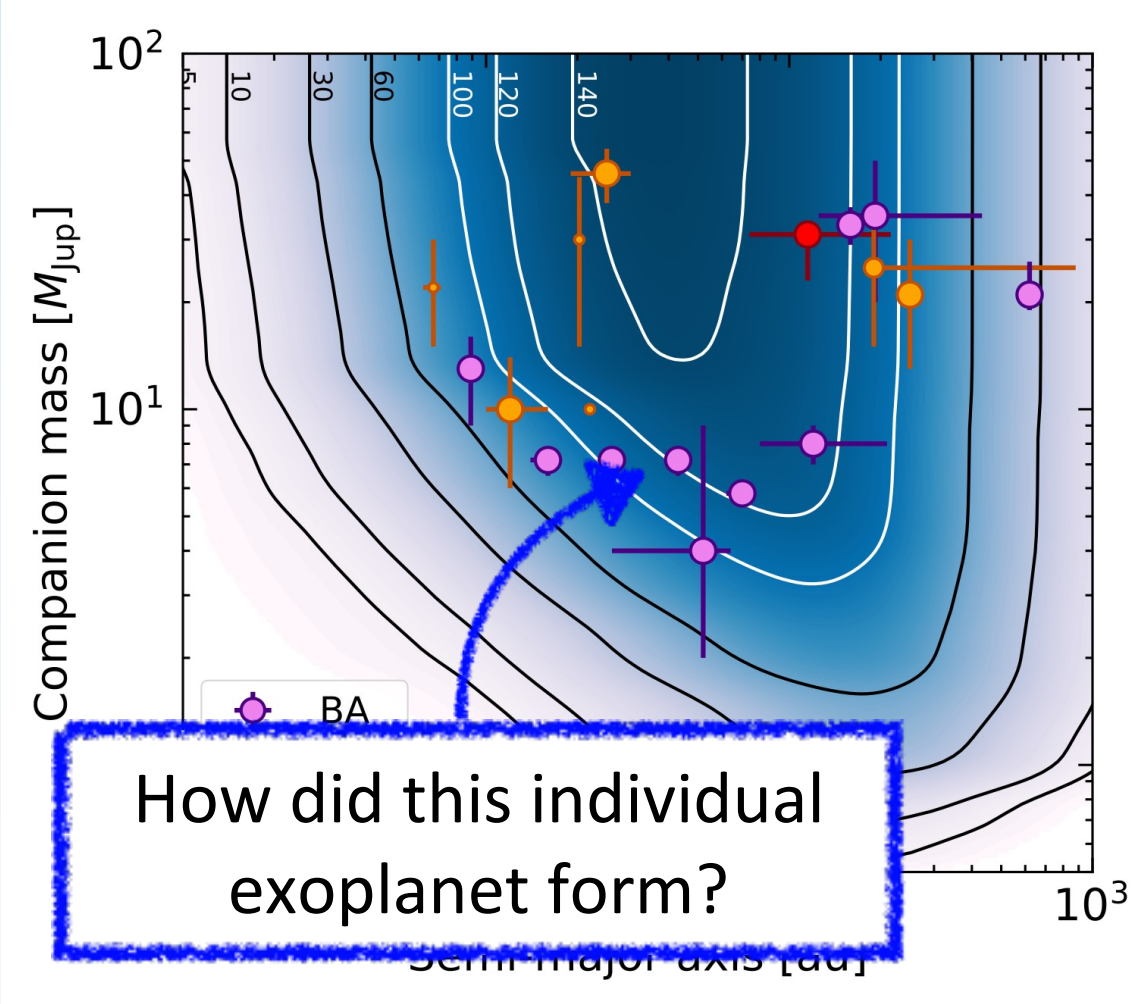


sh et al. 2015



Chauvin et al. 2017

Imaging of planetary systems

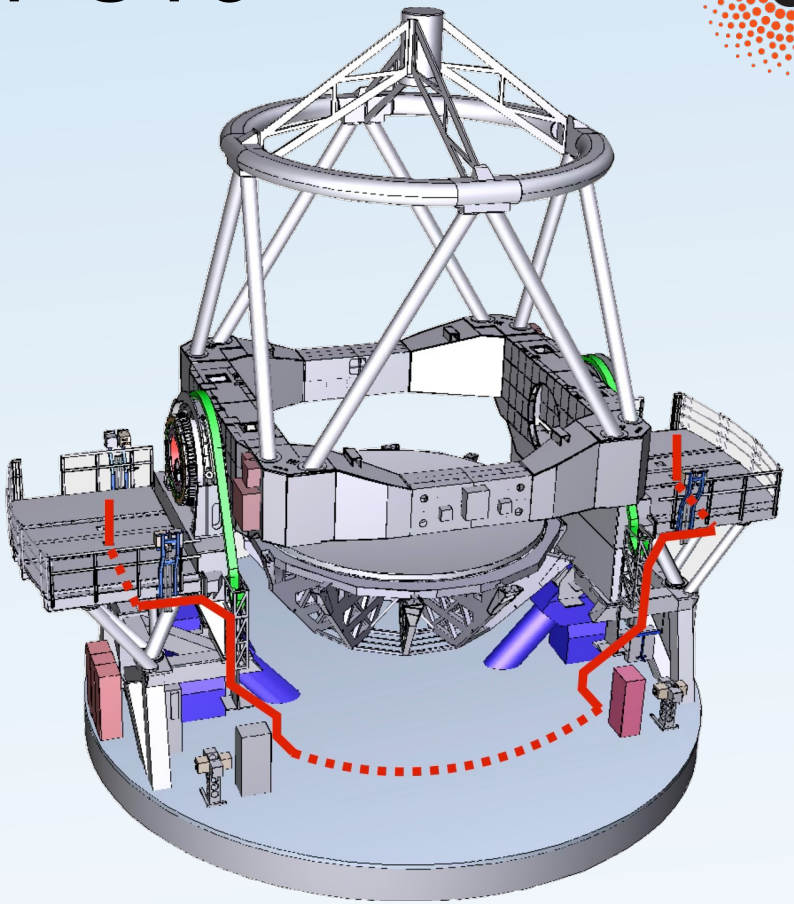


- Instruments like SPHERE or GPI designed for large-scale search and statistics
- Less for characterisation
  - Low-resolution spectroscopy (R~50)
  - Relative astrometric accuracy only

Need for high spectral resolution!

Nielsen et al. (2019)
Vigan et al. (2021)

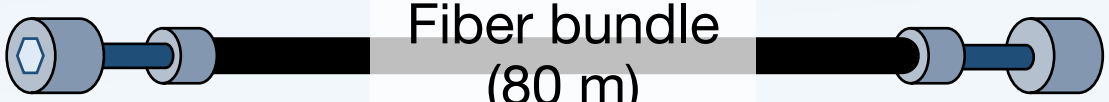
HiRISE @ VLT-UT3



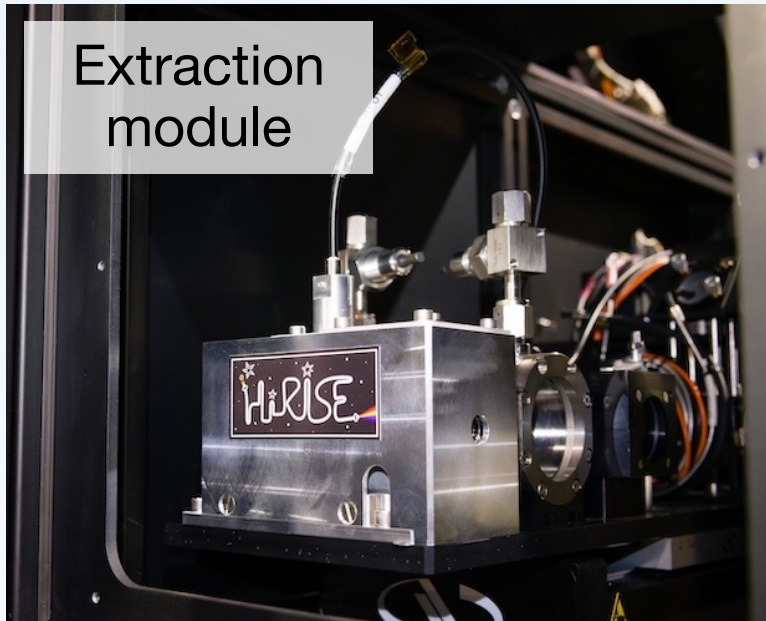
- Visitor instrument for the VLT
- 6 years of development, ~22 FTEs
- First light: summer 2023
- H-band at R~140 000

SPHERE

Injection module



Fiber bundle (80 m)



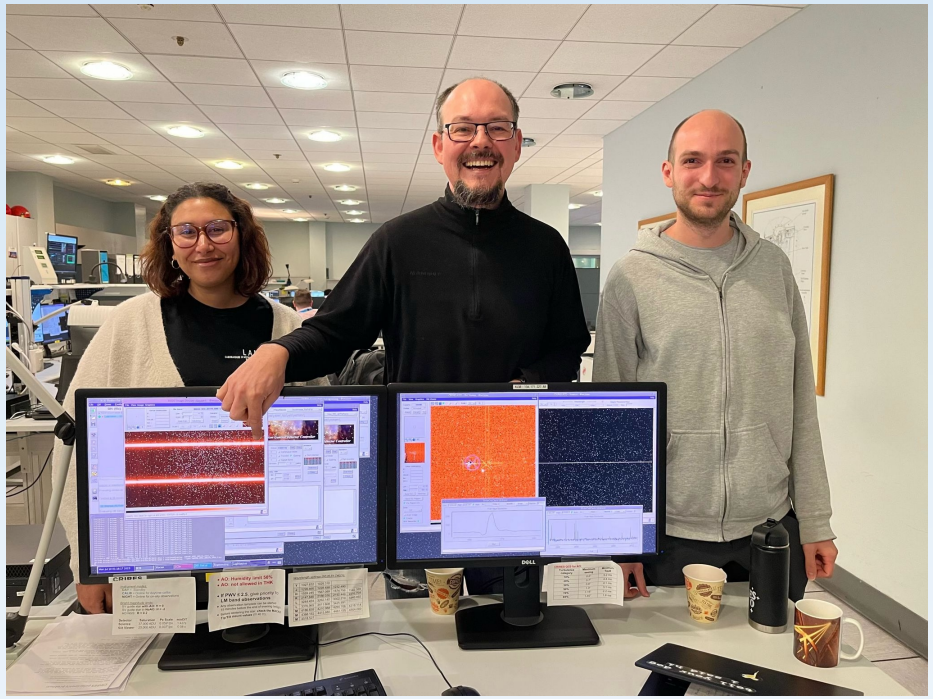
Extraction module

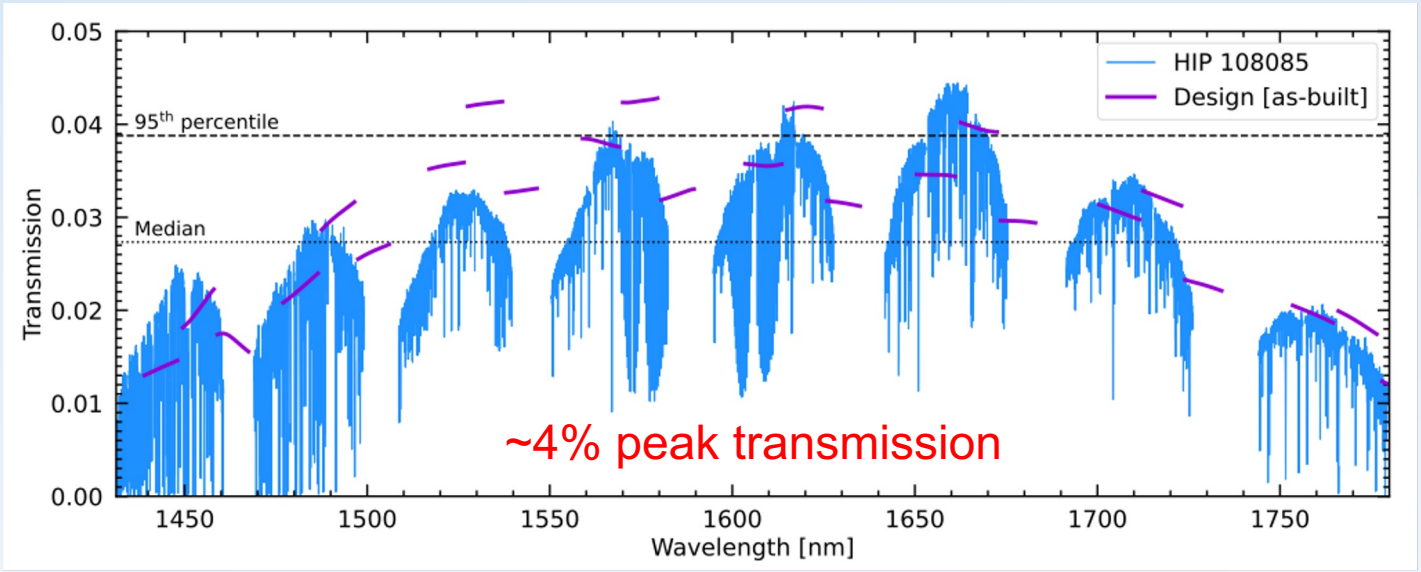
Vigan et al. (2018)
Otten, Vigan et al. (2021)
El Morsy, Vigan et al. (2022)
Vigan et al. (2024)

Costes et al. (2024)
Denis et al. (2025)
Denis et al. (in prep.)

HiRISE @ VLT-UT3: first light

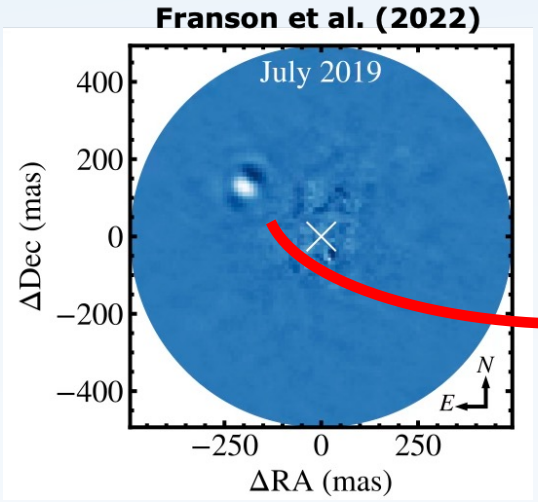
Vigan et al. (2024)

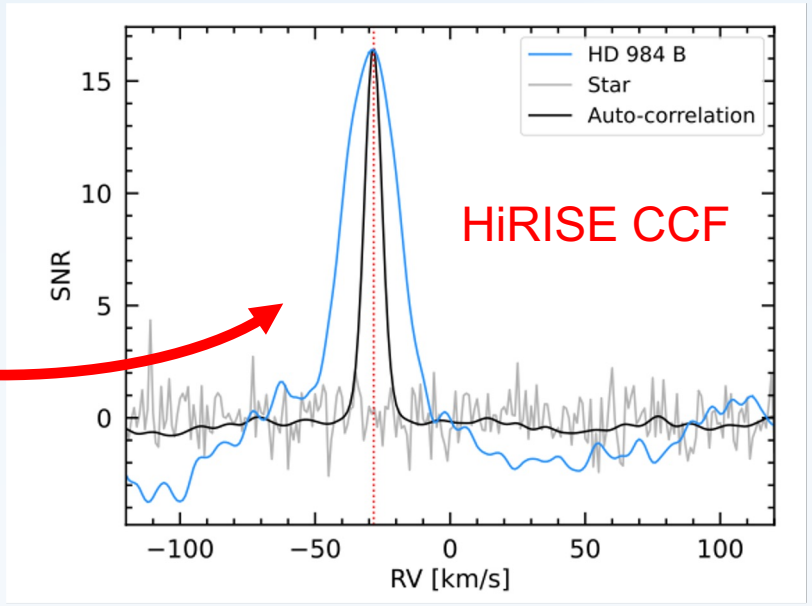




First science target: HD984B

- Least-square CCF analysis
- BT-Settl model at T_{eff} = 2700K
- v_{orb} sin i = -31 km/s, v_{rot} sin i = 13 km/s
- Value in agreement wit KPIC data (Costes et al. 2024)

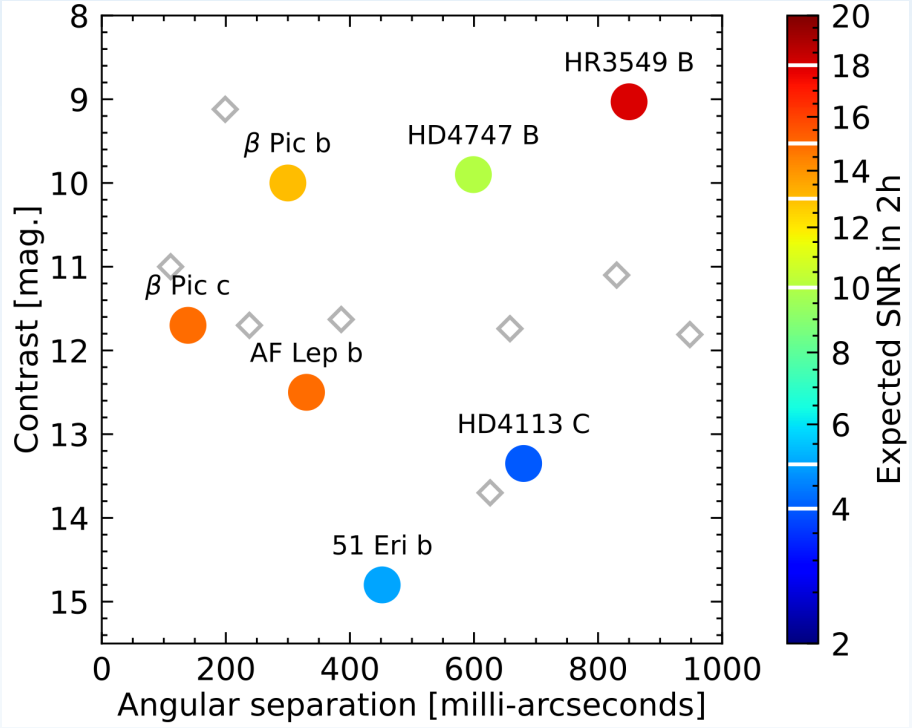


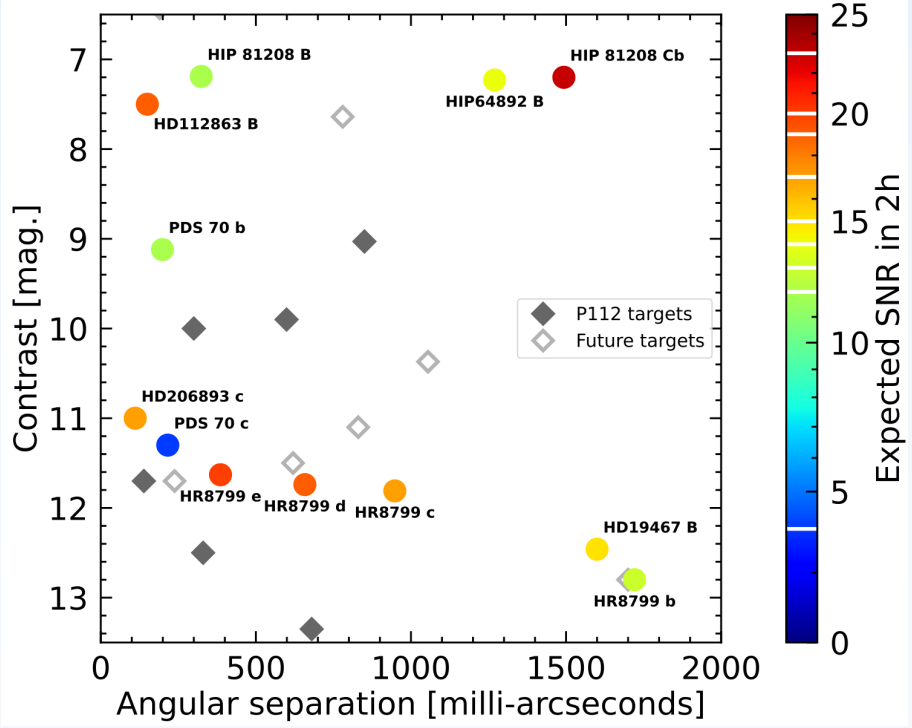


Allan Denis - ExoELT

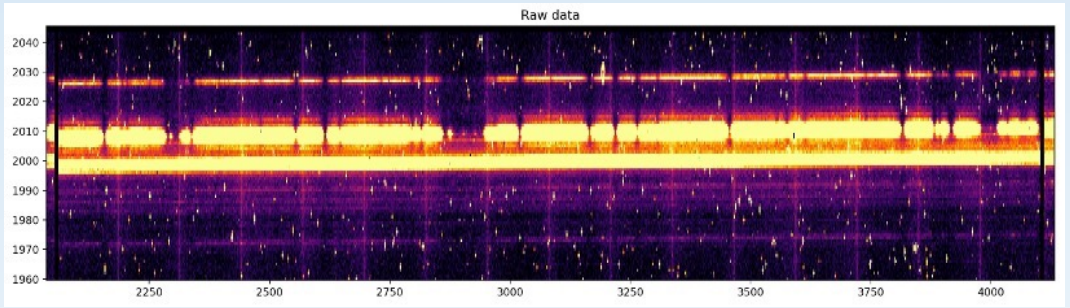
The HiRISE survey

- Goal: survey all companions accessible to HiRISE
  - Detailed characterization ➡ forward modelling & retrieval
  - Direct RV measurements ➡ 3d orbits, search for exomoons
  - Rotational periods. ➡ comparison with field object
- 25 nights since November 2023



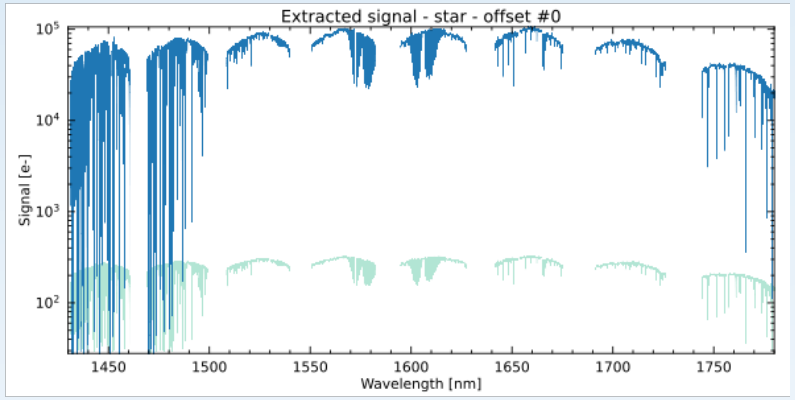


HiRISE data reduction and analysis

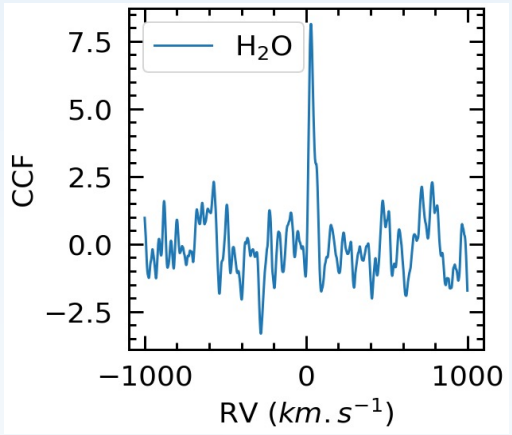


Costes, Denis & Vigan et al. (2024)

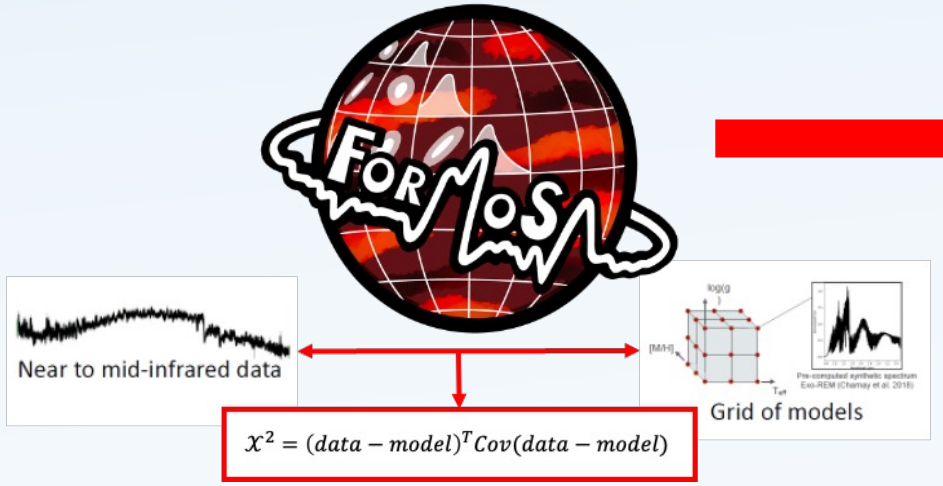
Custom data reduction pipeline

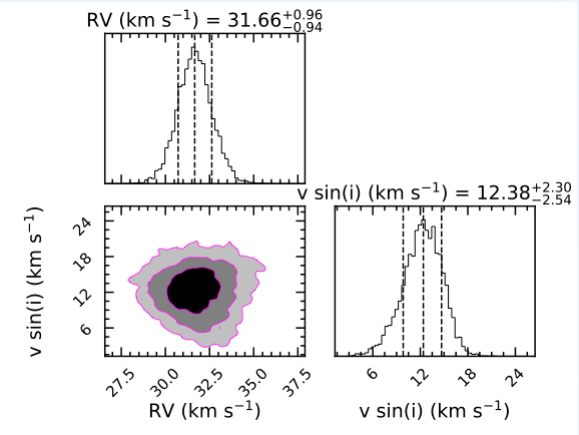


Cross-correlation function analysis



Forward modeling analysis



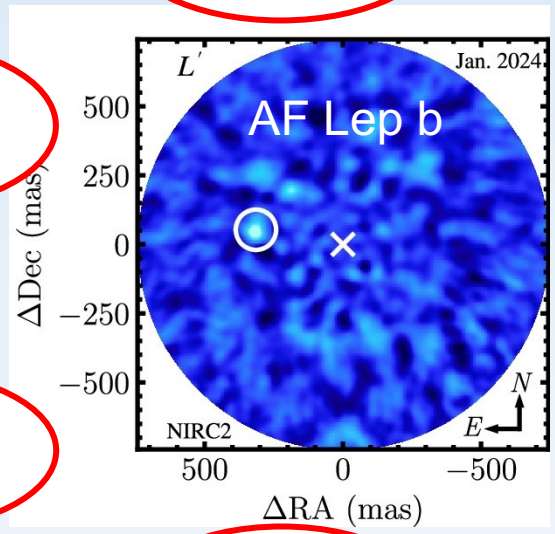


Petrus et al. (2021), Petrus et al. (2023), Palma Bifani et al. (2023), Petrus et al. (2024), Palma Bifani et al. (2024), Denis et al. (2025), Ravet et al. (2025)
ForMoSA collaboration paper (in preparation)

AF Lep b and 51 Eri b: 2 cold super-Jovians at low-angular separation

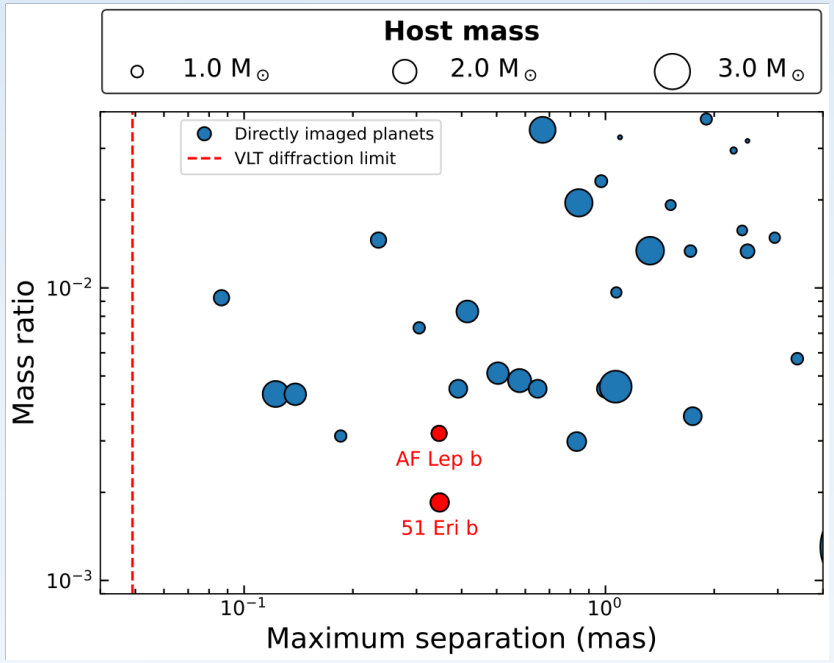
ecc < 0.13 at 3 σ

$T_{eff} \approx 800$ K



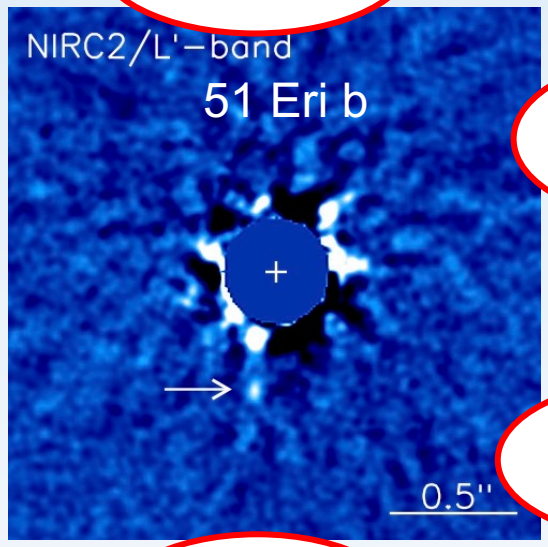
Disk debris at ~ 46 au

M = 3.75 ± 5 M_{Jup}



Pearce et al. (2022), Franson et al. (2023), Mesa et al. (2023), De Rosa et al. (2023), Balmer et al. (2025)

ecc > 0.30 at 3 σ



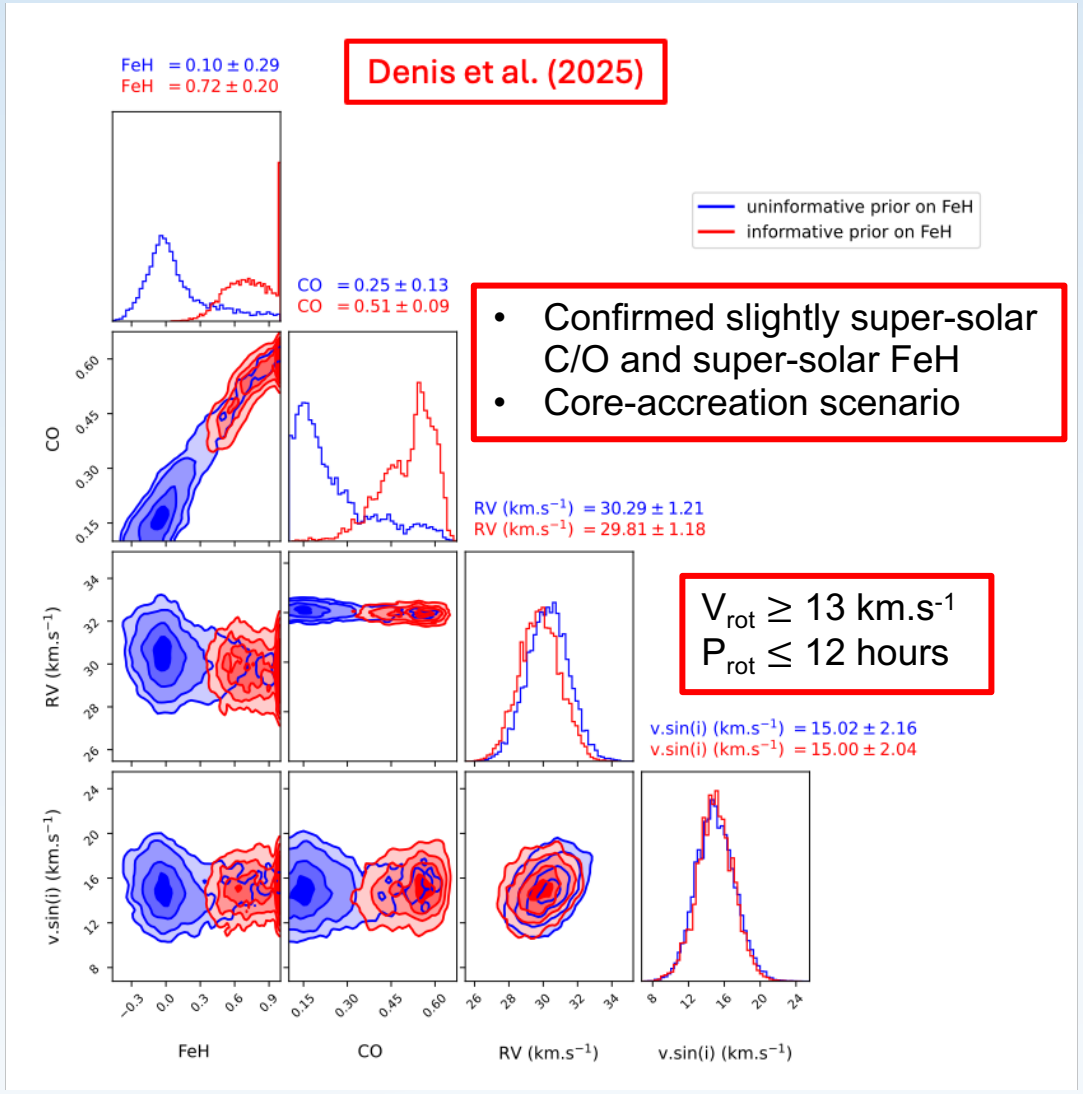
$T_{eff} \approx 700$ K

Disk debris at ≥ 80 au

M < 9 M_{Jup} at 3 σ

Riviere-Marichalar et al. (2014), Macintosh et al. (2015), Samland et al. (2017), Brown-Sevilla et al. (2023), Balmer et al. (2025)

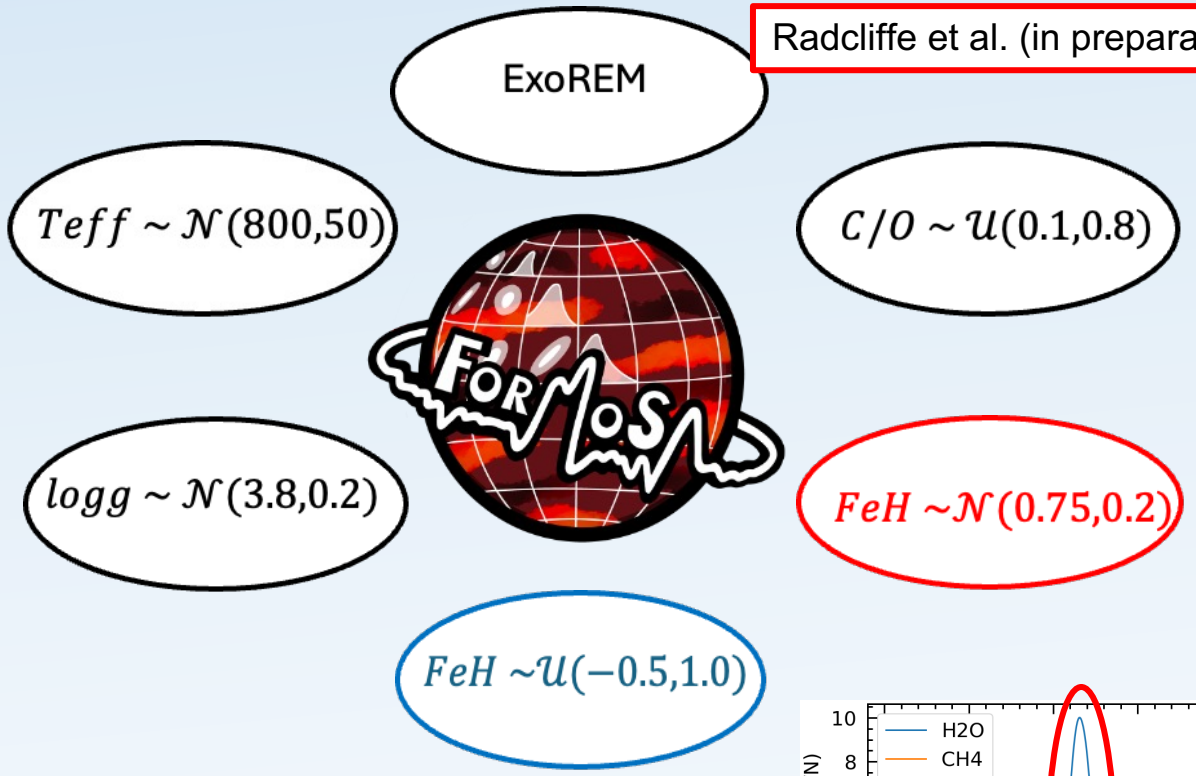
Atmospheric characterization of AF Lep b with ForMoSA

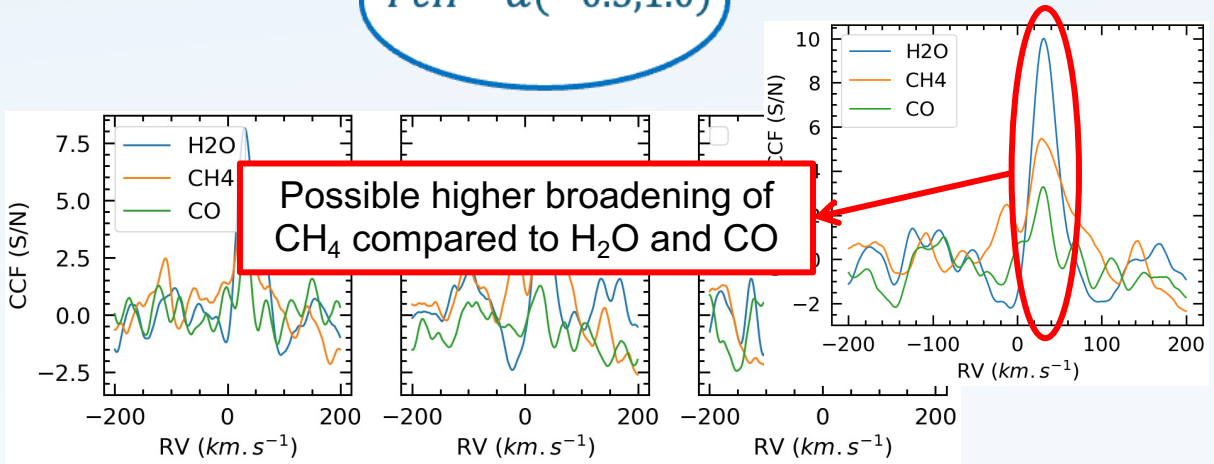


- Confirmed slightly super-solar C/O and super-solar FeH
- Core-accreation scenario

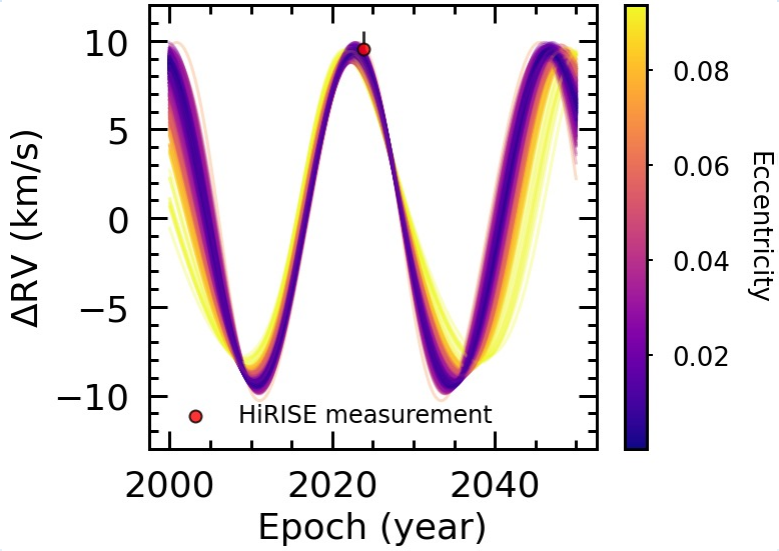
$V_{rot} \geq 13$ km.s^{-1}
$P_{rot} \leq 12$ hours

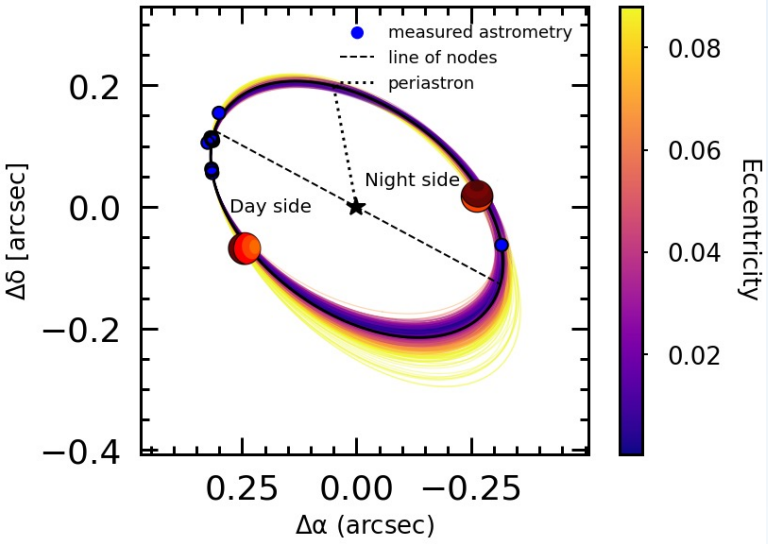
Radcliffe et al. (in preparation)

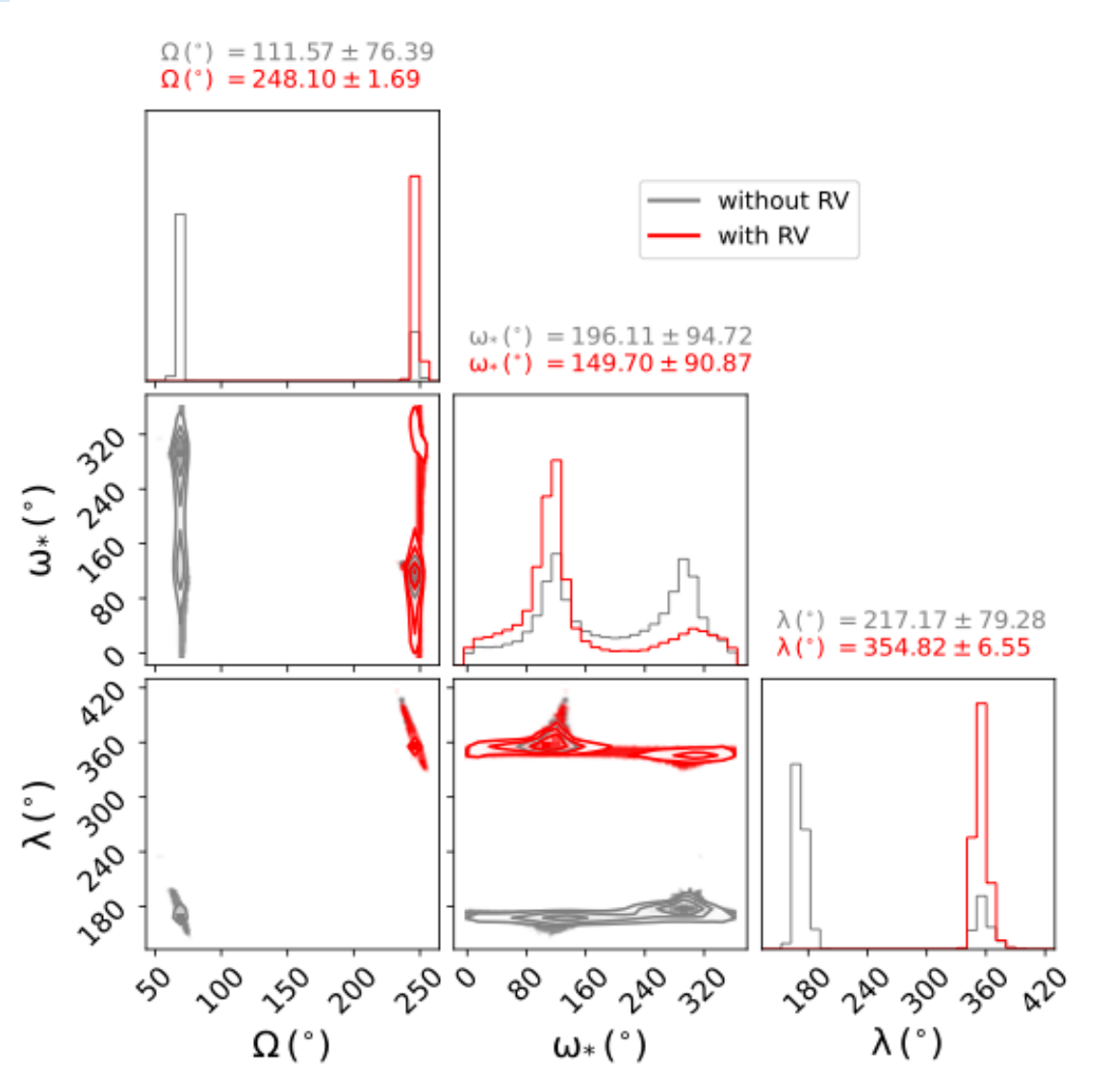




Orbital characterization of AF Lep b

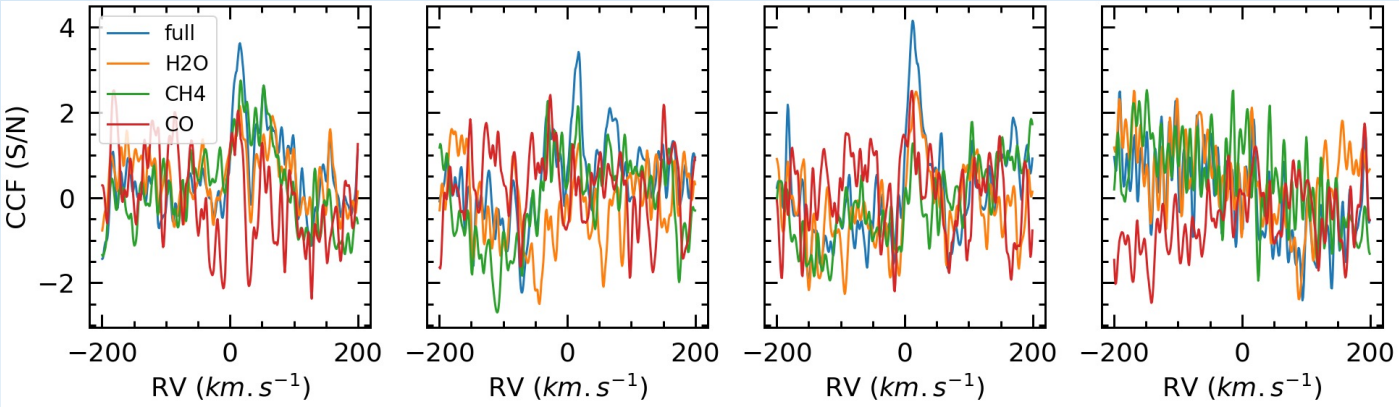


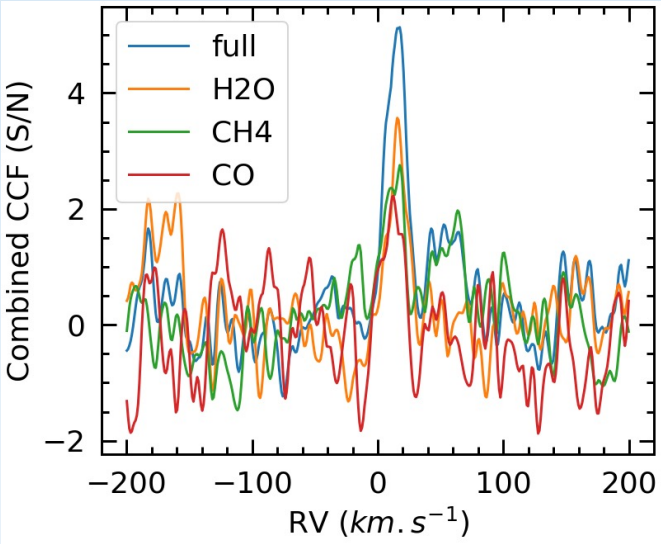


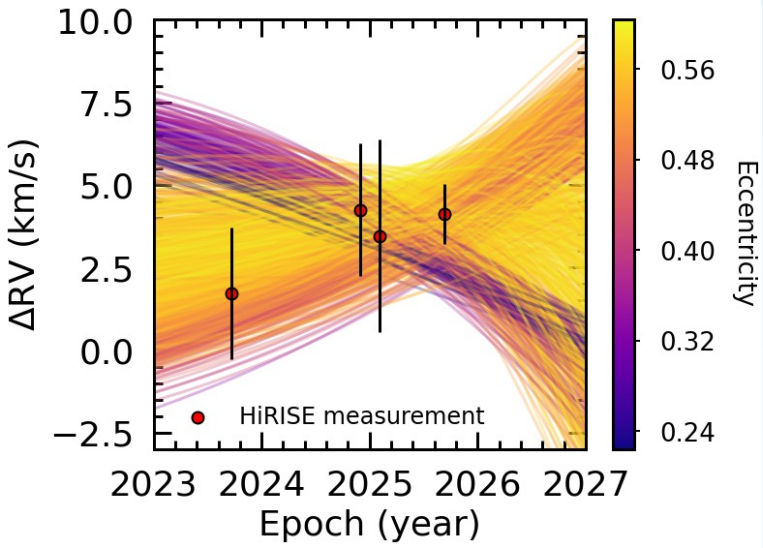


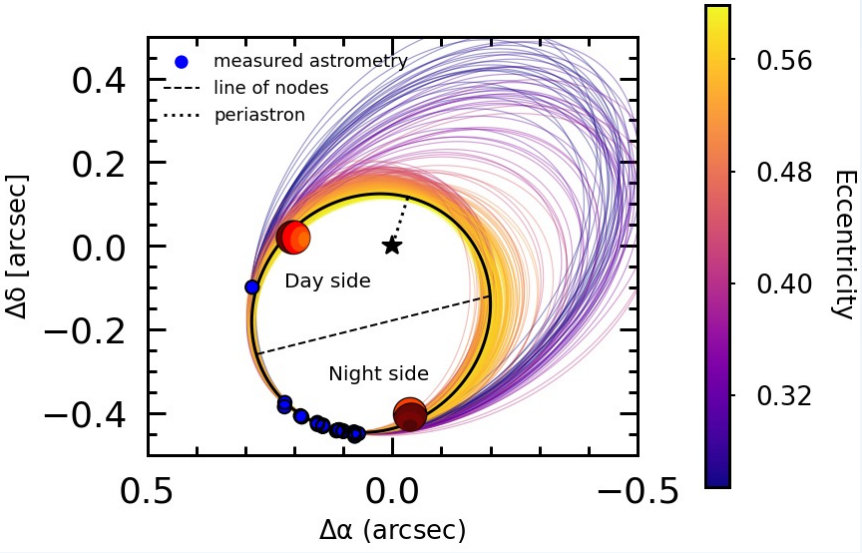
Mesa et al. (2023)
de Rosa et al. (2023)
Franson et al. (2023)
Bonse et al. (2024)
Balmer et al. (2025)
Denis et al. (2025)

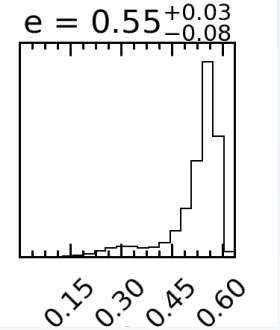
Characterization of 51 Eri b











Macintosh et al. (2015)
Maire et al. (2019)
de Rosa et al. (2020)
Balmer et al. (2025)
Denis et al. (in preparation)

Implications of the high-eccentricity of 51 Eri b

Resonances between planet and outer dipersing disk can excite the eccentricity of the planet up to 0.6

PLanet-disk interaction

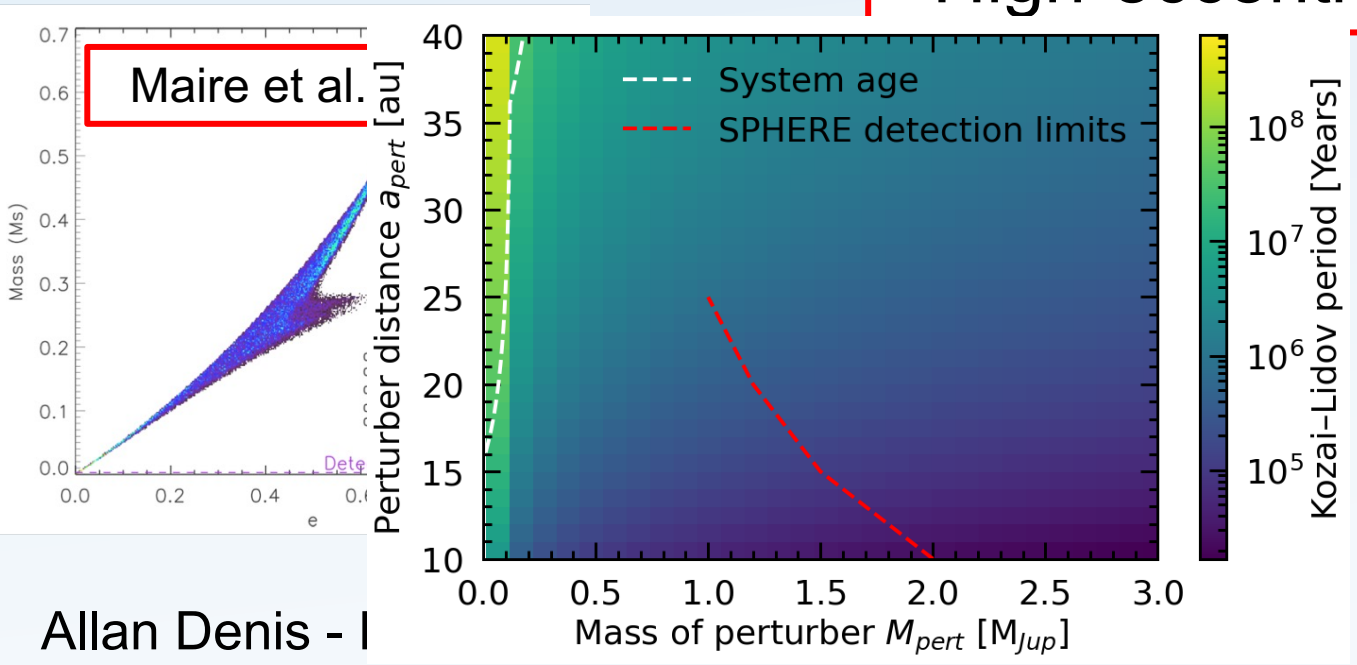
Li & Lai (2023)

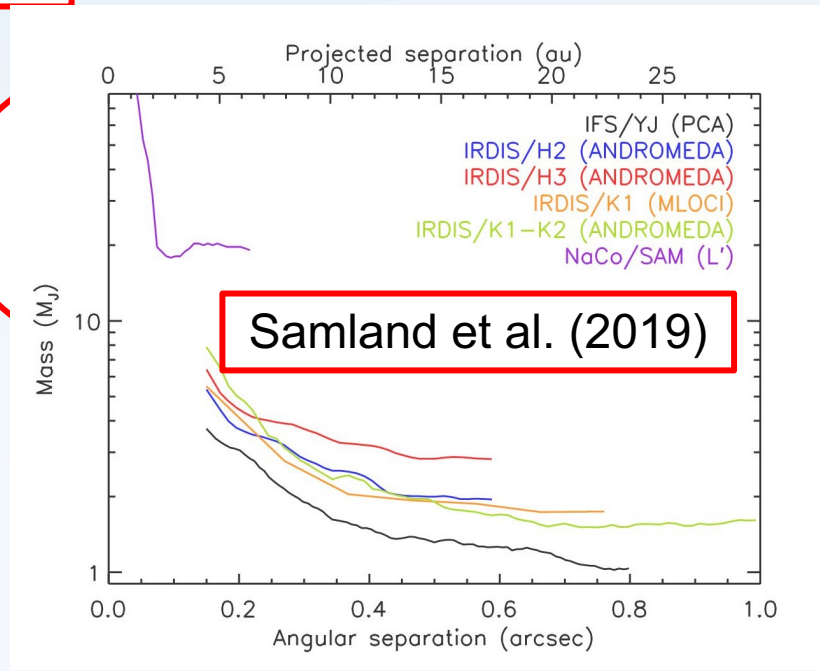
Kozai-Lidov oscillations

Ford + (2020)

Kozai-Lidov oscillations with stellar companion GJ 3305 AB is unlikely (Montet et al. 2015)

High-eccentricity





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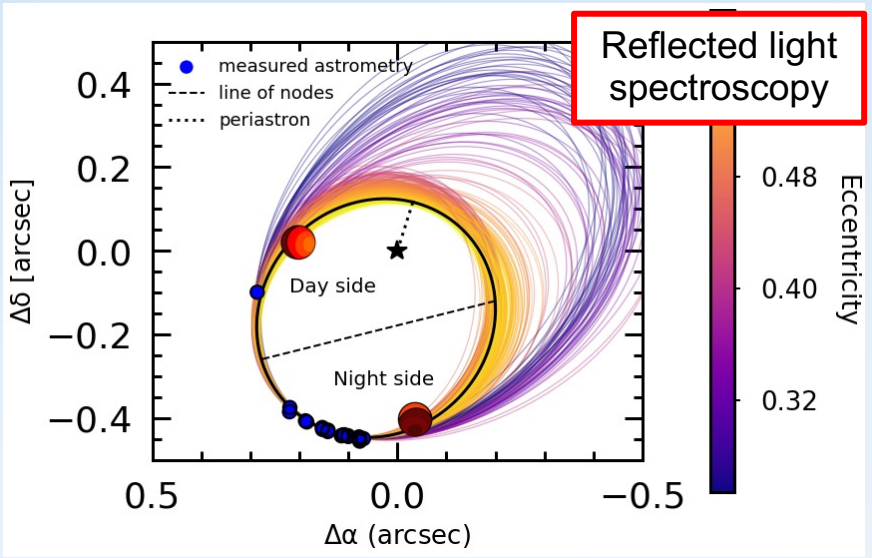
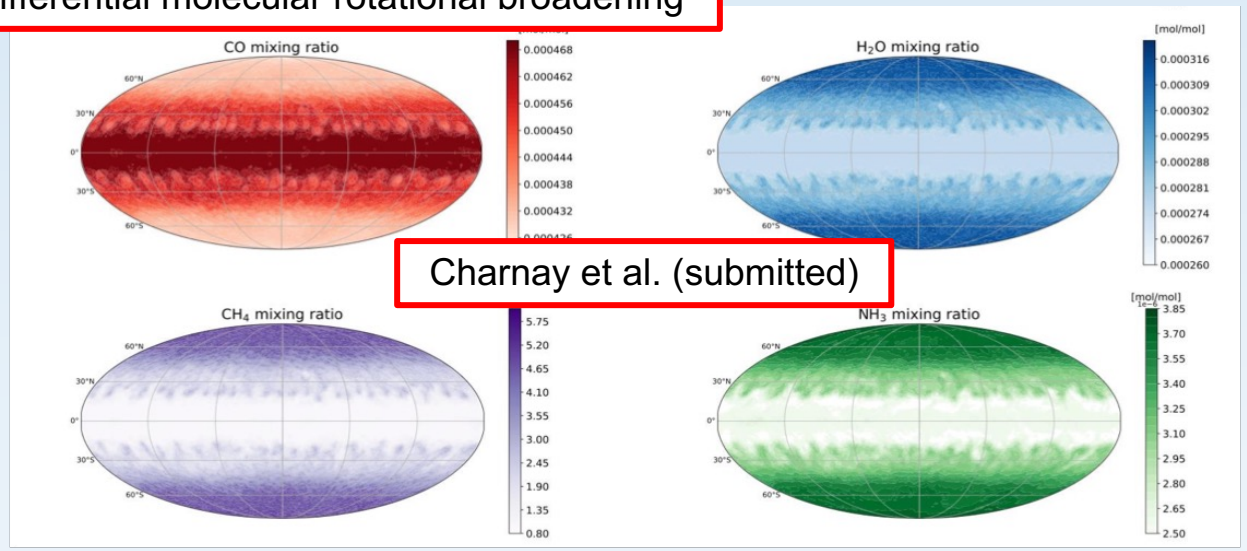
HiRISE : a pathway for ELT instrumentation

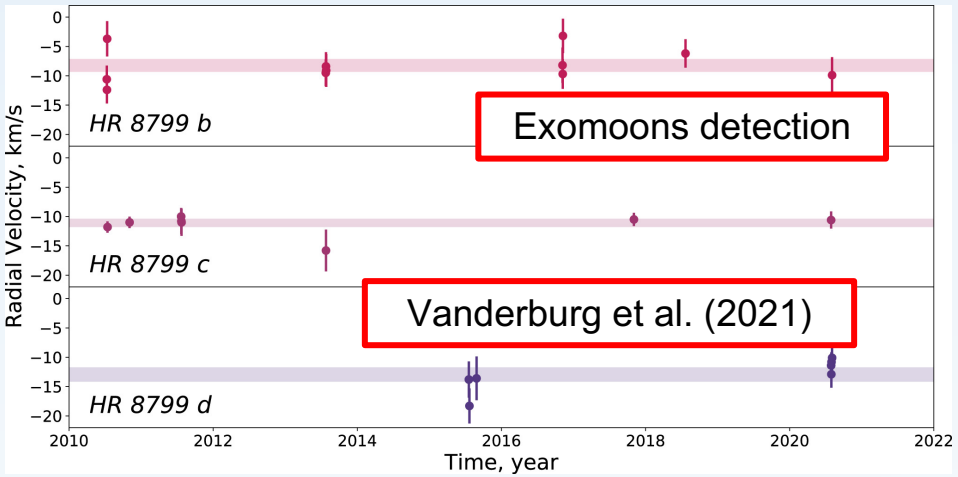


Reflected light spectroscopy

Differential molecular rotational broadening



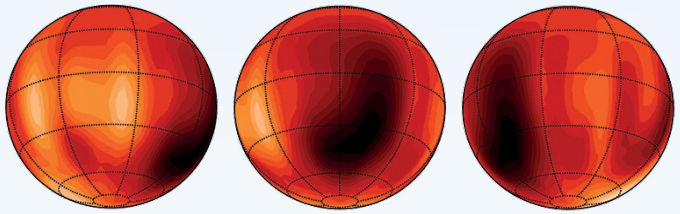
Charnay et al. (submitted)



Exomoons detection

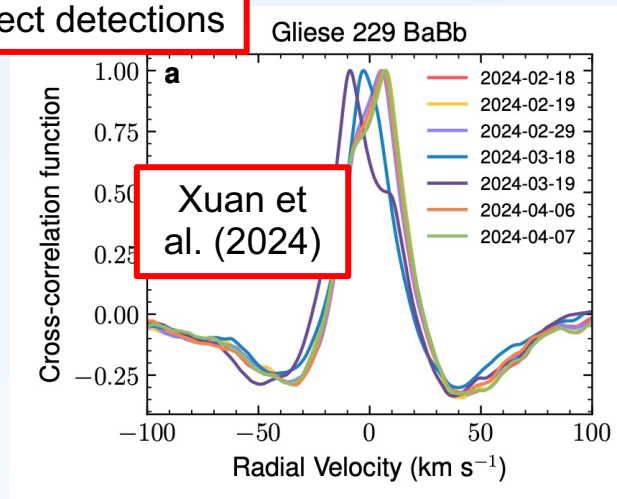
Vanderburg et al. (2021)

Variability and Doppler imaging



Crossfield et al. (2014)

Undirect detections



Xuan et al. (2024)