

# HUNTING FOR FORMING GAS GIANT PLANETS

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Together with the SPHERE and the ISPY consortia

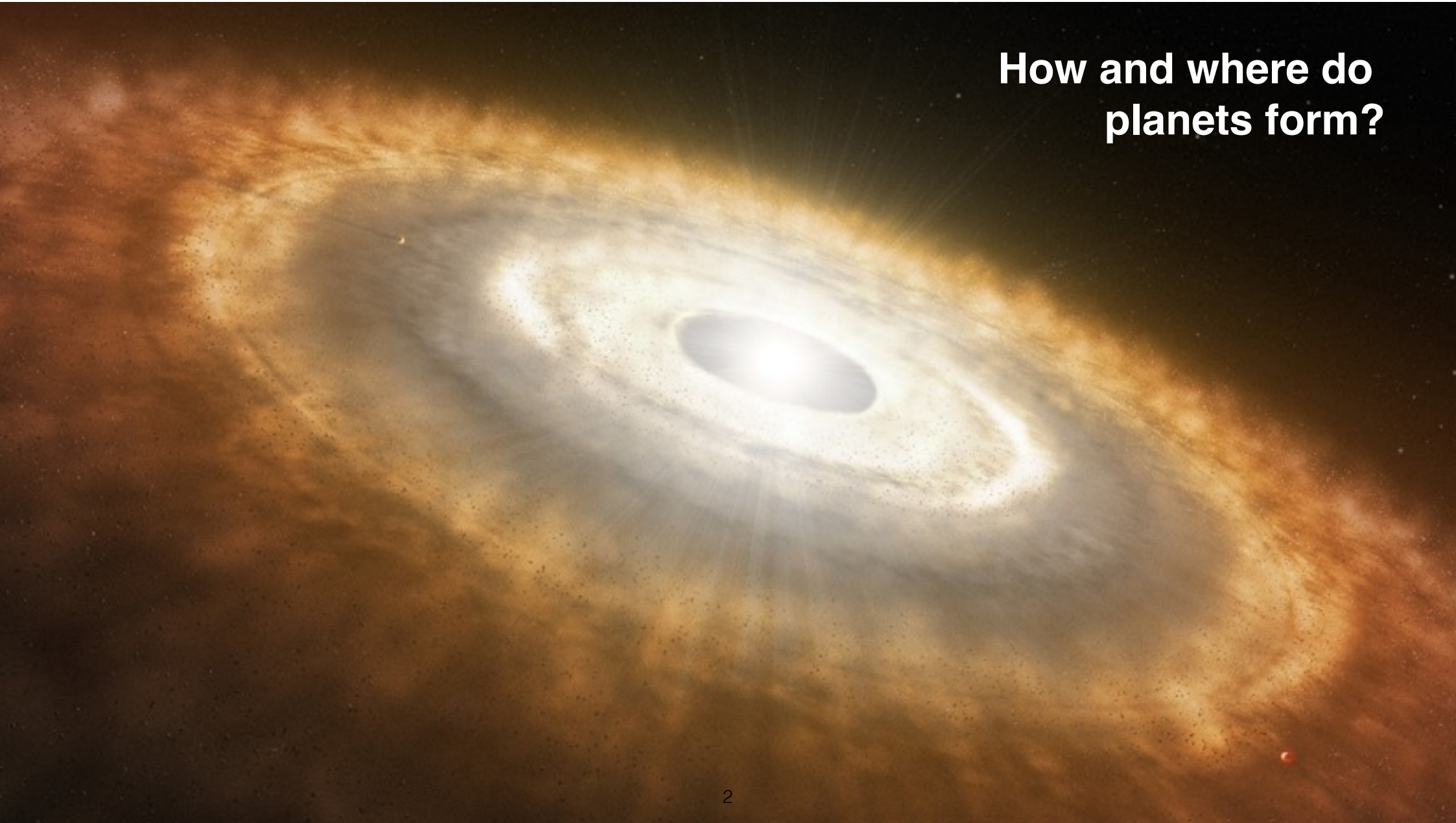
**ETH**

Eidgenössische Technische Hochschule Zürich  
Swiss Federal Institute of Technology Zurich

**PlanetS**

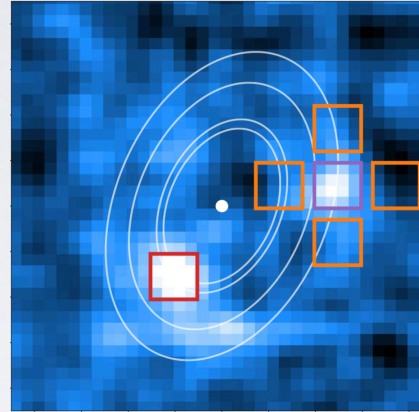
 *PynPoint*

**How and where do  
planets form?**



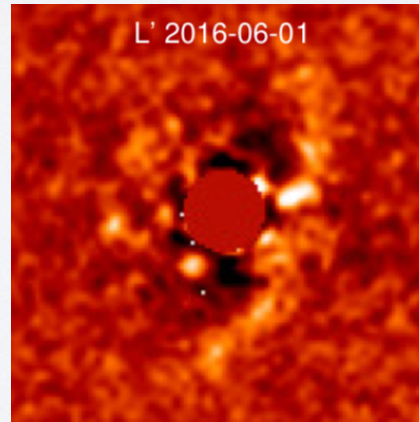
# How can we detect forming planets?

## 1) Accretion signatures in H $\alpha$



Haffert+2019

## 2) Infrared thermal emission from planet and circumplanetary disk

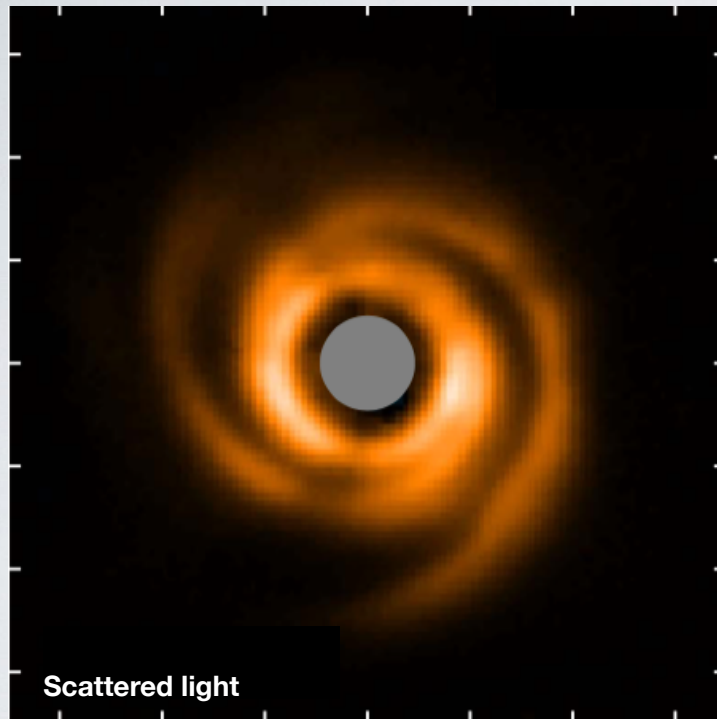


Keppler+2018

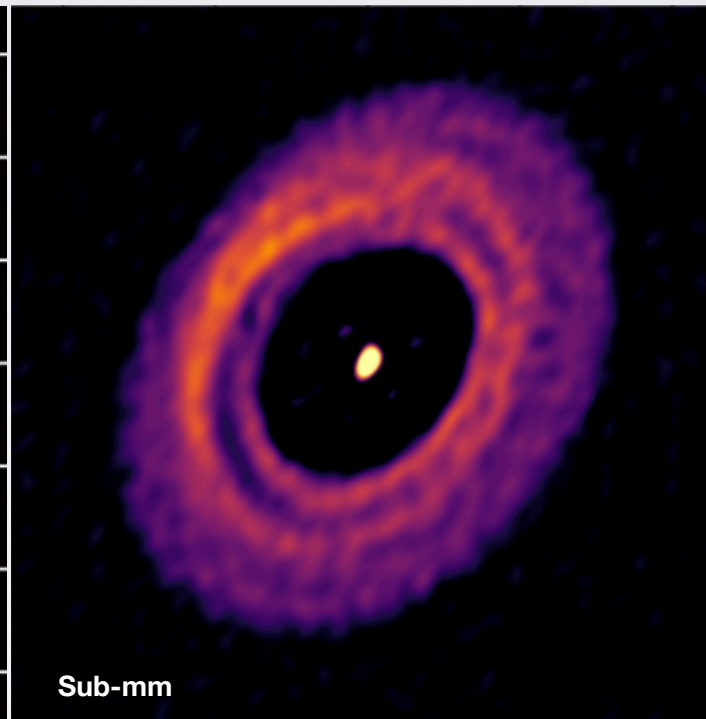


The SPHERE consortium conducted the largest (6 targets) H $\alpha$  survey to search for accreting companions

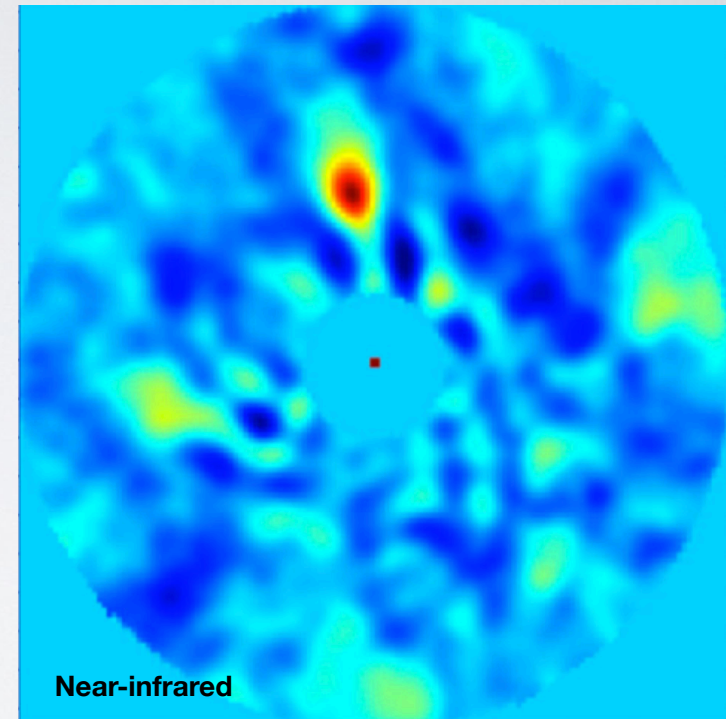
**HD135344B**



**HD100546**

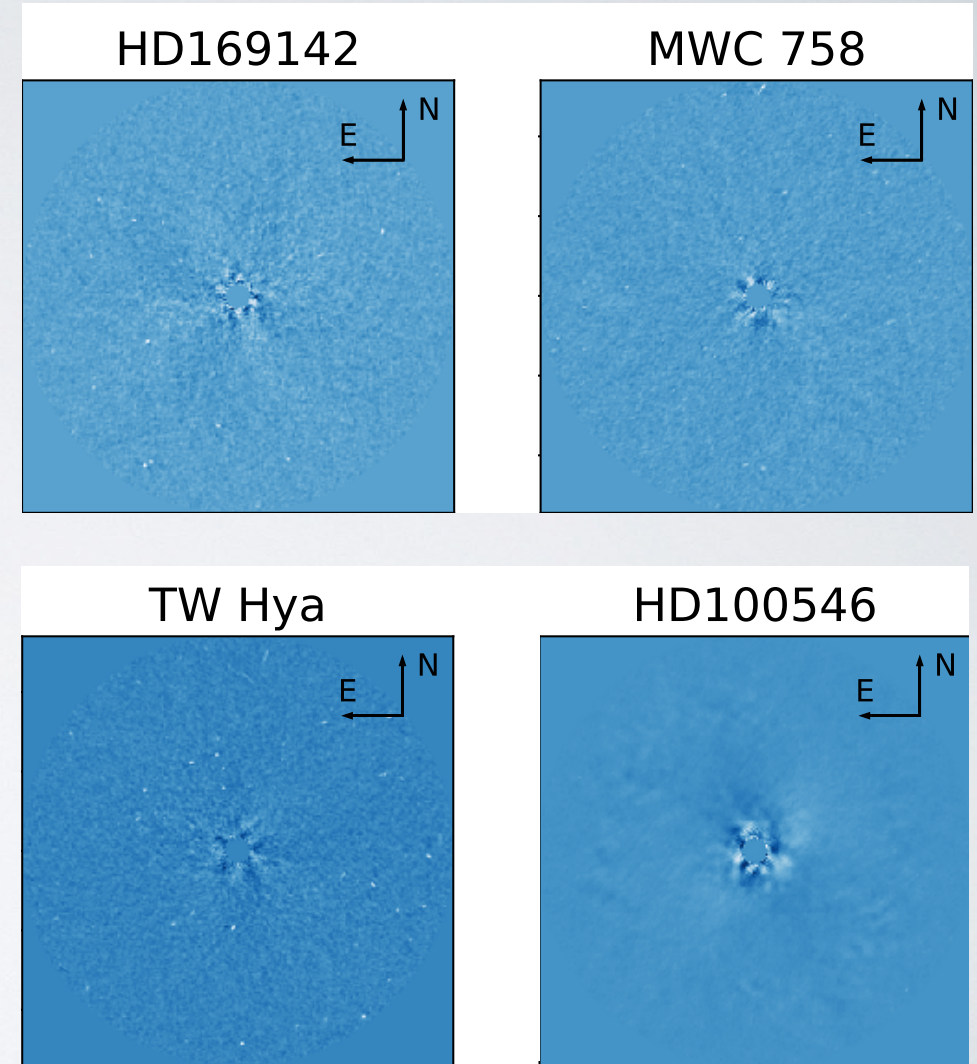
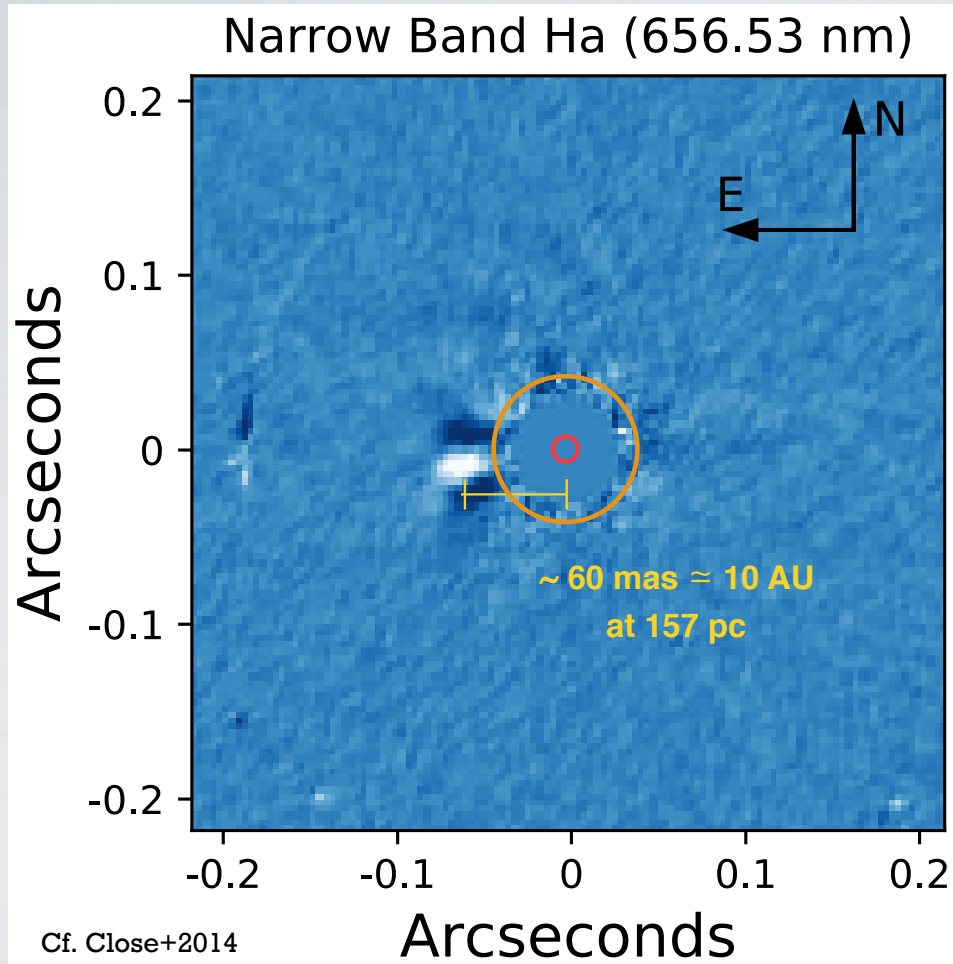


**HD100546**



**Other targets: TW Hya, HD169142, MWC758, HD142527**

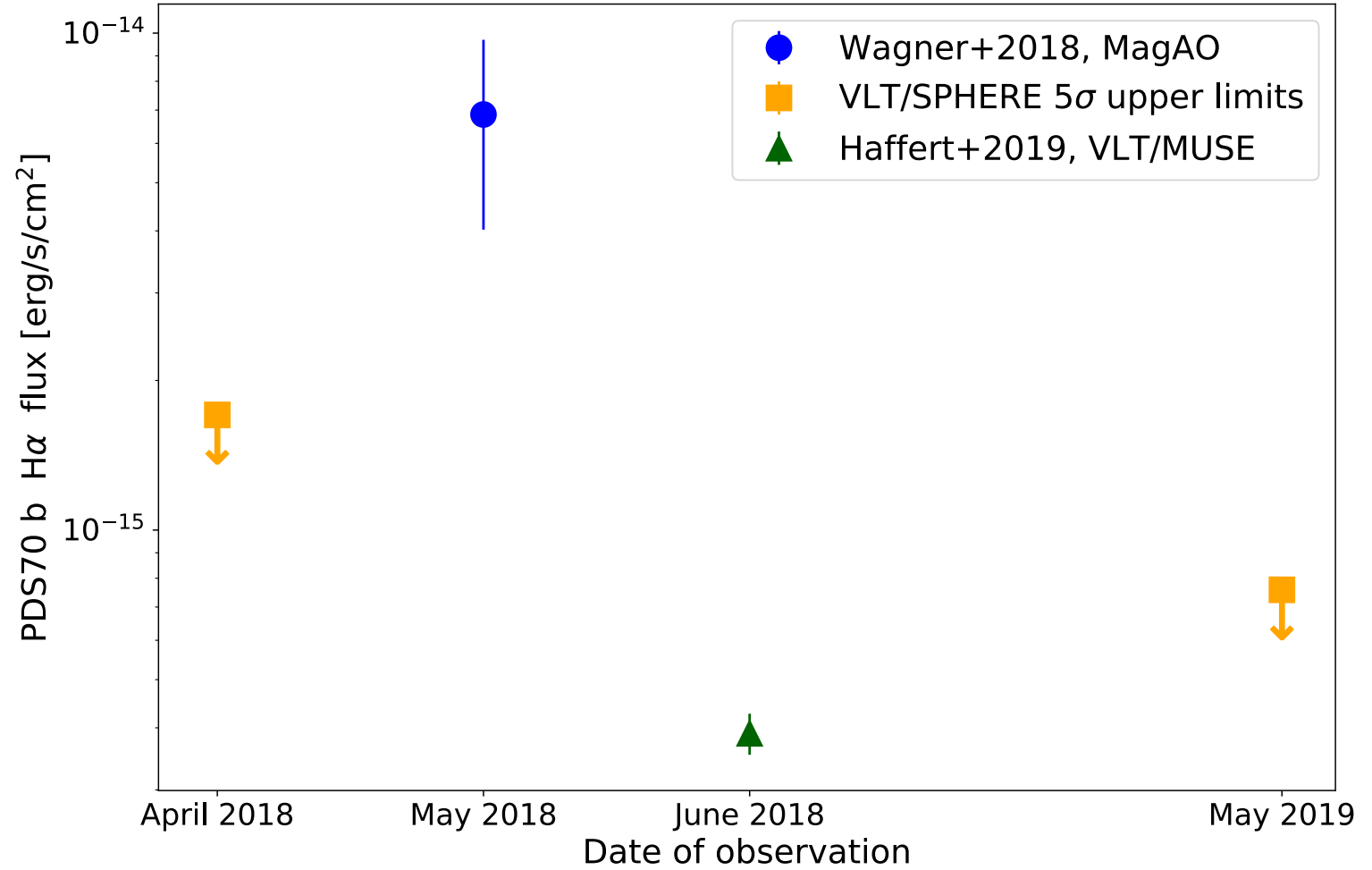
The only companion from the sample detected in H $\alpha$  is HD142527 B



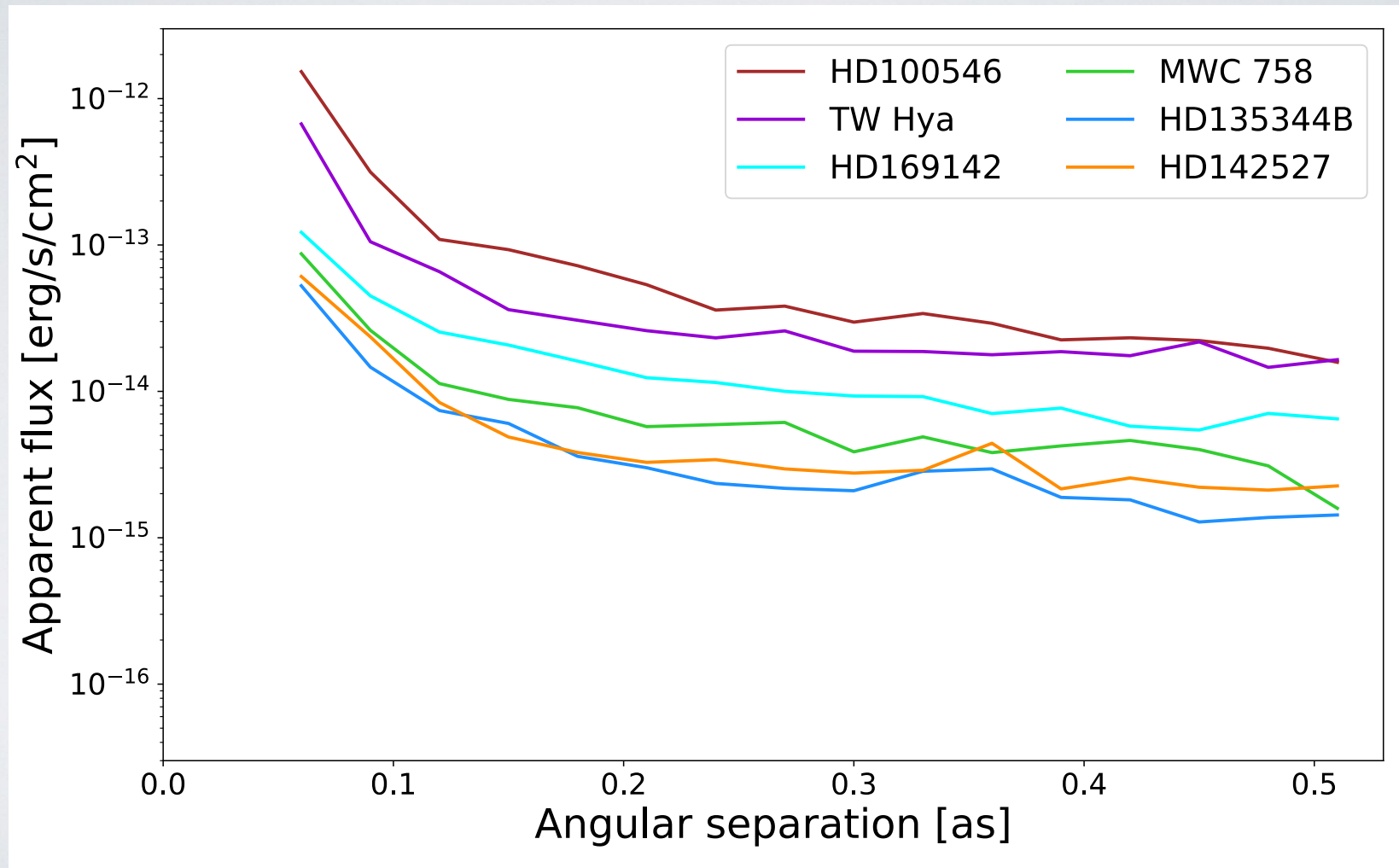
Cugno+2019a

L' 2016-06-01

## PDS70 b detections and non-detections imply variability in the H $\alpha$ line flux

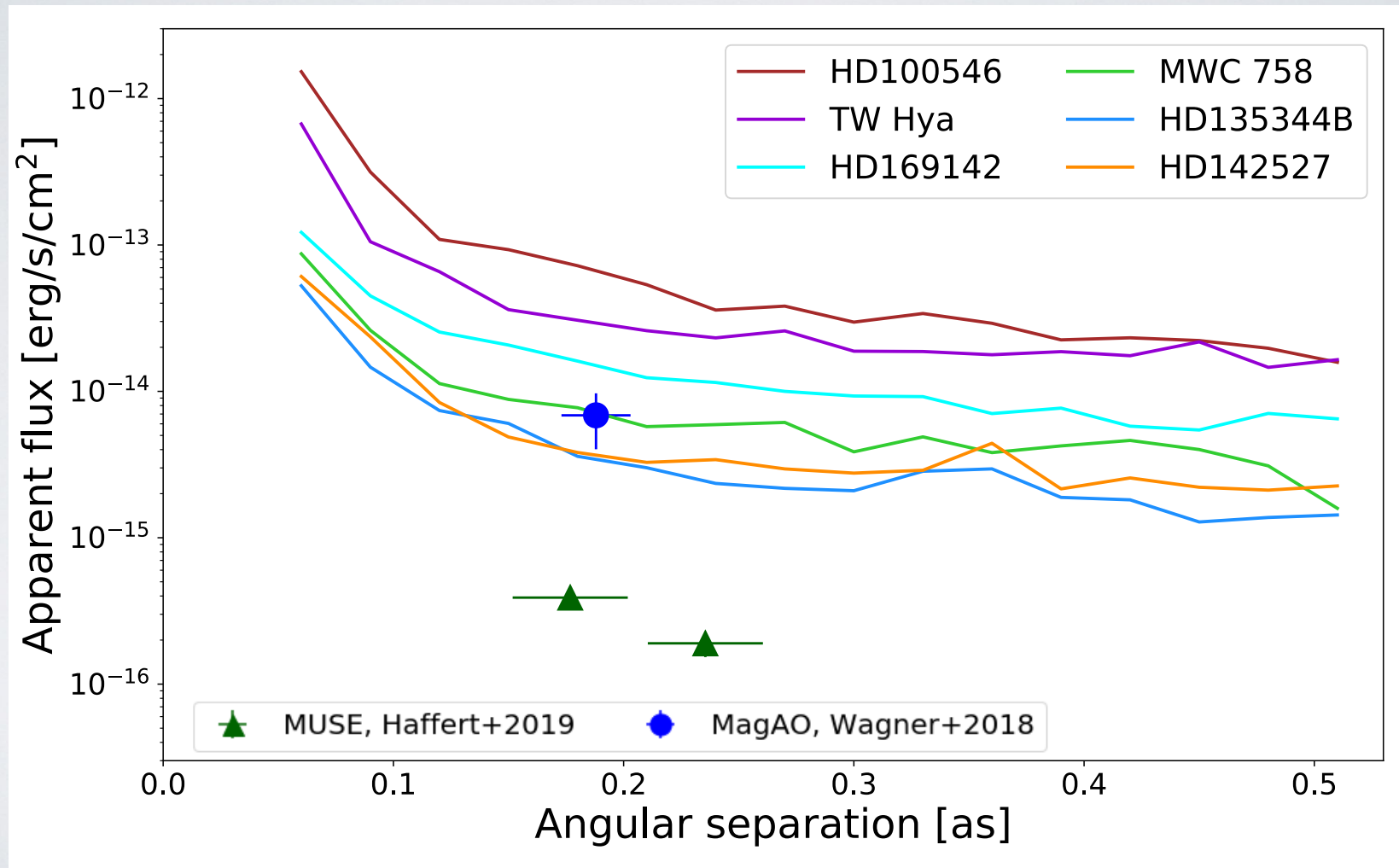


Non-detections give informations on accretion processes that could be excluded



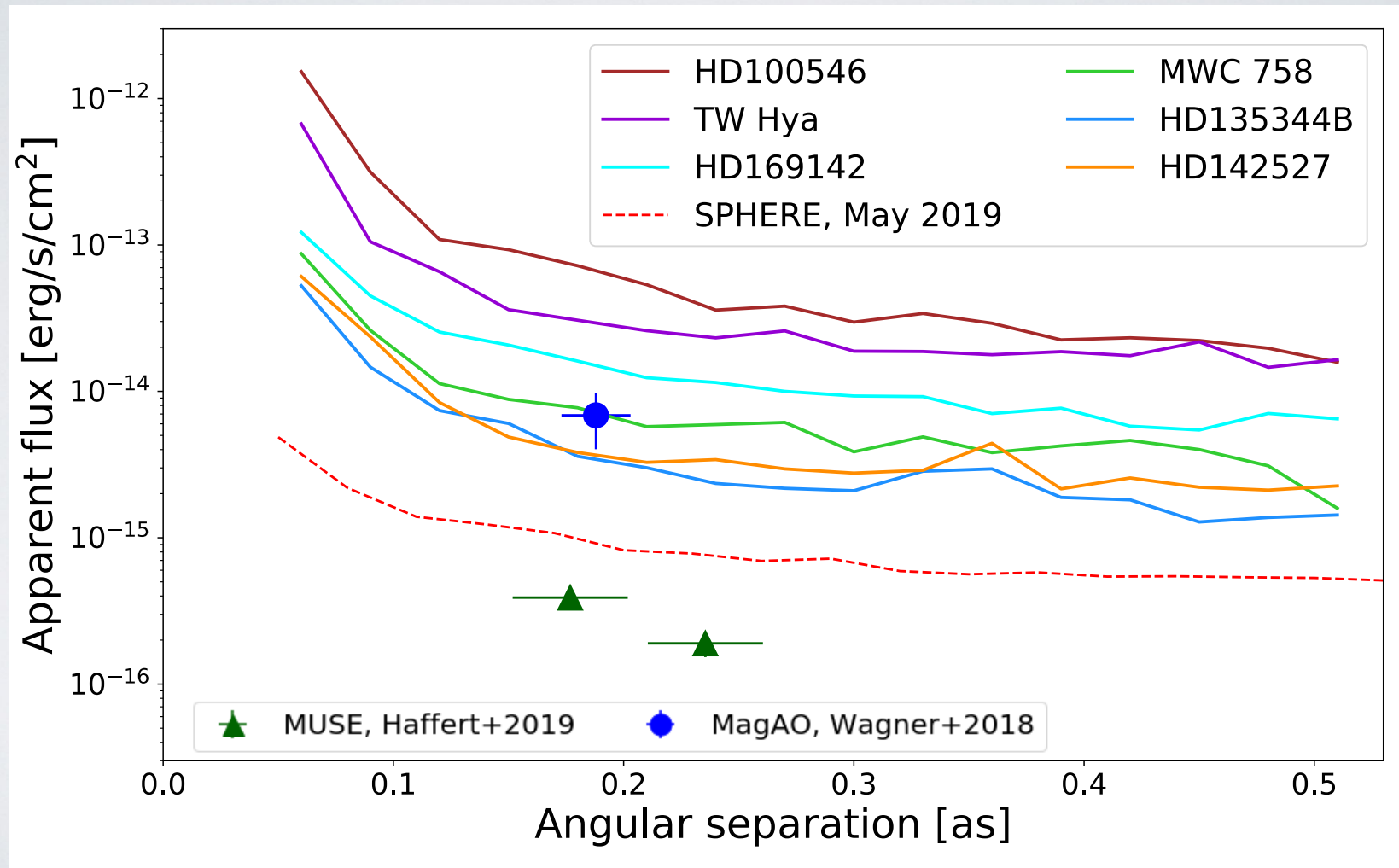


Non-detections give informations on accretion processes that could be excluded

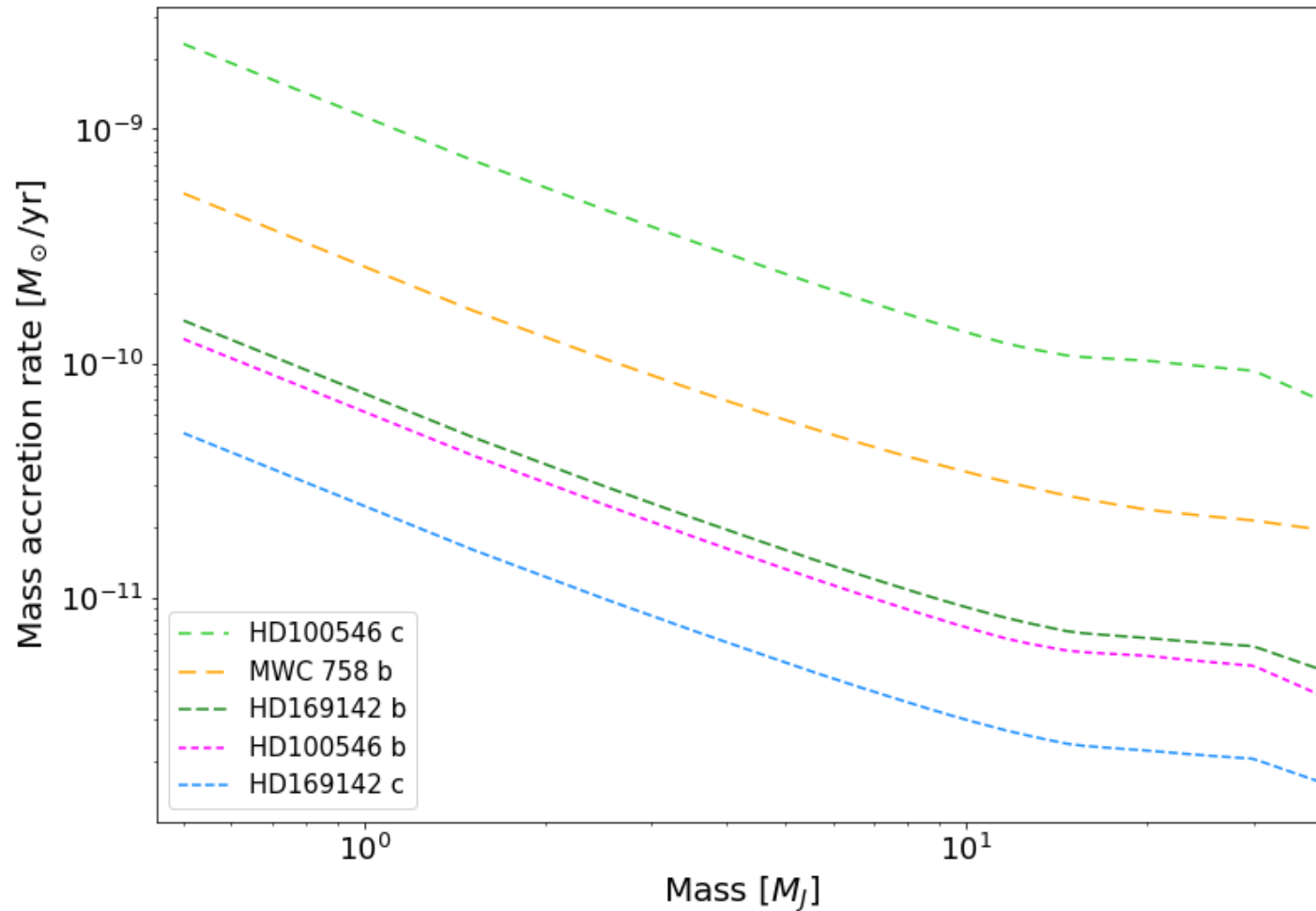




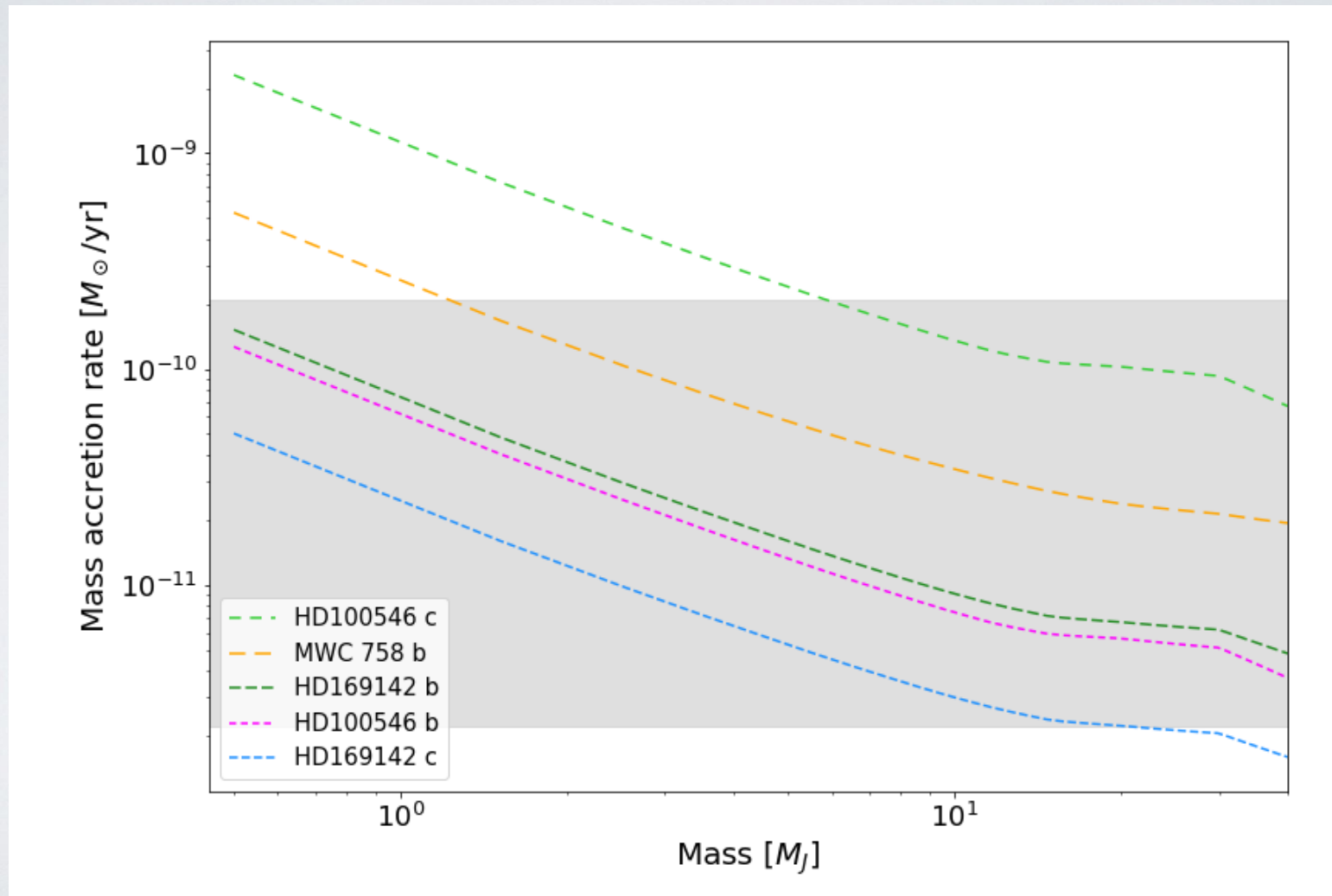
Non-detections give informations on accretion processes that could be excluded



# Achieved mass accretion rates limits at candidate locations as a function of the companion mass

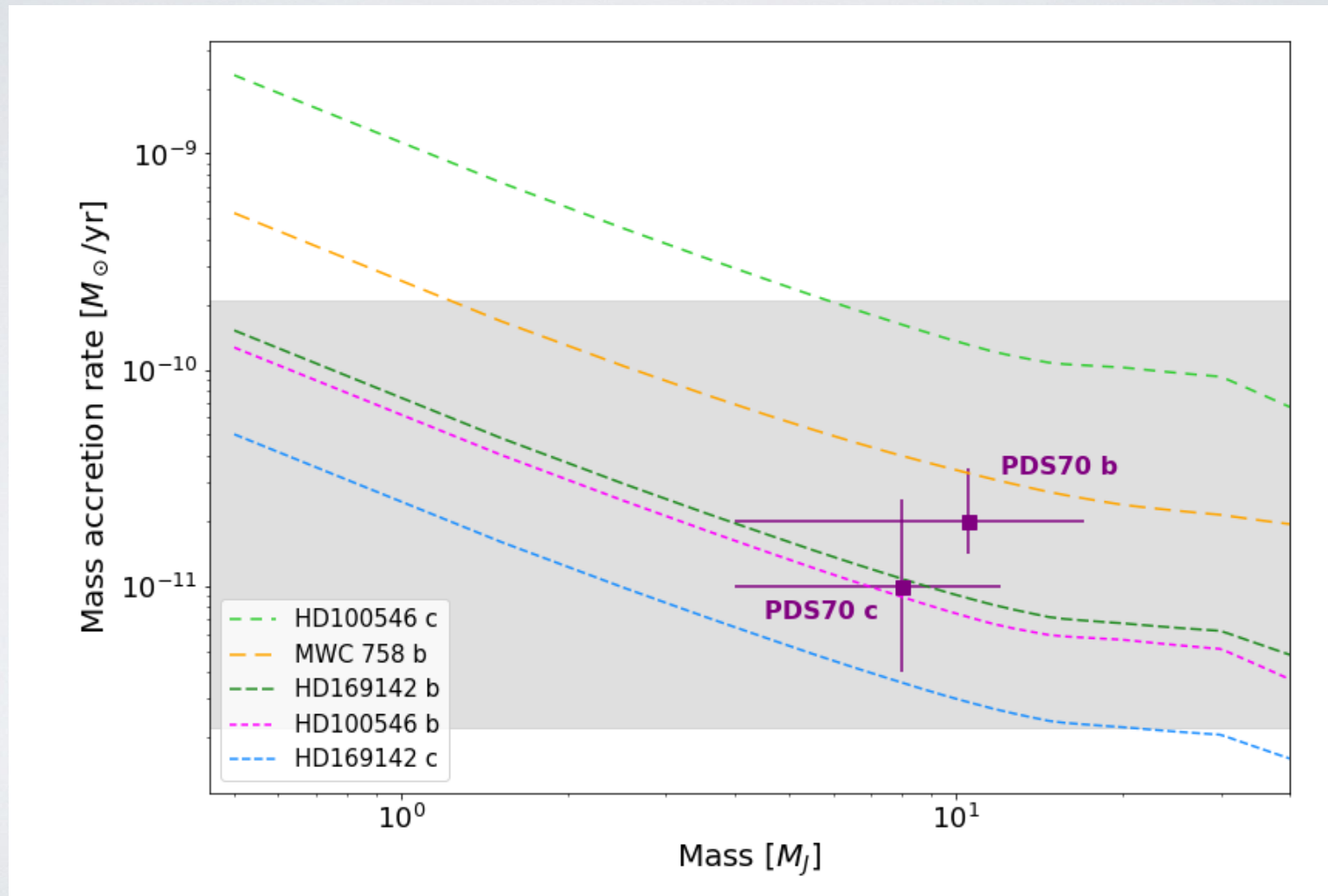


Achieved mass accretion rates limits are range between  $10^{-10}$  and  $10^{-12}$   $M_{\odot}/\text{yr}$



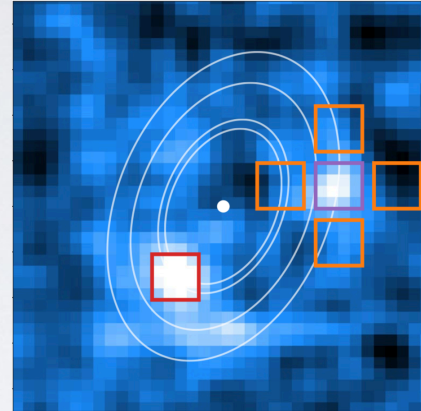


Achieved mass accretion rates limits are similar to existing companion candidates detected in H $\alpha$



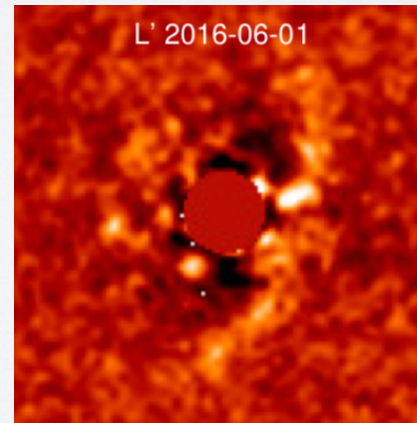
# How can we detect forming planets?

## 1) Accretion signatures in H $\alpha$



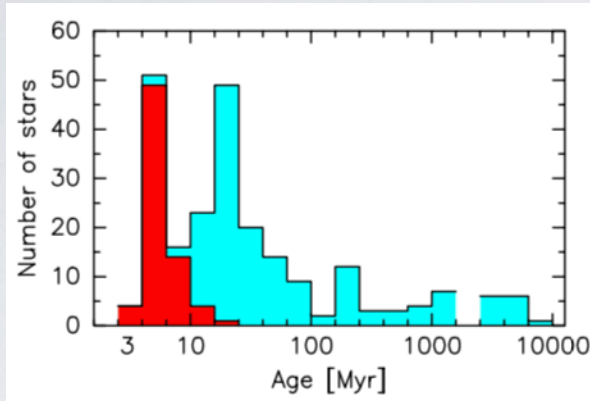
Haffert+2019

## 2) Infrared thermal emission from planet and circumplanetary disk

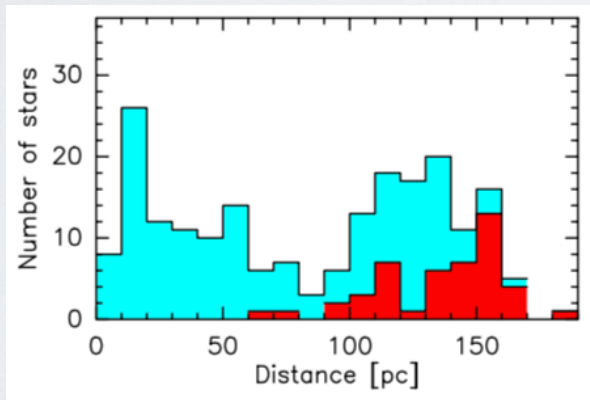


Keppler+2018

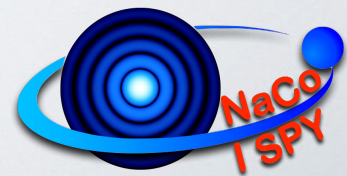
# The NaCo-ISPY survey in the L' band aims at statistically characterise the giant planet population



- **VLT/NaCo in the L' band ( $3.8 \mu\text{m}$ )**
- **120 nights in 4 years**
- **Only a few nights remain**
- **Total of 253 targets, 76 of which surrounded by a protoplanetary disk (PPD)**



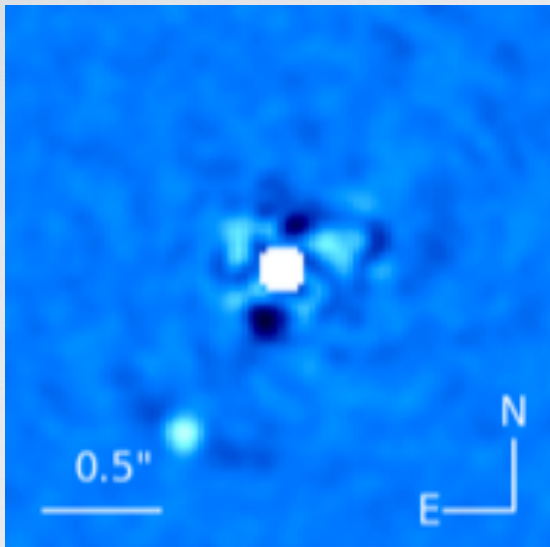
**Protoplanetary disks (PPD)**  
**Debris disks**



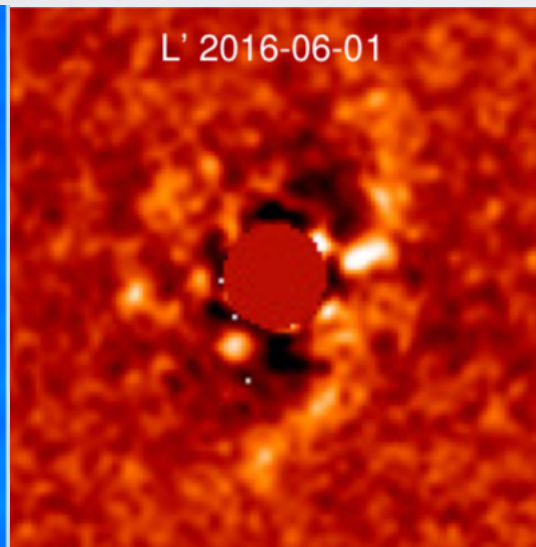


ISPY already delivered several remarkable companion detections in L'-band ( $3.8\ \mu\text{m}$ )...

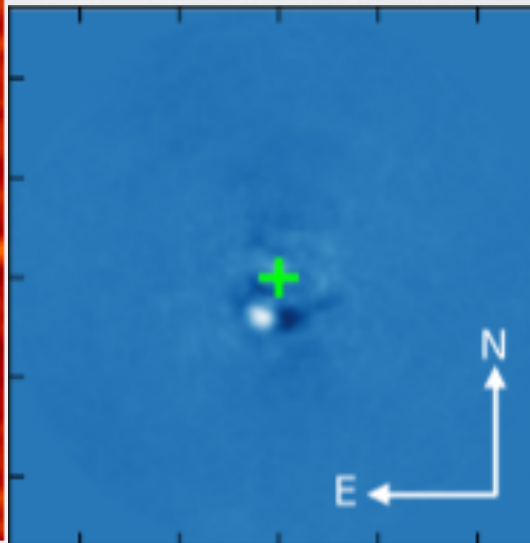
**HIP65426 b**



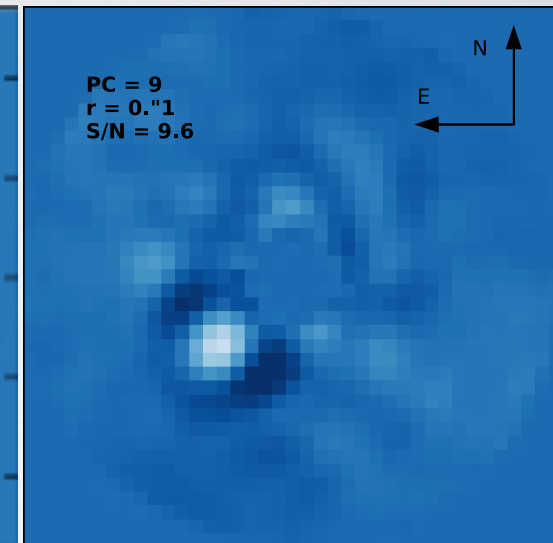
**PDS70 b**



**HD193571 B**

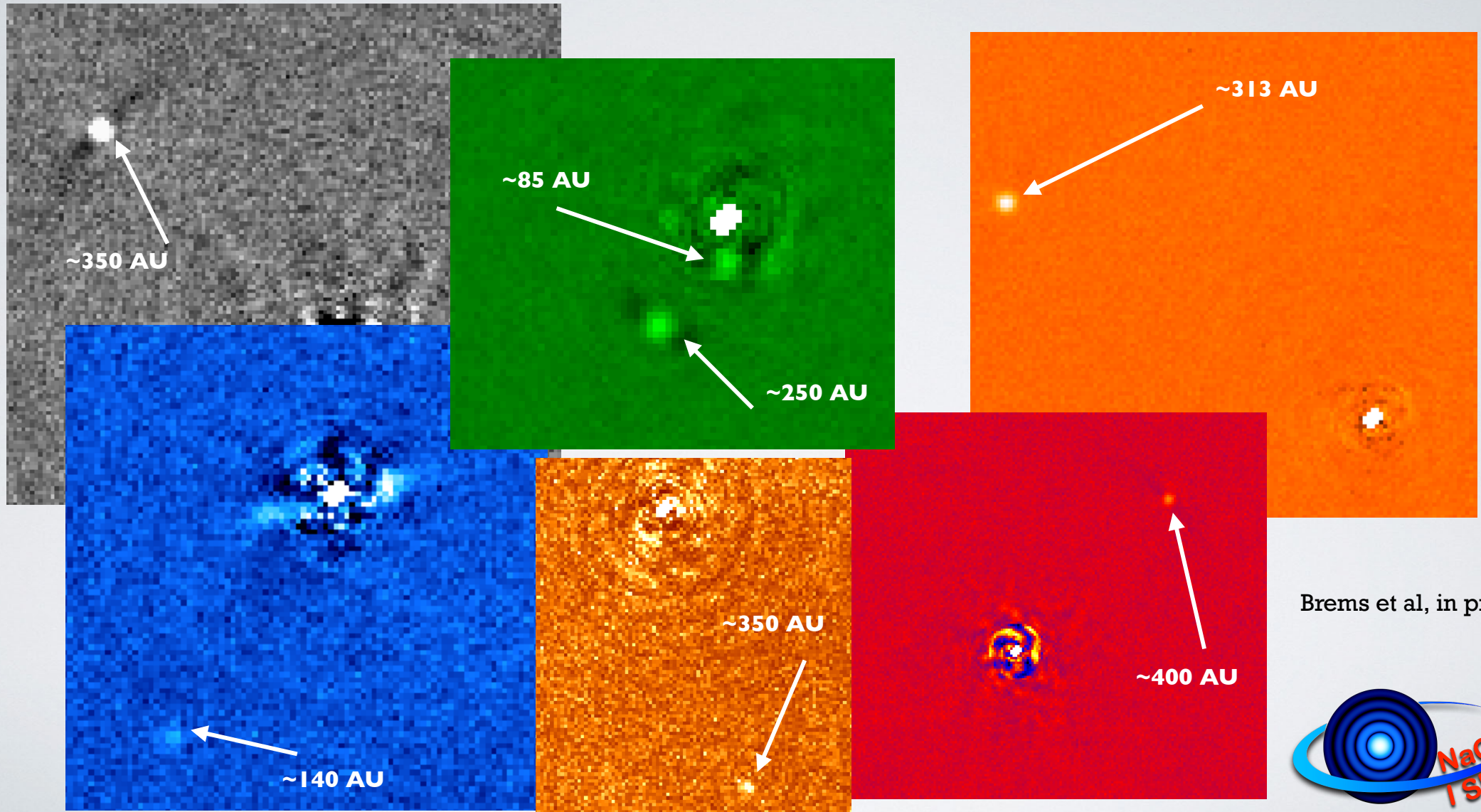


**RCrA B**

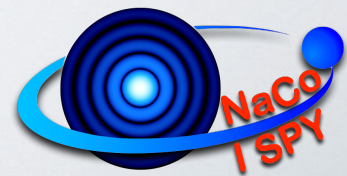


Sources: Cheetham+2019, Keppler+2018, Musso Barcucci+2019, Cugno+2019b

... and many others are expected to come!



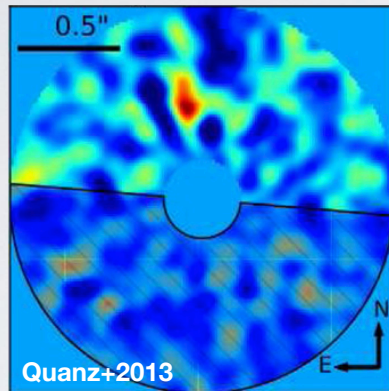
Brems et al, in prep



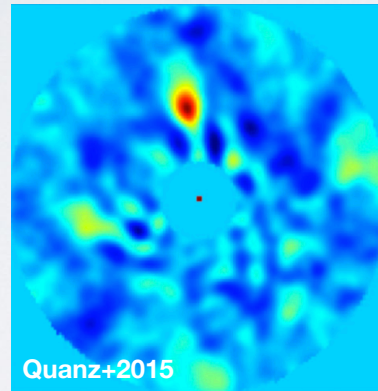
Other candidates embedded in the circumstellar disk still require further analysis.

## HD100546

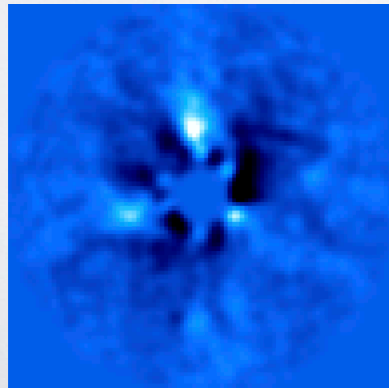
Observed 2011



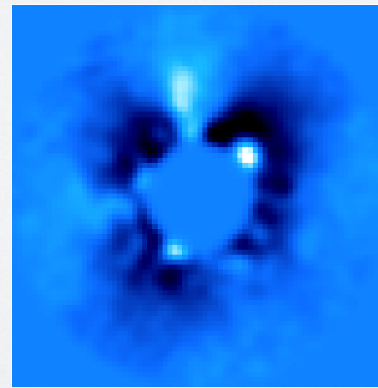
Observed 2013



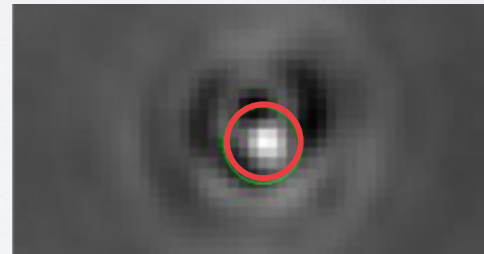
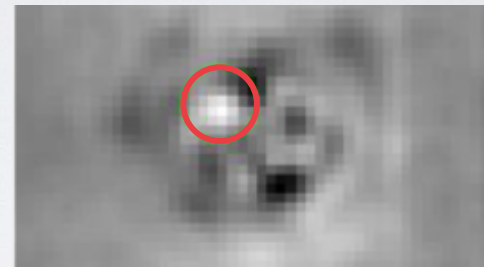
Observed 2016



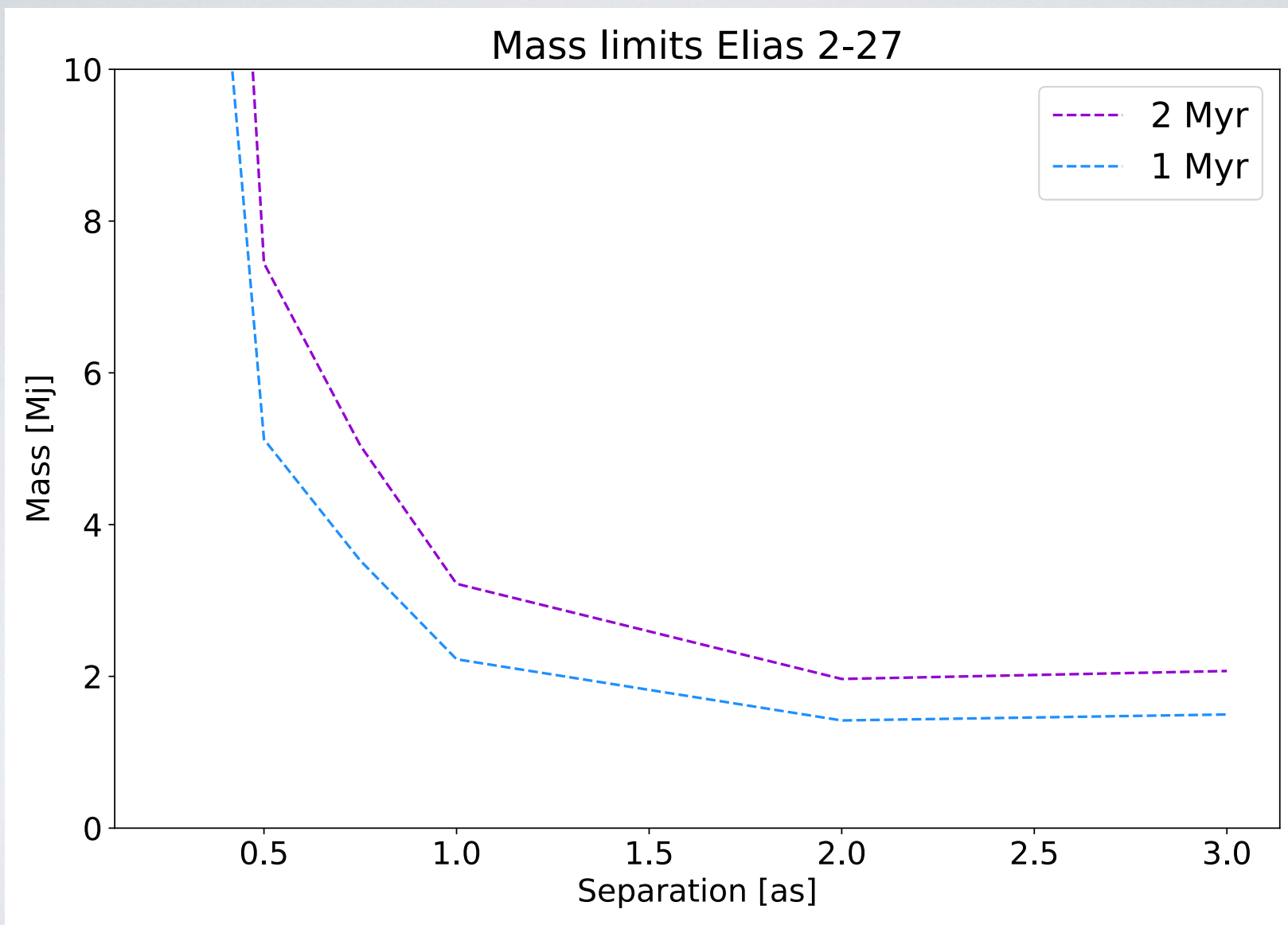
Observed 2019



## Other objects







Launhardt et al., in prep



# Conclusions

## 1) Accretion signatures

- **H $\alpha$  imaging is able to detect accretion processes within circumstellar disks (Cugno+2019a).**
- **Future searches should include multi-epoch observations in order to account for strong accretion variability.**
- **The detection limits from Cugno+2019a will be useful to study accretion rate variability.**

## 2) Infrared thermal emission

- **During the past 4 years the NaCo-ISPY survey systematically targeted the nearest young stars surrounded by a PPD, searching for young giant planets.**
- **Several detections were already published (e.g., Cugno+2019b)**
- **Several candidates embedded in the circumstellar disk wait for confirmation or disproval**
- **The occurrence rate of these planets remains low, in agreement with previous results. Precise numbers will be given only at the end of the survey.**