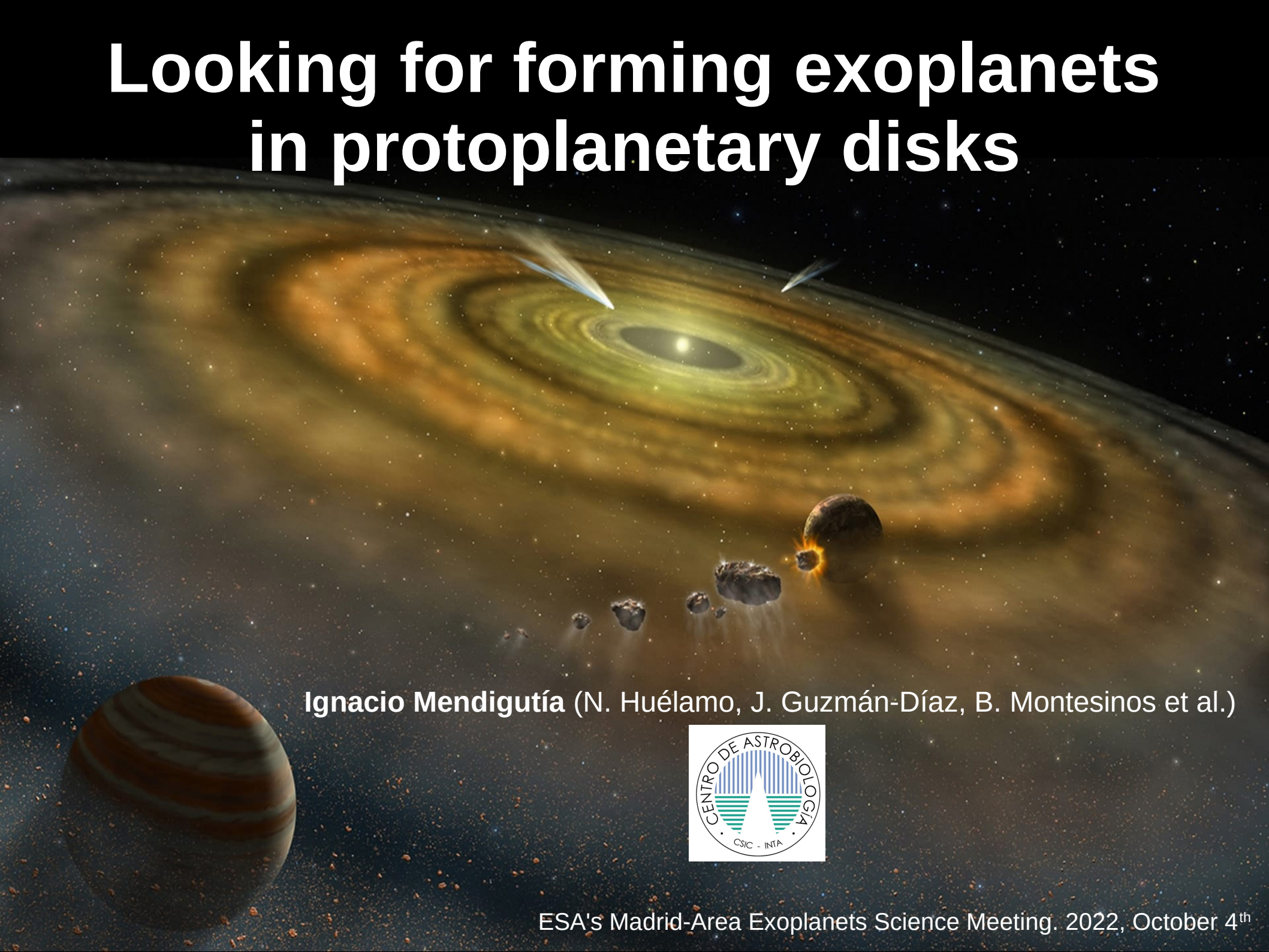
Looking for forming exoplanets in protoplanetary disks

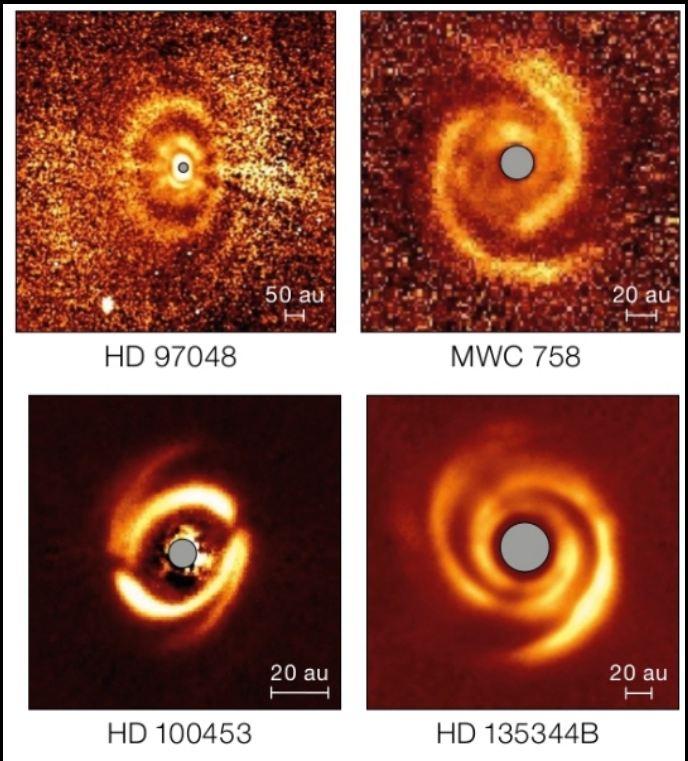


Ignacio Mendigutía (N. Huélamo, J. Guzmán-Díaz, B. Montesinos et al.)

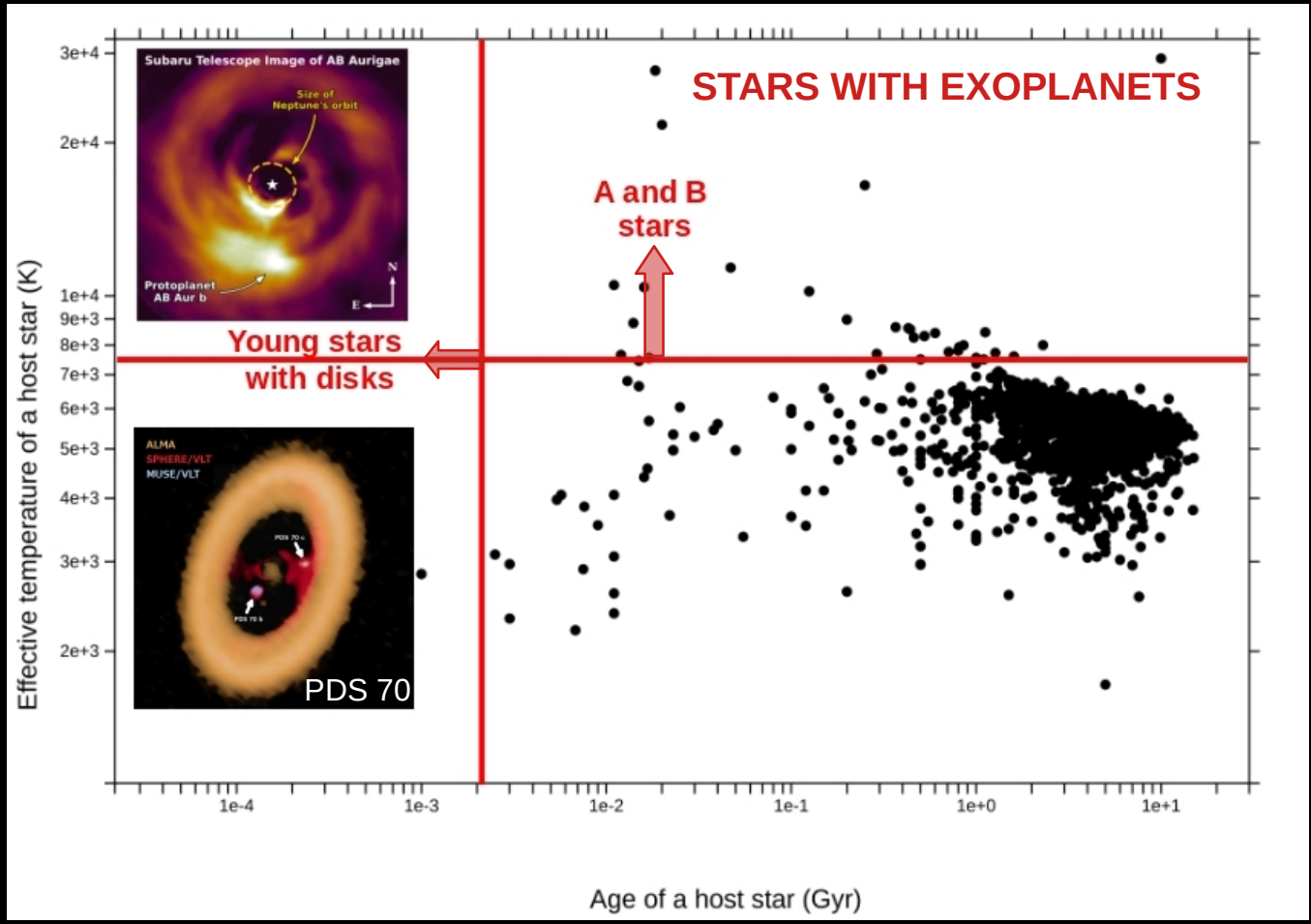
CENTRO DE ASTROBIOLOGÍA
CSIC - INTA

ESA's Madrid-Area Exoplanets Science Meeting. 2022, October 4th

Transit and radial velocity methods work for evolved (low-mass) stars



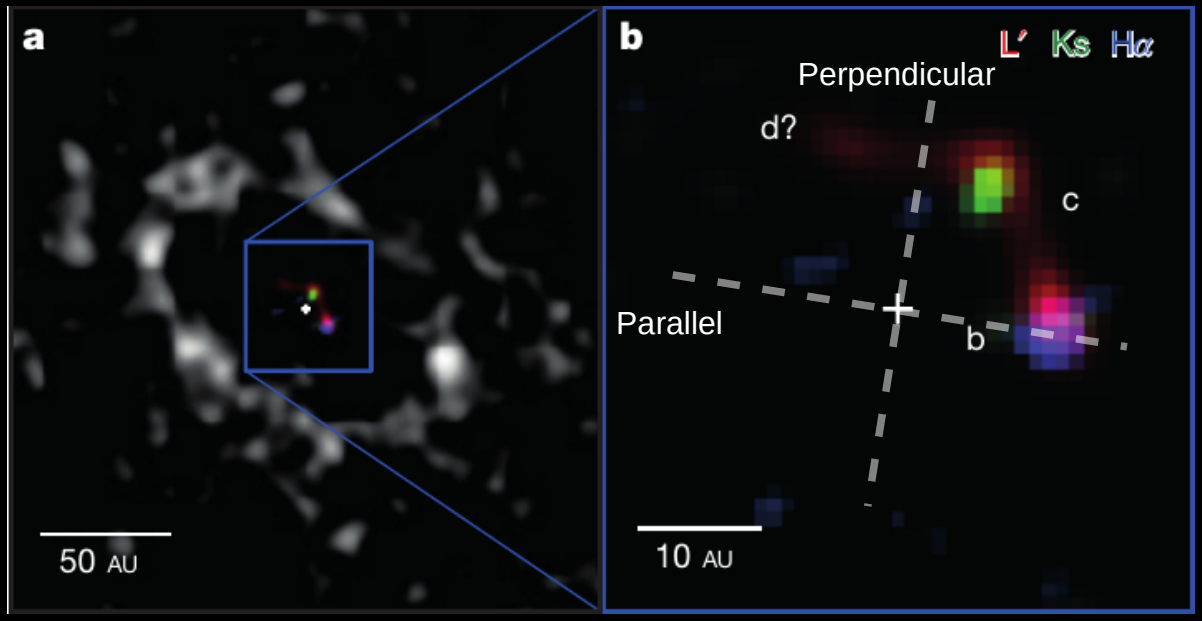
Garufi+2017

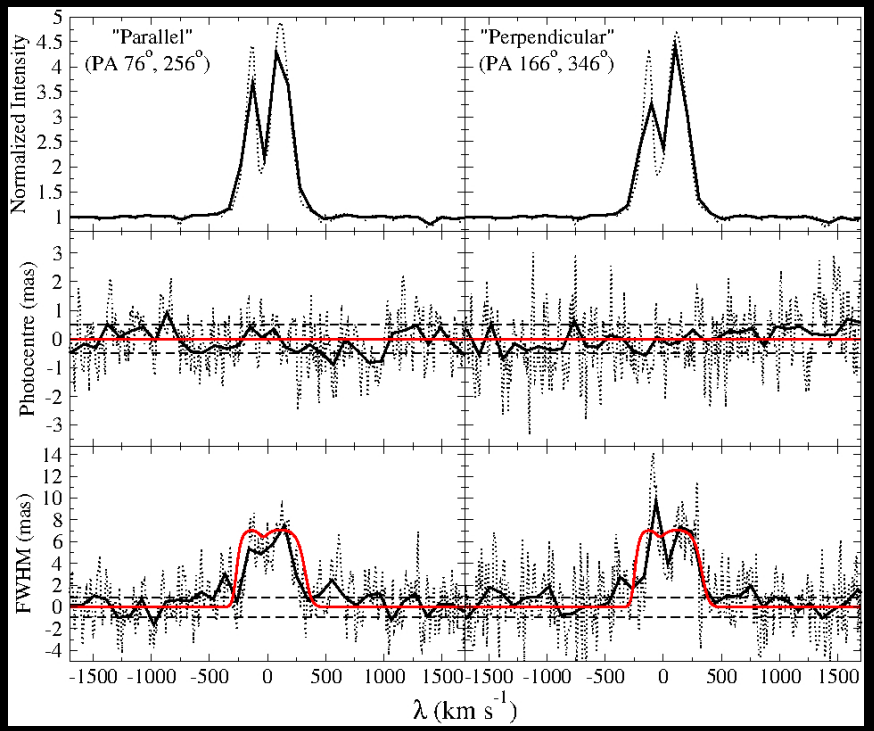


Forming planet <--> signatures of planetary accretion (Hα emission)
PDS 70 b, c (Keppler+2018; Wagner+2018; Haffert+2019; Benisty+2021...)
AB Aur b? (Currie+2022; Zhou+2022)

Spectro-astrometry to detect forming planets

"BORN" survey (Baby-planets ORigiN, PIs Mendigutía & Huélamo)
~ 25 young stars observed with ISIS/WHT & MEGARA/GTC
0 detections (+AB Aur? under analysis).

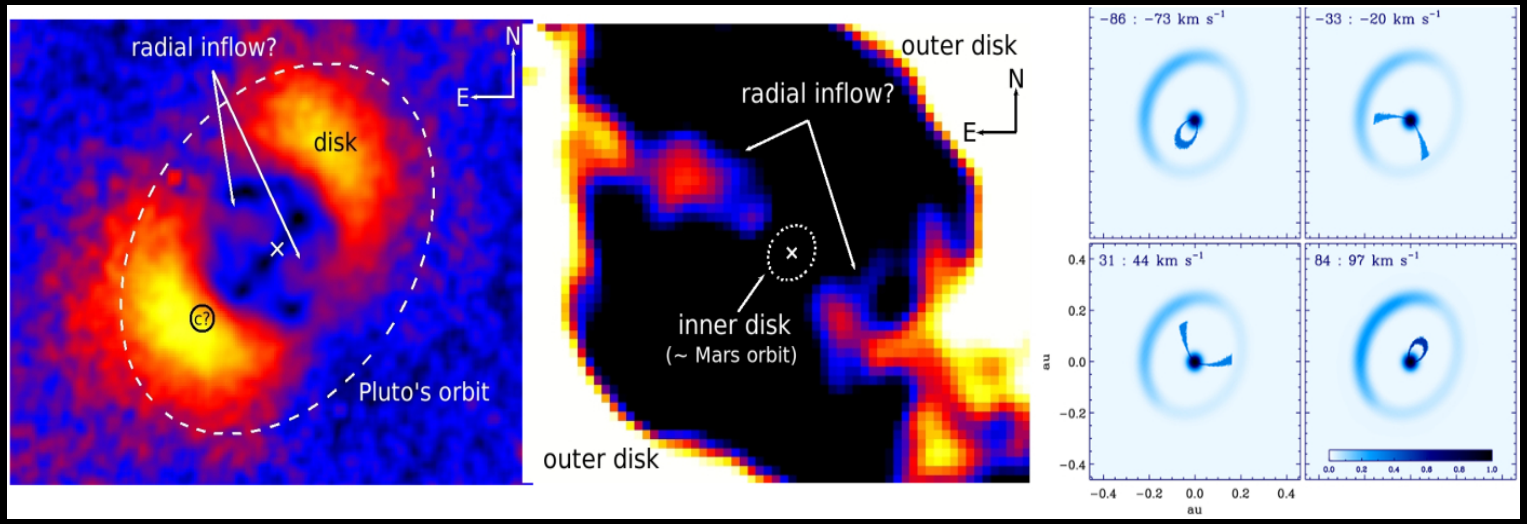




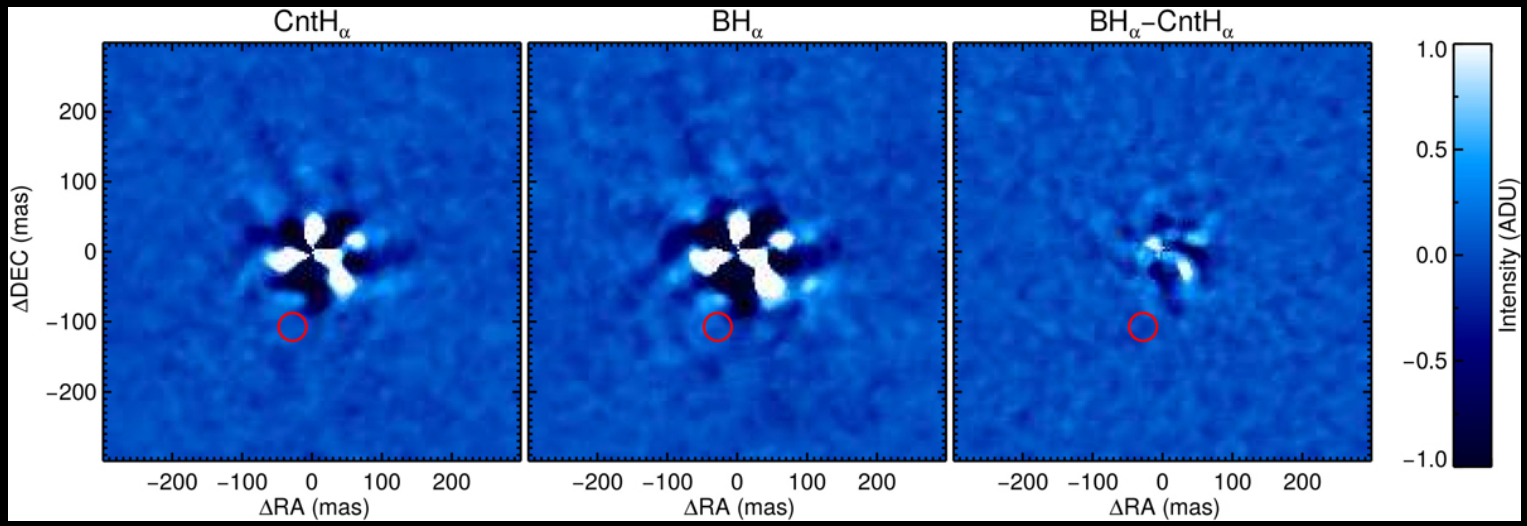
1st accreting protoplanet LkCa15 b? (Sallum+2015, Nature)…

…or aggressive data reduction? (Mendigutía+2018, confirmed by Currie+2019; Blakely+2022)

High-resolution observations to detect forming planets



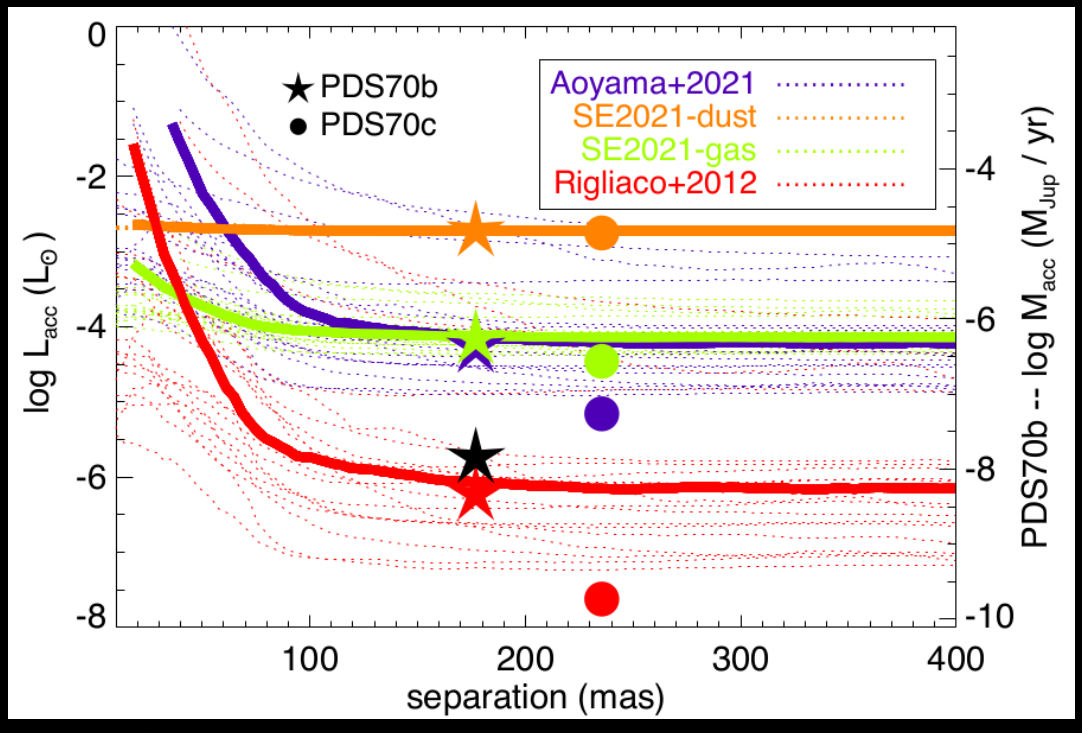
HD 100546
(Mendigutía+2015, 2017)



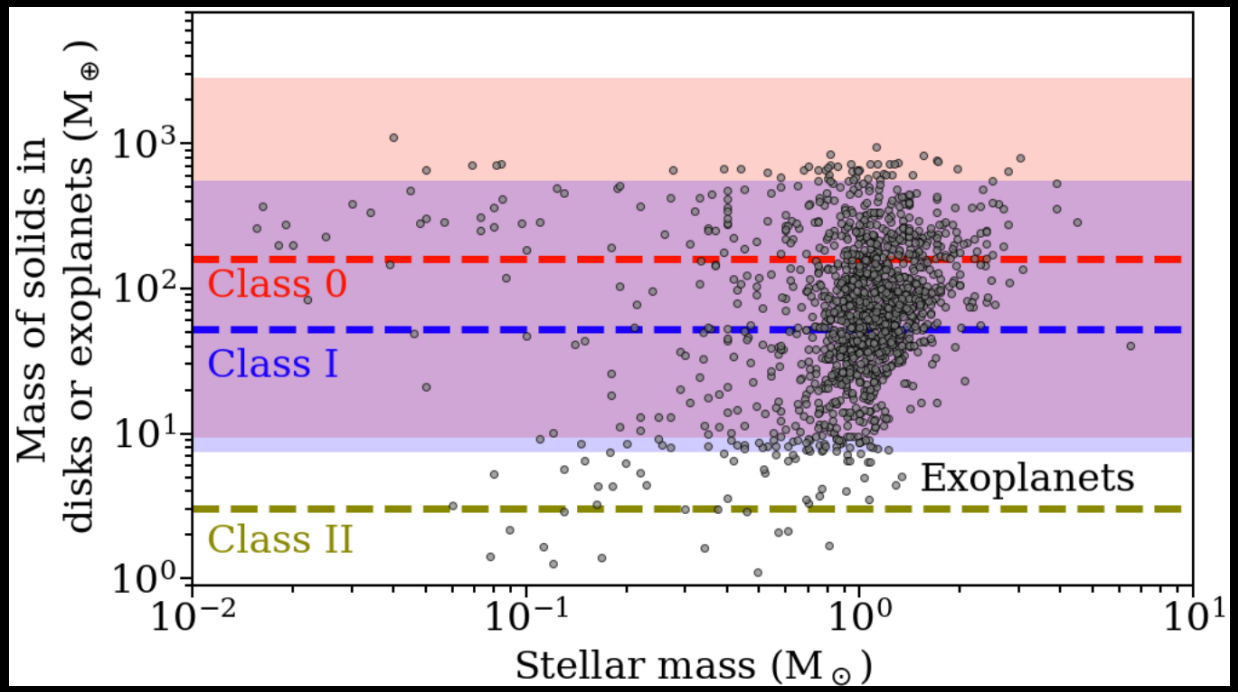
MWC 758
(Huélamo+2018)

Hα Surveys with SPHERE/VLT (Cugno+2019; Zurlo+2020; Huélamo+, accepted in A&A),
MUSE/VLT (Xie+2020) and SCExAO+VAMPIRES/Subaru (Uyama+2020)
~ 28 young stars. 0 detections (+ PDS 70)

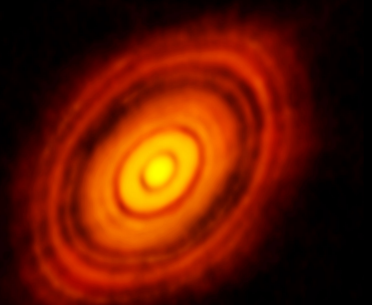
Planets form earlier than expected?



Huélamo+ (accepted in A&A): Undetected planetary accretion luminosities in Class II stars larger than previously assumed

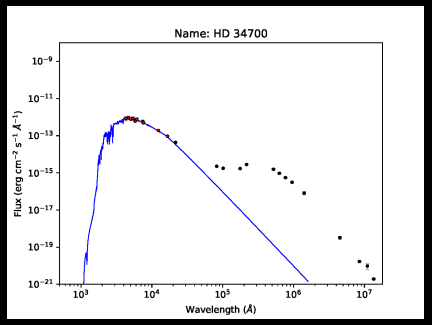


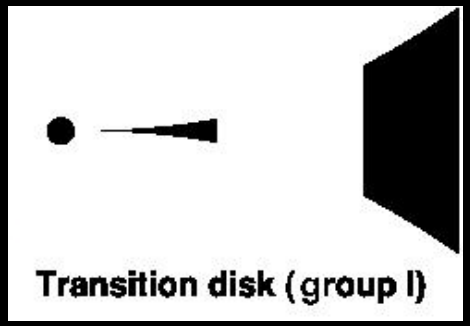
Tychoniec+(2020): exoplanet masses consistent with Class 0/I disk masses (but not with Class II)

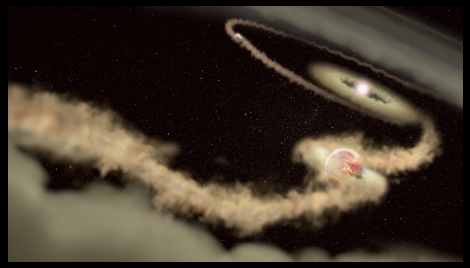


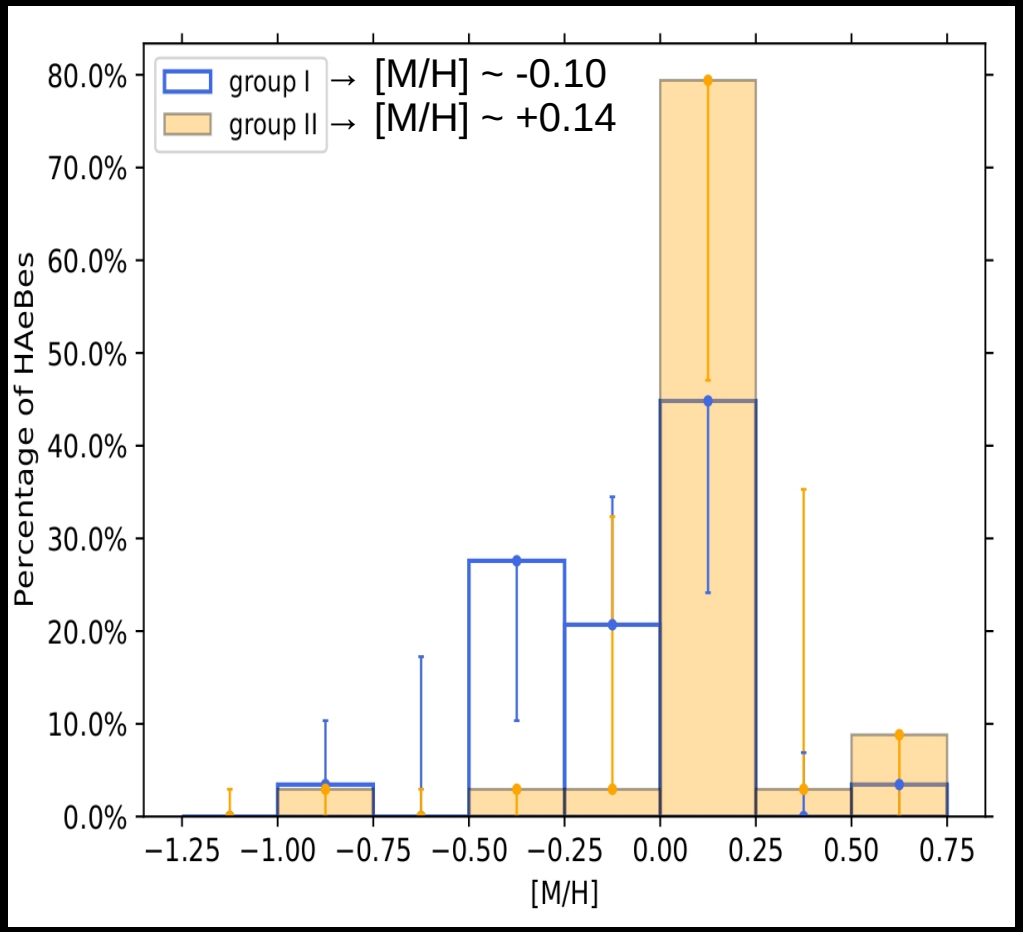
ALMA/HL Tau (Class I)

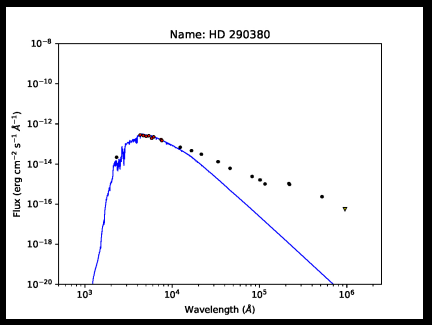
Link between the presence of planets in disks and the properties of the host protostars?

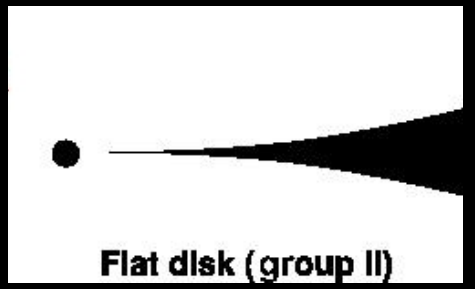


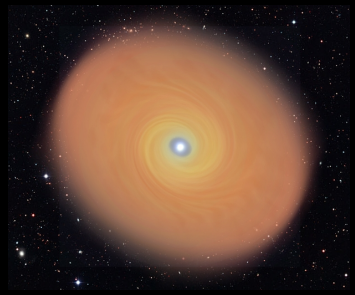






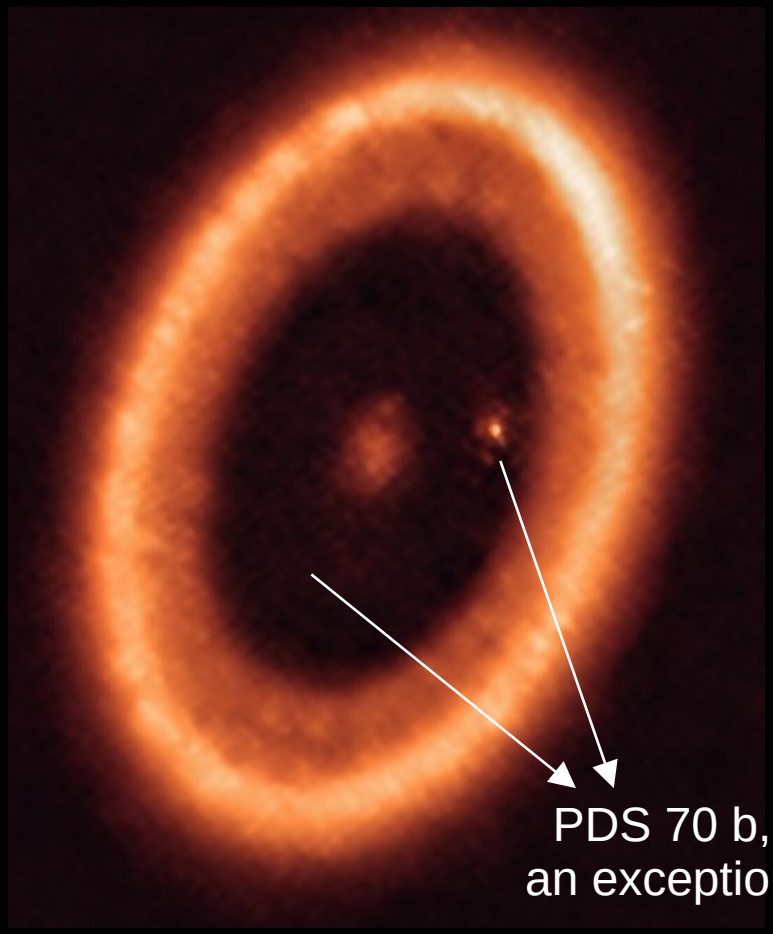






- Group I disks -with cavities- in stars with **smaller metallicities** (Guzmán-Díaz+2021 & in prep)
- Compatible with giant planets being more frequent in group I disks (Kama+2015; Jermyn+2018)
- Can we infer the presence of planets based on “simple” observables (SED, [M/H]..)?
- Can we extend the planet-metallicity correlation from evolved stars to young stars?

Take home messages



Credit: ESO/ALMA/Benisty+2021

- Detecting forming planets is a very challenging (but crucial!) task, and only now it is starting to be possible.

- At CAB we combine direct searches with state-of-the-art instrumentation + studies looking for indirect links between observables and the presence of planets.

- Only 1 (+1?) confirmed detection out of ~ 50 optically-visible young stars --> Are planets already formed in previous stages?

Future

JWST, ELT, High precision astrometry with Gaia?