The MagAO Giant Accreting Protoplanet Survey (GAPlanetS): Recent Results

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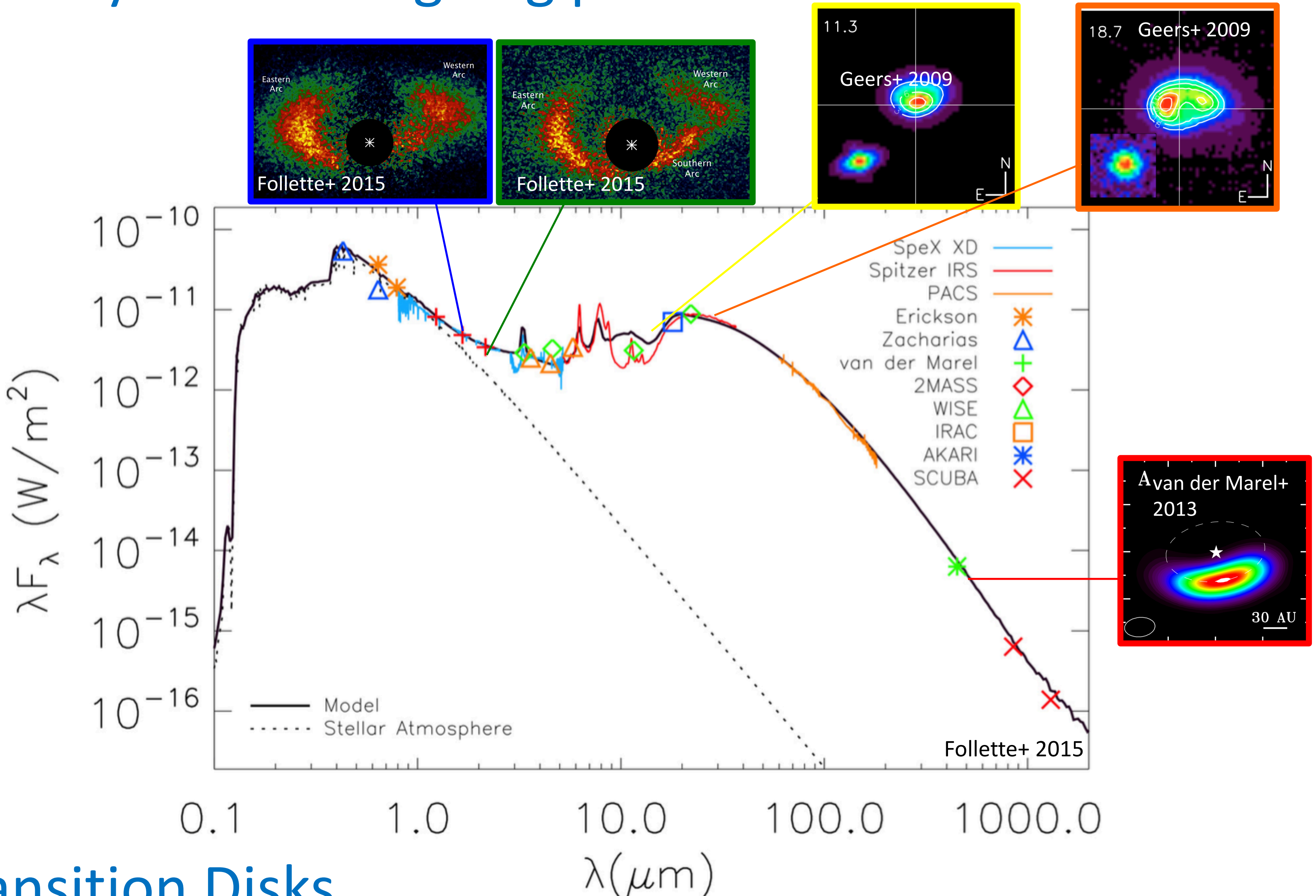
How do you study the planet formation process?

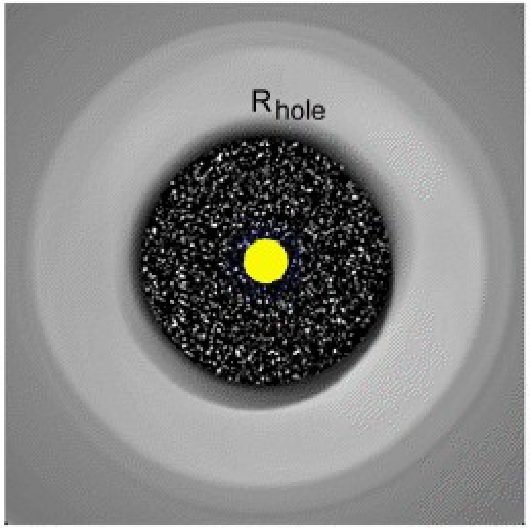
Identify sites of ongoing planet formation



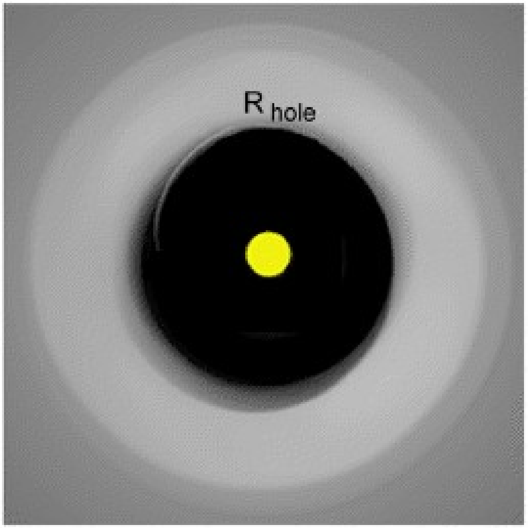
Transition Disks

How do you study the planet formation process?

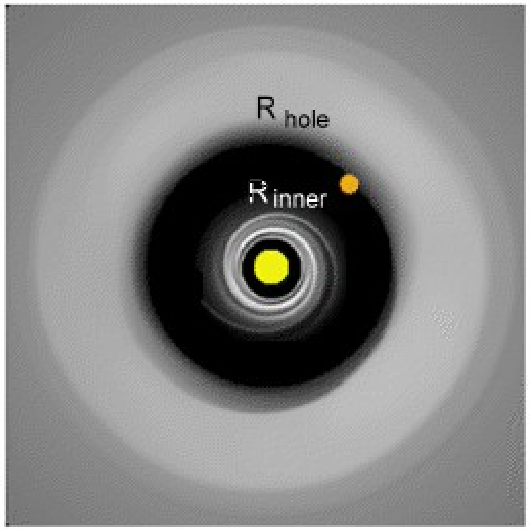
Grain Growth



Photoevaporation

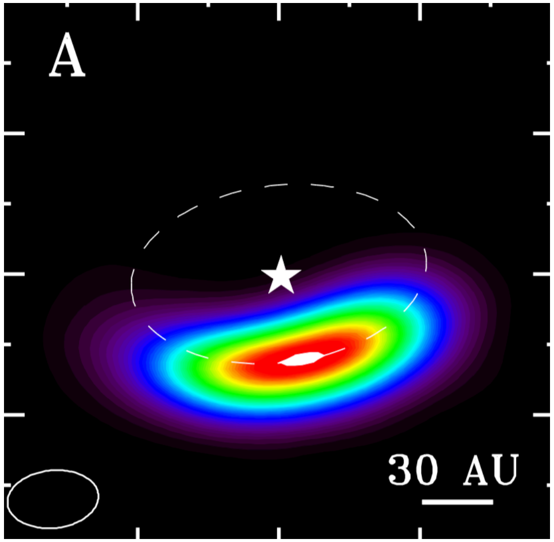


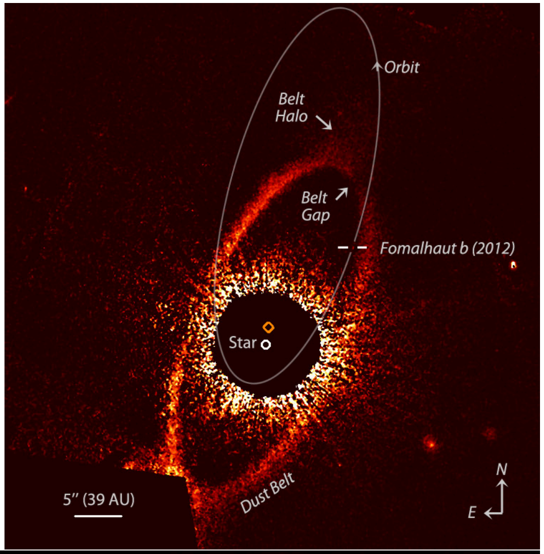
Planet Formation

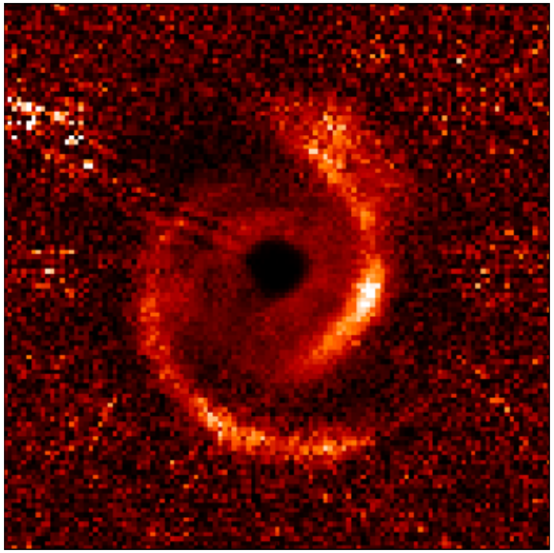


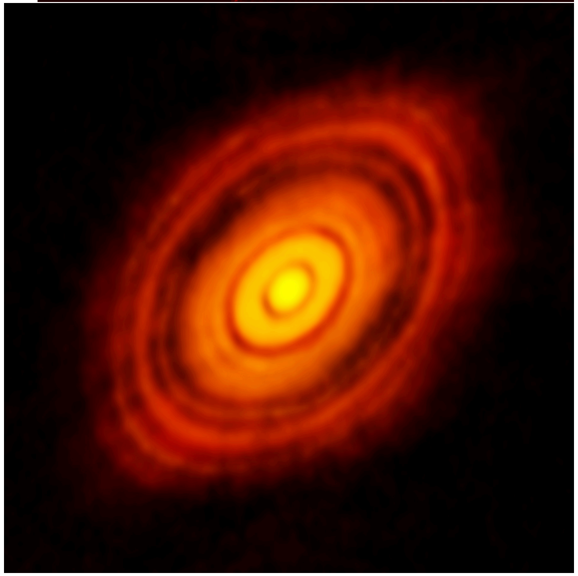
Strategy 1: Take high resolution, high contrast images of transition disks and look for "signposts"

Disks as "Signposts" of Planets



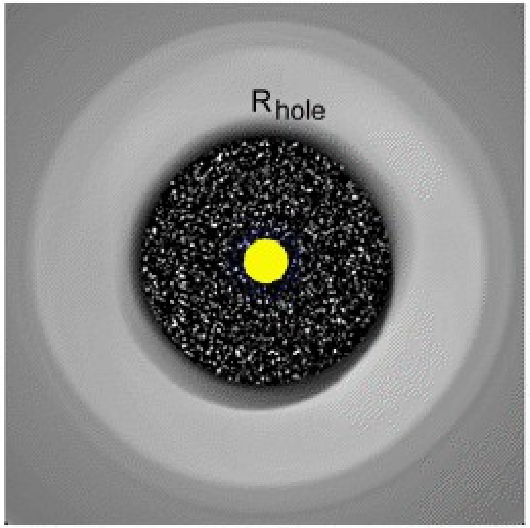




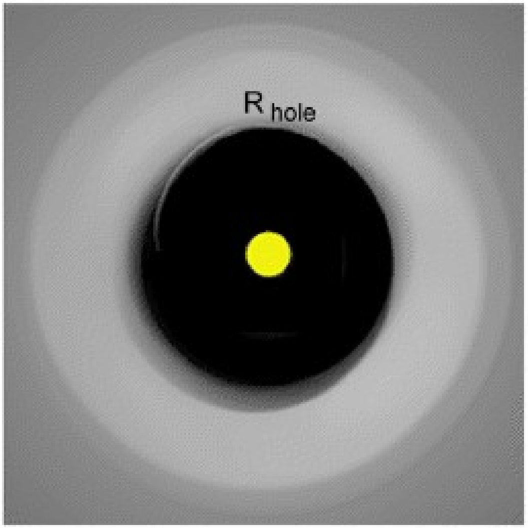


How do you study the planet formation process?

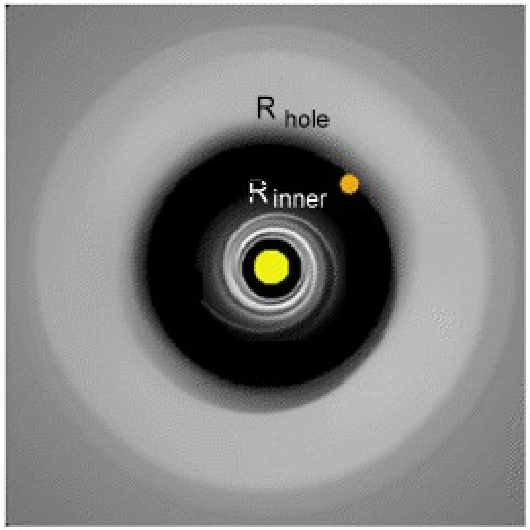
Grain Growth



Photoevaporation



Planet Formation



Strategy 1: Take high resolution, high contrast images of the disks and look for ”signposts”

Strategy 2: Look for the planets themselves!

<u>Obstacle 1: Resolution</u>

@ 140pc, a 10AU hole (Saturn-sized orbit) is 0.07”

$$\boldsymbol{\theta = 1.22\frac{\lambda}{D}}$$ → Bigger telescope or **<u>shorter wavelength</u>**

Obstacle 2: Contrast

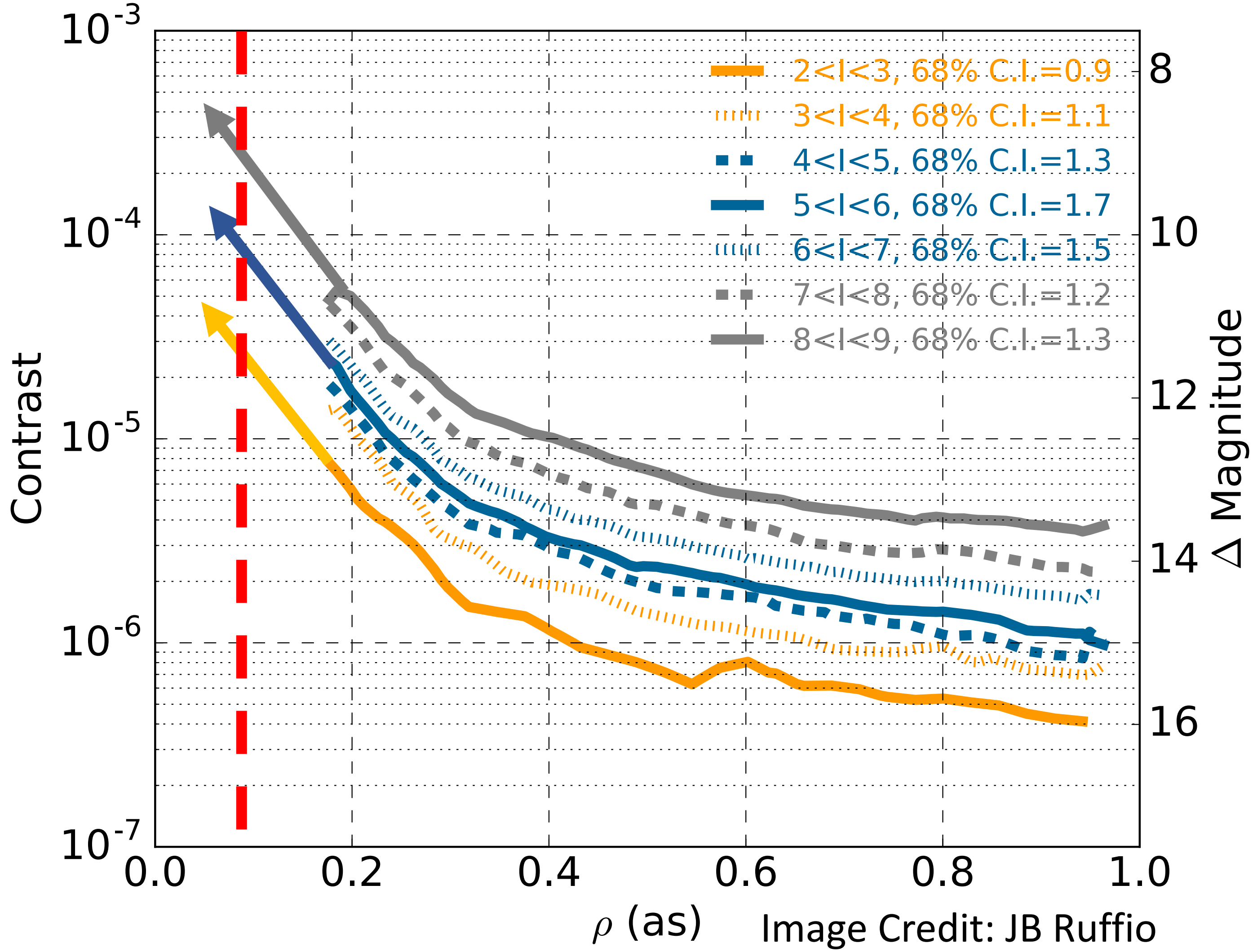
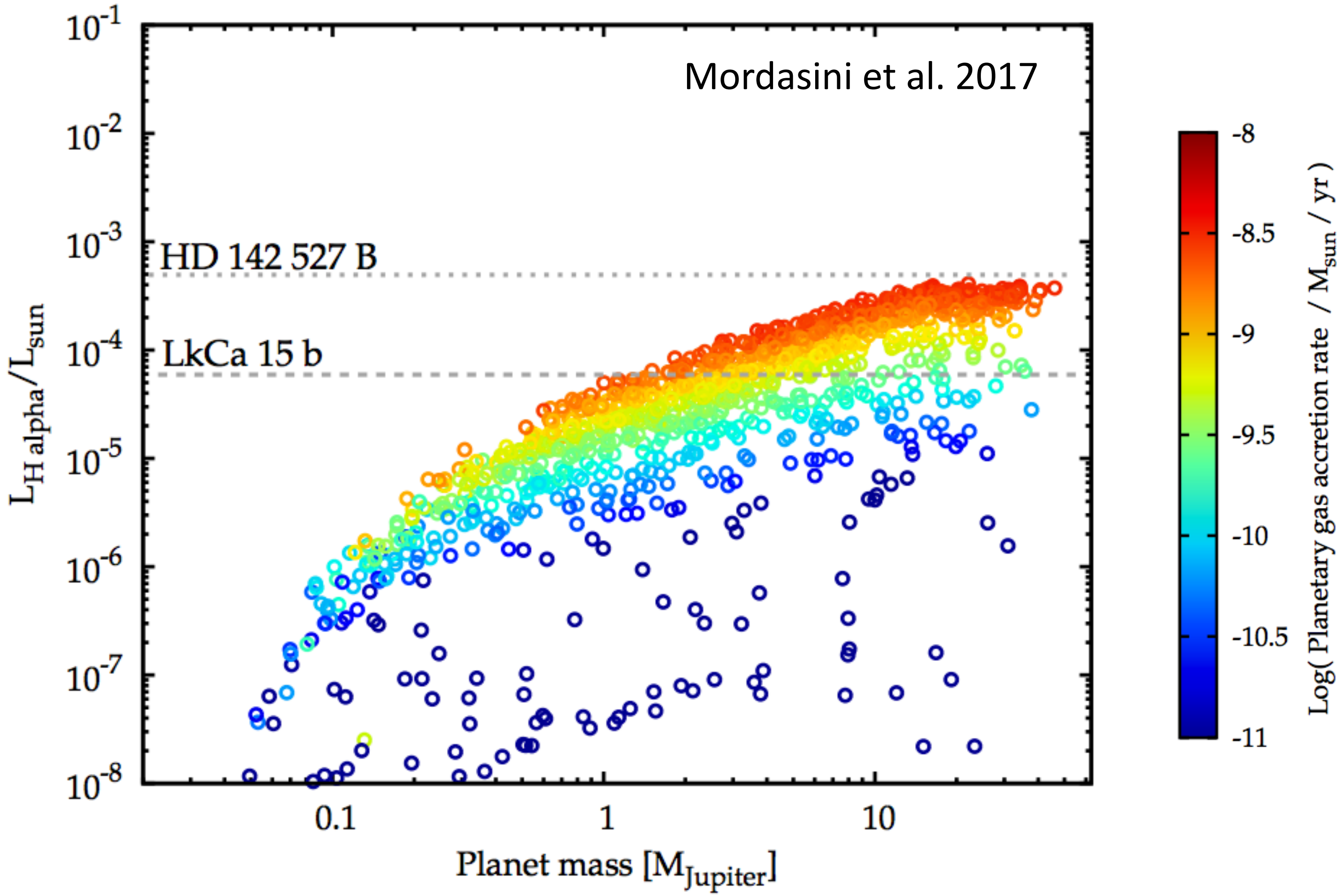
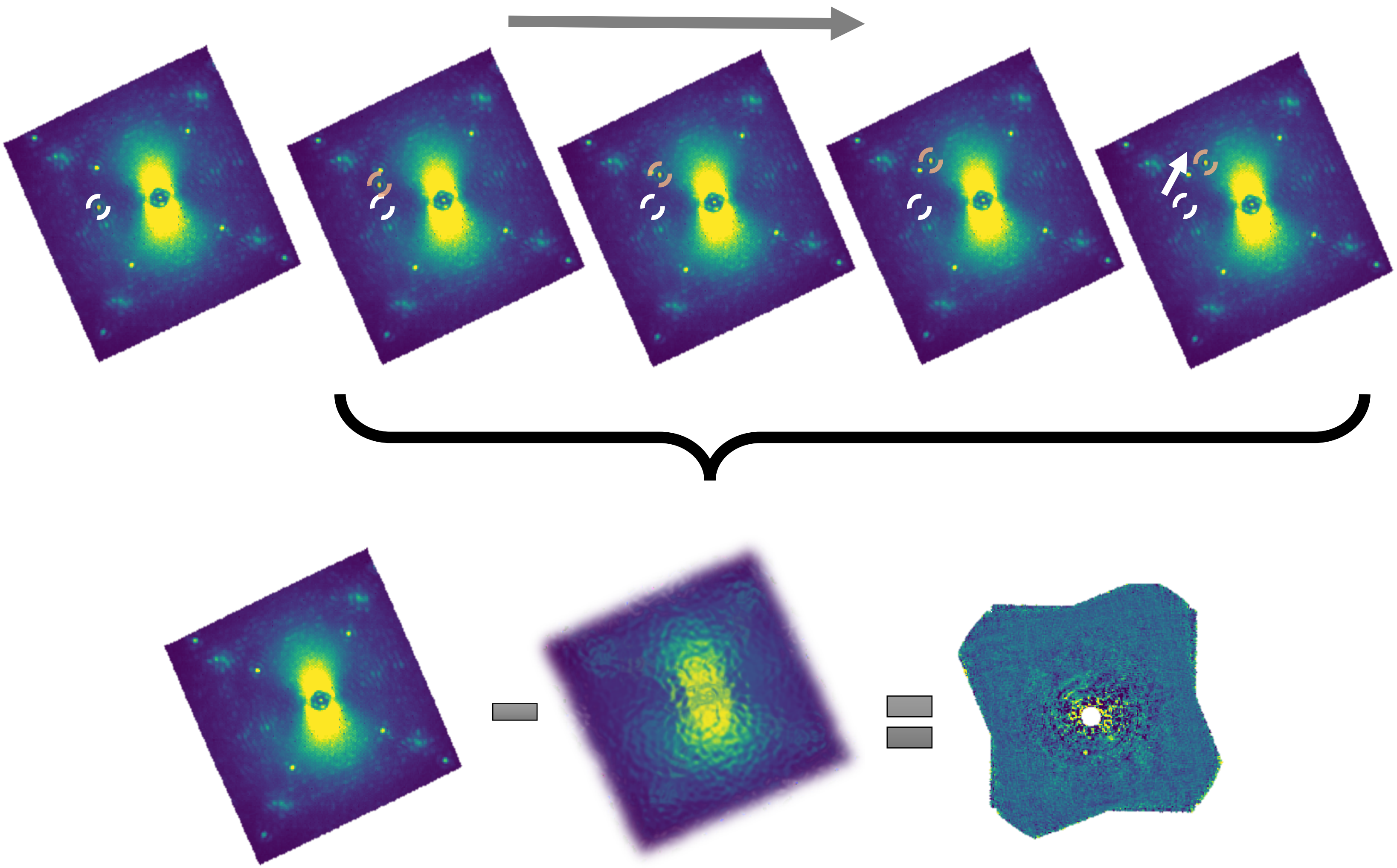


Image Credit: JB Ruffio

Obstacle 2: Contrast

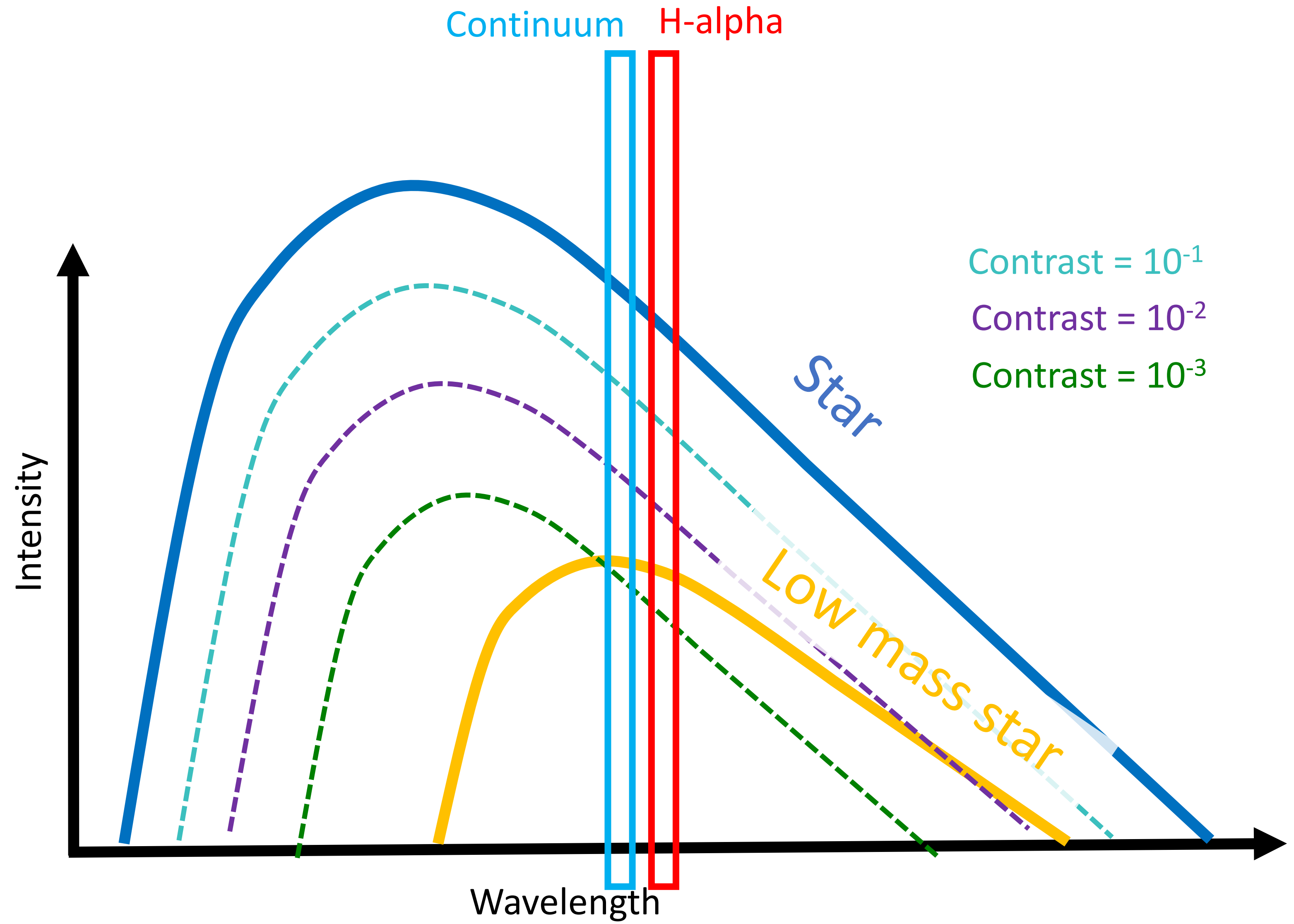


ADI$^+$ Post-Processing = LOCI/KLIP

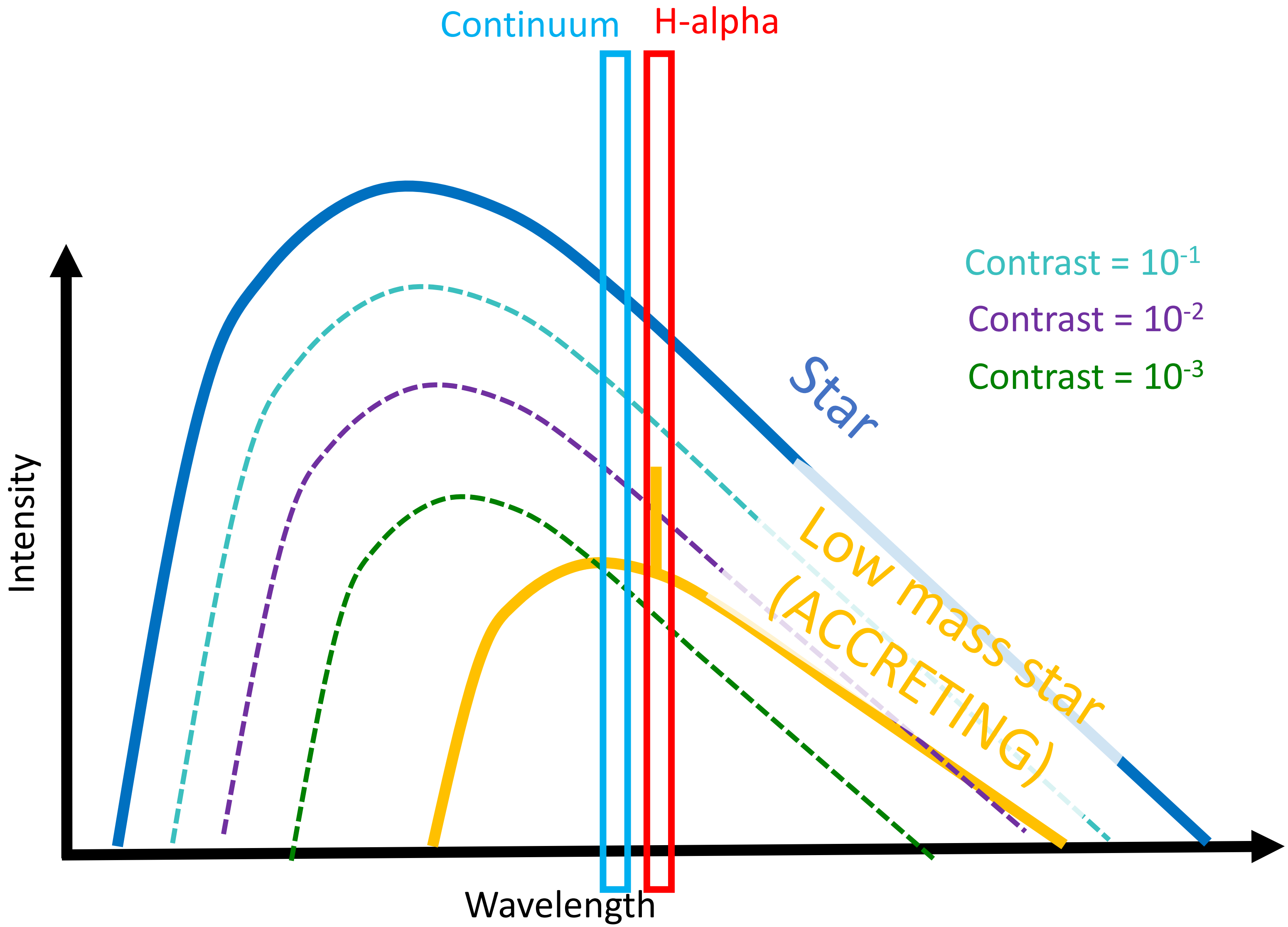


Credit: JB Ruffio

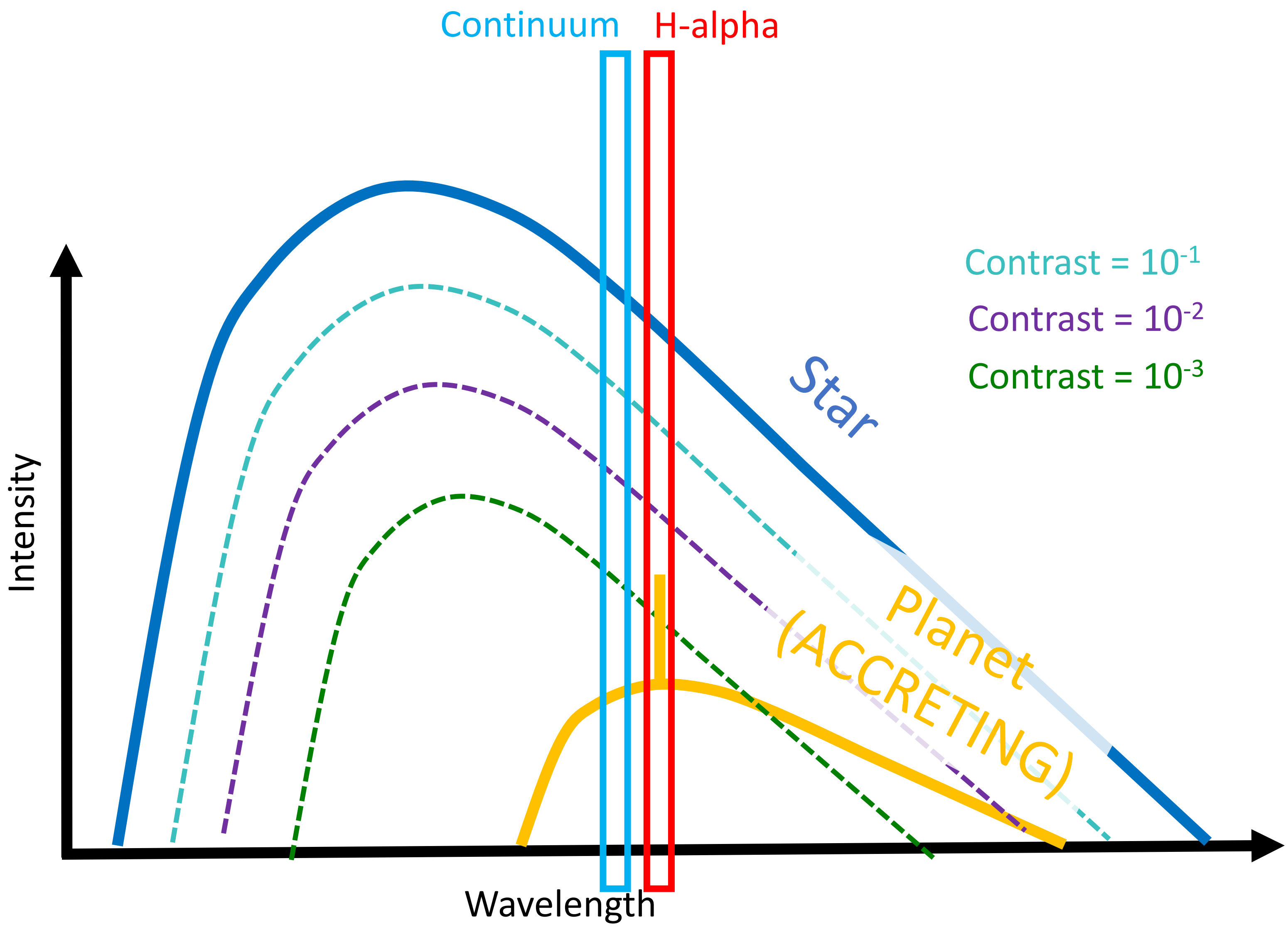
Simultaneous (Spectral) Differential Imaging



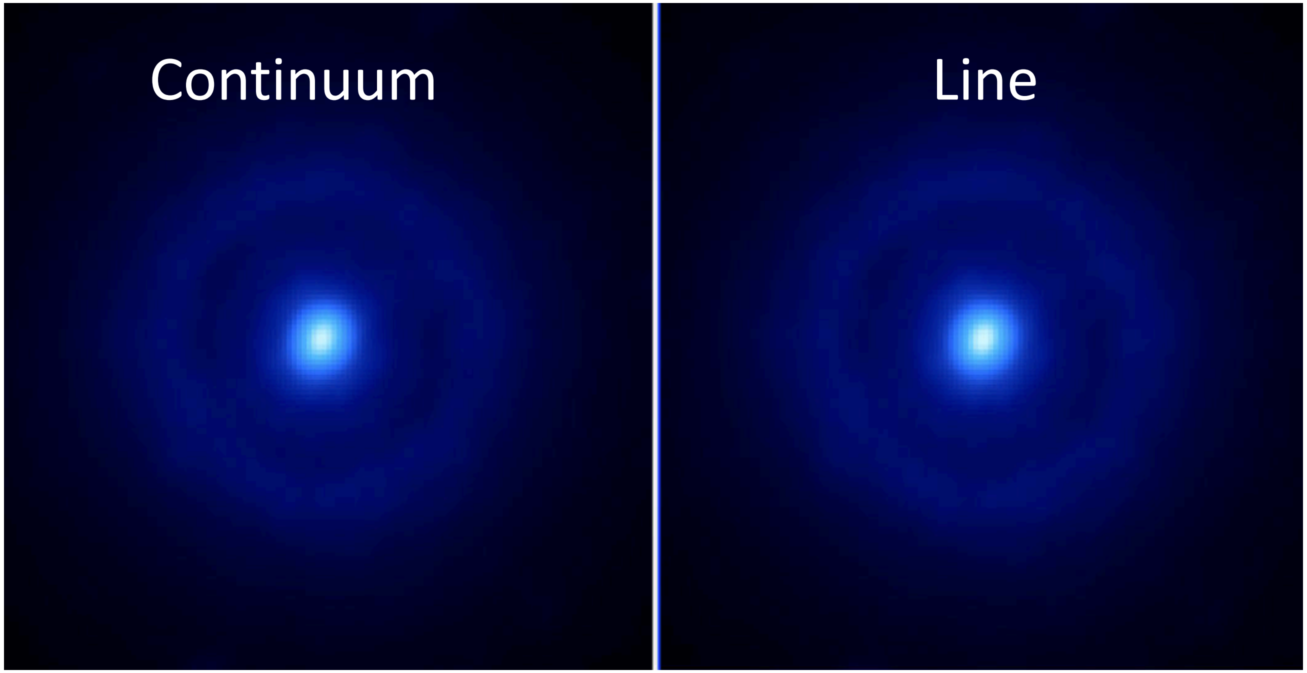
Simultaneous (Spectral) Differential Imaging

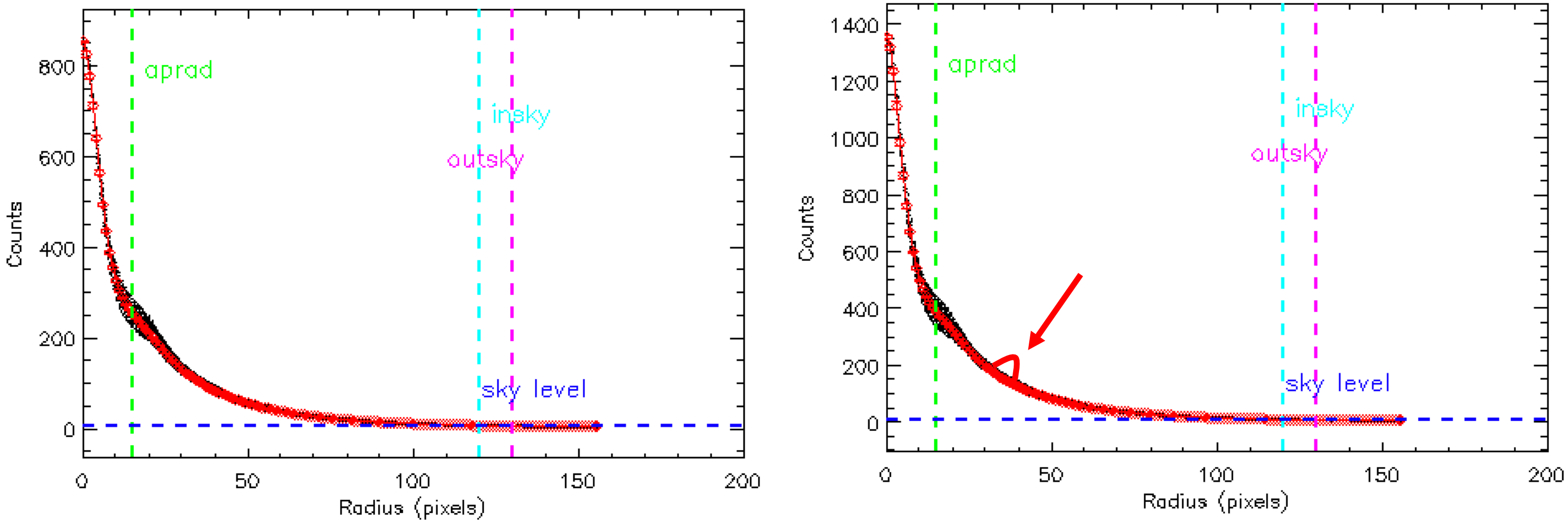


Simultaneous (Spectral) Differential Imaging



Simultaneous (Spectral) Differential Imaging





Giant Accreting Protoplanet Survey (GAP planetS)

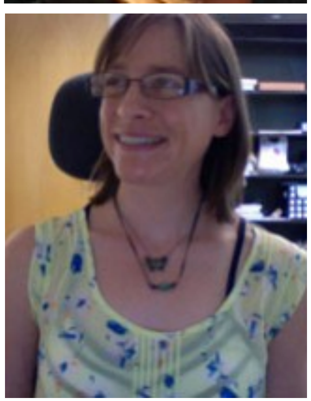
GAPplanetS Candidates	Rmag	Cavity Radius (AU)	distance (parsec)
HD100546	6.7	13	97
HD142527	7.0	100	144
Object 3	7.0	15	98
Object 4	8.2	23	145
Object 5	8.3	130	230
Object 6	8.3	73	200
Object 7	8.4	5.9	47
Object 8	8.4	80	150
Object 9	8.7	46	142
Object 10	9.7	46	385
Object 11	10.2	29	73
Object 12	10.7	25	140
Object 13	10.8	43	160
Object 14	10.9	46	56
LkCa15	11.6	50	140

GAPlanetS Team

Laird Close
MagAO PI

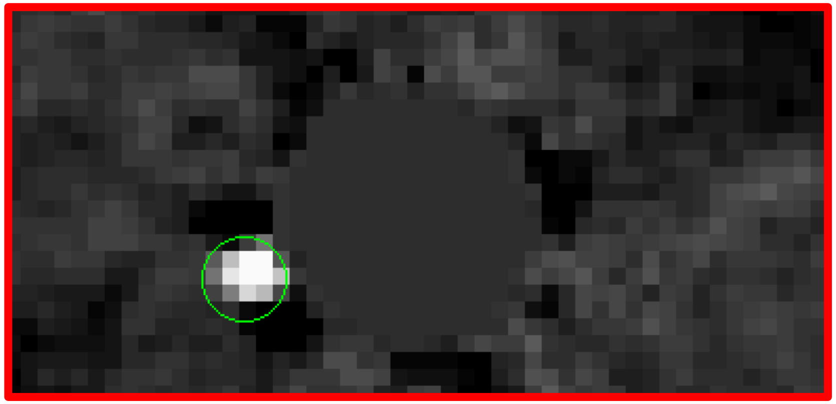
Jared Males
VisAO PI
MagAOX PI

Clare Leonard
Alex Watson
Elijah Spiro
Wyatt Mullen
Ray Saitoti

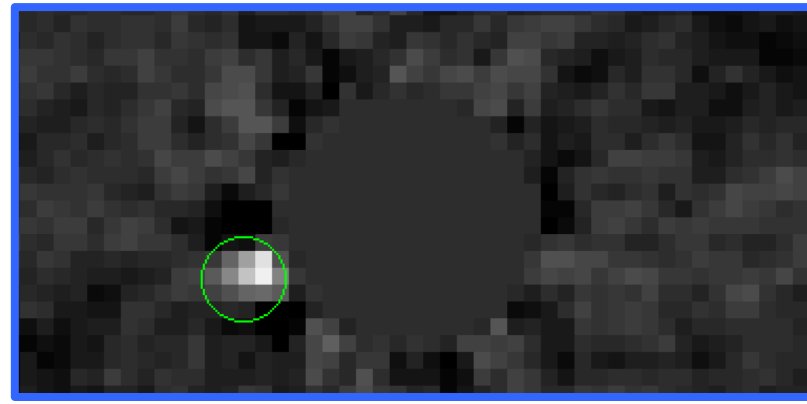


Katie Morzinski
MagAO Instrument Scientist

HD 142527 – An Accreting Stellar Companion

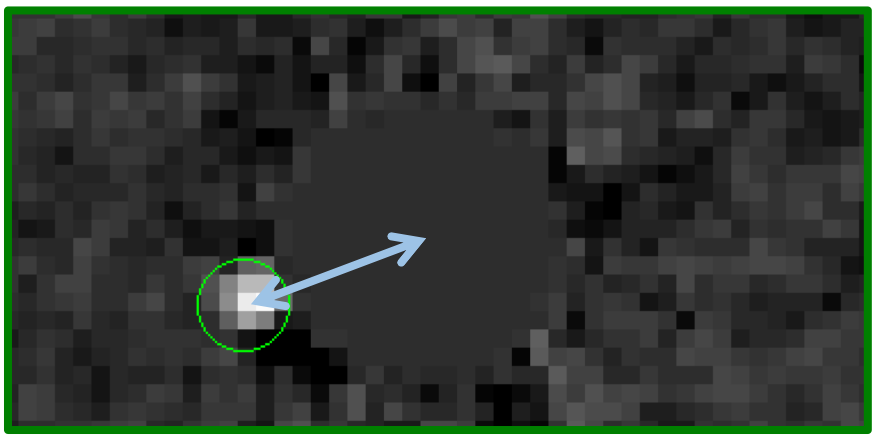


H-alpha



Continuum

Alex Watson
Undergraduate thesis

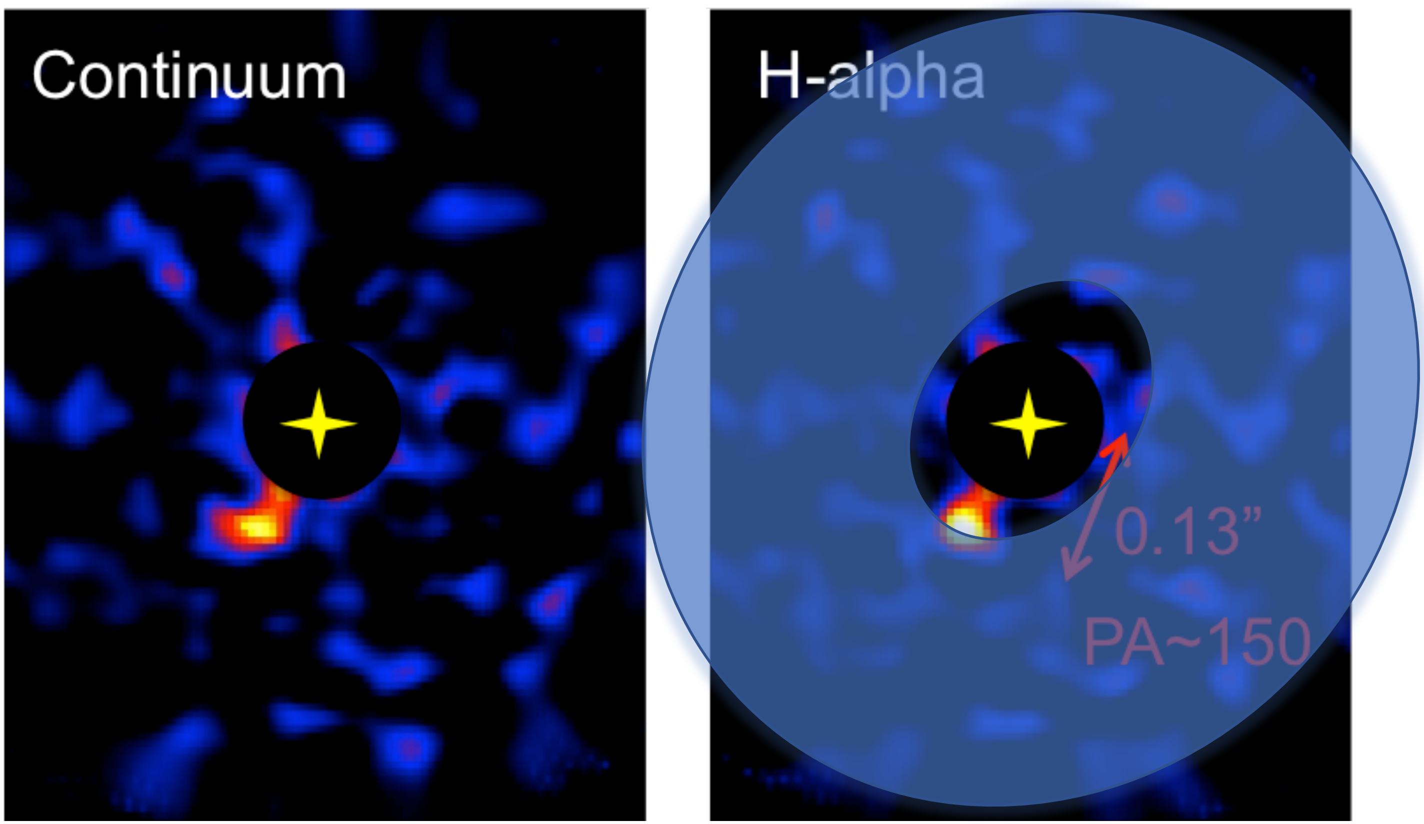


Difference (ASDI)

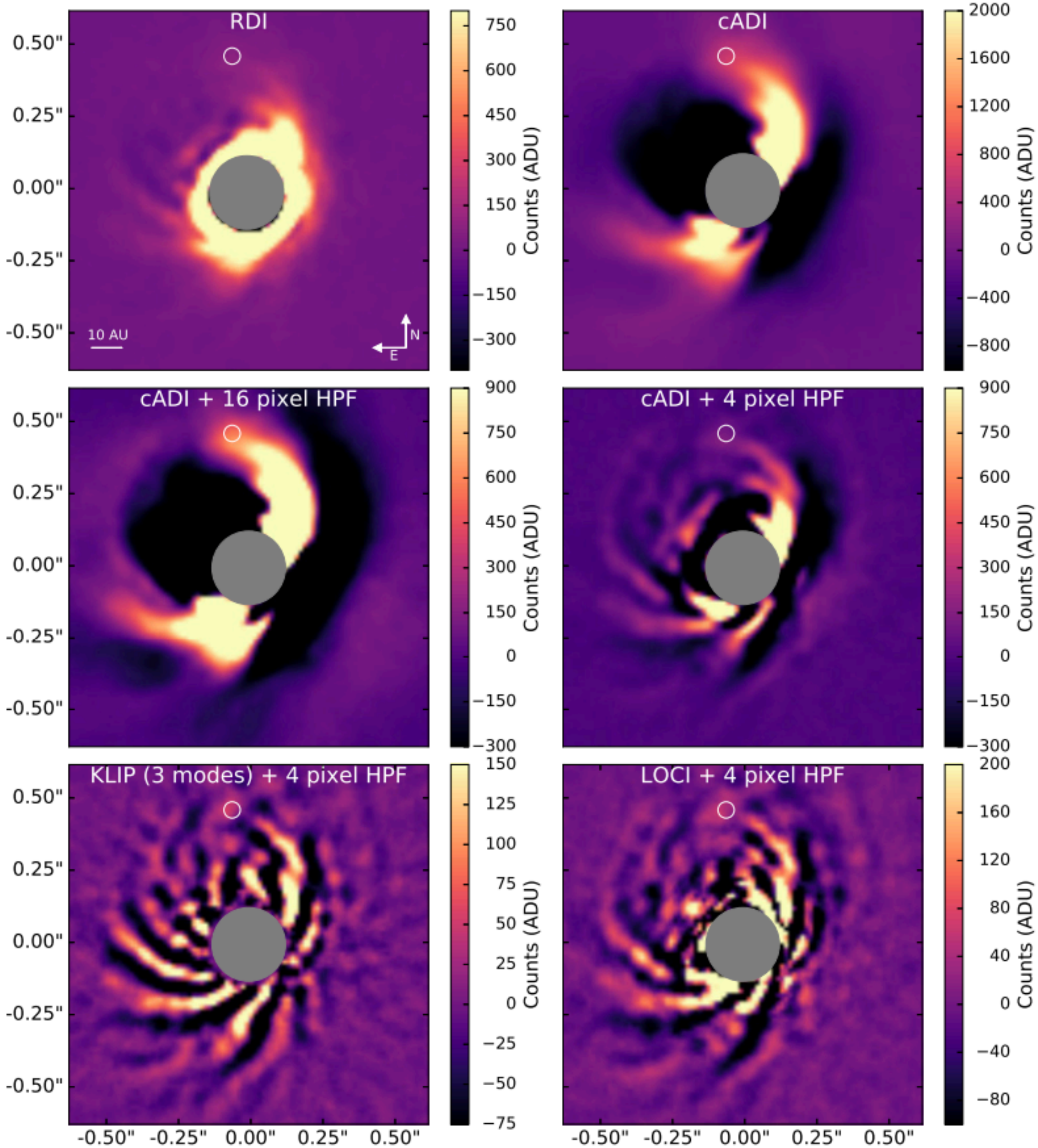
Brighter in H-alpha
→ accreting

Just 0.086” separation → 12AU!

HD100546 "b" – An accreting protoplanet?

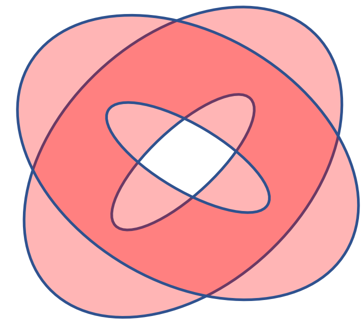


H-band Total Intensity

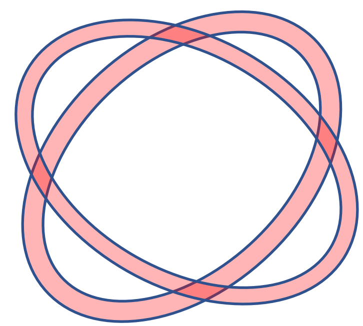


Follette, Rameau et al. 2017

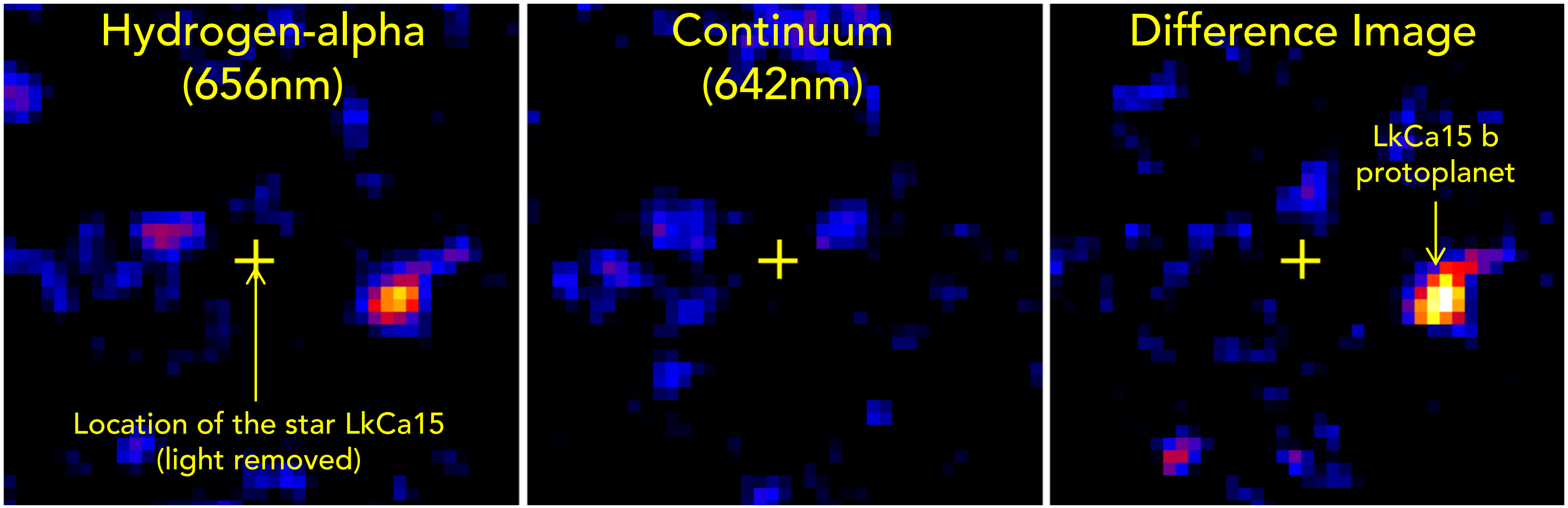
Big diffuse features= erased

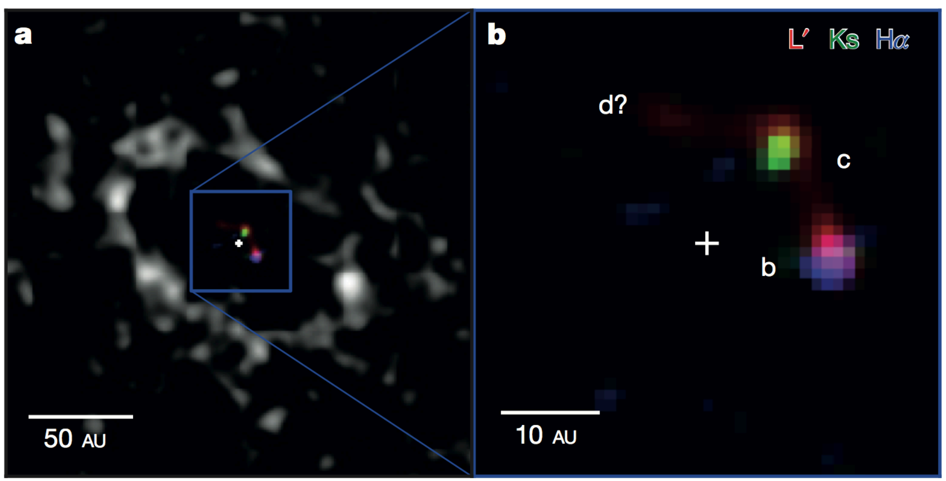


Sharp features = preserved



LkCa15 b – An Accreting Protoplanet





Sallum, Follette et al. 2015 *Nature*

Properties

Separation: 93 ± 8 mas

1.3 × FWHM

14.7 ± 2.1AU

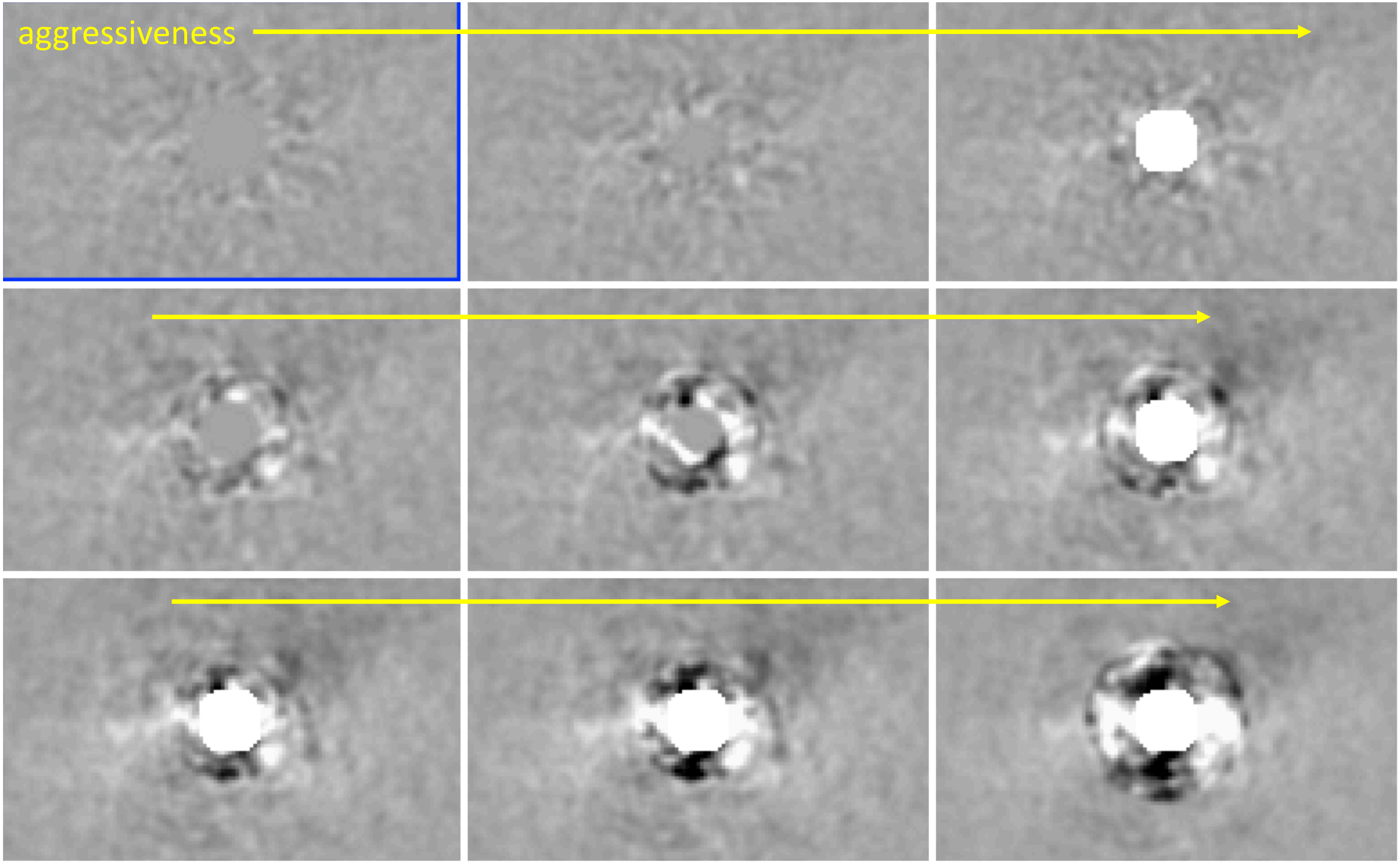
PA: -104 ± 3°

Δ_{mag}: 5.2 ± 0.3

8×10^{-3} contrast

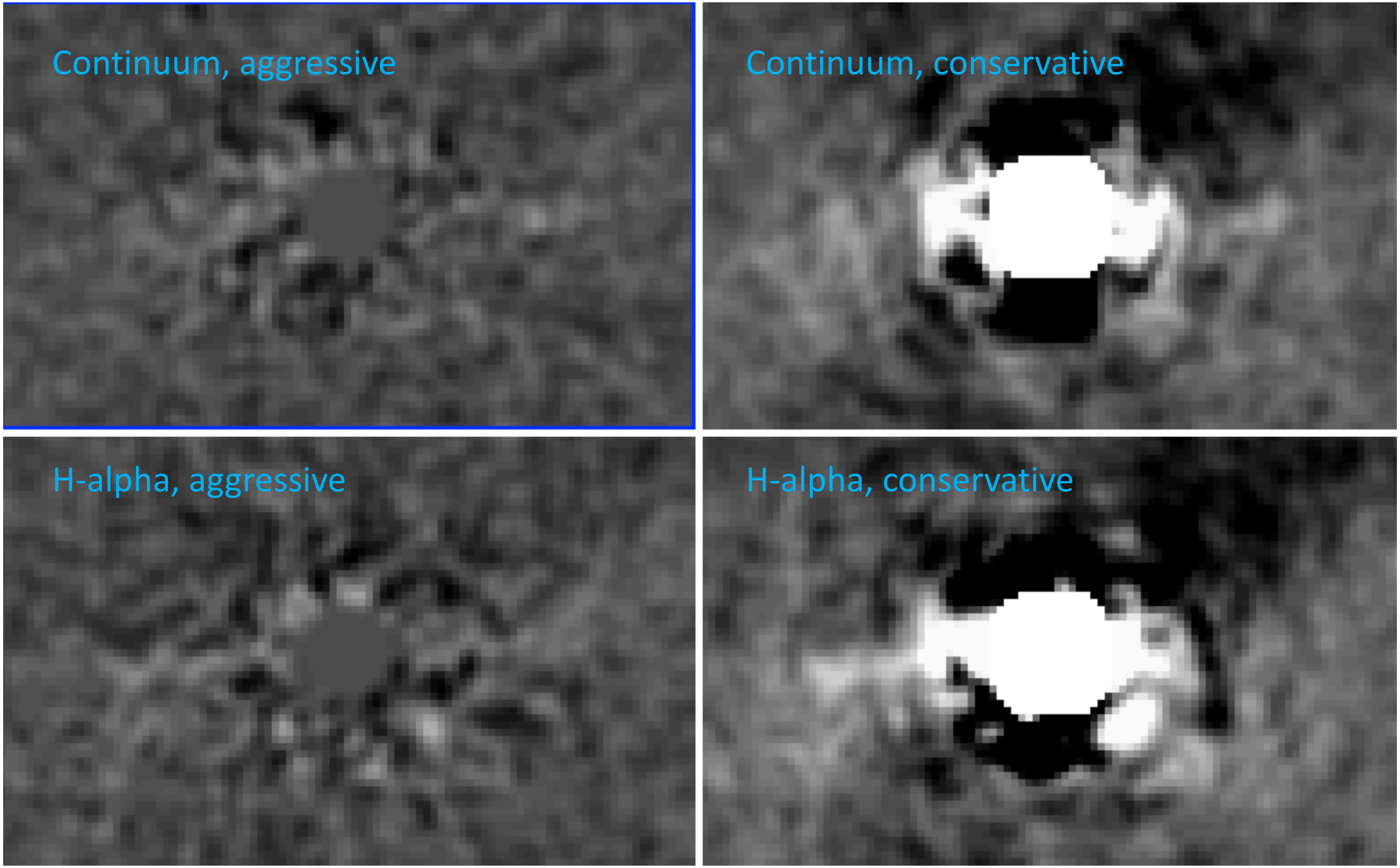
SNR: 6.8

New LkCa 15 Data (2016)



Follette et al, in prep

New LkCa 15 Data (2016)



Follette et al, in prep

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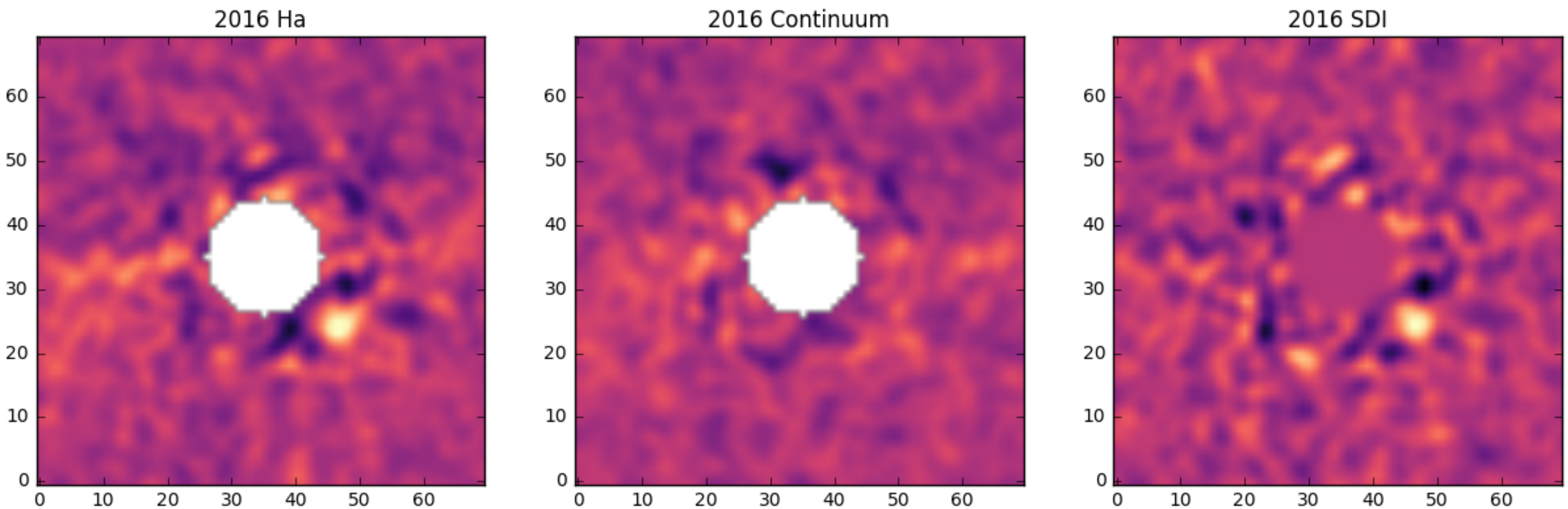
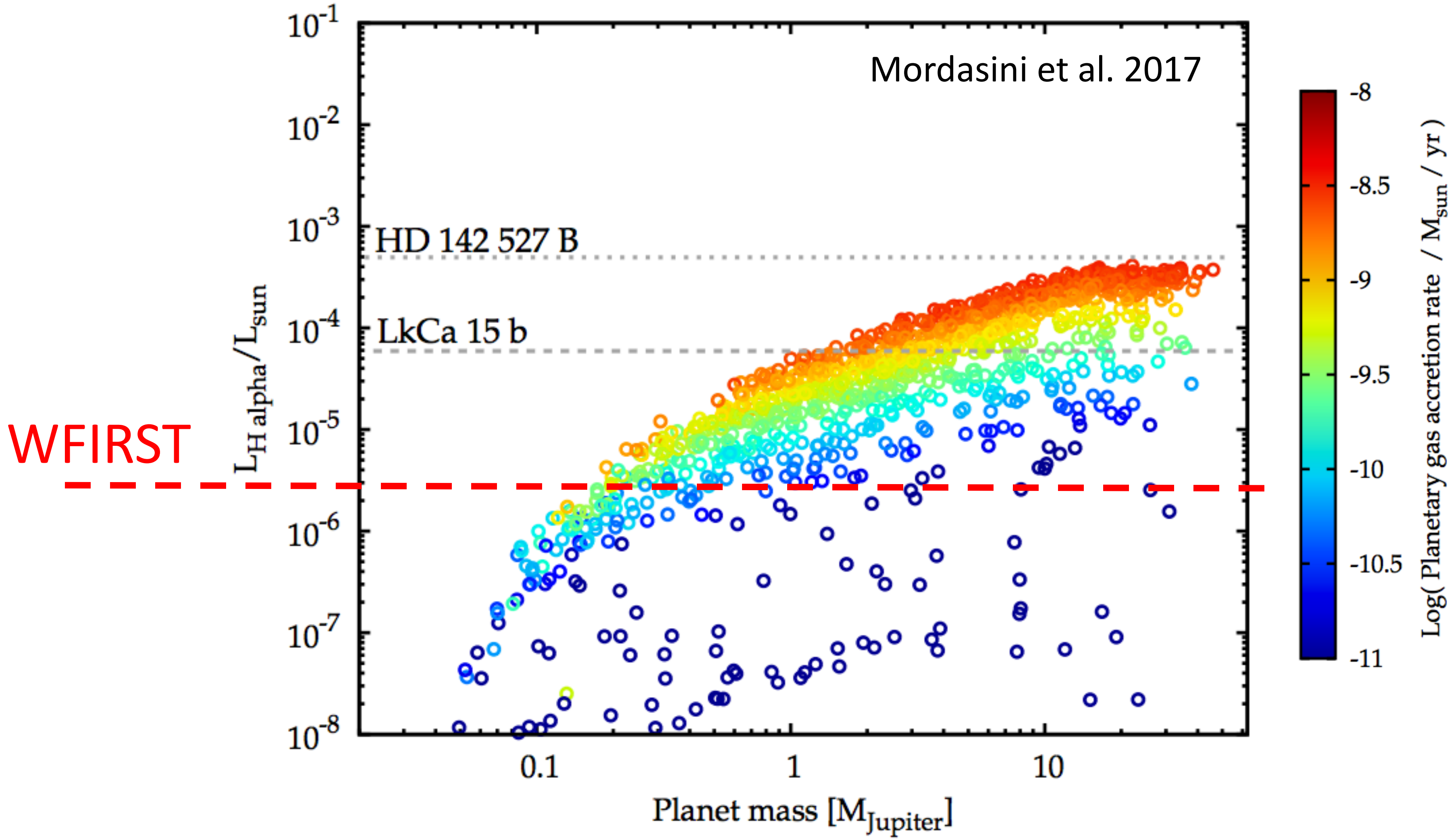
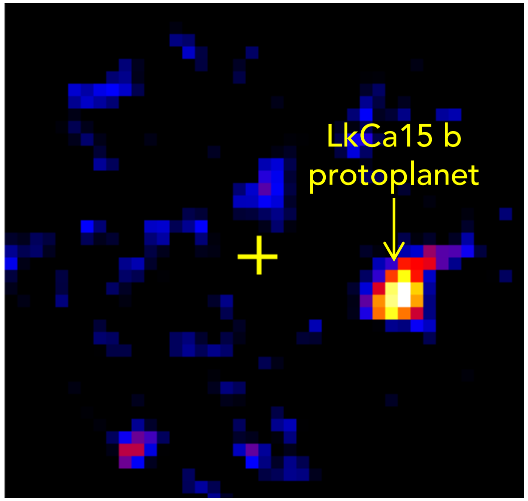
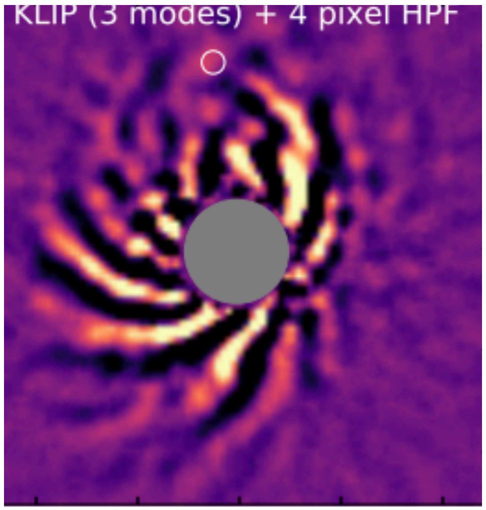


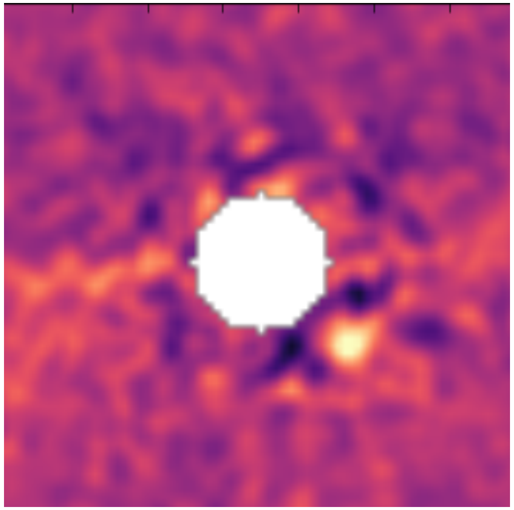
Applications in Space



Conclusions







Imaging in visible light and at wavelengths that require more moderate contrasts allows for ***direct detection of planets within disk gaps****…*

However ***interpretation of sources near scattered light features is complicated*** *requires large rotations and thorough exploration of the parameter space*

The future of this technique is bright*, particularly in the context of future space missions*