

Results and perspectives of dual-field interferometry for the study of exoplanets

Mathias Nowak

LIRA, Observatoire de Paris



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23 juin 2026, Grenoble, France

VLTI's Instrumental Suite



Dual-field K-band combiner

- 1.98 - 2.4 microns
- Resolutions 20 to 4000
- Fringe tracking ($M_K = 13$)
- Sensitivity $M_K = 20$
- Astrometry < 50 uas

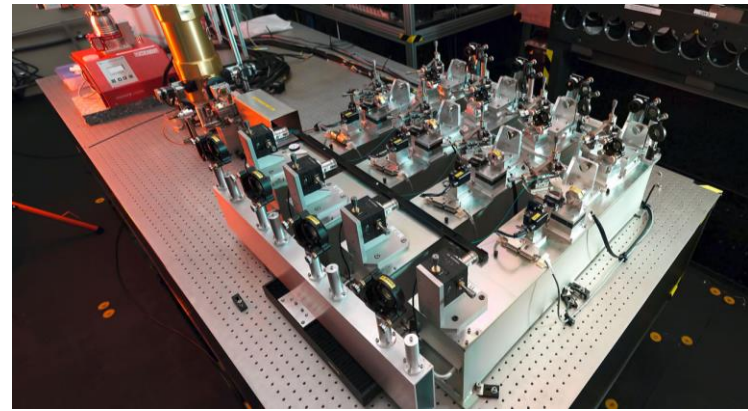
Gravity Collaboration (2017)



L-M-N band combiner

- 3.2-3.9, 4.5-5.0, 8-13 microns
- Resolutions 30 to 3500 L/M, 220 N
- Fringe tracking (GRA4MAT)
- Sensitivity 0.01 Jy (L-band low, FT)

Lopez et al. (2022)



H band beam combiner

- 1.5 to 1.8 microns
- Low resolution (5 to 30)
- Interferometric imaging (mostly ATs)

Le Bouquin et al. (2011)

GRAVITY (2017)

MATISSE (2022)

PIONIER (2011)

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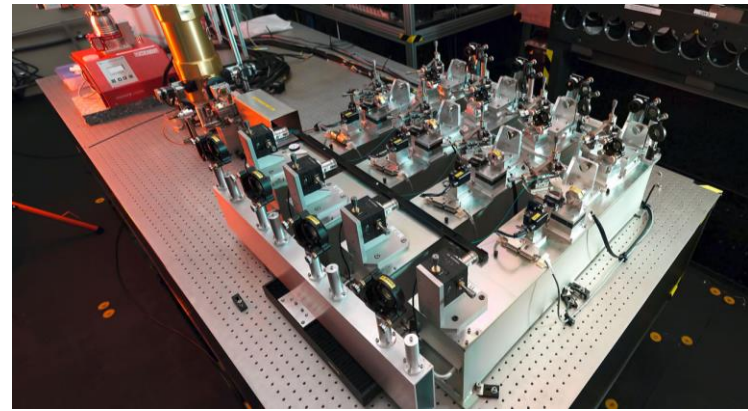
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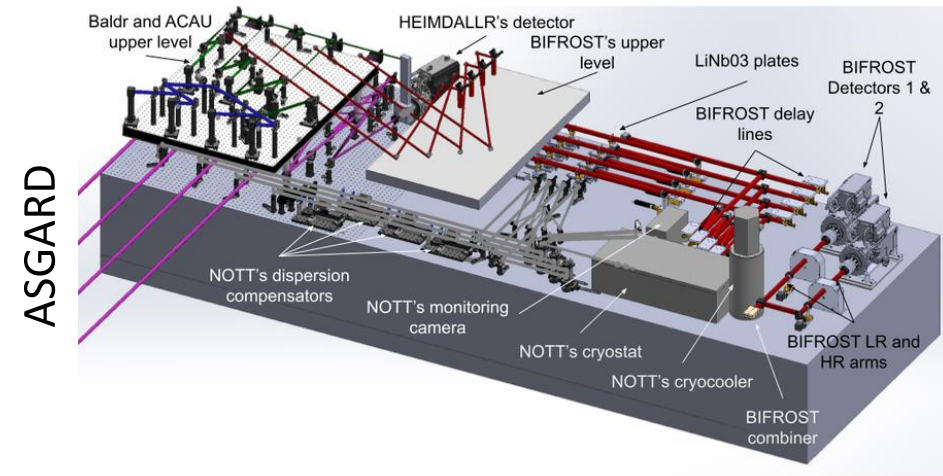
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Suite of NIR instruments at visitor focus

- Heimdallr Fringe Tracker in K-band
- Baldr AO in J/H bands
- BIFROST (YJH bands, $R = 50$ to 25000)
- NOTT (L band nuller)

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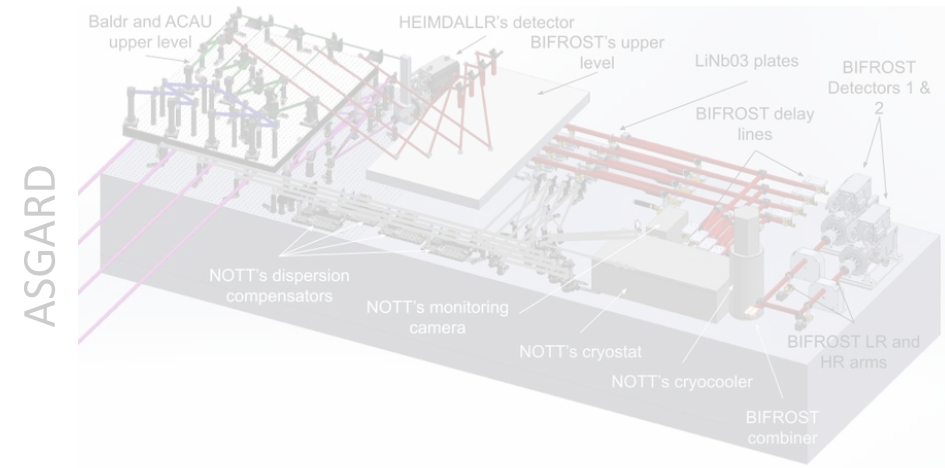
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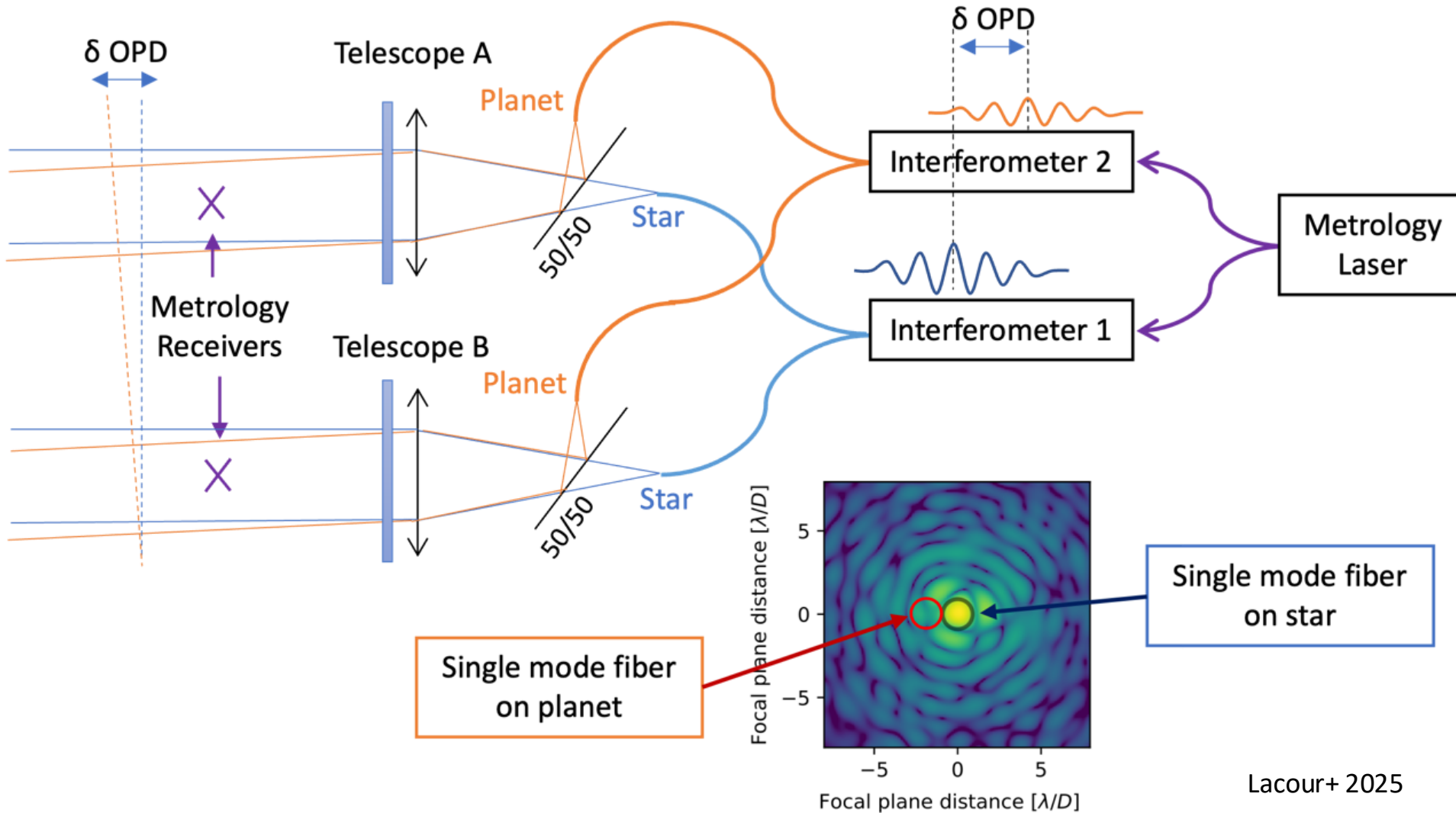
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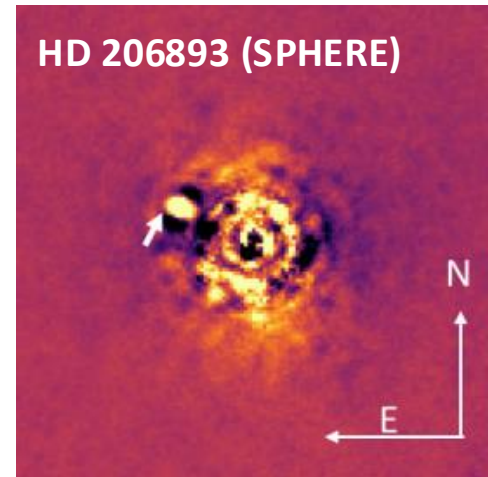
High-contrast dual-field interferometry



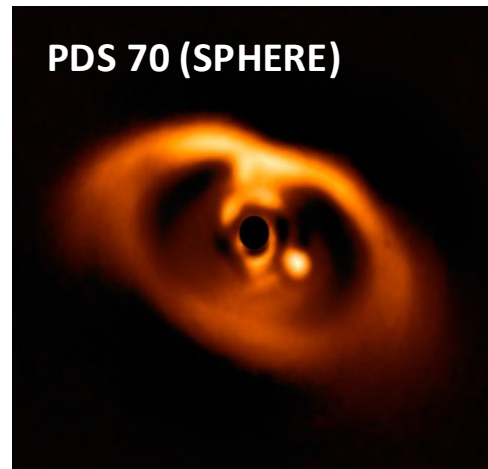
beta Pic (SPHERE)



HD 206893 (SPHERE)



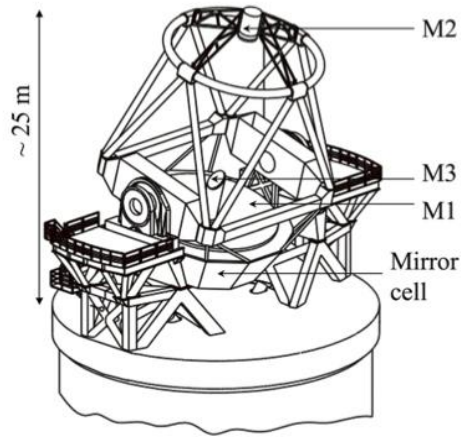
PDS 70 (SPHERE)



Lacour+ 2025

High-contrast dual-field interferometry

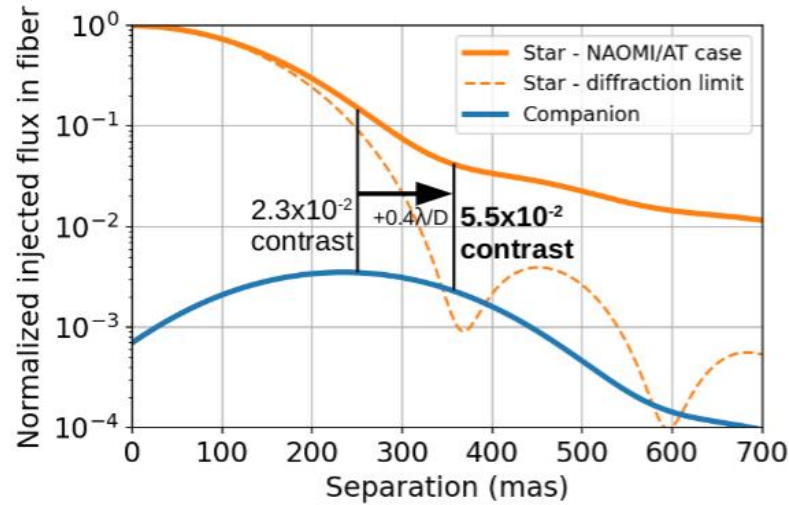
Adaptive Optics



AO

Improve the Strehl ratio
to decrease off-axis light

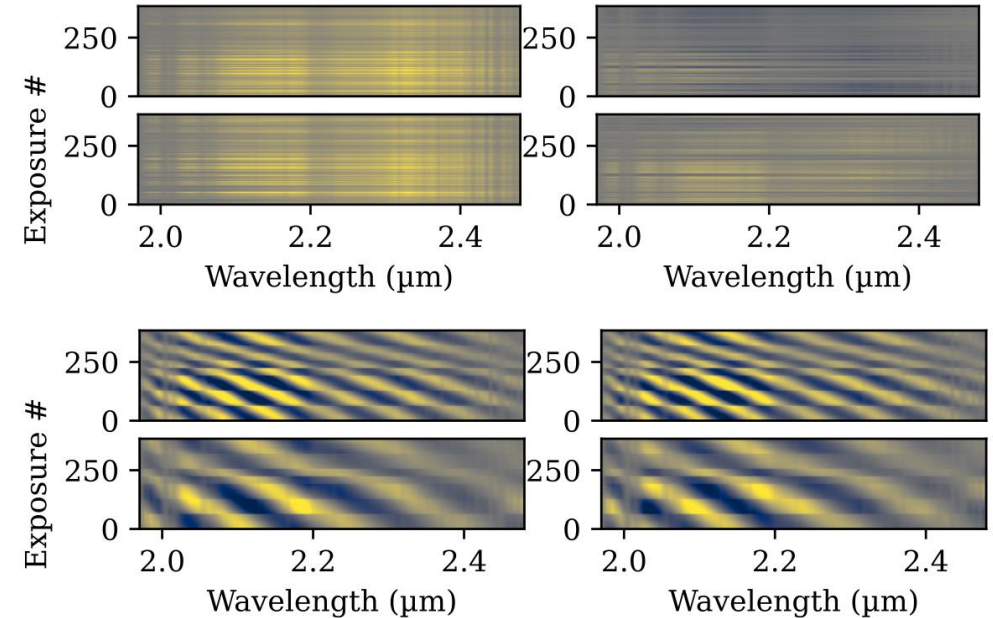
Single-mode filtering



Star rejection

using the single-mode fibre, possibly in
combination with dark-hole techniques

Metrology and phase referencing

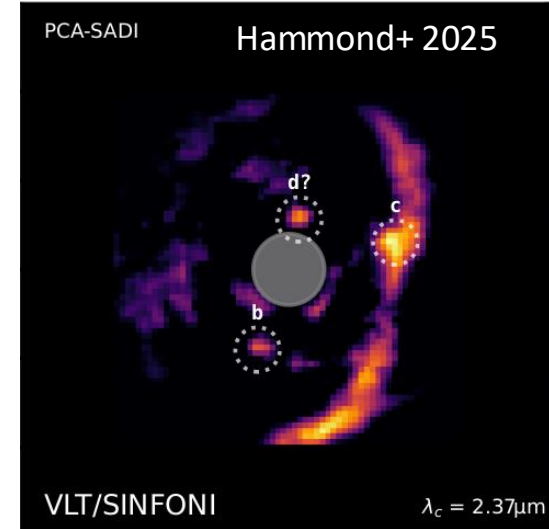
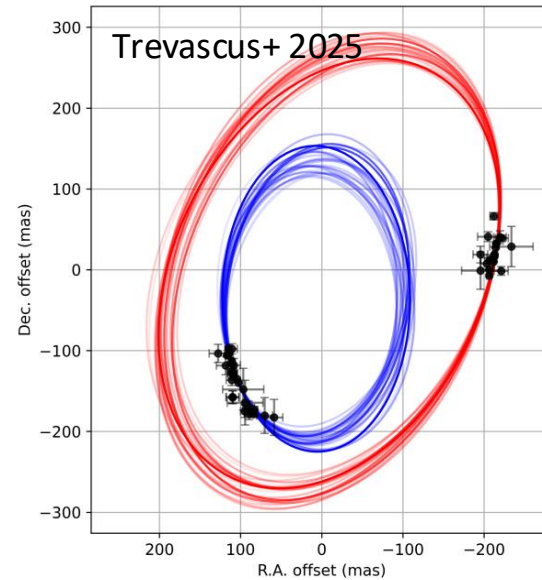


Speckle filtering

using low-order polynomials

High-contrast dual-field interferometry

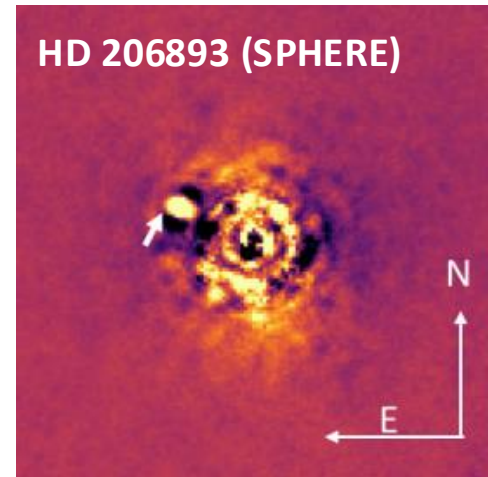
- Astrometric precision $< 50 \mu\text{as}$
- Excellent orbital characterization even with small coverage
- Very powerful tool for dynamical mass measurement



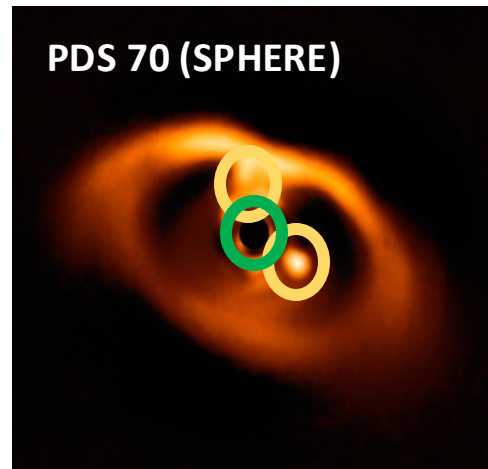
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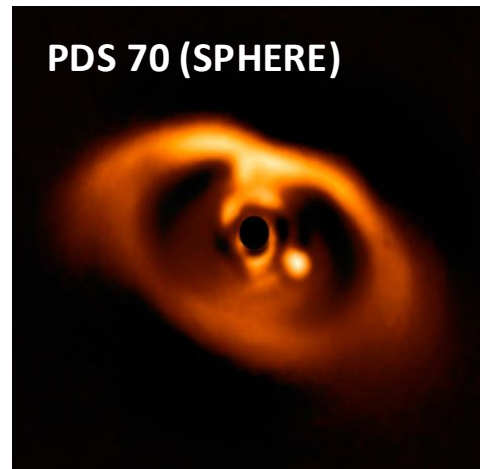
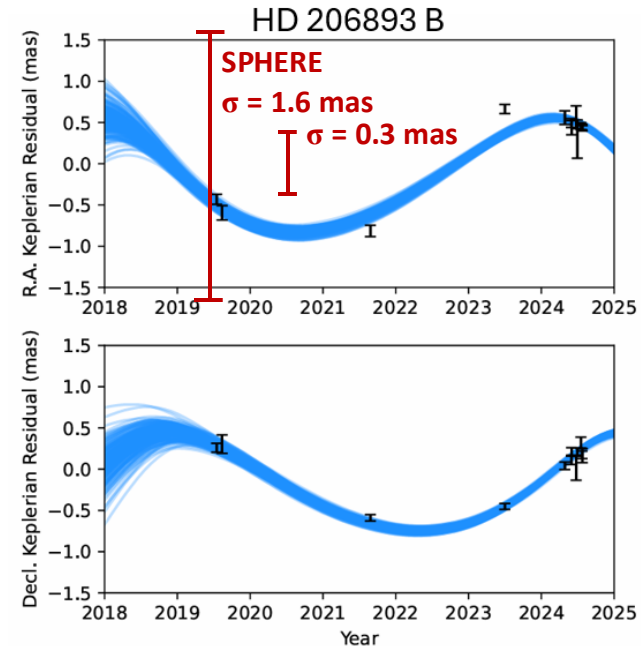
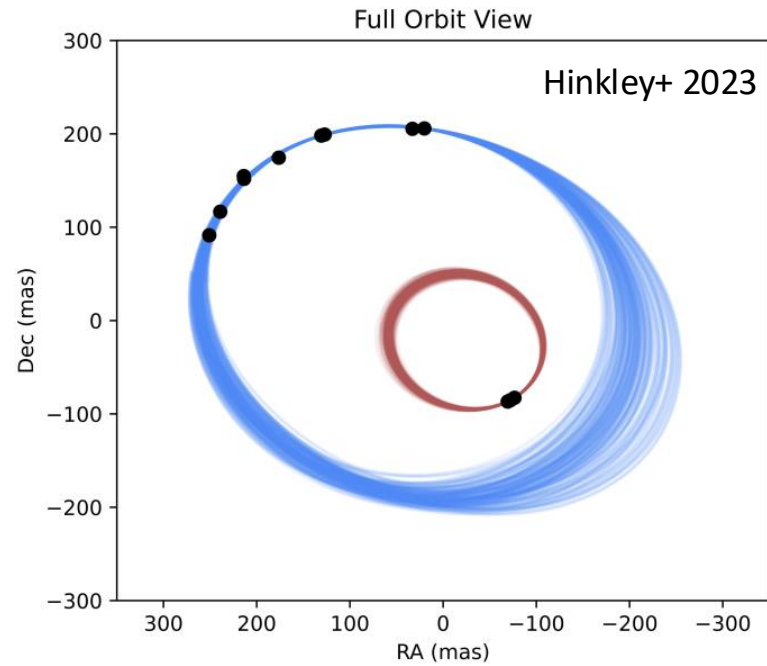
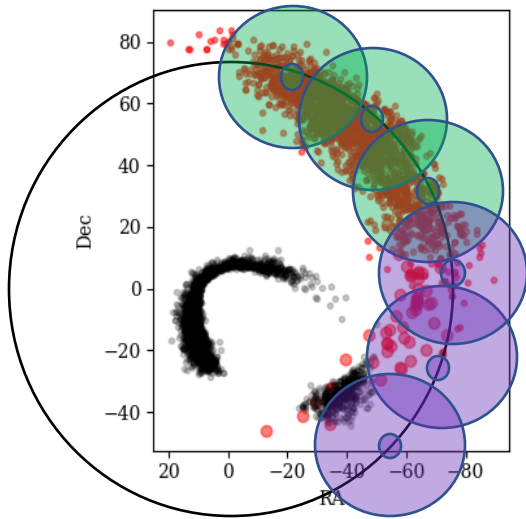
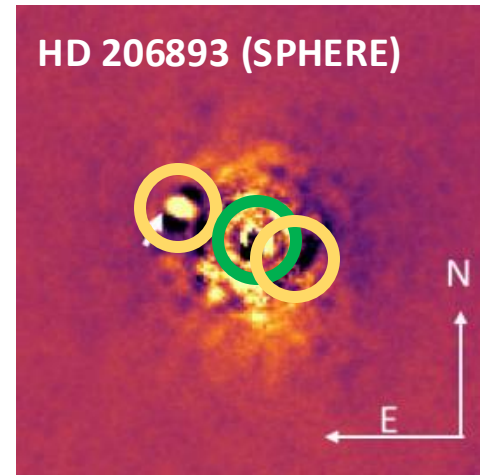
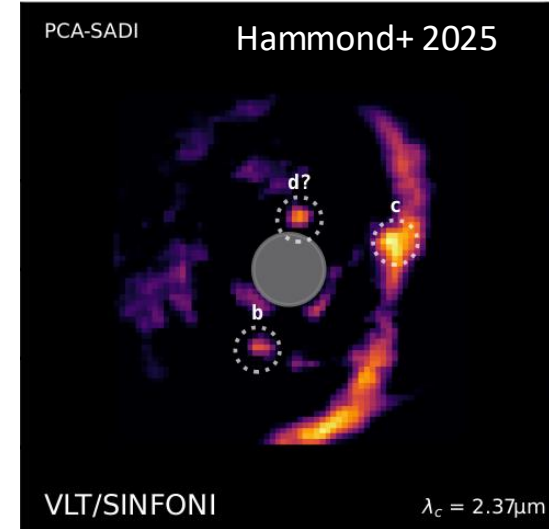
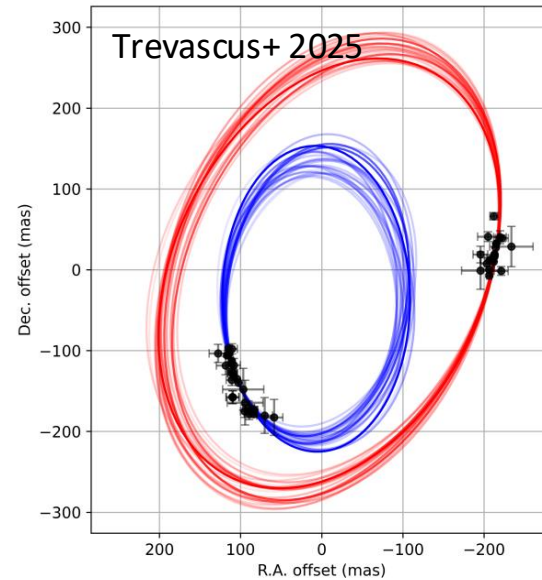


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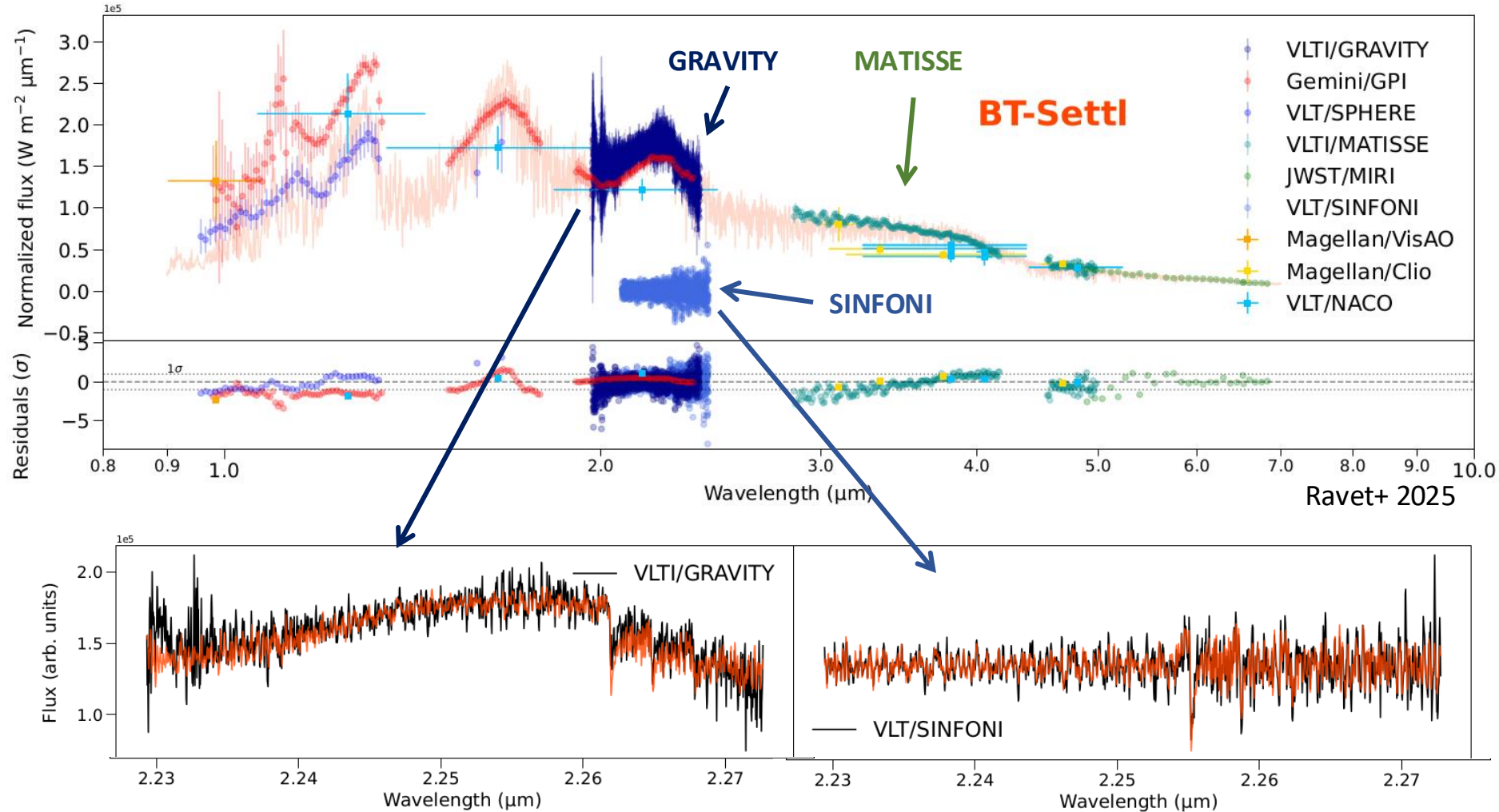


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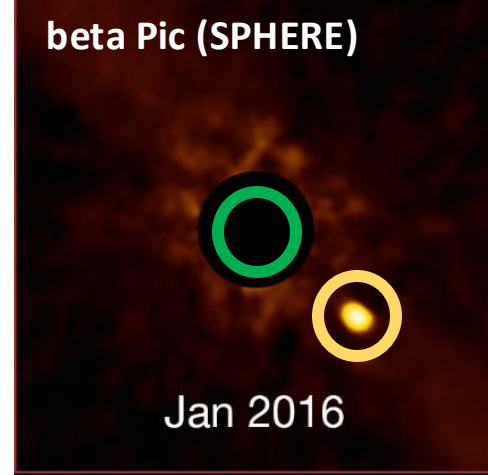


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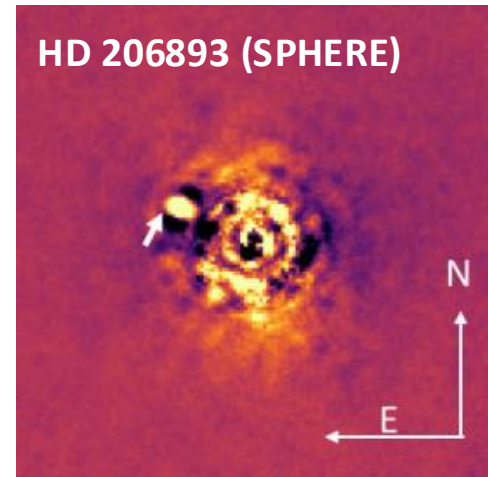


- Low to medium ($R < 4000$) spectroscopy for high-contrast targets
- Sensitive to the continuum, even at high resolution
- K band (GRAVITY) and L/M band coverage (MATISSE)

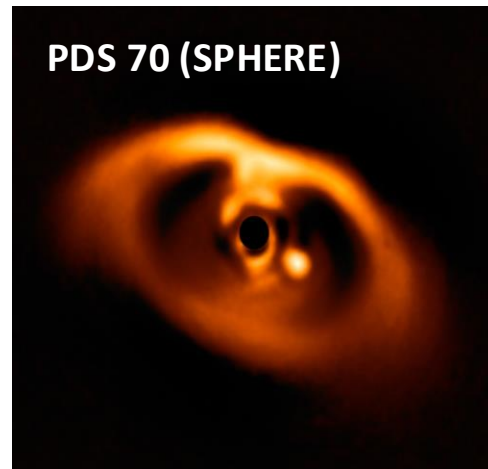
beta Pic (SPHERE)



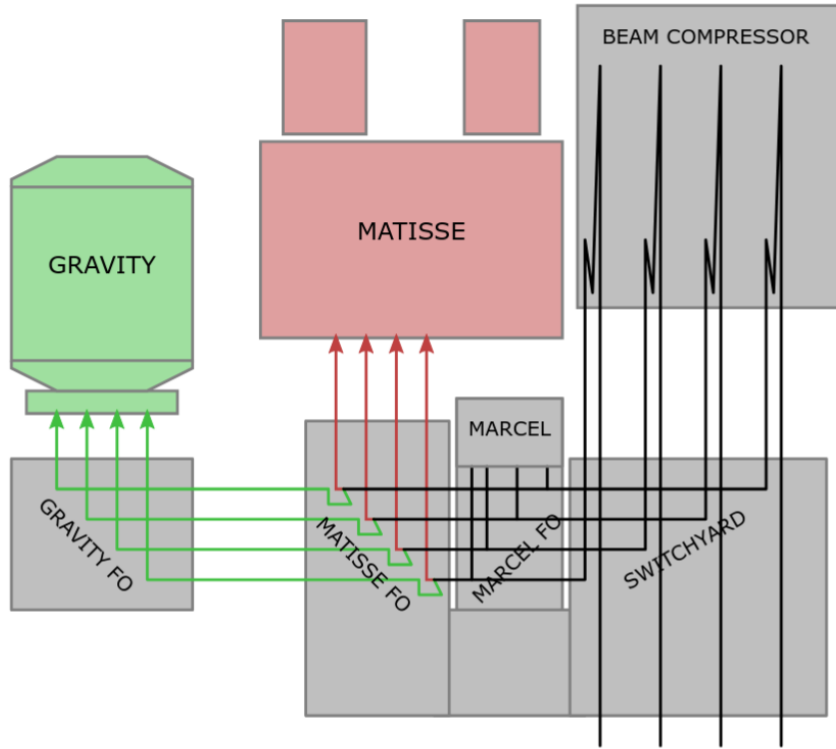
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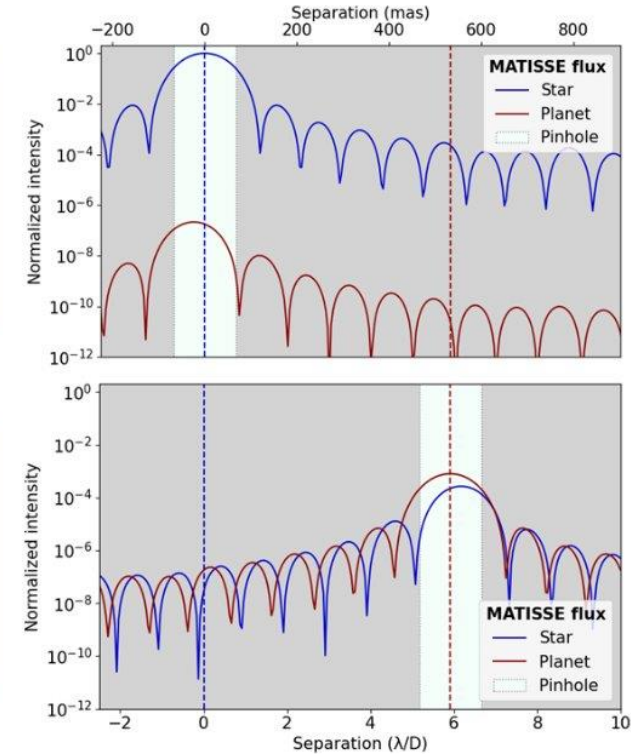
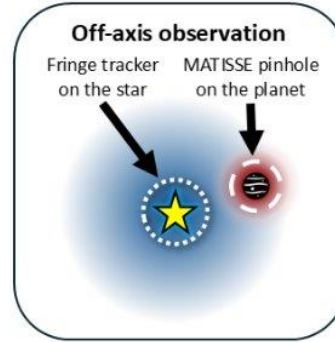
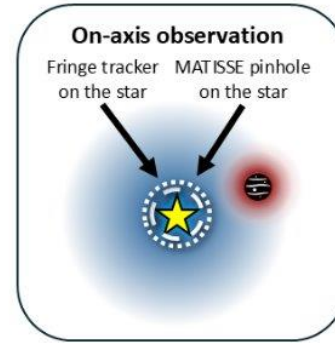
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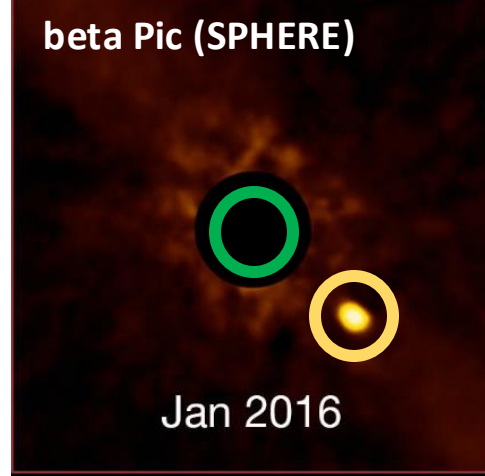


Woillez+ 2024



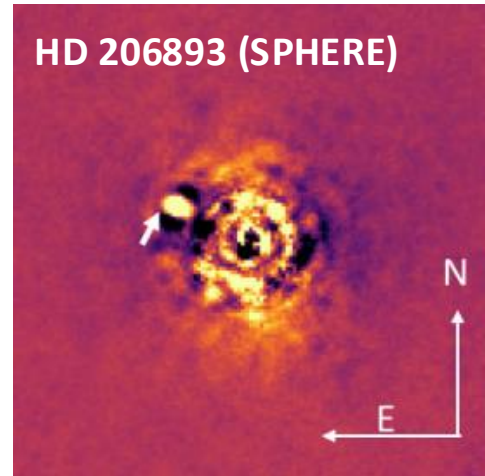
Houlle+ 2025

beta Pic (SPHERE)

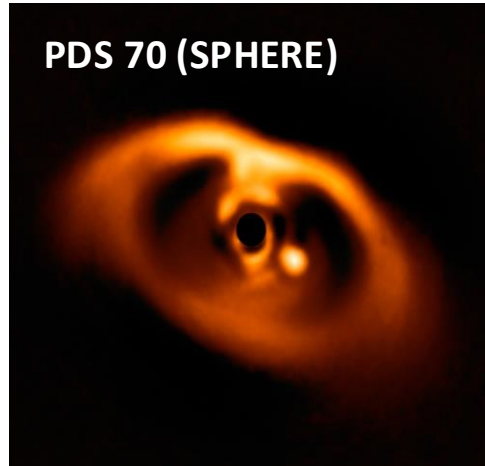


Jan 2016

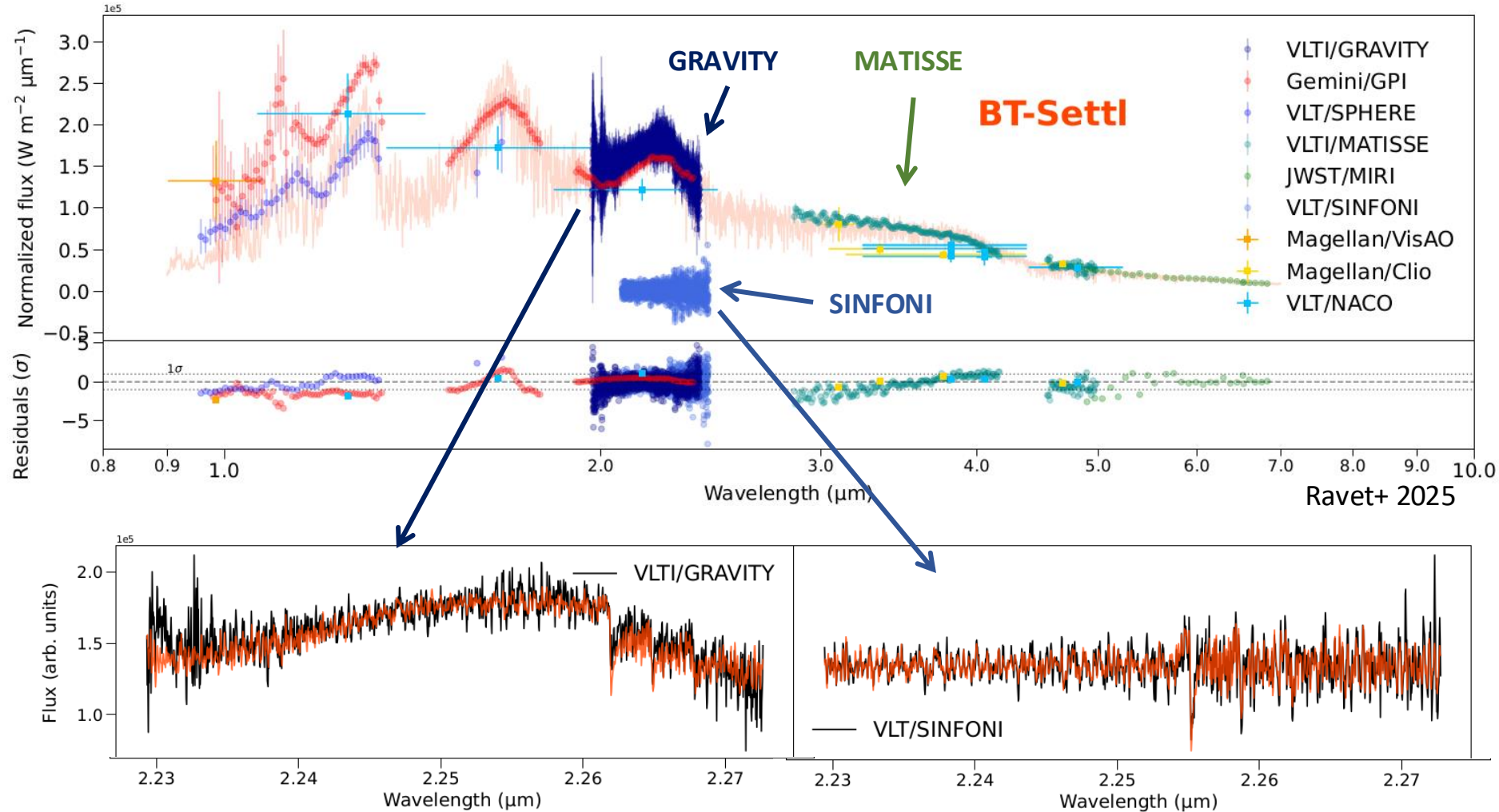
HD 206893 (SPHERE)



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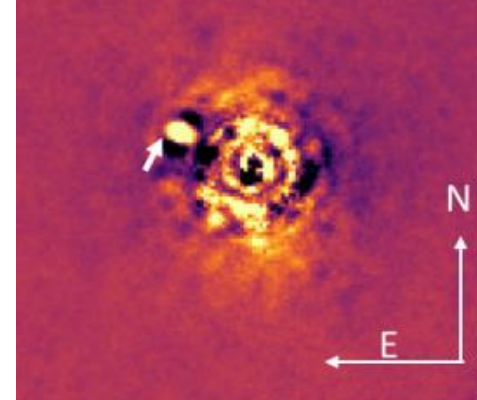


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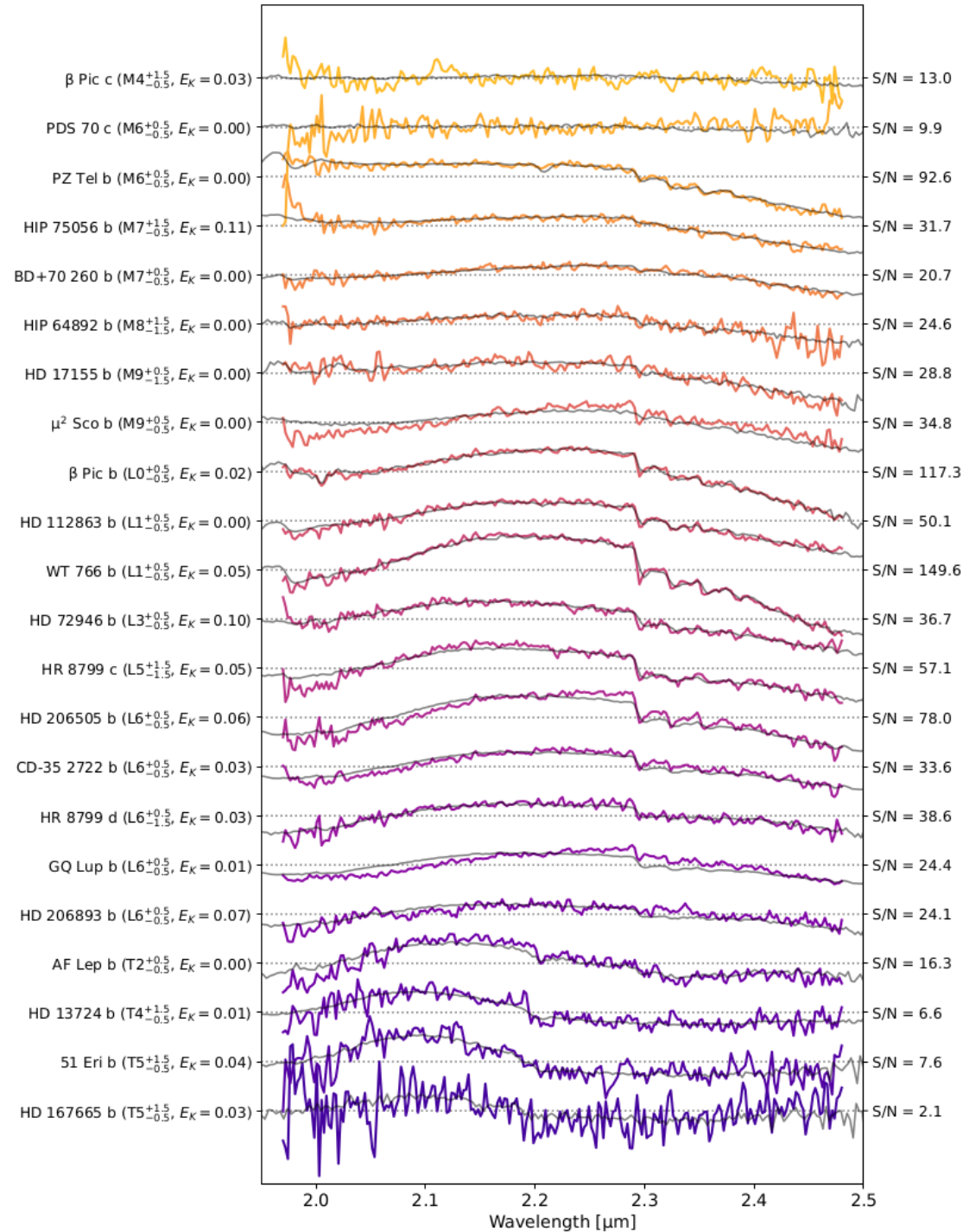
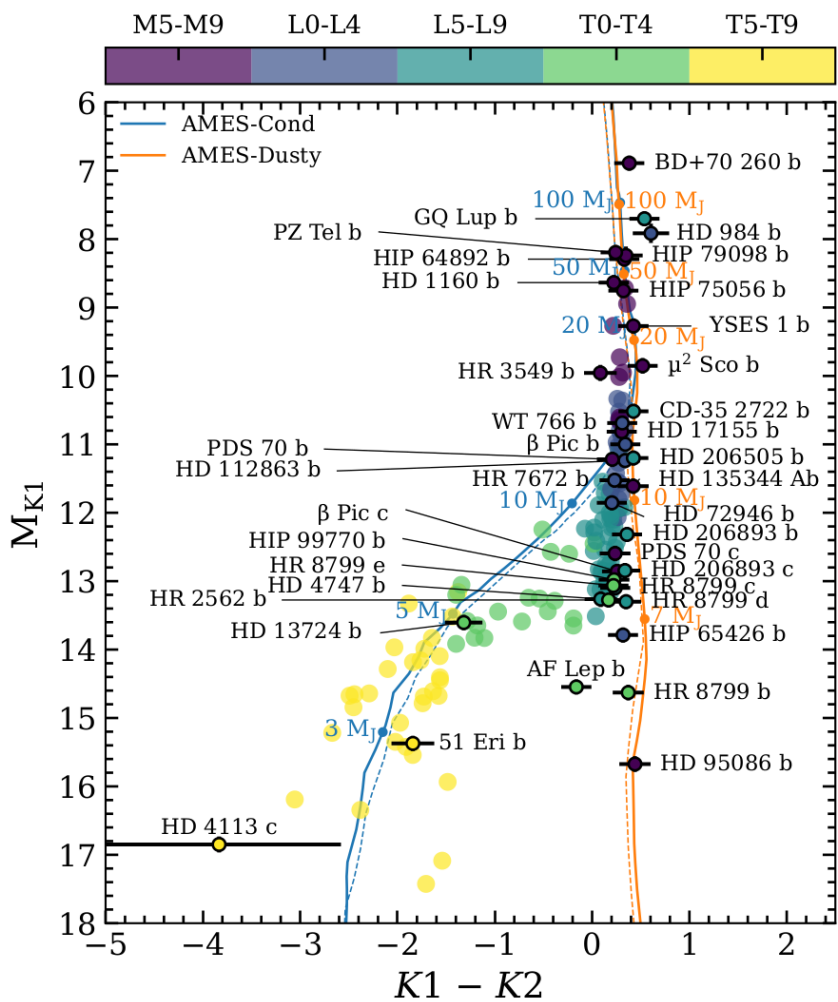
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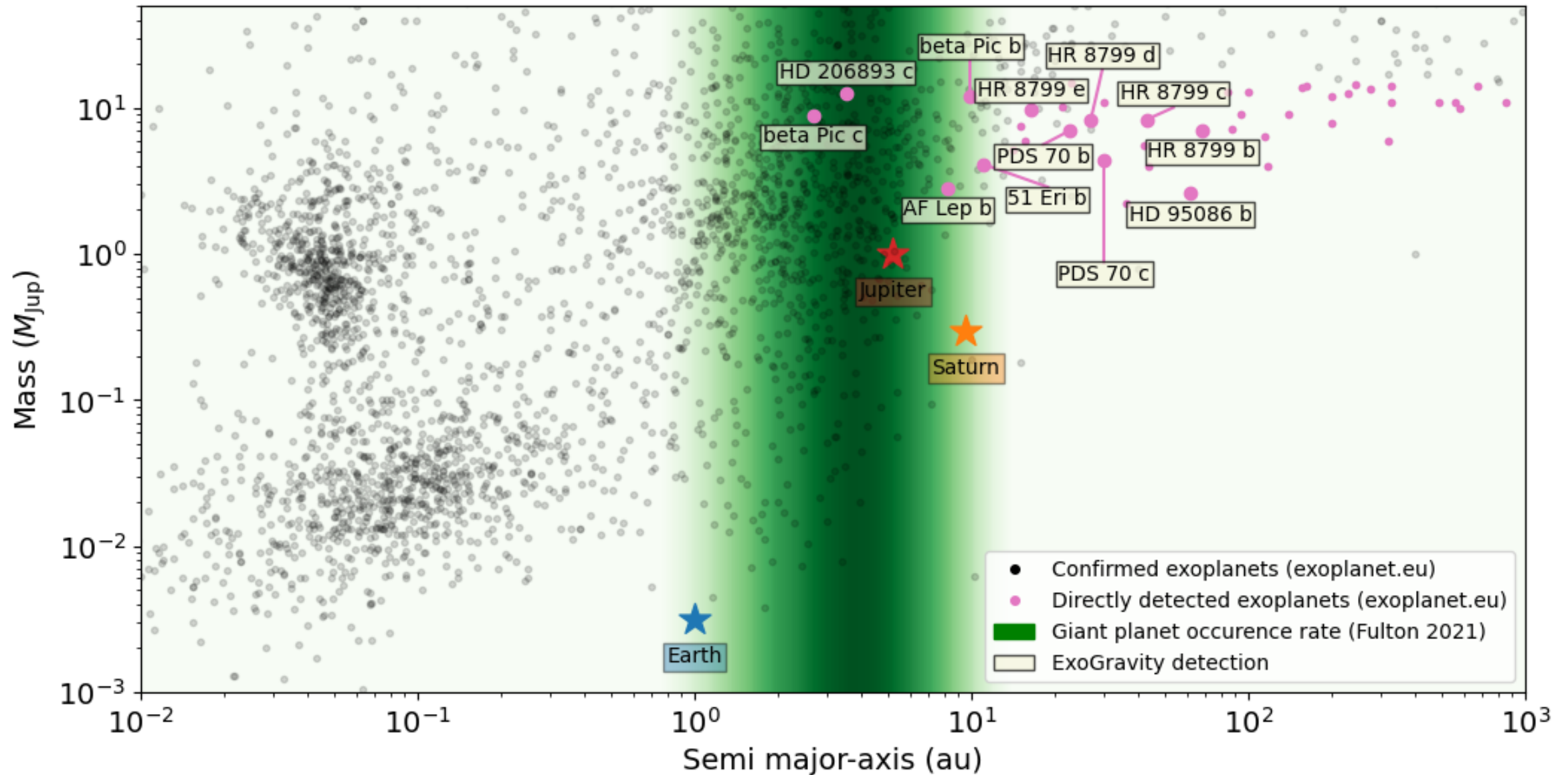
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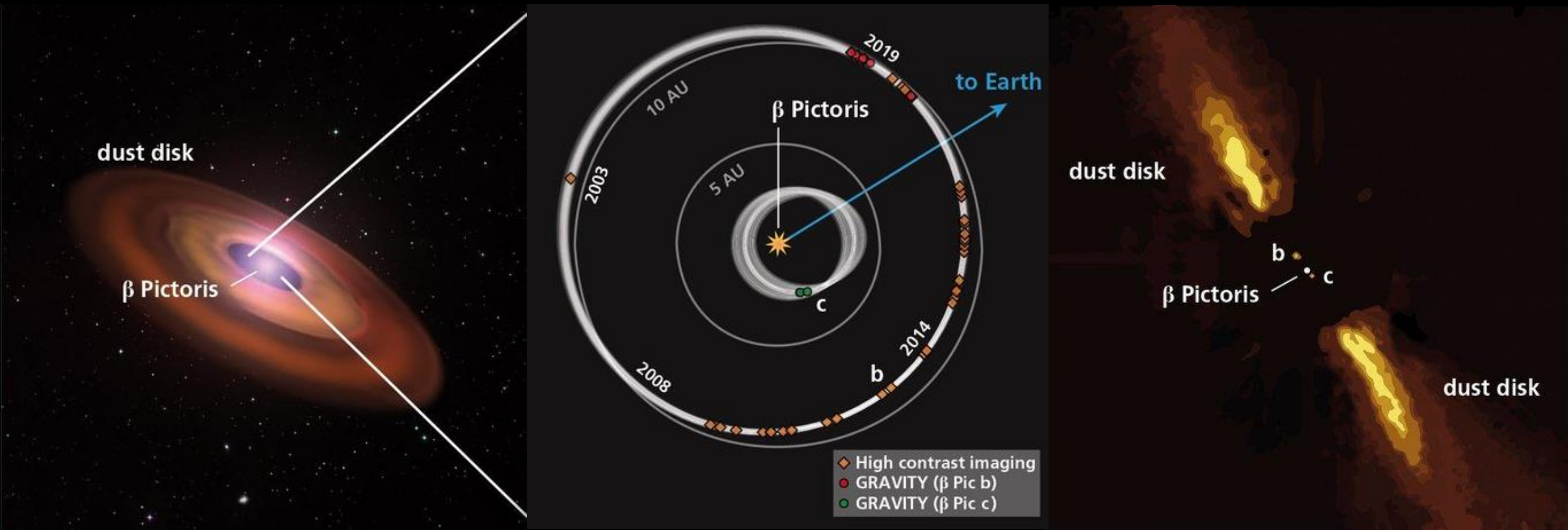
ExoGRAVITY Large program



Masses and luminosities of young giant planets



Combining interferometry and radial velocity

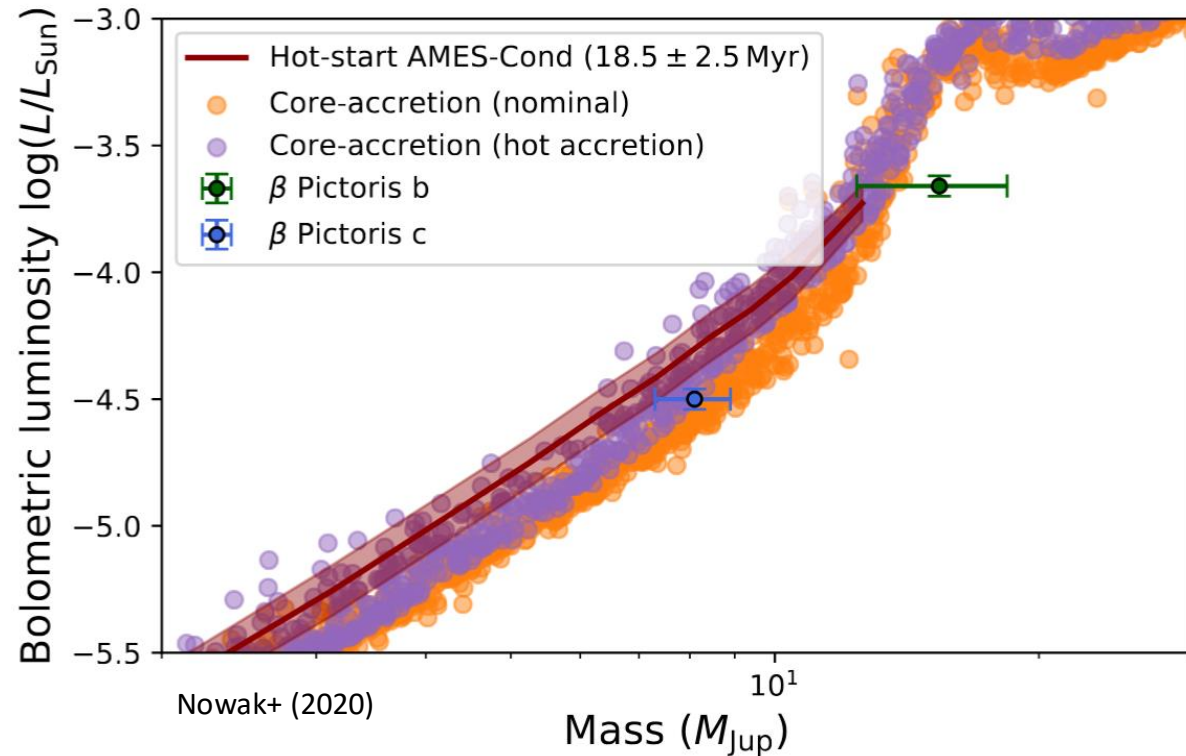


Lagrange et al. (2019, 2020), Nowak et al. (2020), etc.

Masses and luminosities of young giant planets

Today

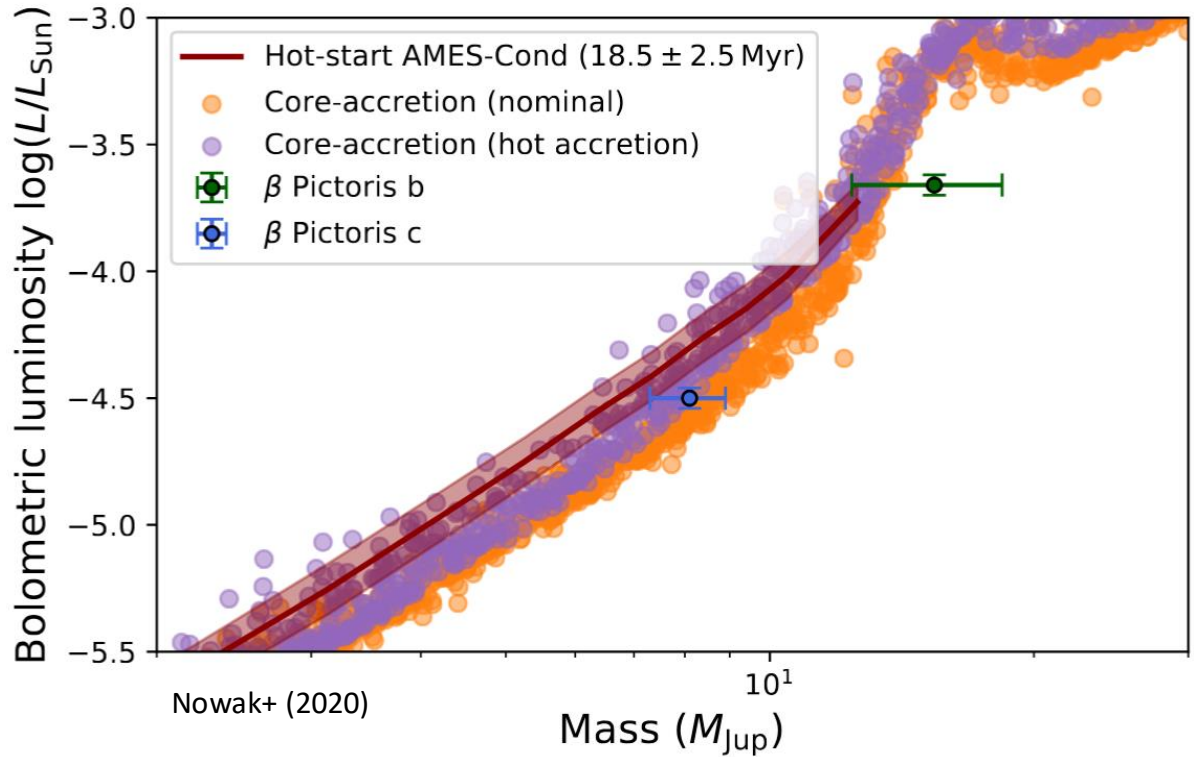
with radial velocity and GRAVITY



Masses and luminosities of young giant planets

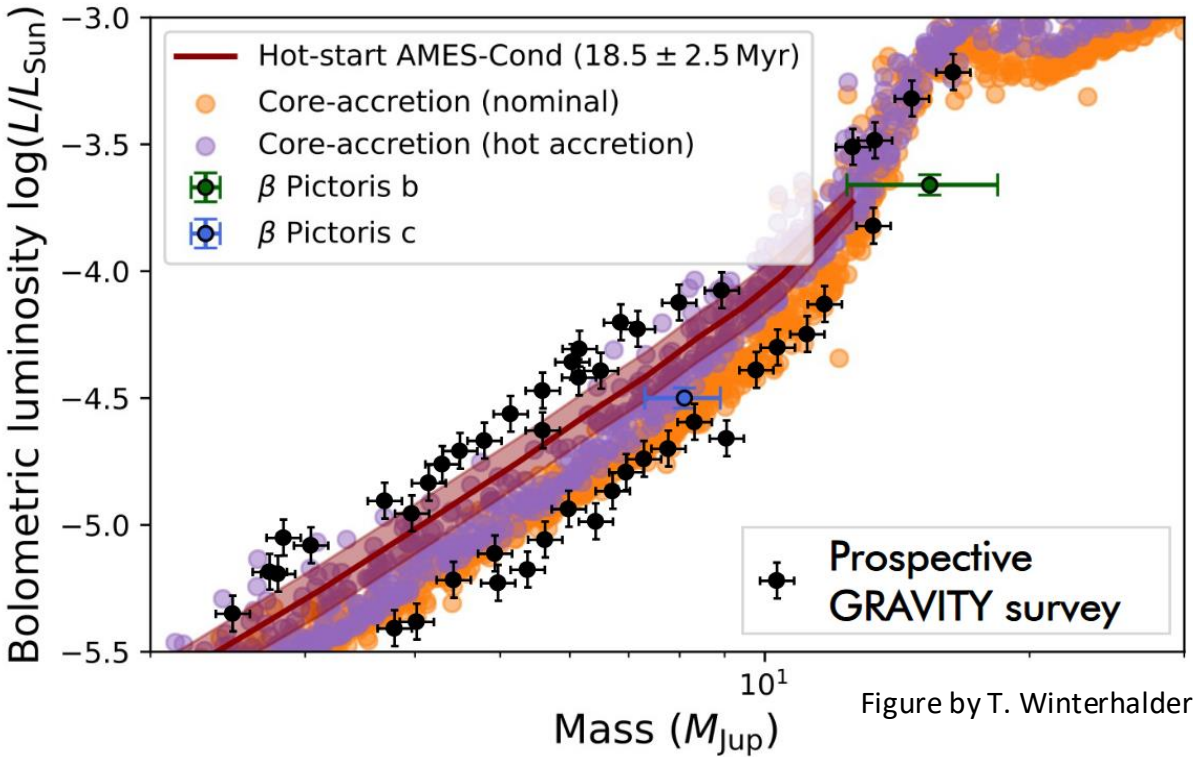
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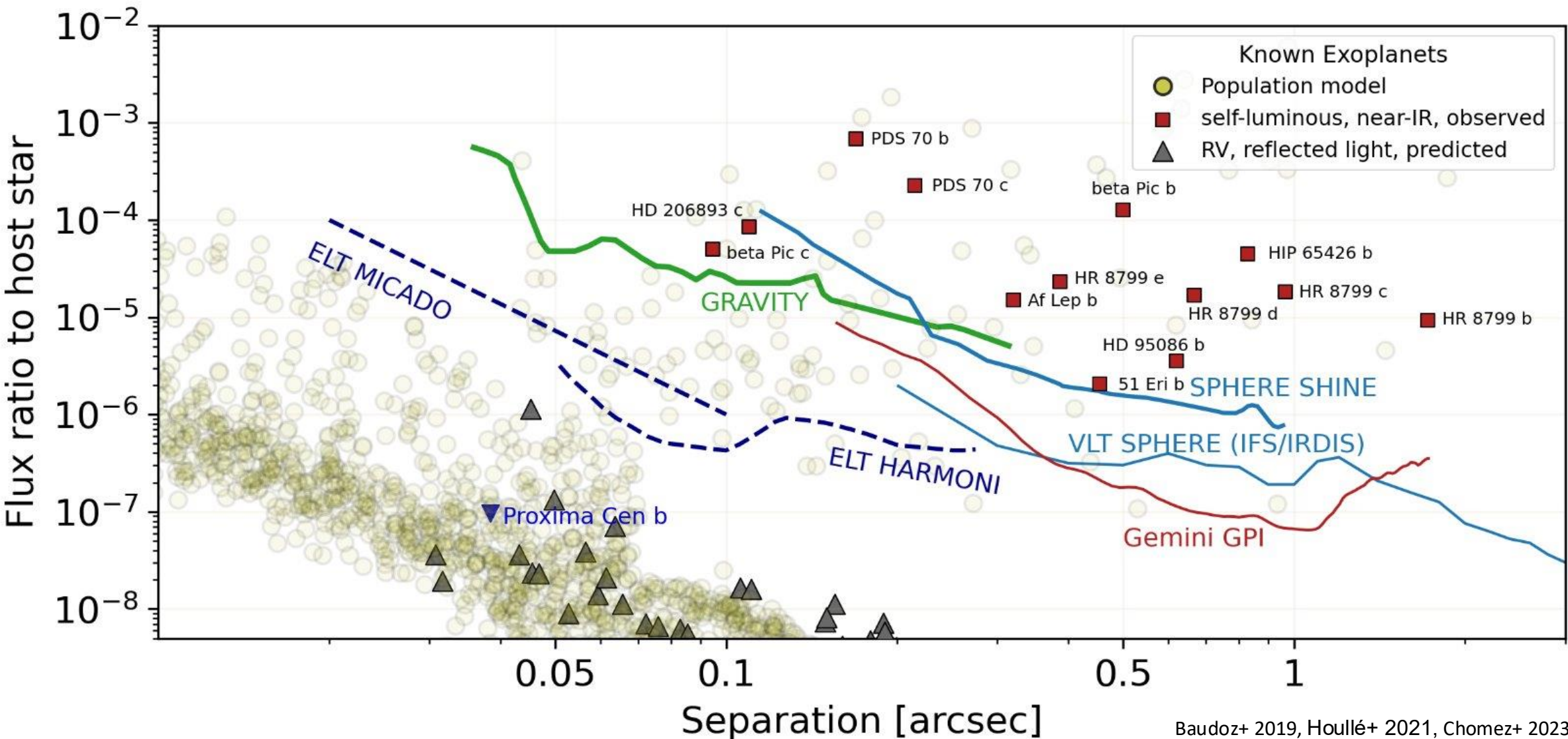


Tomorrow?

with GAIA DR4 and GRAVITY+



Current contrast limits with GRAVITY



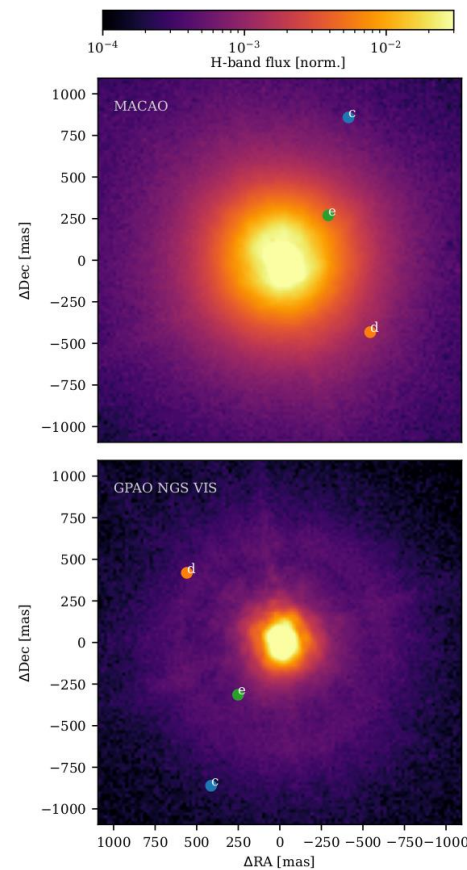
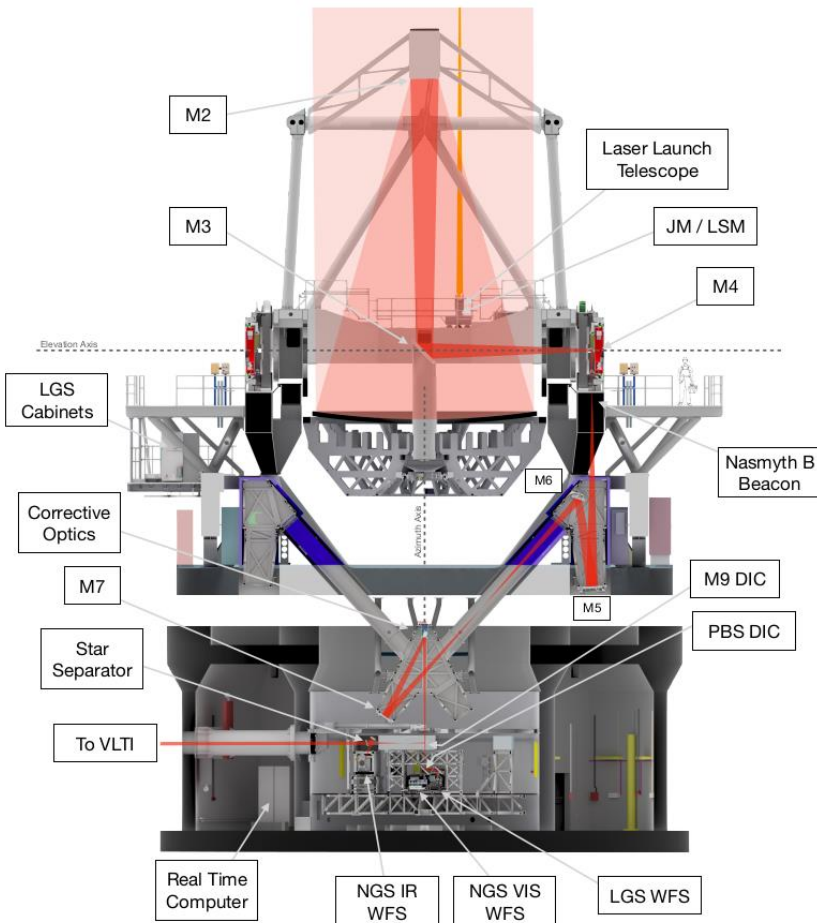
Baudoz+ 2019, Houllé+ 2021, Chomez+ 2023,
Pourré+ 2024, Lacour+ 2025, Laugier+ 2023

Improving the contrast at the VLTI

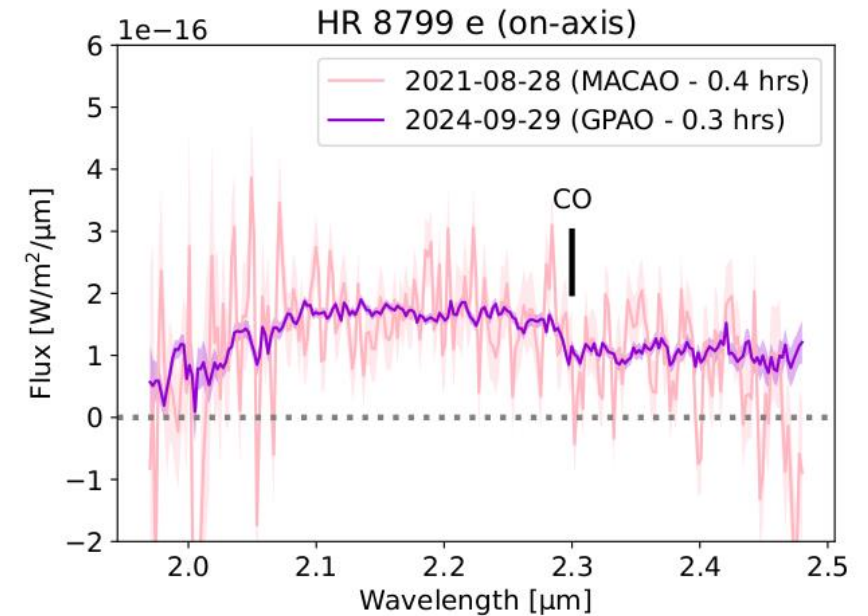


New GPAO on all 4 UTS:

- Strehl ratio now up to 80%
- SNR gain of at least 5 on exoplanets



Acquisition camera



Gravity+ Collaboration (2025)

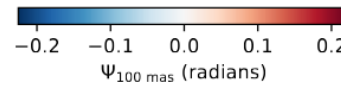
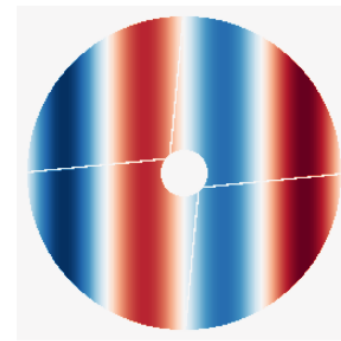
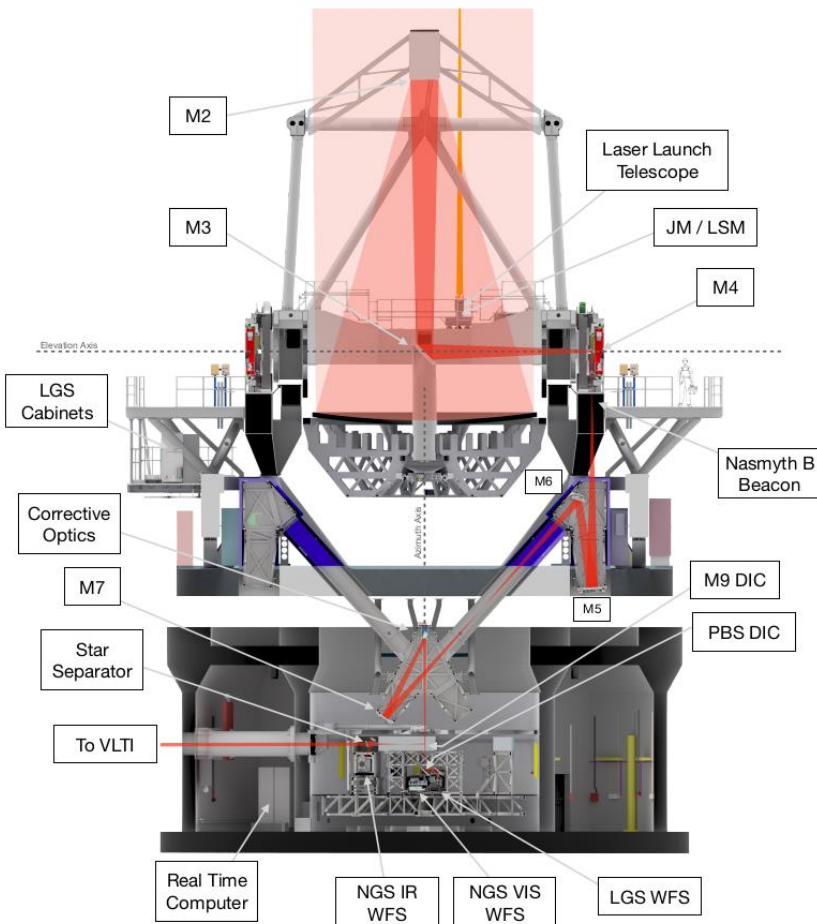
Improving the contrast at the VLT



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- Can be used to manipulate "speckles" and cancel residual starlight in the fiber ("speckle nulling")



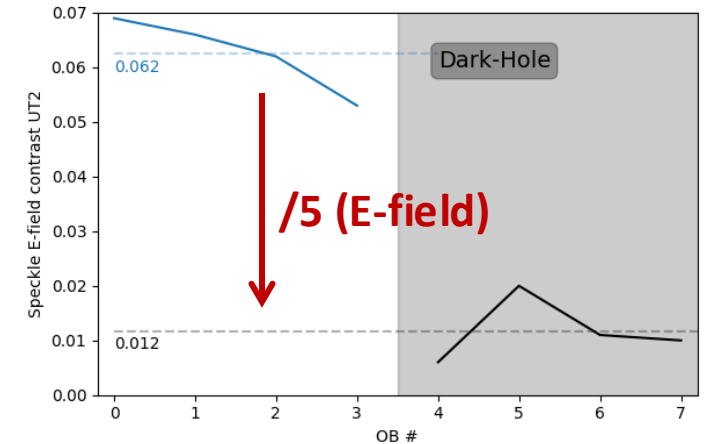
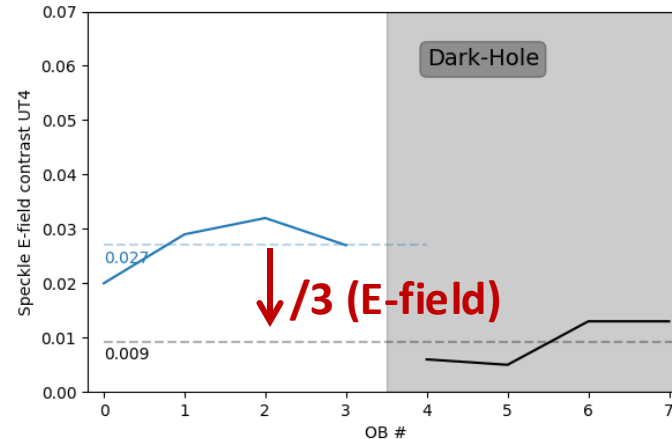
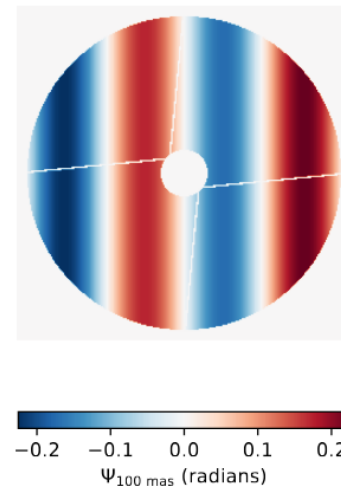
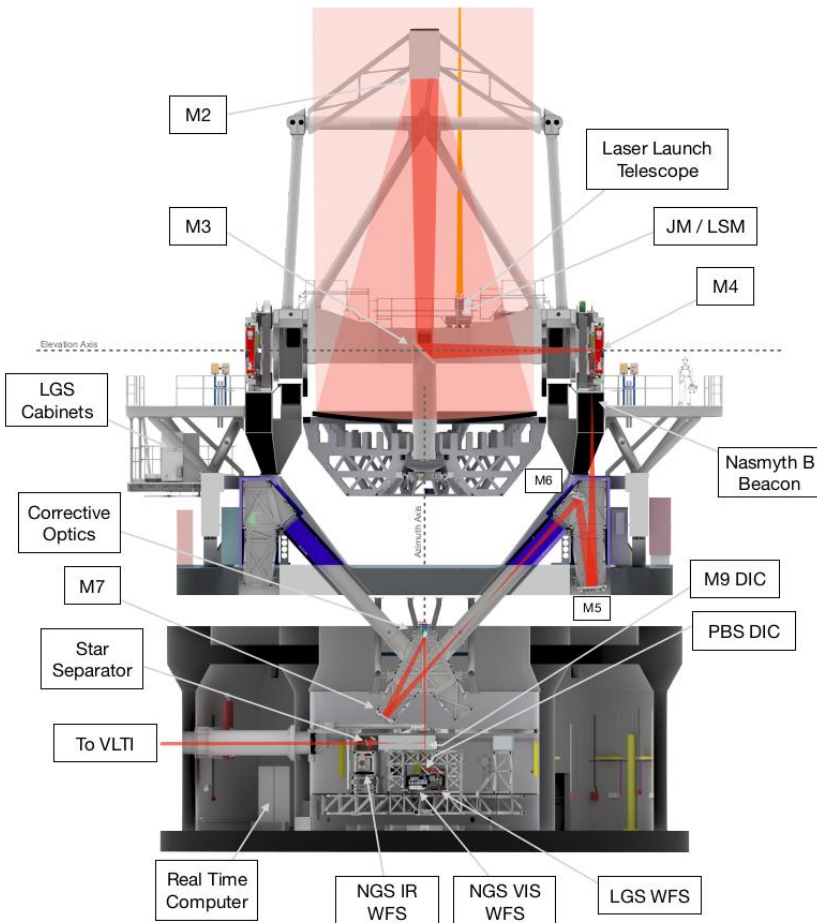
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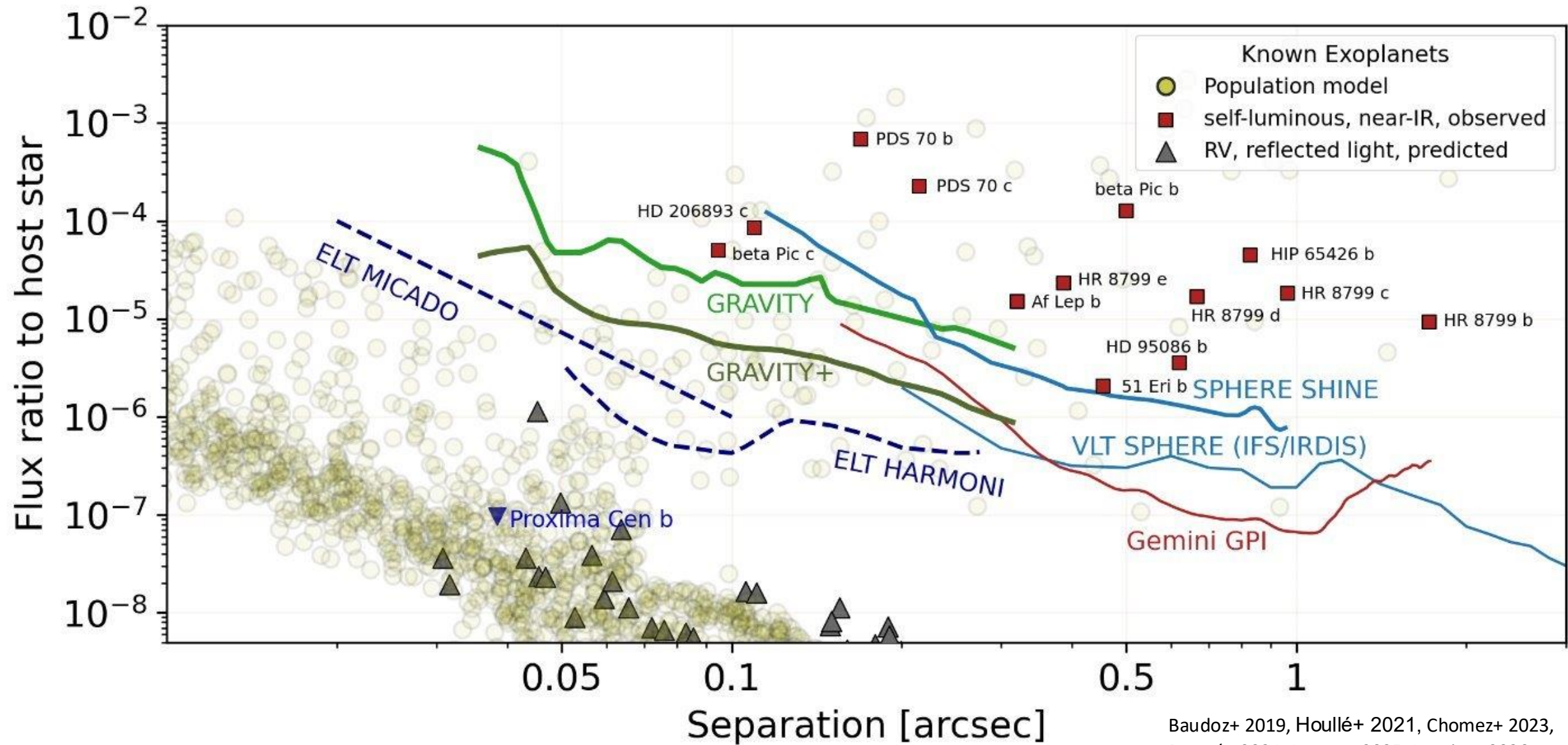
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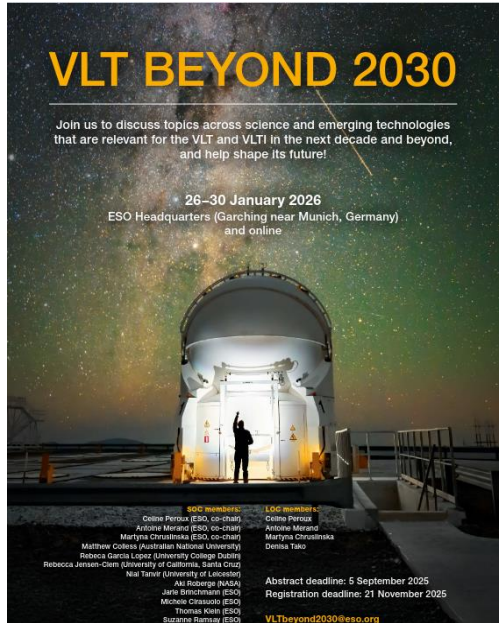
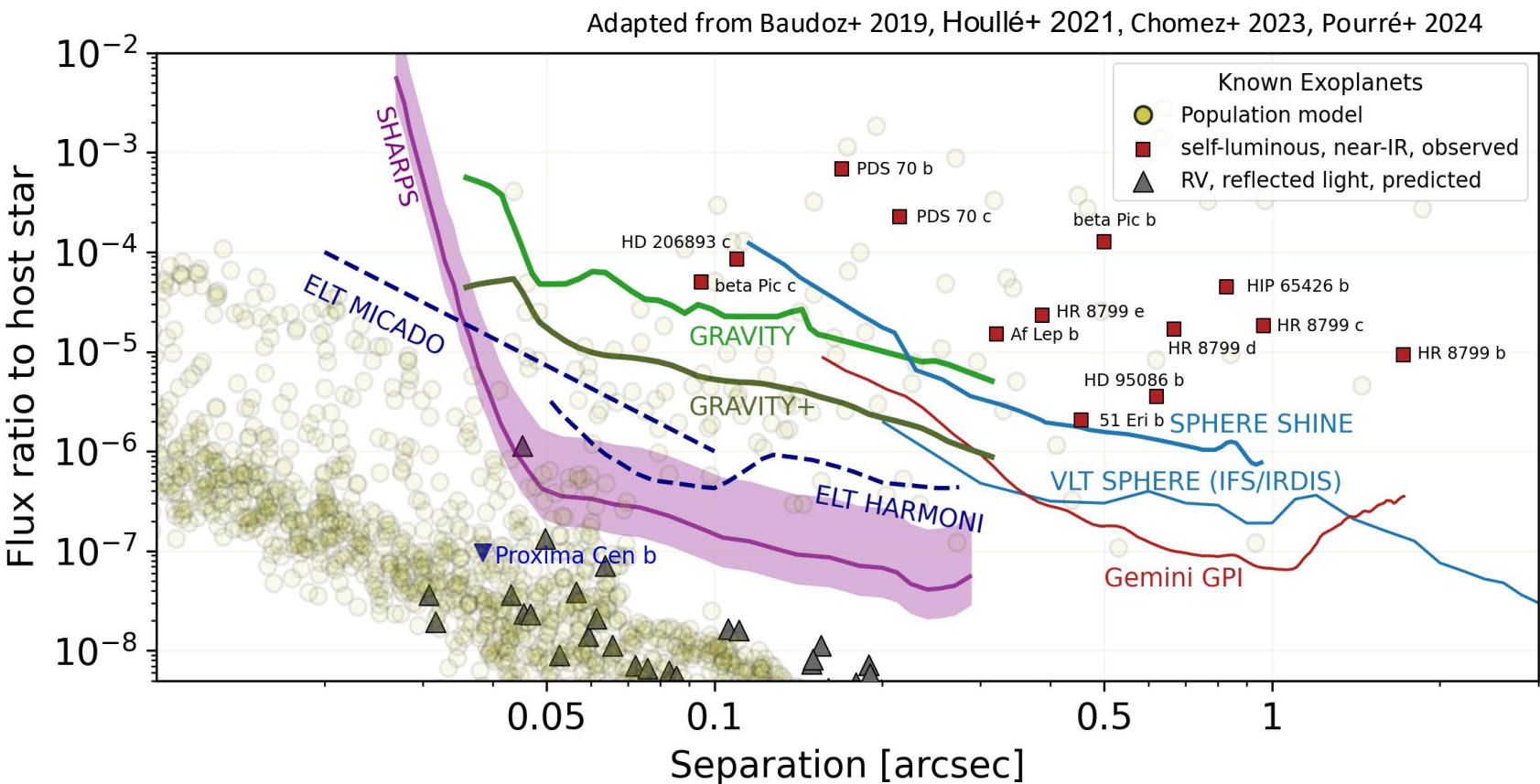


Current contrast limits with GRAVITY



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Pourré+ 2024, Lacour+ 2025, Laugier+ 2023

Towards high-sensitivity, high-contrast, short wavelengths at VLT

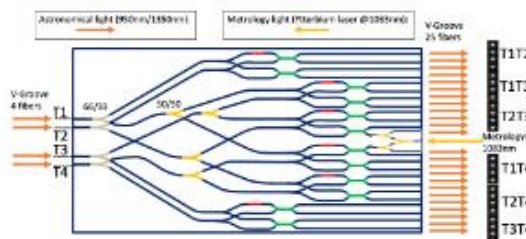


Characteristic	Target/Value
Spectral Range	YJH bands (0.95 - 1.8 μm)
Spectral Resolution	Up to 30000
Astrometric precision	10 μas
Contrast	10^{-5} at 50 mas; 10^{-7} at 100 mas
Sensitivity (J band)	22.0 at R = 100; 16.0 at 30000

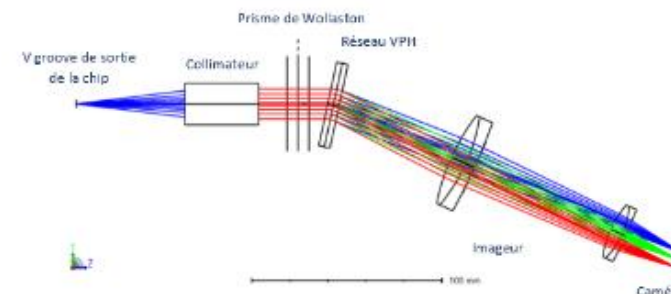
PLANETES: towards J-band high-contrast at the VLT



1) A new injection

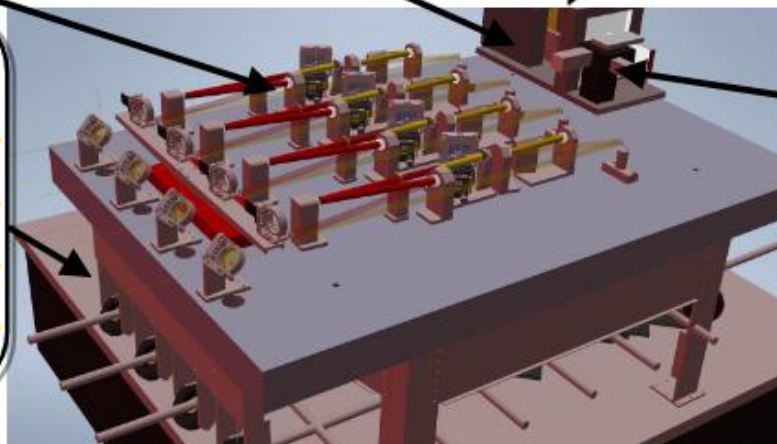
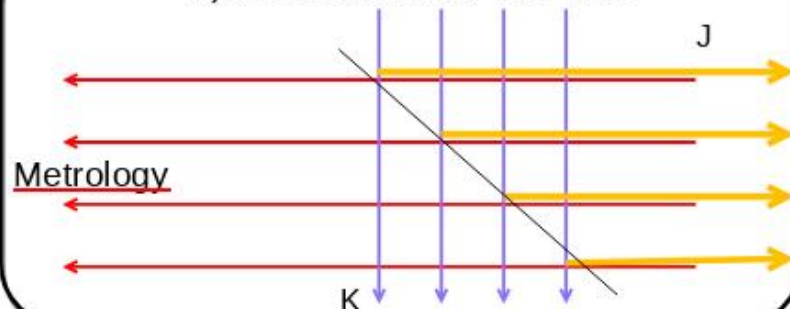


2) A new integrated optic



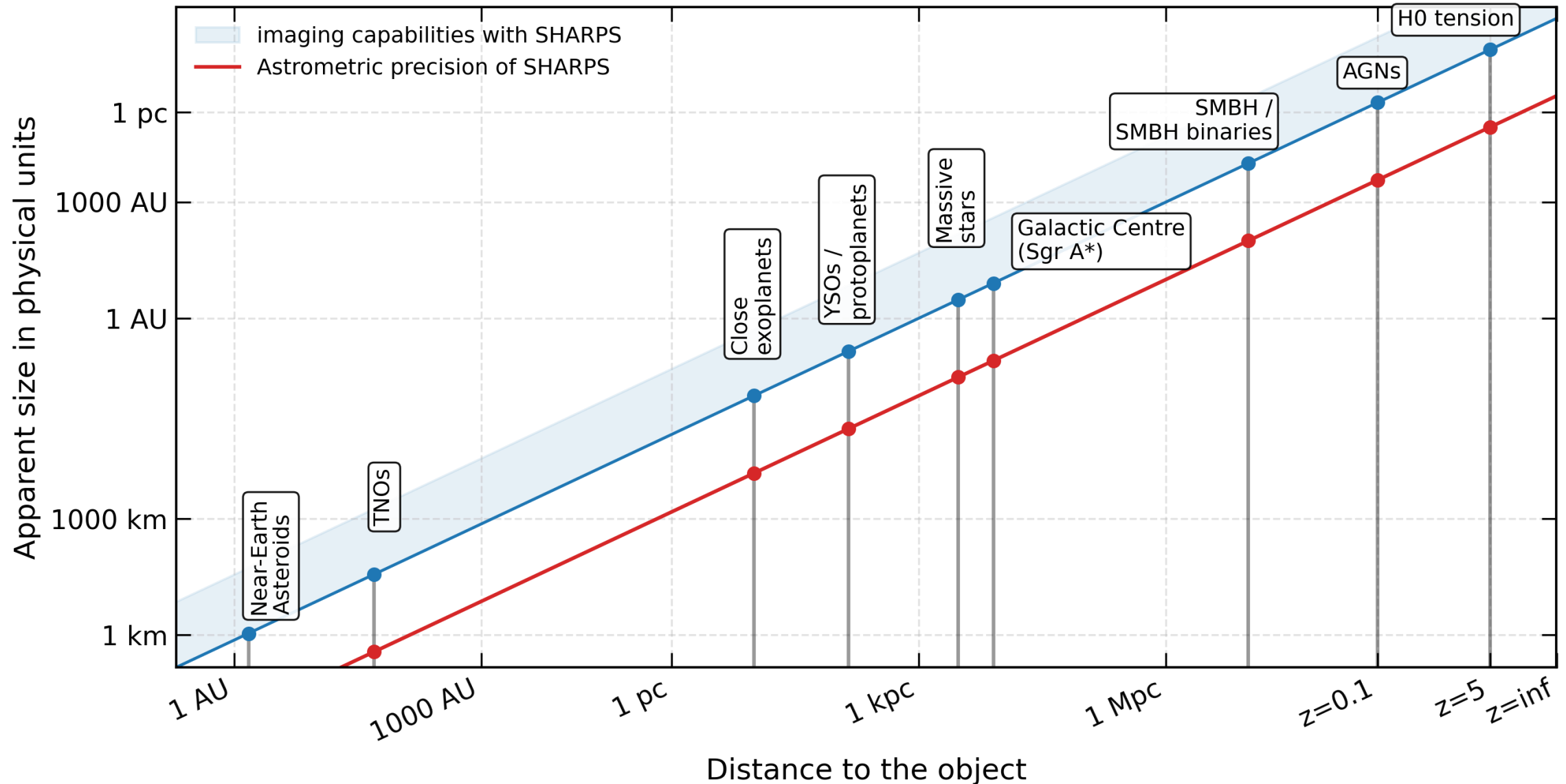
3) A new spectrometer

0) A new interface with VLT

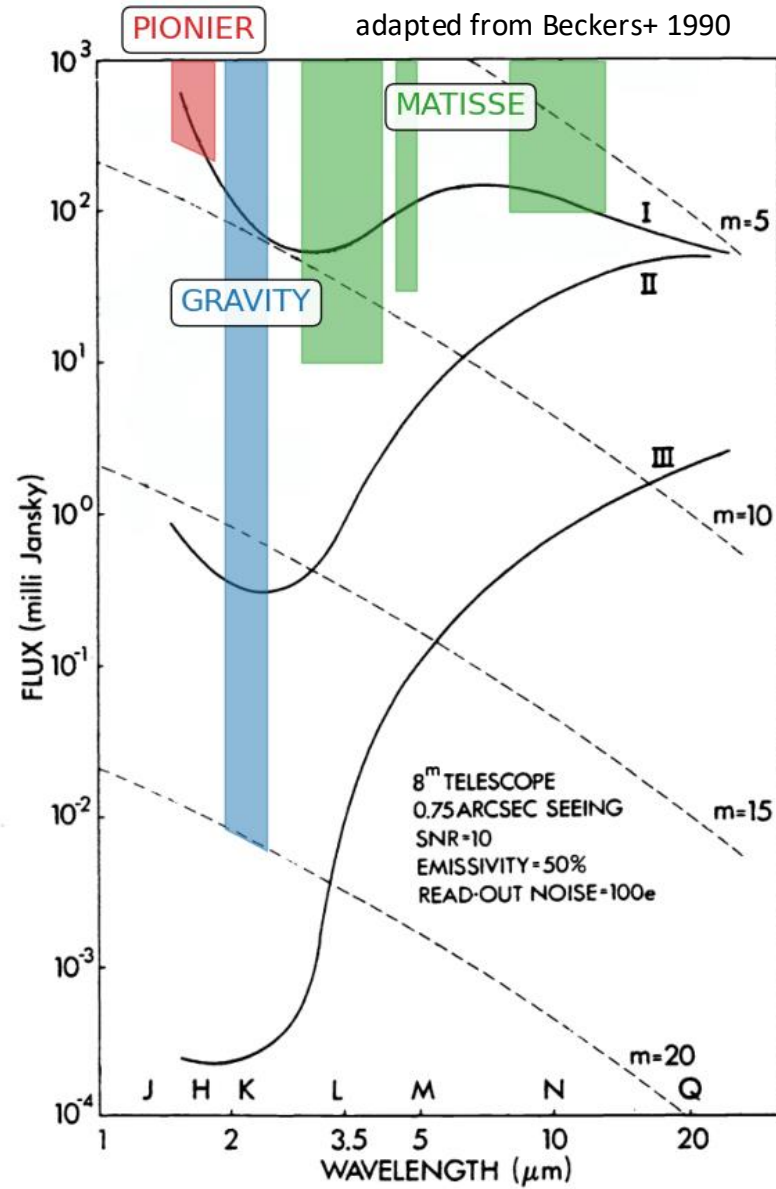


4) A new camera

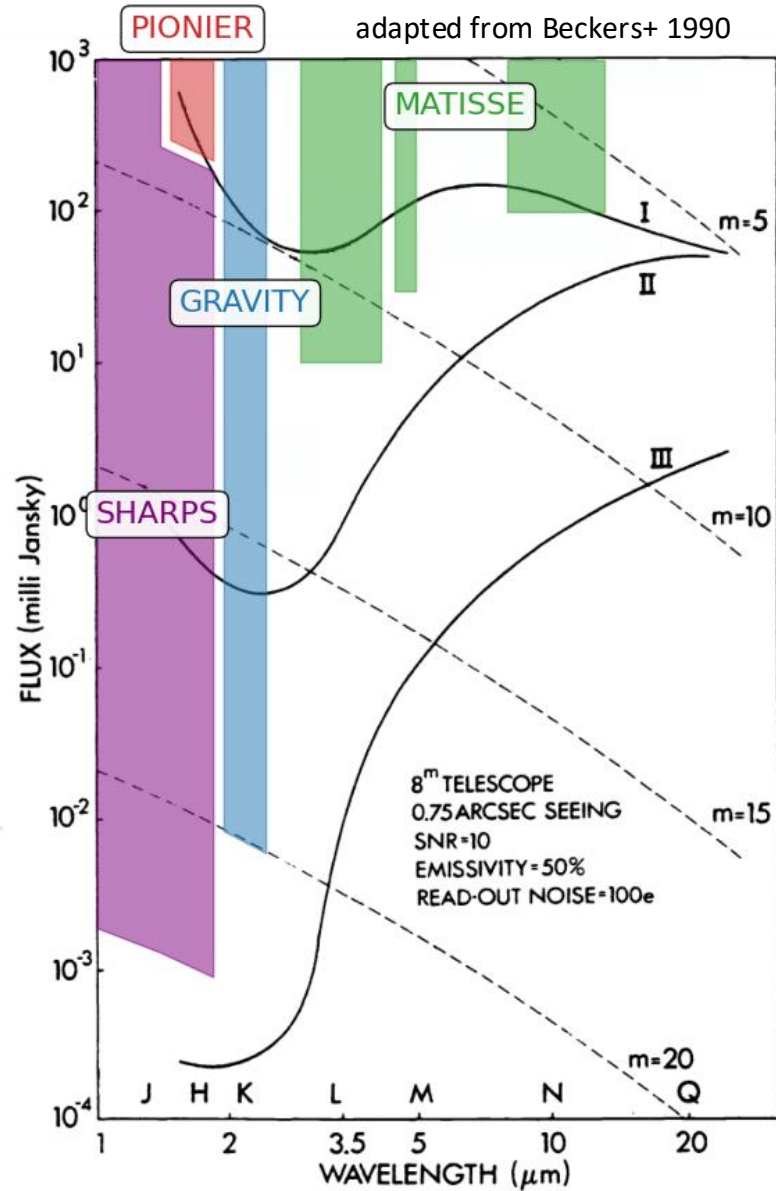
SHARPS: a proposed 3rd generation instrument at the VLTI



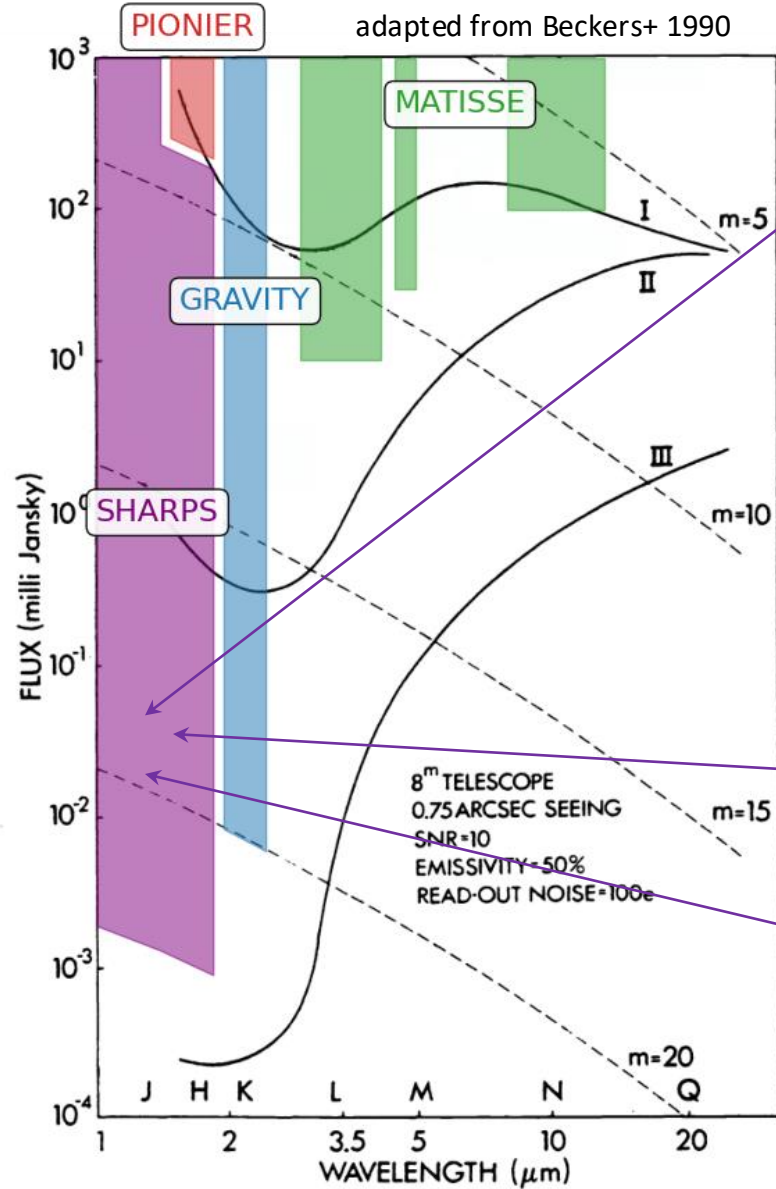
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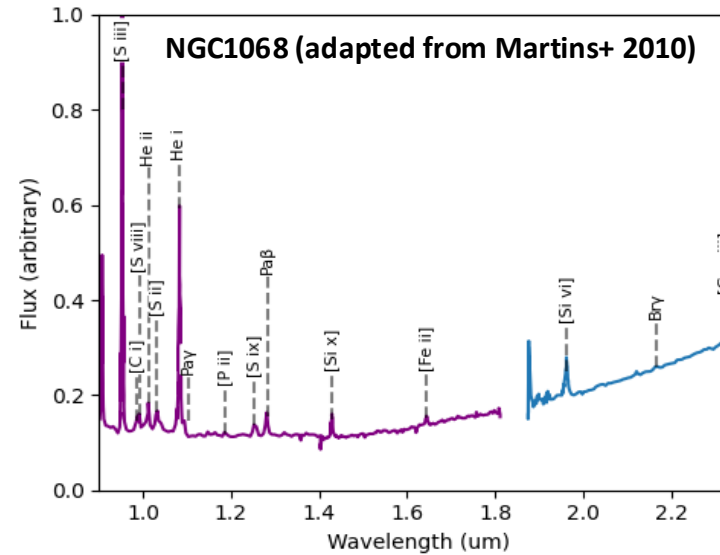
SHARPS: a proposed 3rd generation instrument at the VLT



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Stronger Lines
(better SNR, less biases, ...)

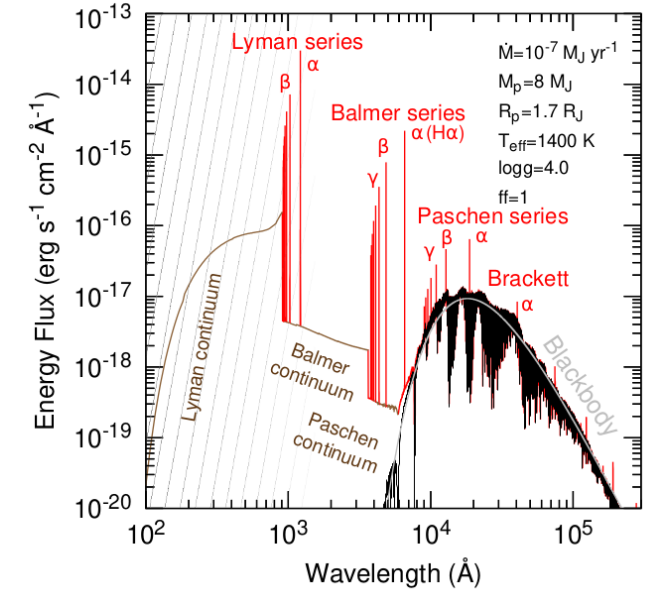


New tracers (ionization, accretion, jets, ...)

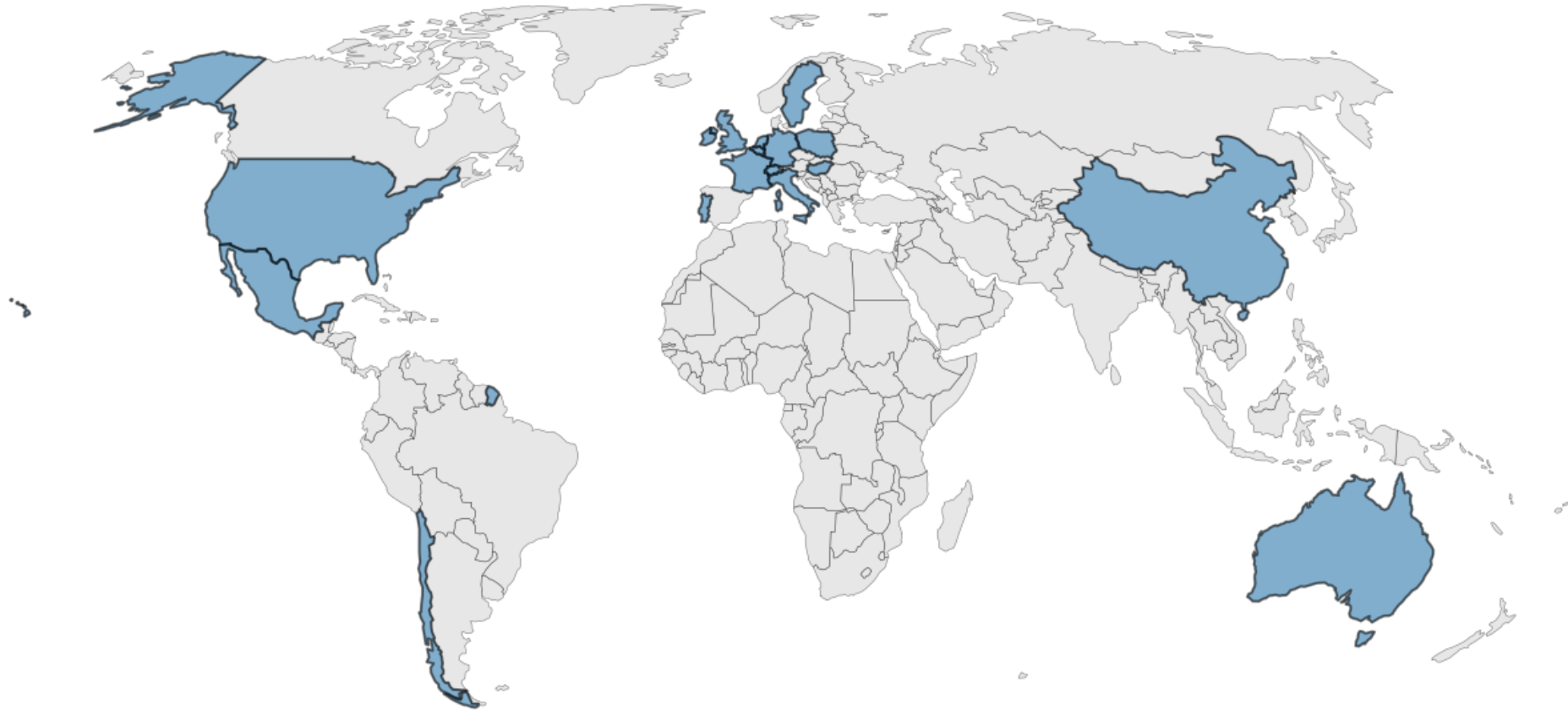
Improved resolution & astrometry at high sensitivity

- Astrometric precision $\sigma \sim \lambda \Rightarrow 10 \mu\text{as}$
- Resolution $\theta \sim \lambda \Rightarrow 1 \text{ mas}$

Accreting planet (model, Aoyama 2021)



SHARPS: a proposed 3rd generation instrument at the VLT



*Olivier Absil, Narsireddy Anugu, William Balmer, Myriam Benisty, **Jean-Philippe Berger**, **Jean-Baptiste Le Bouquin**, Guillaume Bourdarot, **Laurent Bourgès**, **Benoit Carry**, Oscar Carrion-Gonzalez, Peter Chingaïpe, Akke Corporaal, Carlos M. Correia, Denis Defrère, Subo Dong, Steve Ertel, Alexandre Gallenne, Alessio Caratti o Garatti, Jonah Hansen, Sasha Hinkley, Sebastian Hoenig, **Mathis Houllé**, **Elsa Huby**, Oriel Humes, Mike Ireland, Jacob Isbell, Walter Jaffe, Jens Kammerer, **Pierre Kervella**, Heide Korhonen, Stefan Kraus, **Sylvestre Lacour**, James Leftley, Rebeca Garcia Lopez, **Bruno Lopez**, Yi Lu, Foteini Lykou, **Frantz Martinache**, **Alexis Matter**, **Florentin Millour**, **Miguel Montargès**, Nuno Morujão, **Denis Mourard**, Przemek Mroz, **Mathias Nowak**, **Karine Perraut**, **Romain Petrov**, Léa Planquart, Joel Sanchez-Bermudez, **Julia Seidel**, **Ferréol Soulez**, **Isabelle Tallon-Bosc**, Matthew Temple, Konrad Tristram, **Pierre Vermot**, Gerd Weigelt, Thomas Winterhalder, Zexuan Wu*