Exoplanets prospects with MATISSE and the VLTI

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MATISSE

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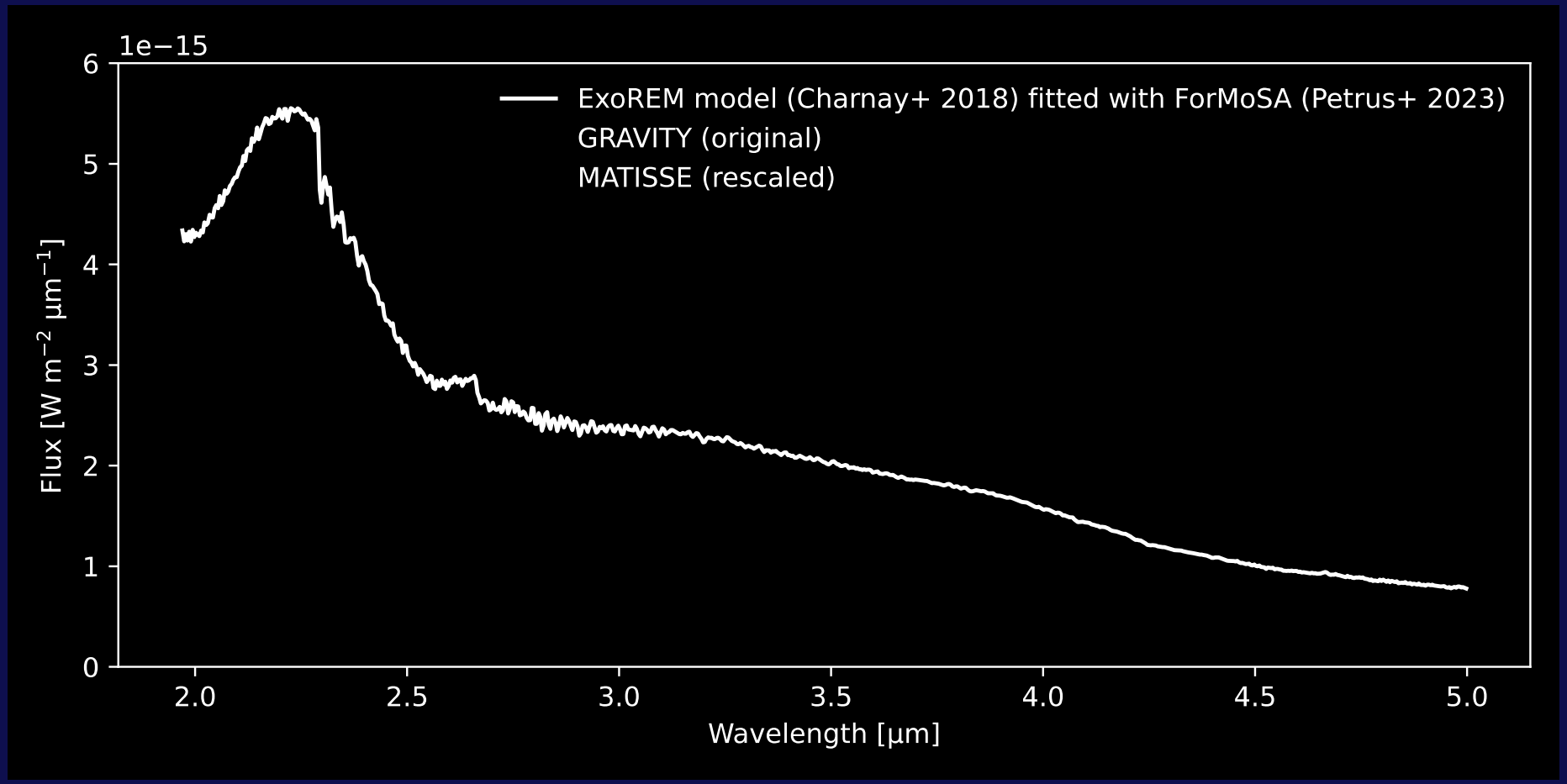
ExoMATISSE

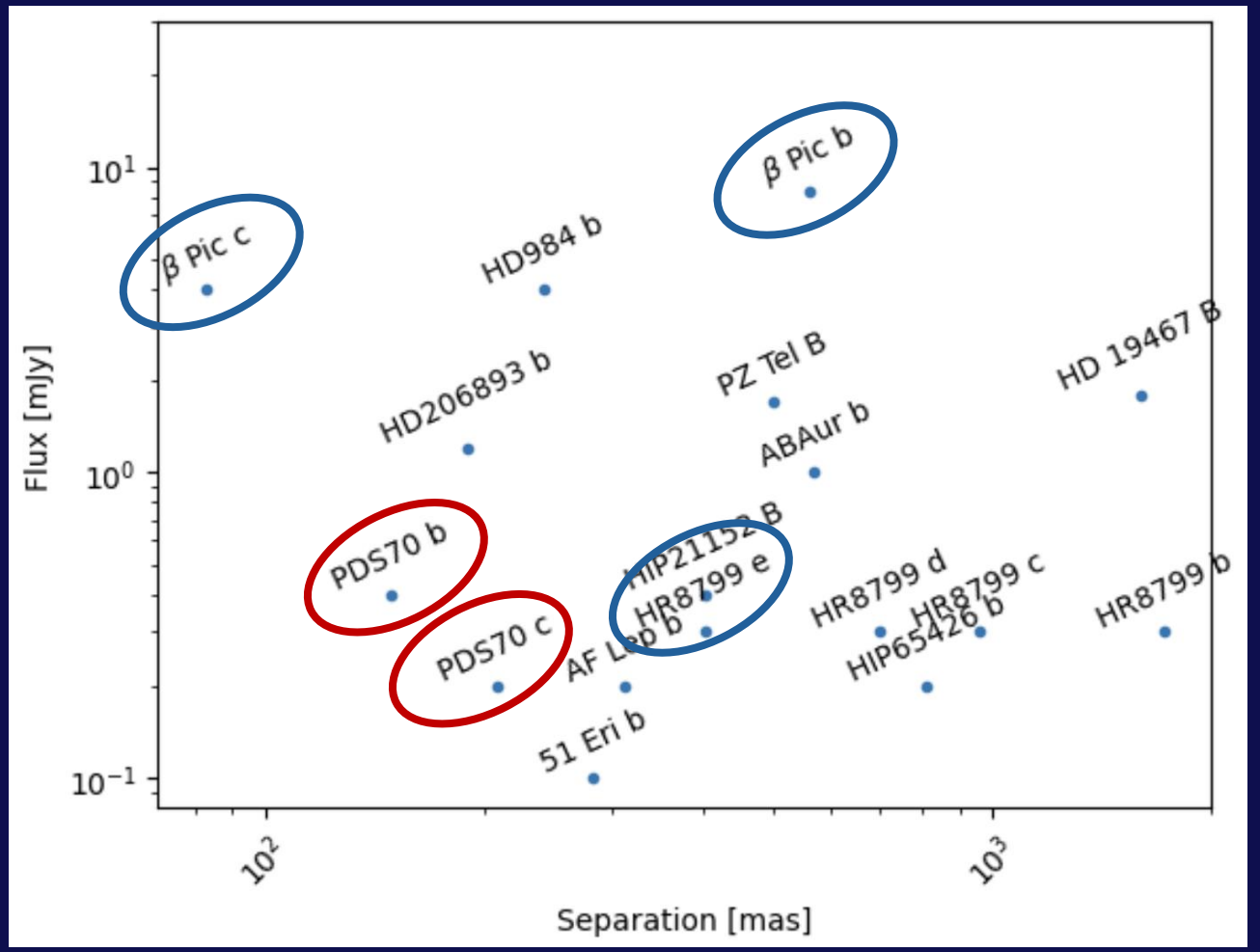
- High S/N obtained on β Pic b in 36 min



ExoMATISSE

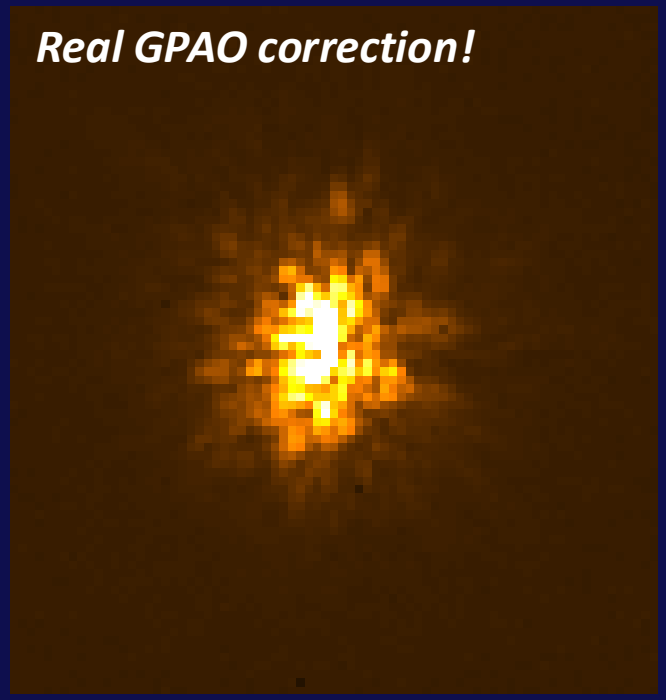
- Observed: β Pic bc, HR 8799 e (with MACAO)
- Programmed: PDS 70 bc(d?)

- Detection limits estimation

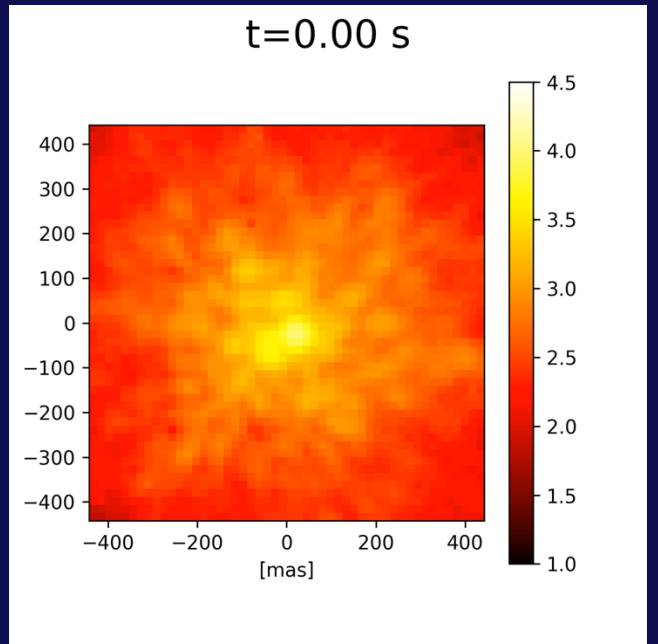


Technical improvements: wavefront control

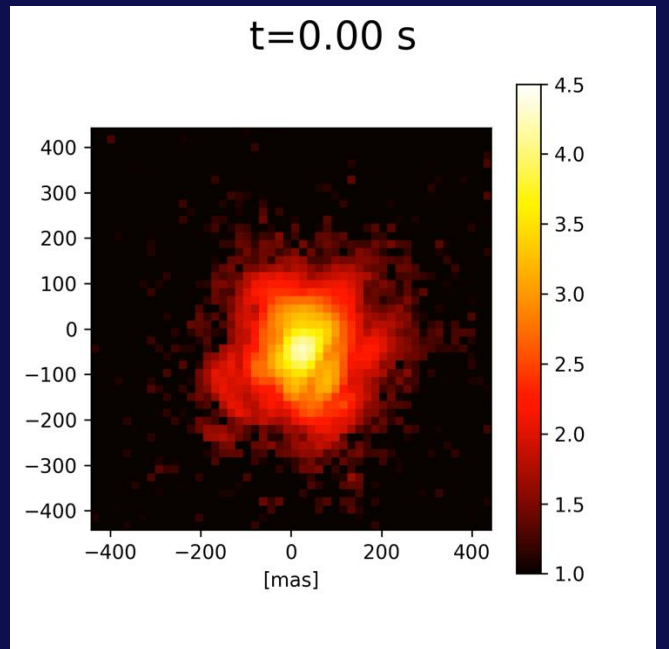
- GPAO
  - ongoing commissioning
  - more planet flux, less stellar contamination
  - SNR x2-3 in *L*?



MACAO

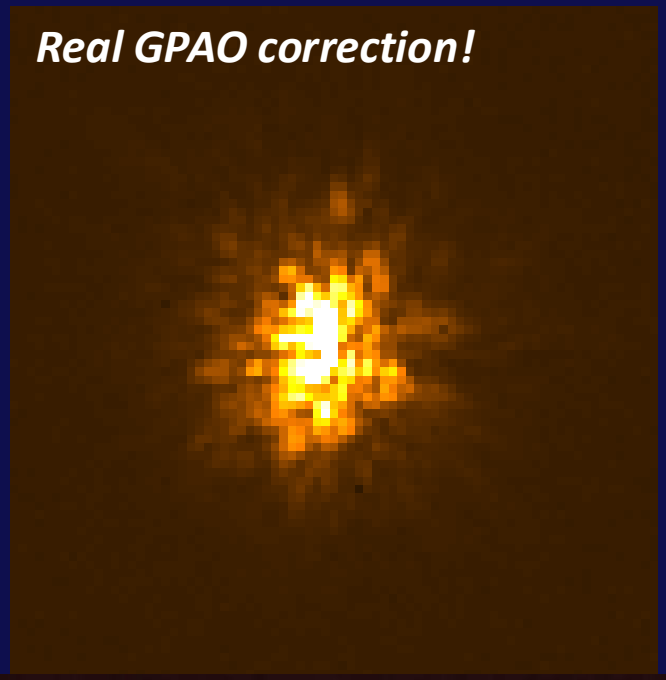


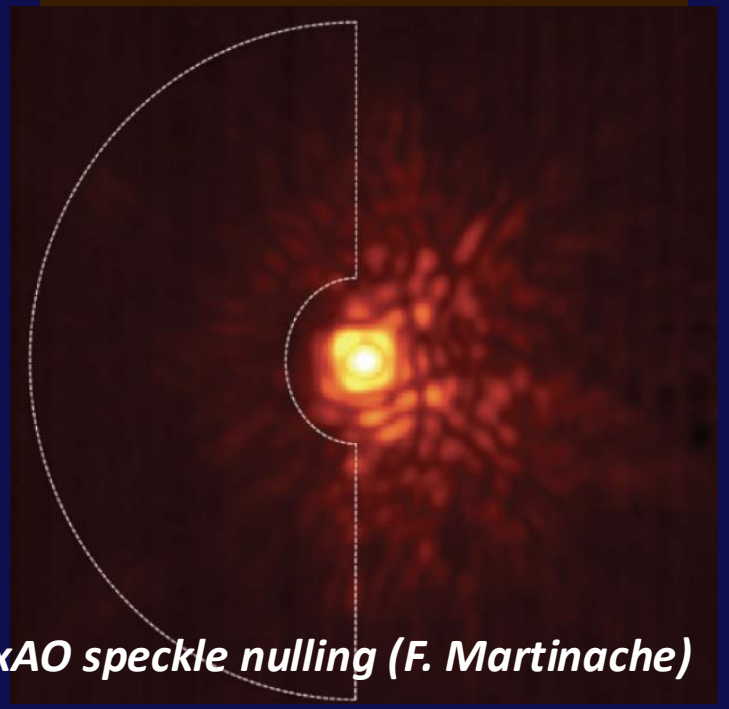
GPAO



Technical improvements: wavefront control

- GPAO
  - ongoing commissioning
  - more planet flux, less stellar contamination
  - SNR x2-3 in *L*?
- Dark hole (speckle nulling)
  - ongoing implementation on GRAVITY
  - to be implemented on MATISSE
  - x10 in contrast limit?

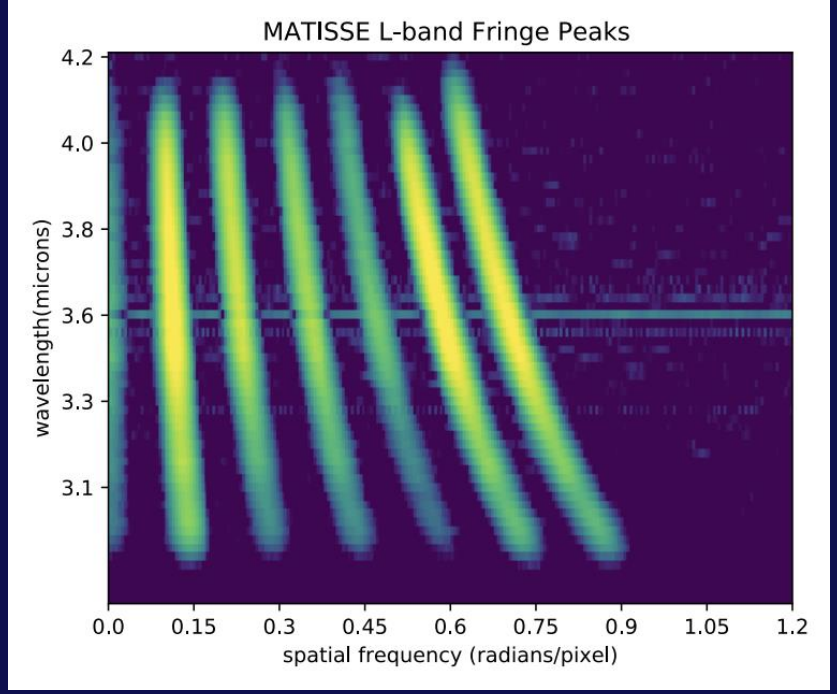


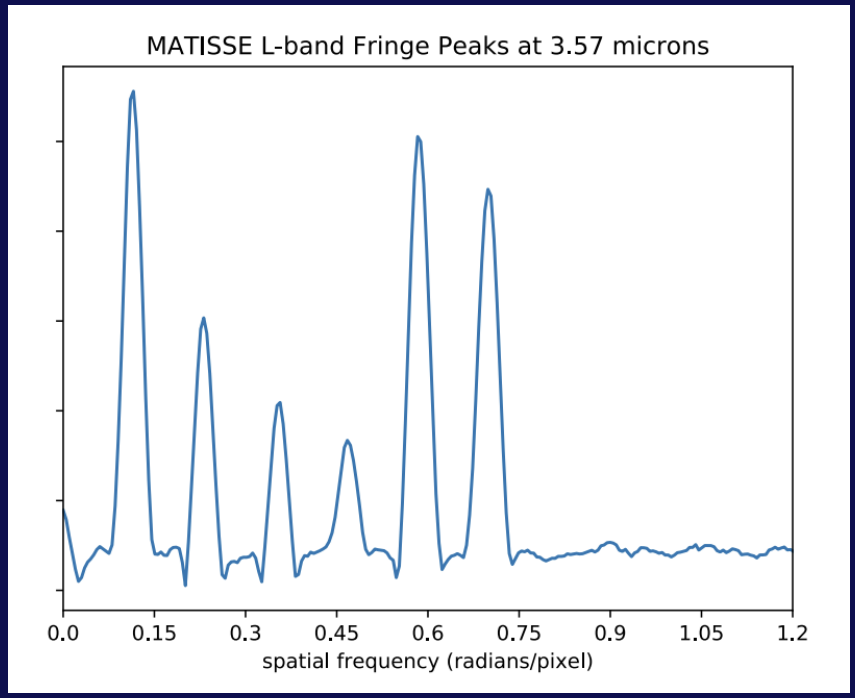


SCExAO speckle nulling (F. Martinache)

Technical improvements: observations & reduction

- 2- or 3-telescope mode
  - shut non-constraining baselines
  - reduce background noise on detector





Technical improvements: observations & reduction

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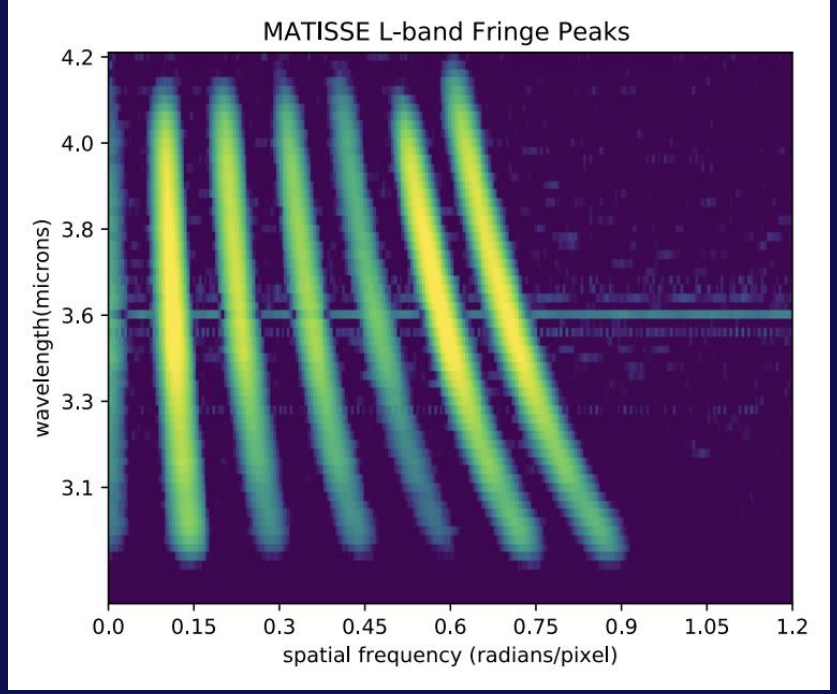
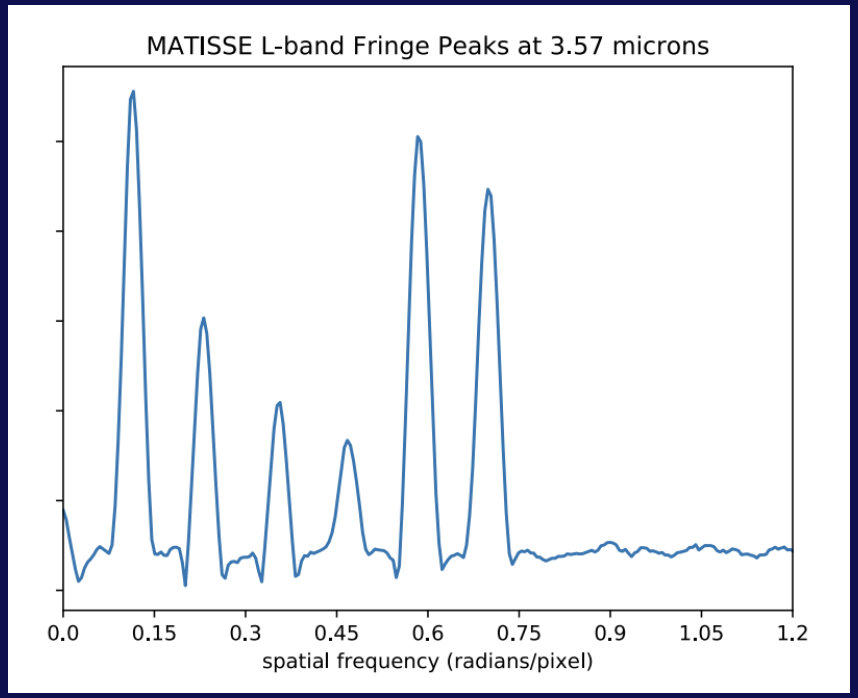
- Apodization (J. Scigliuto's work)
  - apodize the fringe peak integration to reduce background noise





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- 2- or 3-telescope mode
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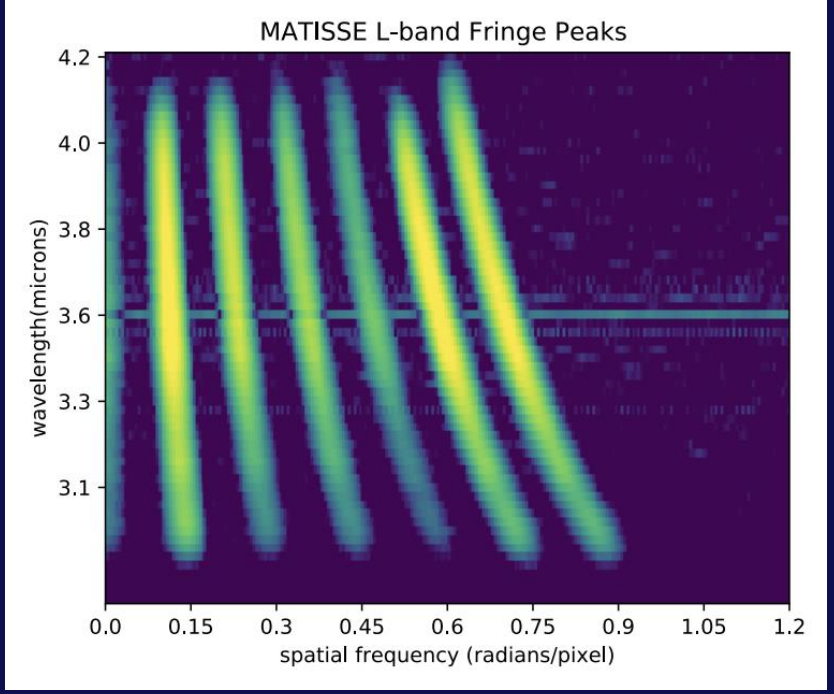
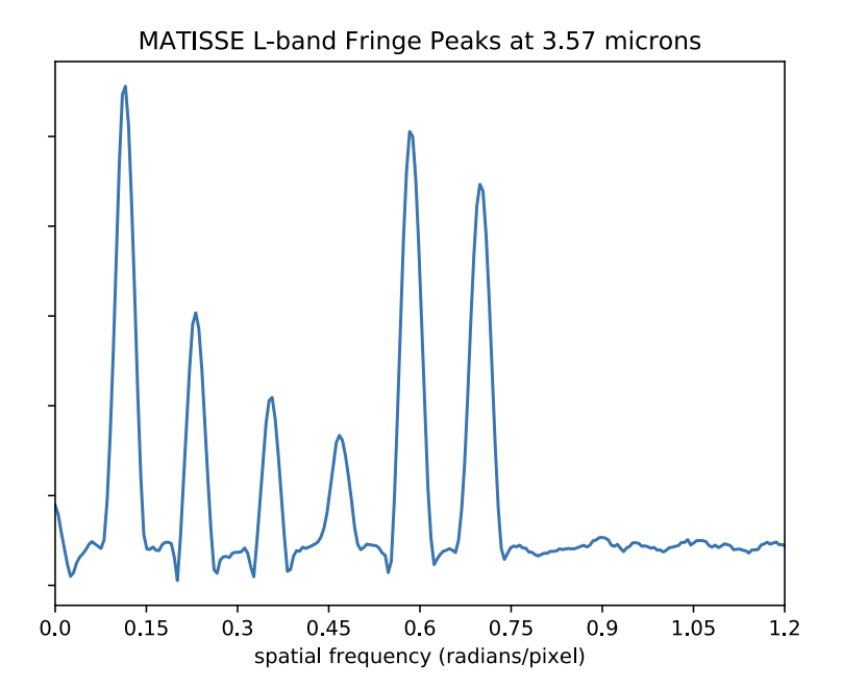
  - apodize the fringe peak integration to reduce background noise

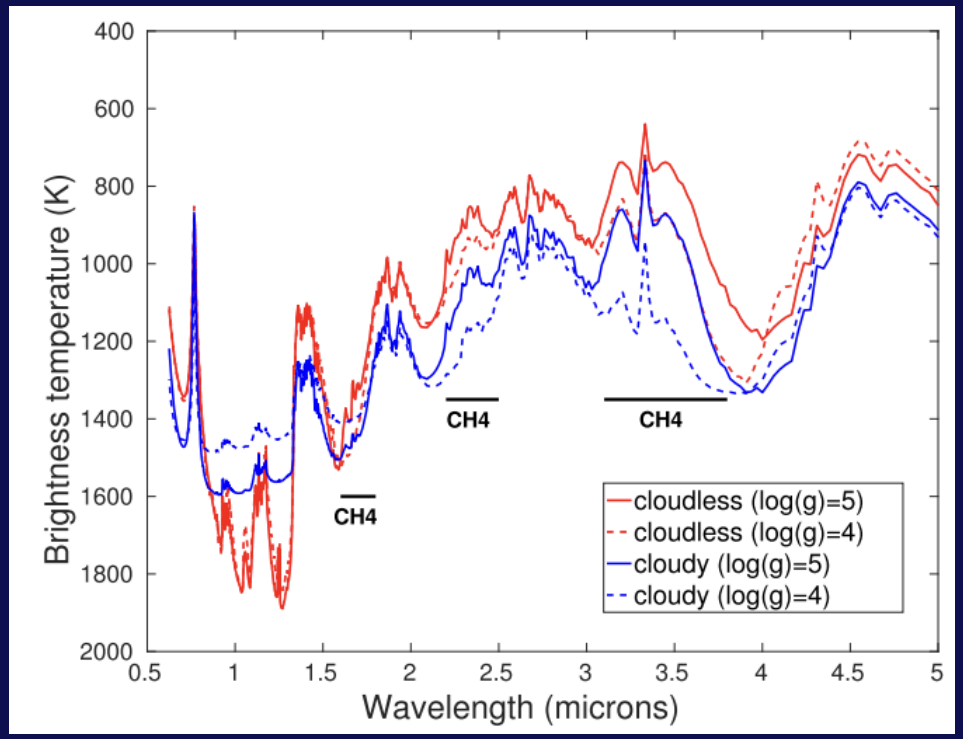
- Better covariance estimate (P. Priolet's talk)
  - could help modeling fainter noisier targets



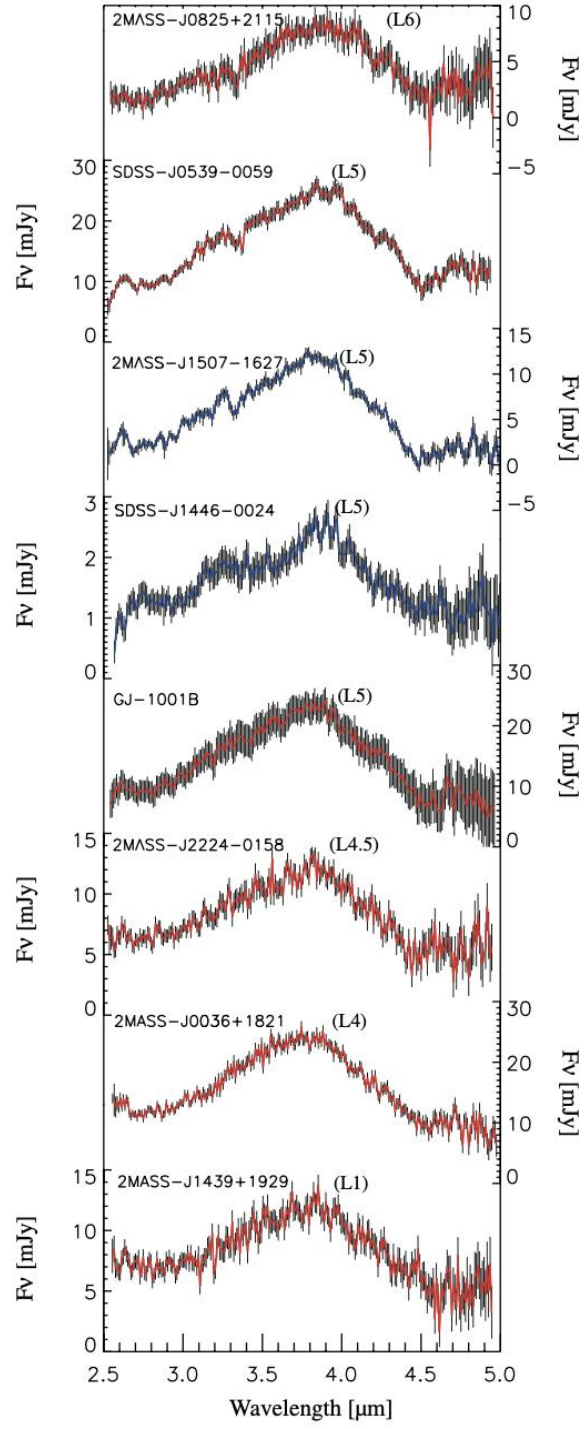


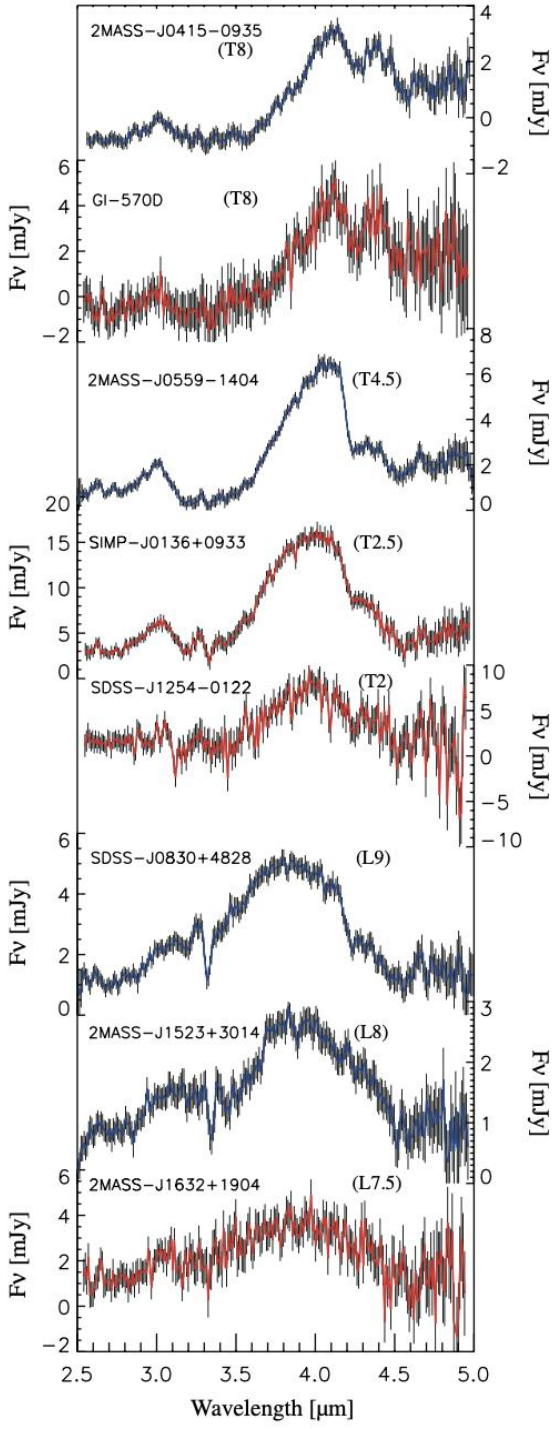
Science cases

- Cold/warm planets (< 1200 K)
  - molecular lines of CO, CH_4, CO_2, PH_3



Charnay+18, ExoREM atmospheric models

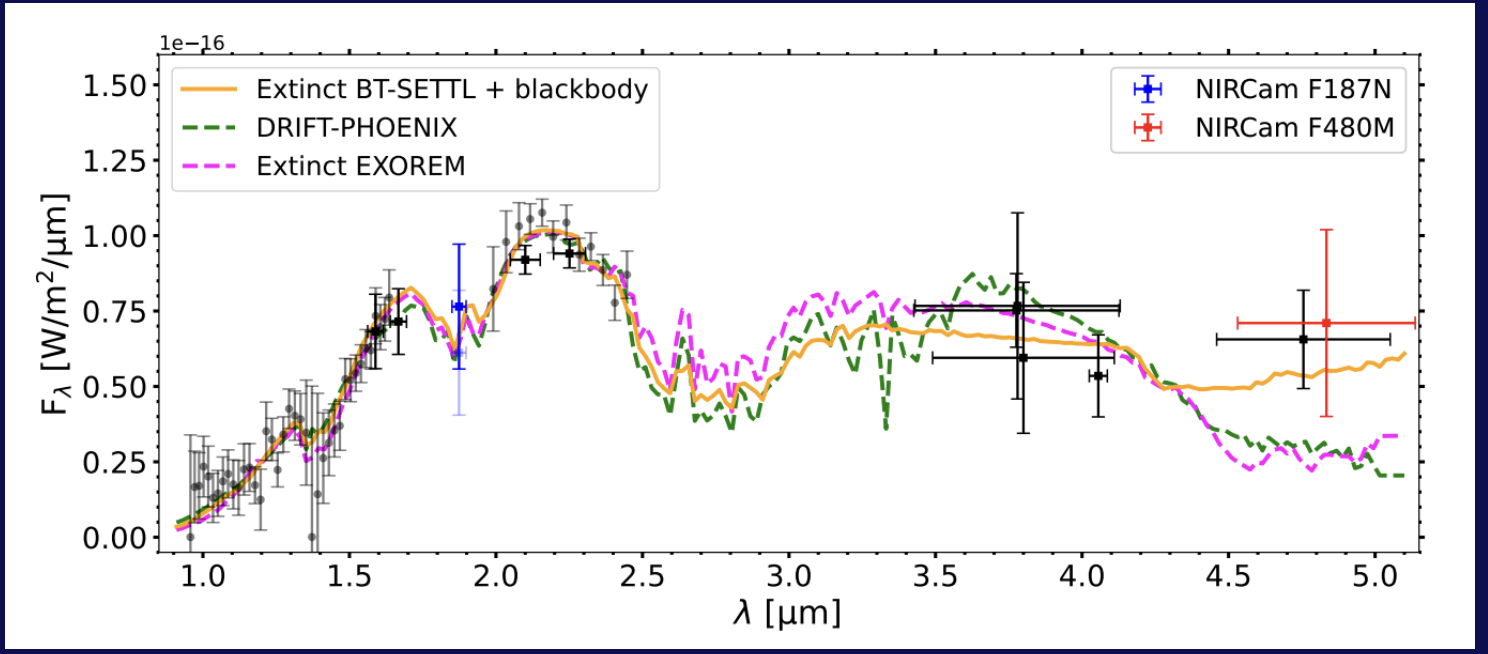




Sorahana+ 2012, isolated brown dwarfs

Science cases

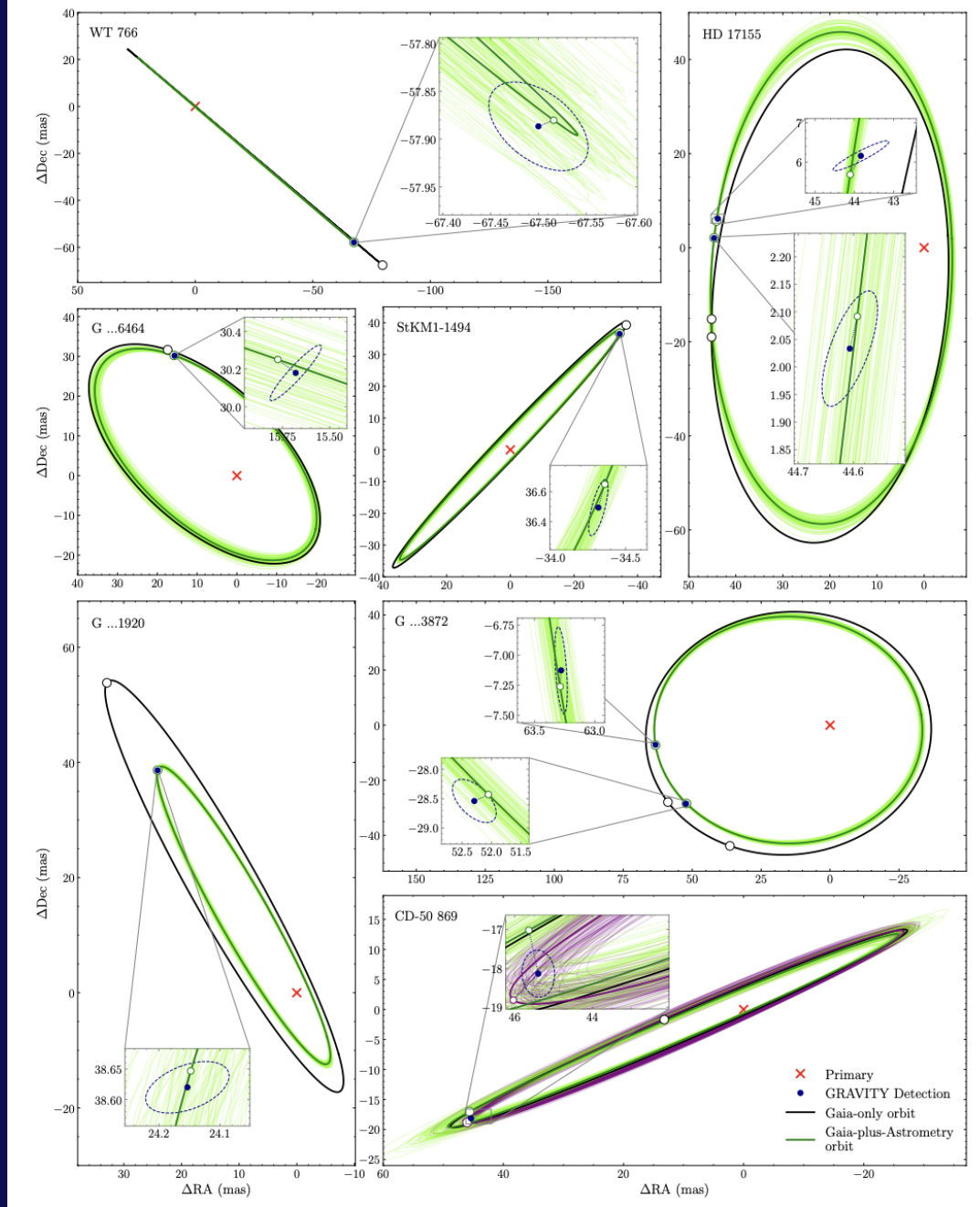
- Cold/warm planets (< 1200 K)
  - molecular lines of CO, CH_4, CO_2, PH_3
- Protoplanets
  - circumplanetary disk emission in the mid-infrared
  - Protoplanetary systems found at > 100 pc (Taurus, Lupus…)



Christiaens+24
PDS 70 b spectrum

The Gaia-interferometry combination

- Thousands of exoplanet detections expected from Gaia DR4 (Perryman+14)
- Hundreds should be accessible to GRAVITY and MATISSE

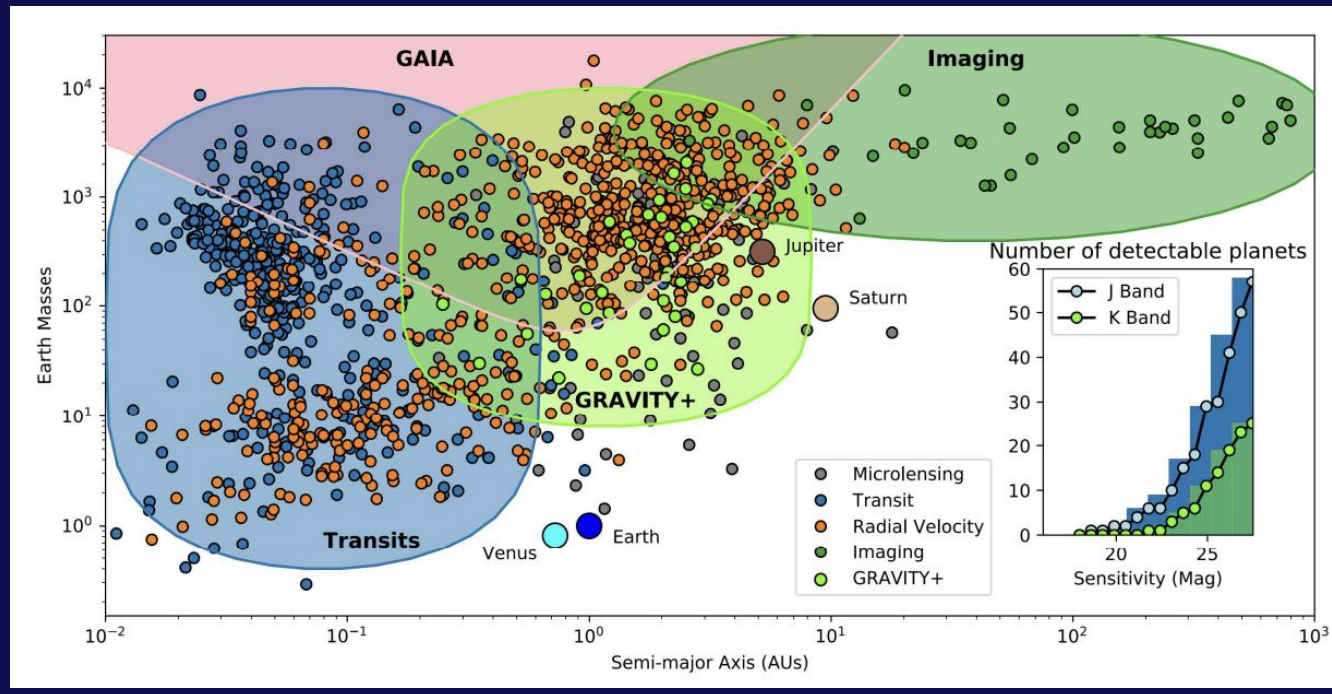


Winterhalder+ 24, Gaia DR3 + GRAVITY

The Gaia-interferometry combination

- Thousands of exoplanet detections expected from Gaia DR4 (Perryman+14)
- Hundreds should be accessible to GRAVITY and MATISSE
- Order of magnitude more planets than today
  - largest exoplanet spectroscopic survey!
  - strong constraints on planetary system architectures at snow line levels (0.1 – 10 au)
  - strong constraints on substellar atmospheres, from Neptunes to brown dwarfs
  - bridge with radial velocities and transits

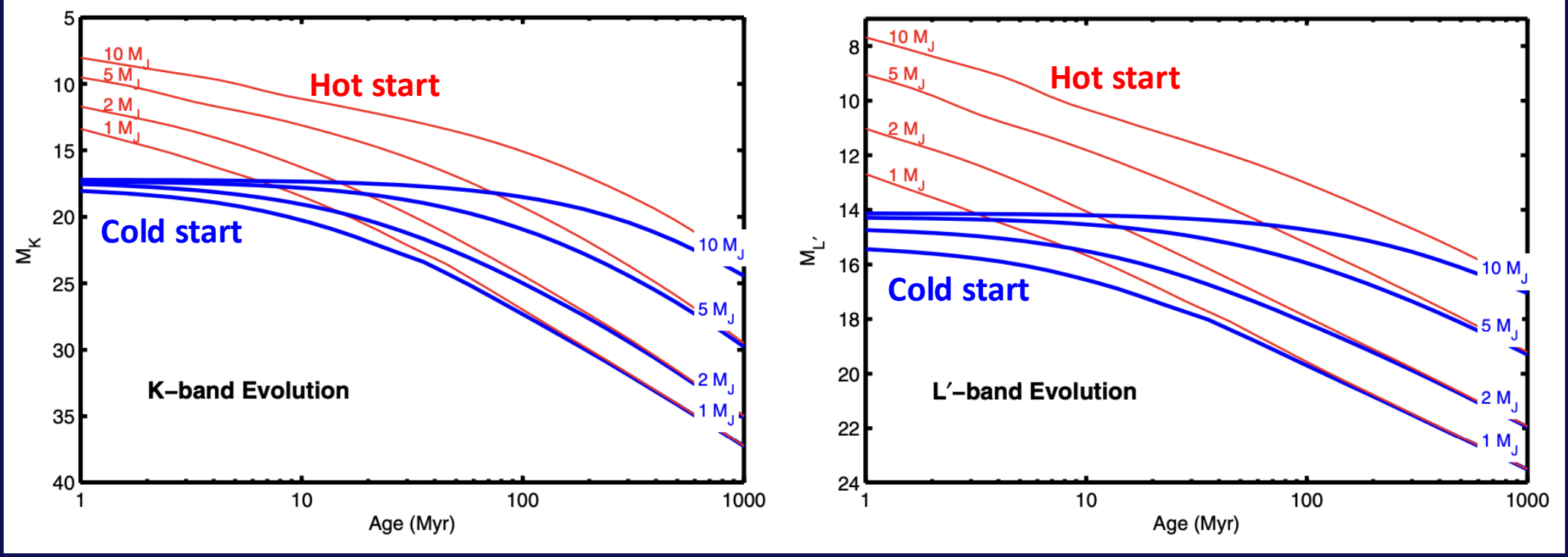
GRAVITY+ White Paper



The Gaia-interferometry combination

- Mass-age-luminosity degeneracy in exoplanet imaging
  - masses derived from luminosities through evolution models
  - large uncertainty on the post-formation luminosity hypothesis in these models
  - produces large uncertainty on the planet mass

Spiegel & Burrows (2012)



The Gaia-interferometry combination

- Mass-age-luminosity degeneracy in exoplanet imaging
- GRAVITY, MATISSE (+ upgraded PIONIER?) can solve it!
  - provide dynamical masses independent of models
  - provide good luminosity estimates: cover emission peaks from 1500 K (1.9 µm) to 600 K (4.8 µm)

- Opportunity for a large program targeting Gaia candidates with all VLTI instruments

ELT vs. VLTI

Important for the mass estimation of ELT planets

Pourré+ 2024