Aperture Masking Interferometry +AO with the 200"

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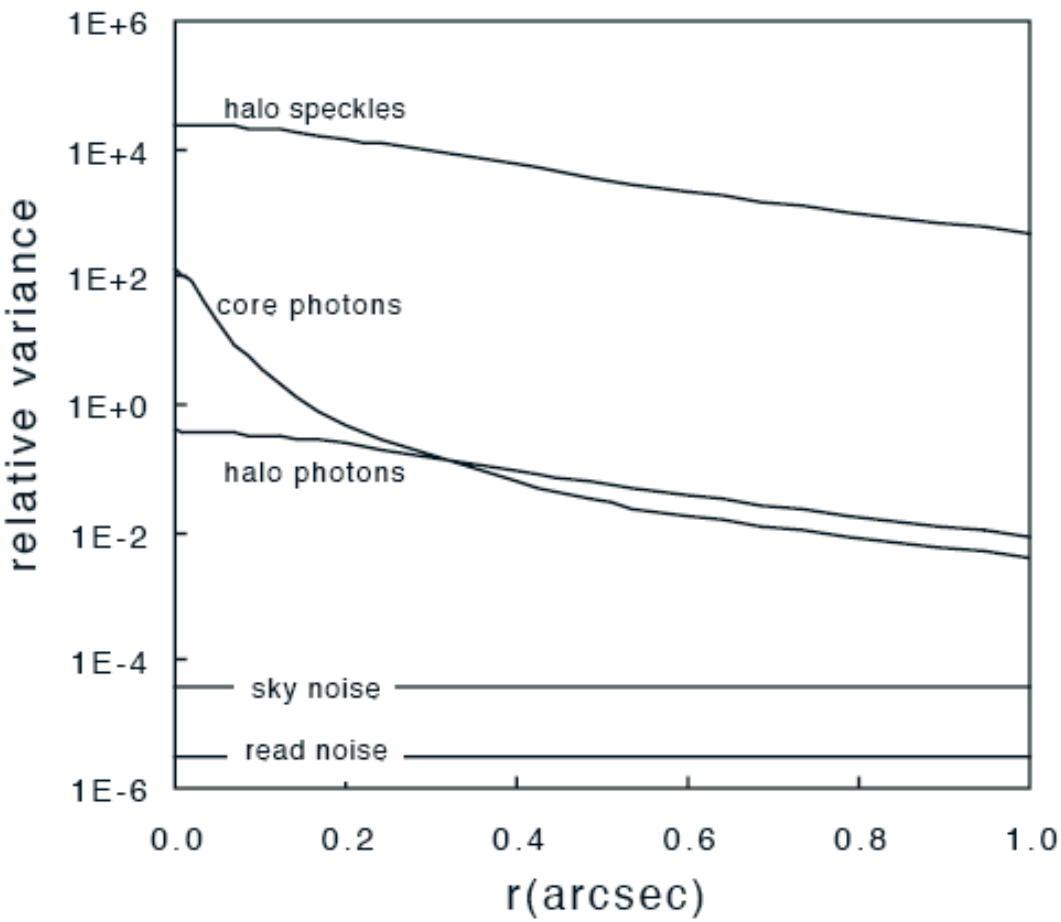
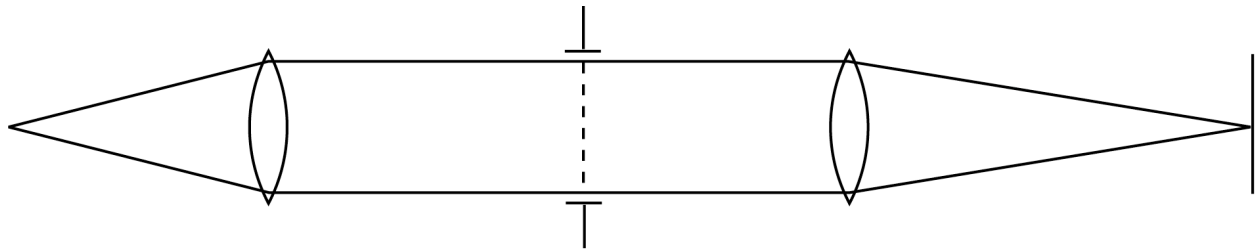
AO imaging & Speckle Noise

PHARO, H band
diffraction limited image

Racine et al, 1999, PASP, 111, 587

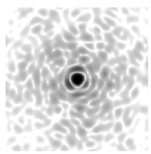


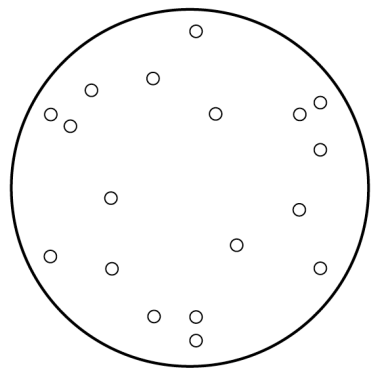
Aperture Masking: Implementation

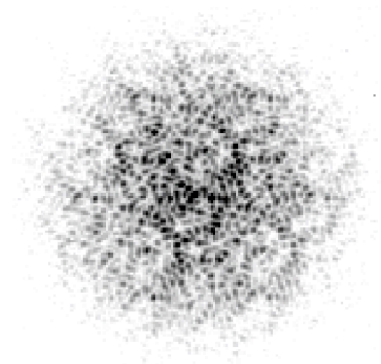


Telescope
Focal Plane

Aperture Mask







$\mathcal{F}\downarrow$

Calibration

Bispectrum
(Closure Phase,
Self-cal)

MEM,
Model Fit

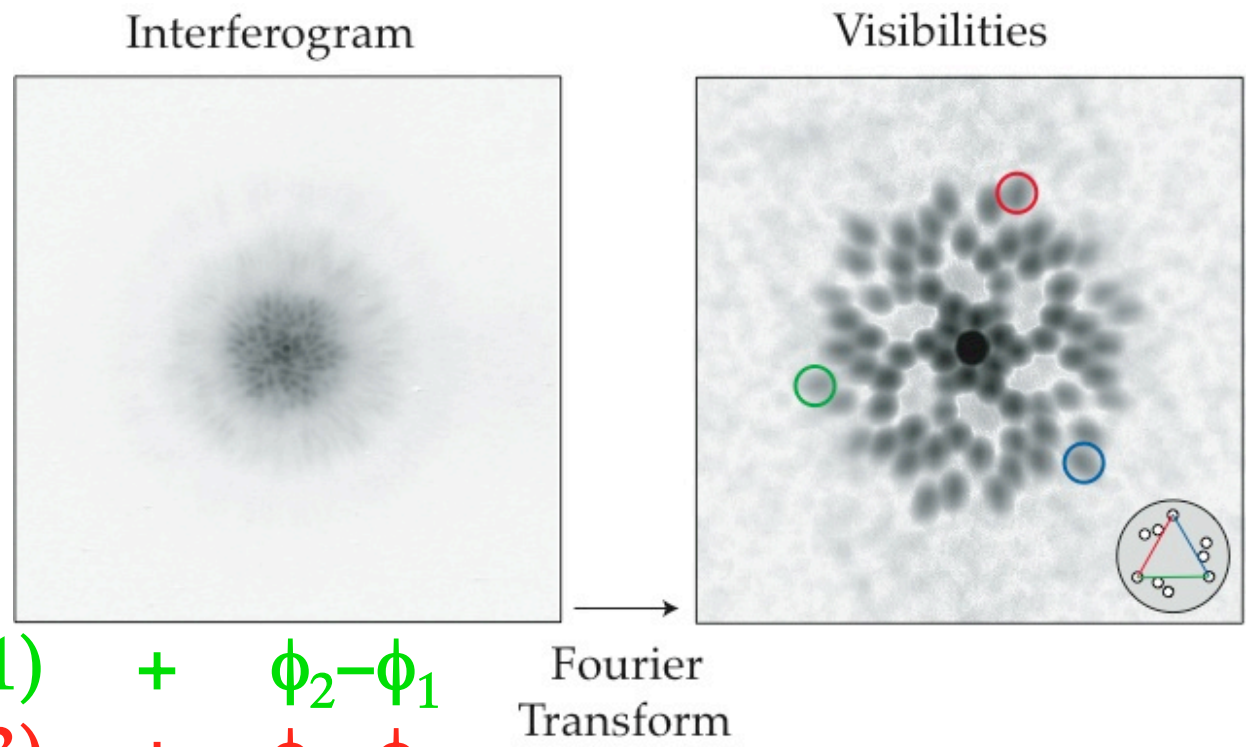
Closure phase to cancel atmospheric residuals and calibrate the telescope

ex: <u>9 holes mask</u>:

- 36 baselines

- 84 triangles

(28 independent)

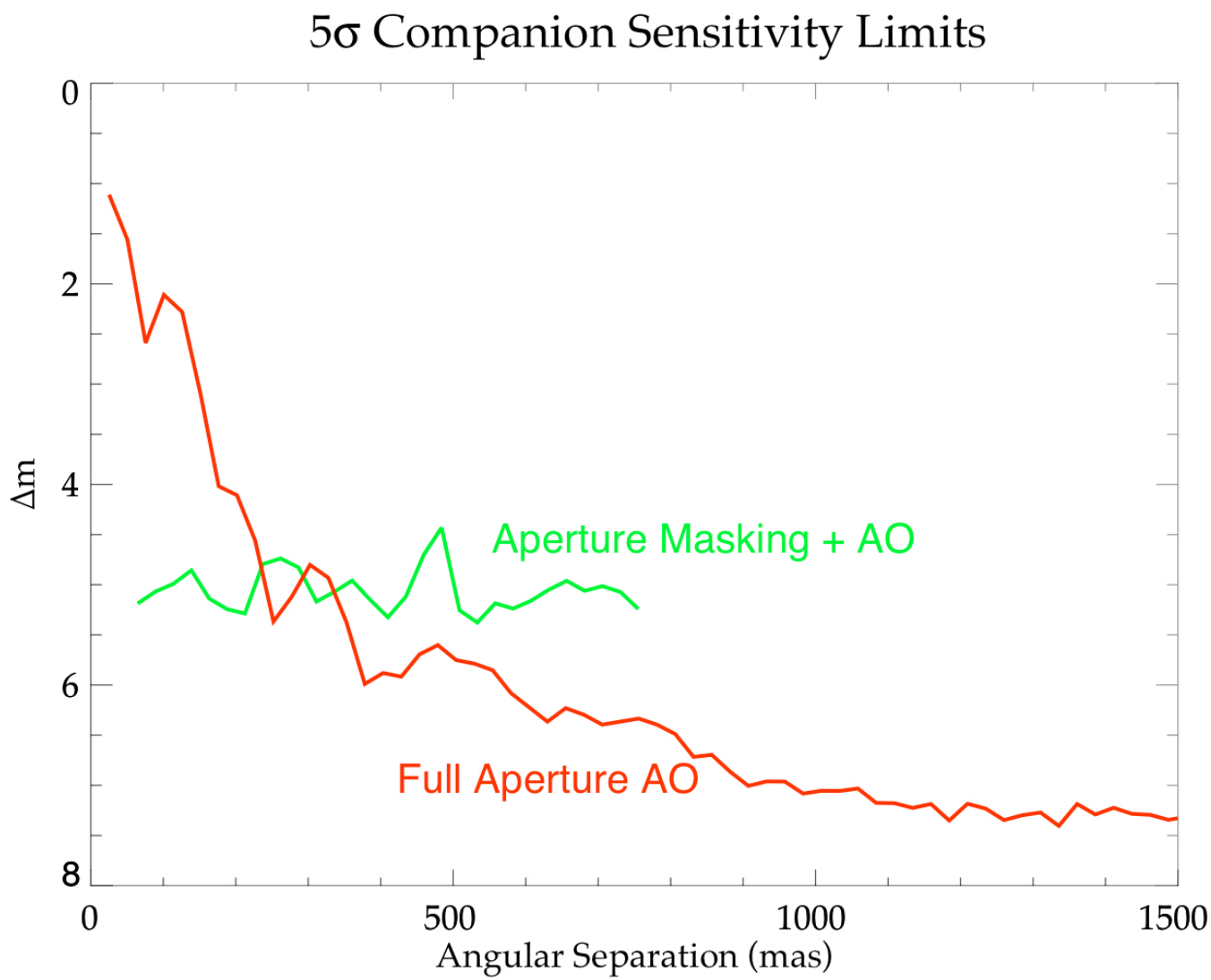


$$\phi(2-1) = \phi_0(2-1) + \phi_2-\phi_1$$
$$\phi(1-3) = \phi_0(1-3) + \phi_1-\phi_3$$
$$\phi(3-2) = \phi_0(3-2) + \phi_3-\phi_2$$

phase = intrinsic phase + atmosphere

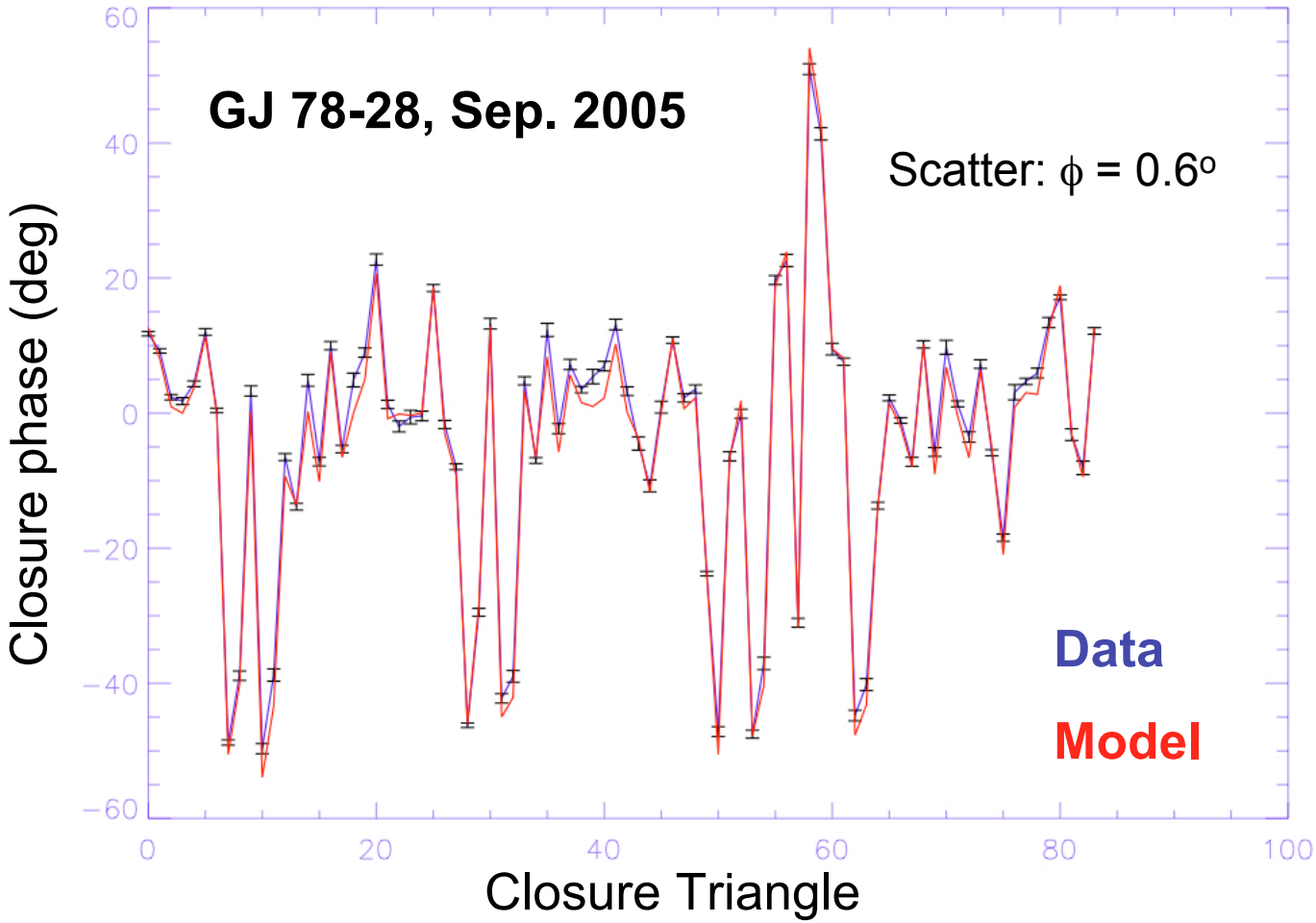
Σ $= 0$

ApM+AO or AO

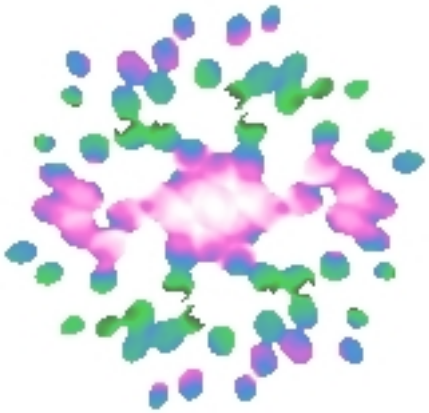

5σ Companion Sensitivity Limits
Δm
0
2
4
6
8
0
500
1000
1500
Angular Separation (mas)
Aperture Masking + AO
Full Aperture AO

Our approach: Model fitting

- Model of binary star: separation, PA, contrast
- Confidence intervals: closure phase scatter
- Mysterious systematic errors … for $\chi_\nu^2 = 1$



Orbit of GJ 78-28 b



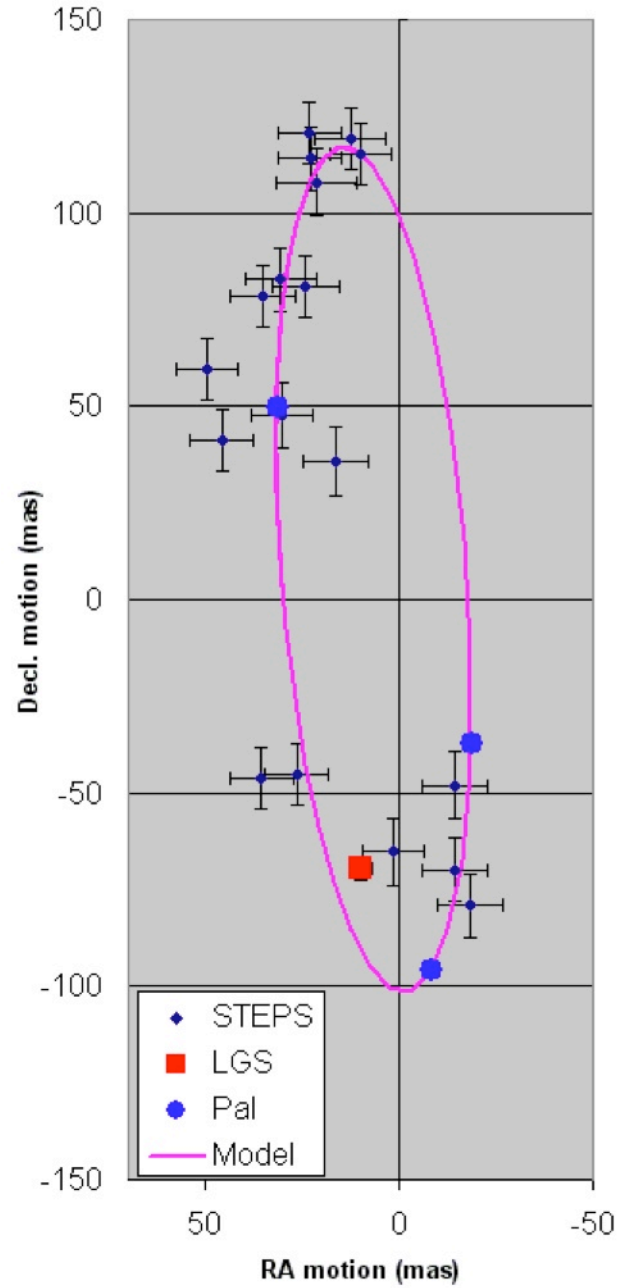
4.2 years orbit M-dwarf

PHARO observations (H band):

Δ_{mag} **= 1.285 +/- 0.023**

Julian data	Sep. (mas)	PA (deg)
2453004.8	58.9 +/- 1.3	32.3 +/- 1.1
2453632.9	96.1 +/- 1.1	184.9 +/- 0.7
2453779.7	41.8 +/- 0.6	206.6 +/- 0.9

NB: in H, λ/D = 66 mas

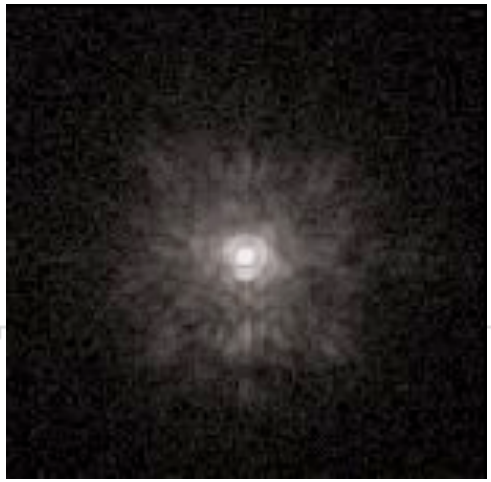


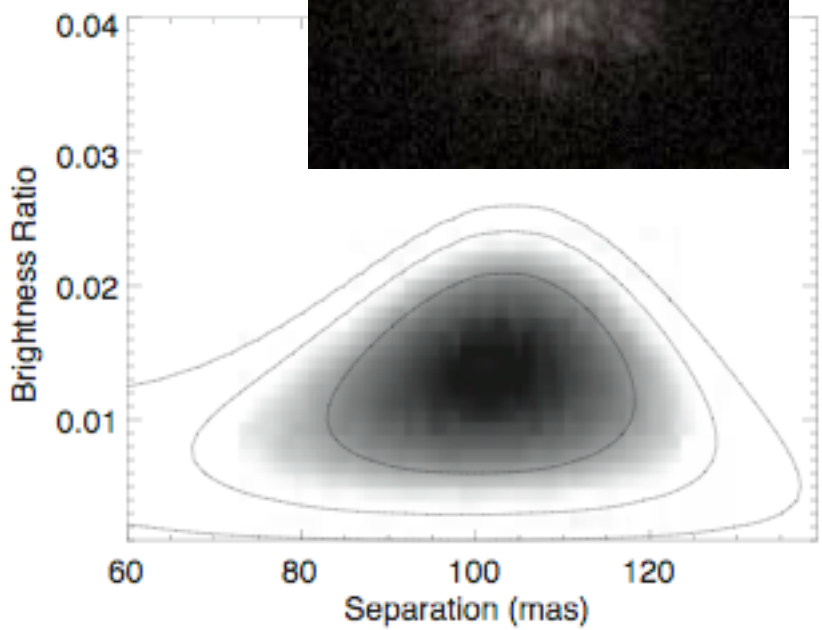
Pravdo et al, 2006, ApJ, accepted

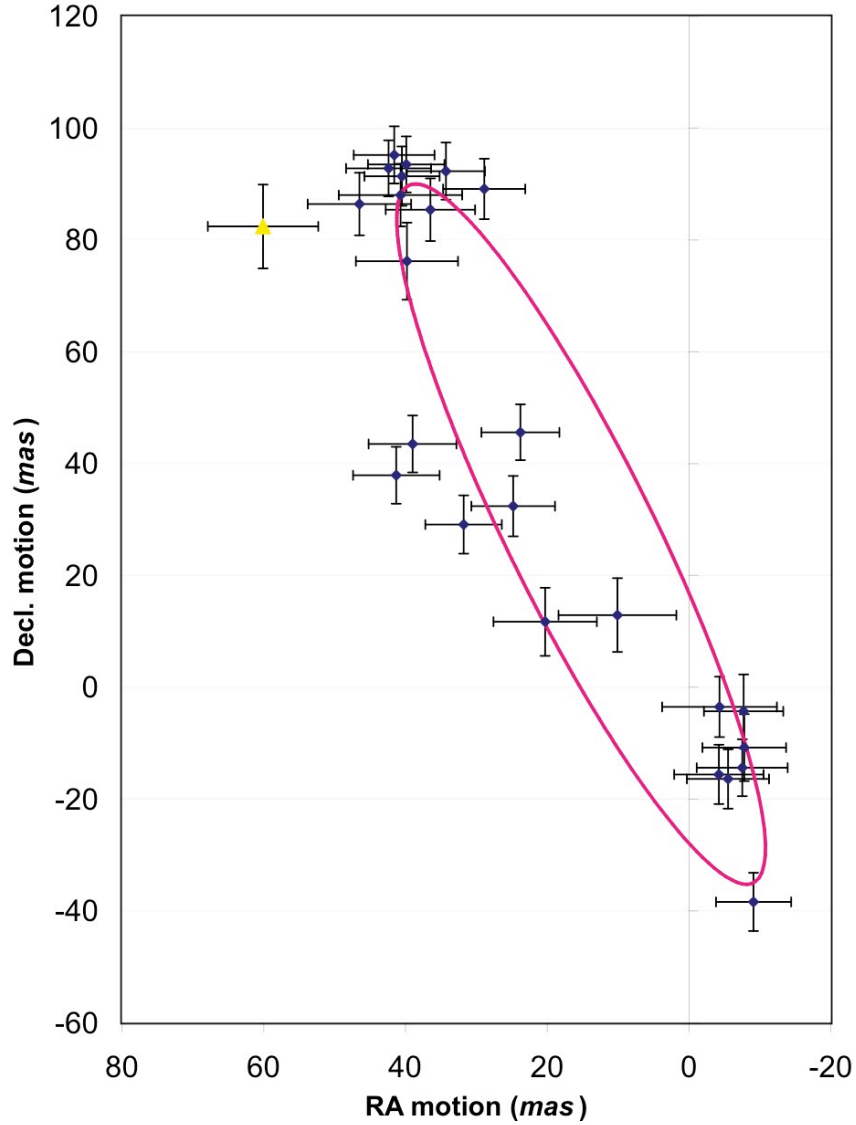
Direct Detection of GJ 802 b

GJ 802,

Aug 2004







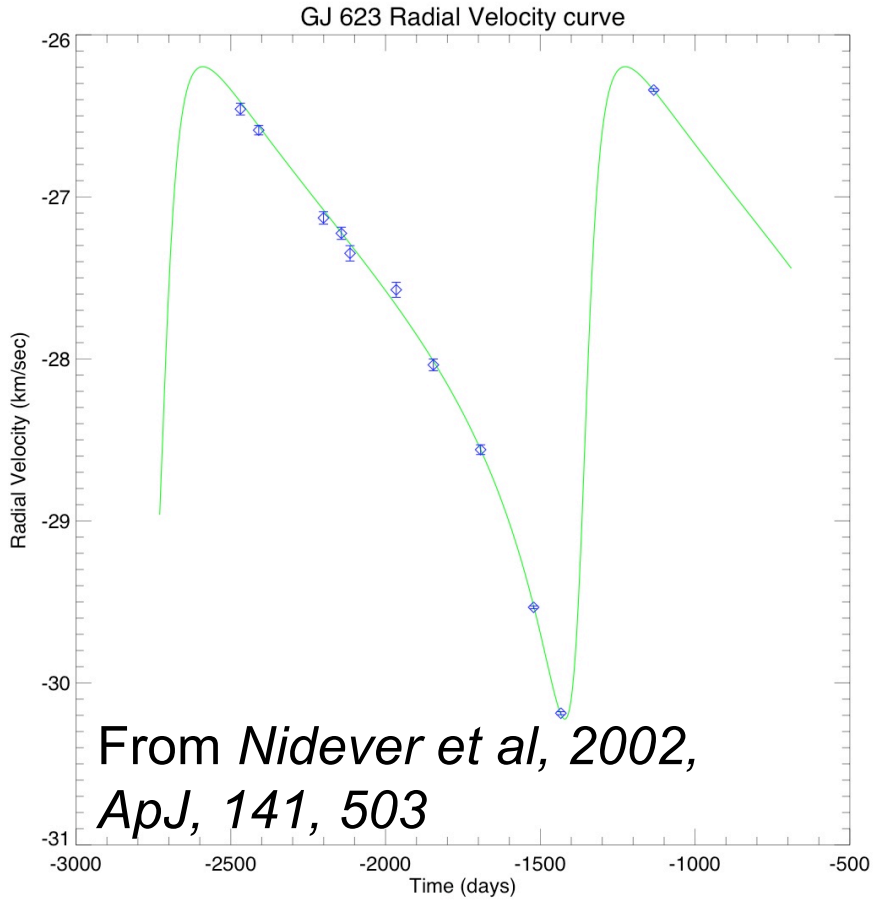
sep = 102 +/- 7 mas

Δ_{mag} = 4.68 +/- 0.28

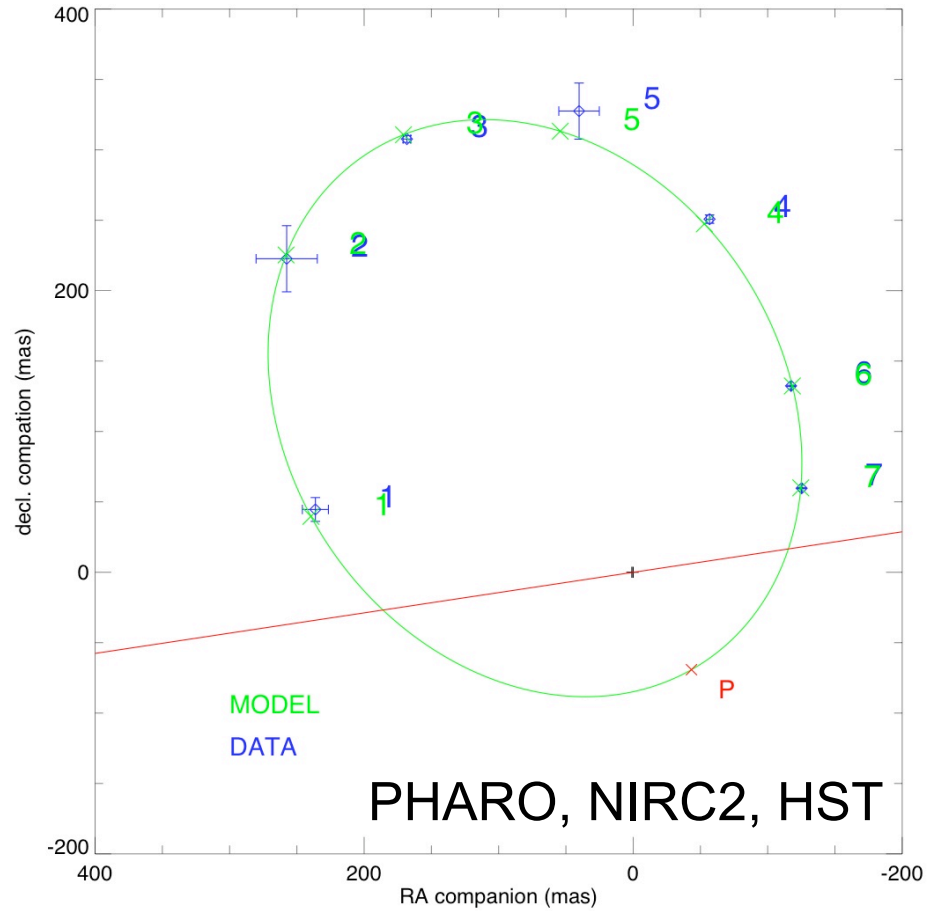
Pravdo et al, 2005, ApJ, 630, 528

Lloyd et al, 2006, ApJL Accepted

Precision astrometry GJ 623 b



From *Nidever et al, 2002, ApJ, 141, 503*



3.7 years orbit

<u>RV + astrometry</u> :

M_2 = 0.120 +/- 0.01 M_{sun} (3%)

Martinache et al, 2006, in prep.

Conclusion

- Direct detection of companions below the limit of resolution.

- milli arc second precision.

Yet

-Amplitudes do not calibrate.

- χ^2 analysis requires the introduction of a term of systematic errors.

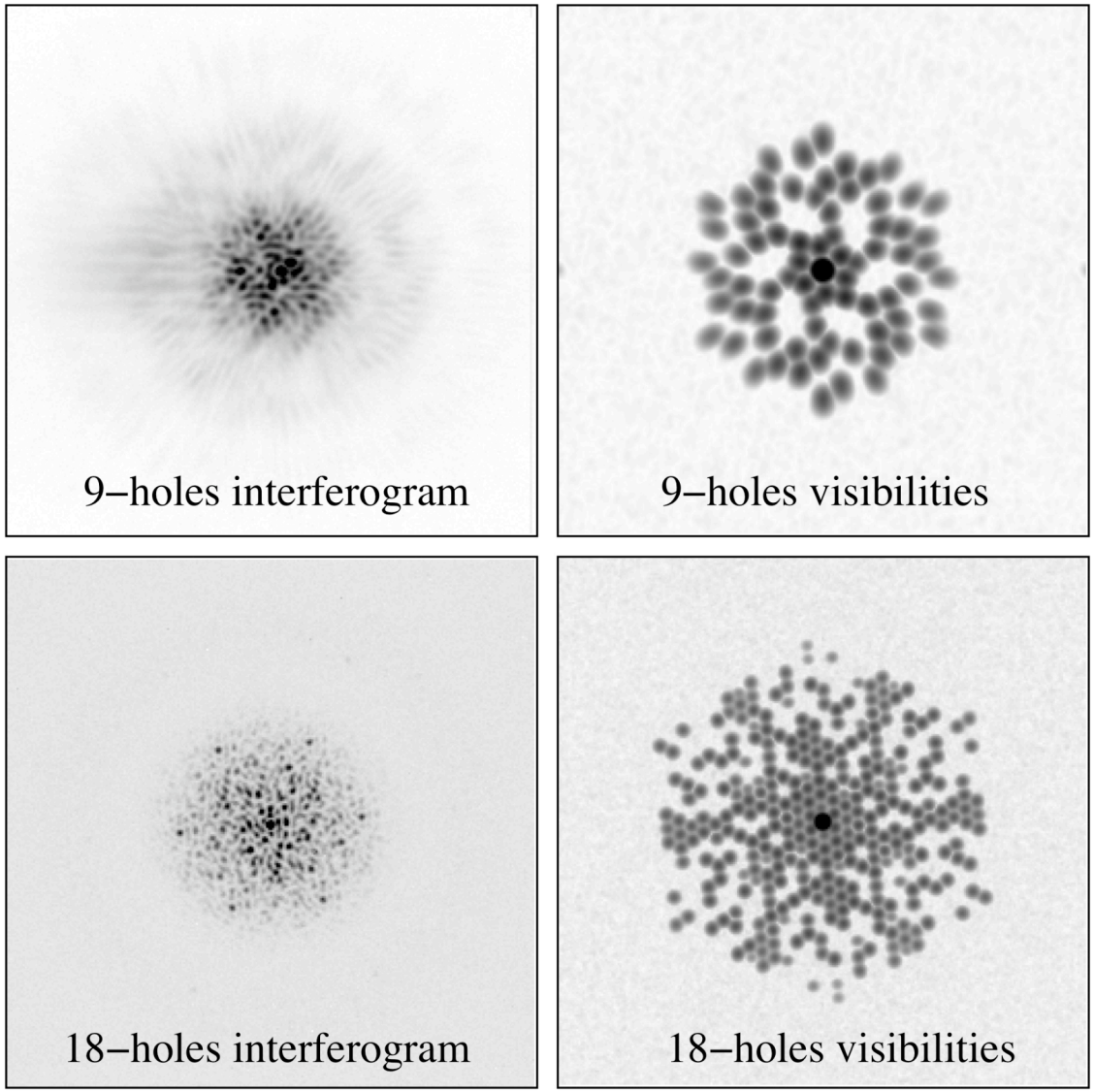
- Dithering of the data, hidden FOI bugs, …

But anyway

- Lots of cool stuff still to come !

Questions ?

Our two masks



For wide band filter:

J, H, K_s

For narrow filters:

Fe II, Br Gamma