

# Coronagraphic Differential Imaging at VLT/NACO

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# Context

NACO (NAOS+CONICA) : nearIR AO system + IR camera (1-5 $\mu$ m)

coronagraphic mode:

- Lyot masks ( $\emptyset$  0.7", 1.4")
- undersized pupil (90%)

2003 : **1st 4QPM ever implemented on a telescope** (using the undersized pupil)

- optimized for Ks
- commissioning results in Boccaletti et al. 2004
- scientific results: Gratadour et al. 2005, Riaud et al. 2006

2007 : two 4QPMs implemented (undersized pupil)

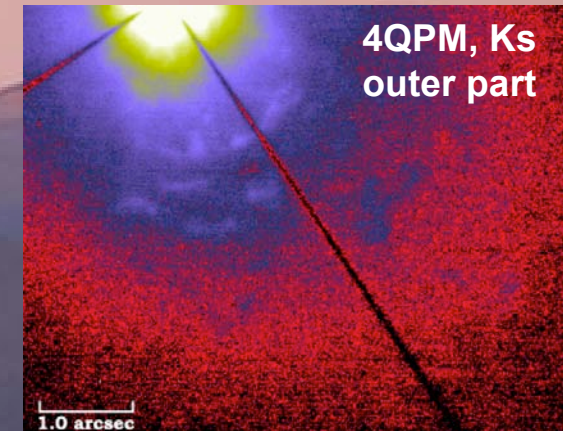
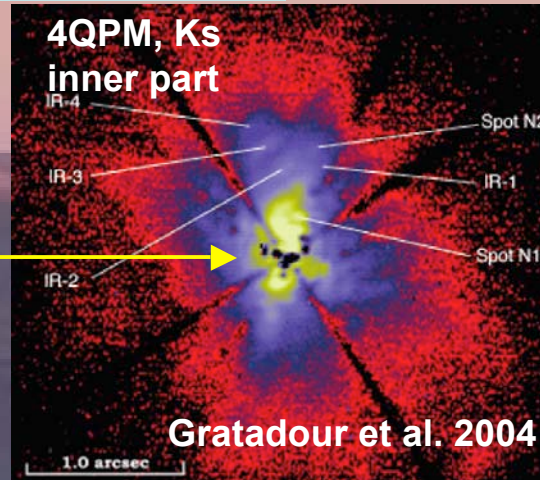
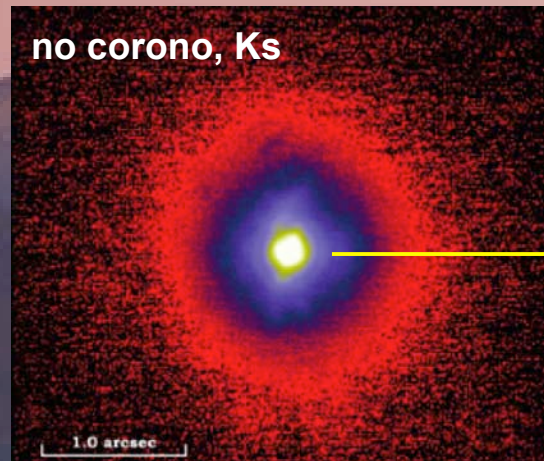
- 1 optimized for Ks
- 1 for H and SDI
- upgrade of SDI : new wollaston prisms

lower dispersion, larger FOV 5" -> 8"

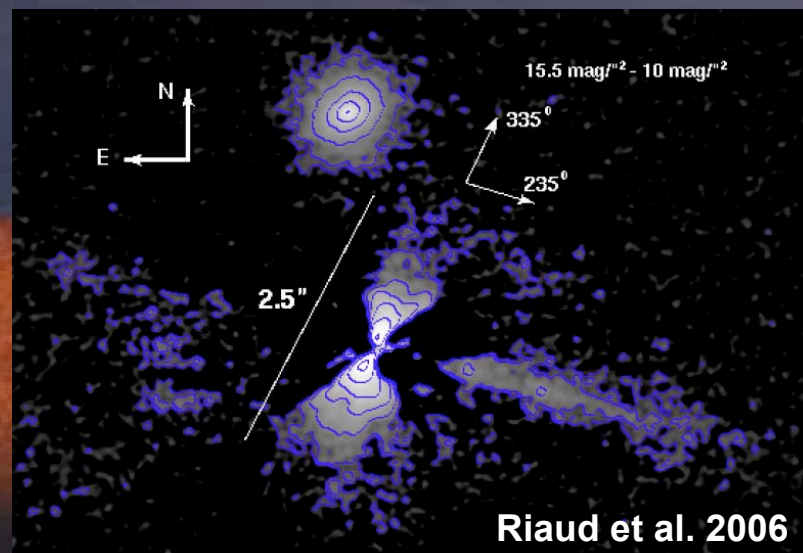


# Results with the 1st component

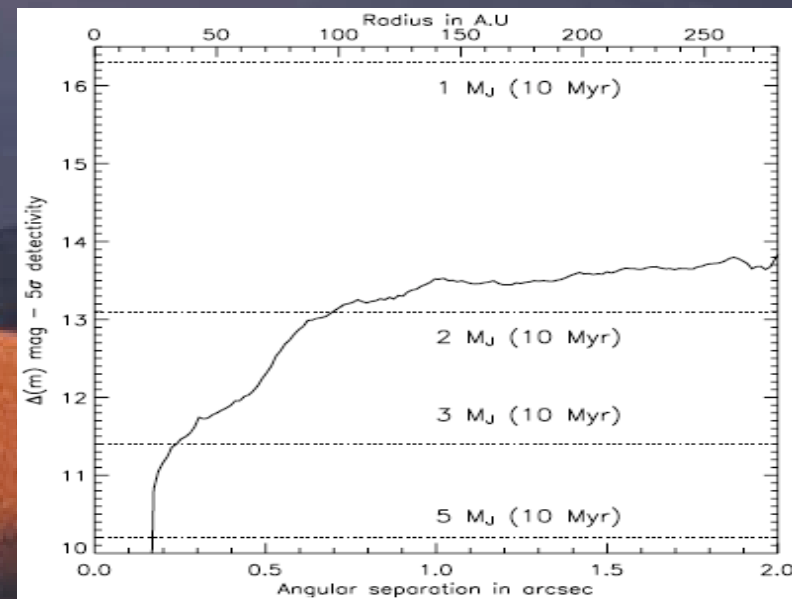
N1068: precise identification of several structures



PDS 70: T Tauri star, discovery of a disk and a candidate BD companion



A. Boccaletti



, 2007



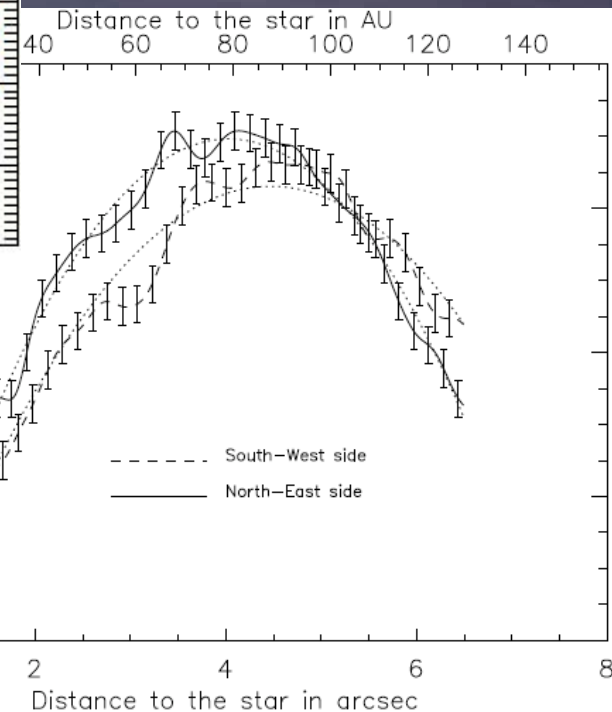
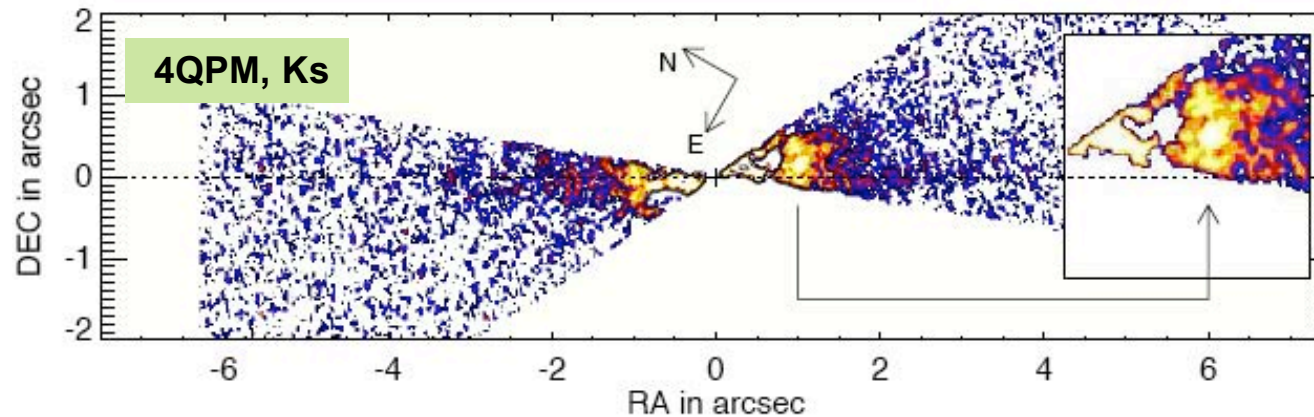
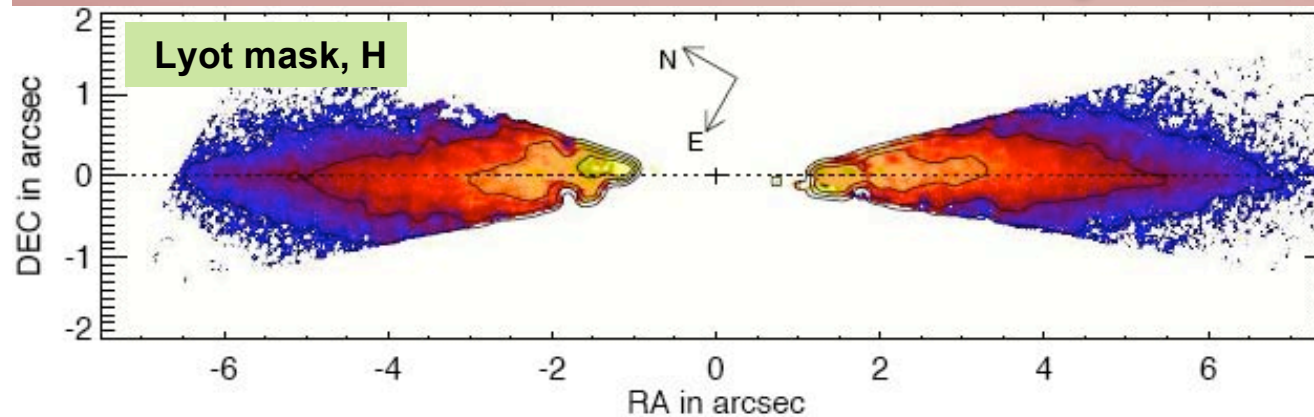
# Results with the 1st component

$\beta$  Pic :

- Lyot mask :  $r > 1.2''$
- 4QPM :  $r > 0.7''$
- (better than ACS)

several asymmetries revealed (some unknown)

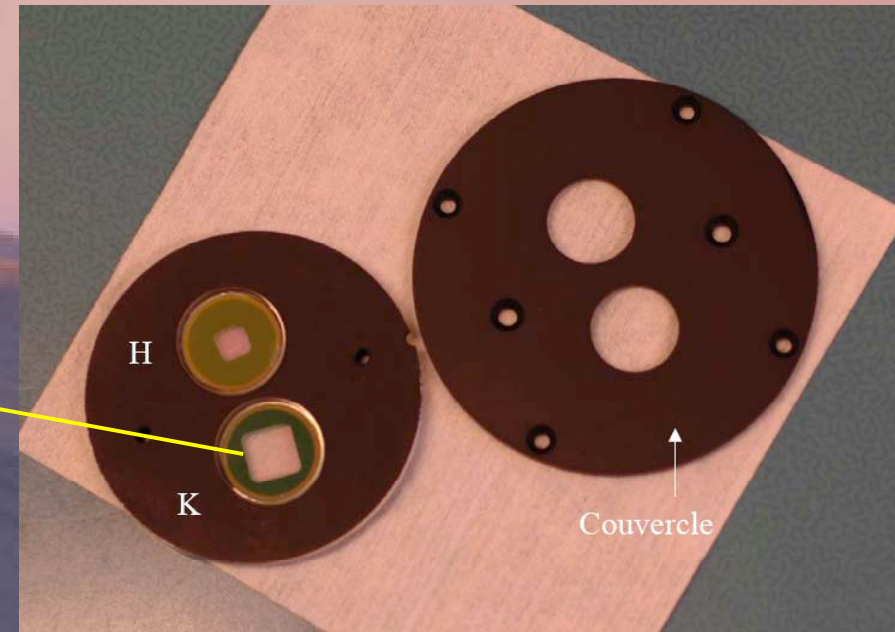
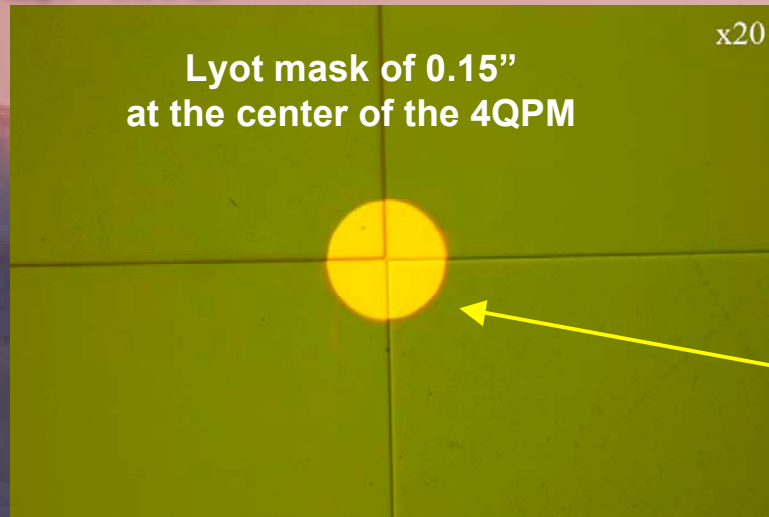
to be published ...



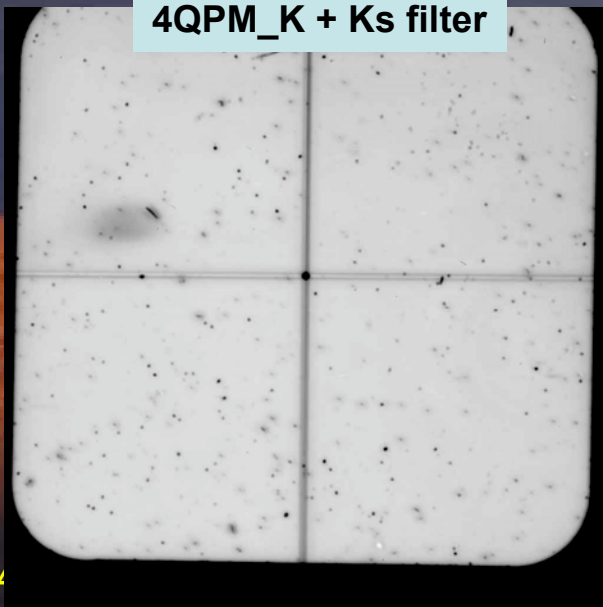
attenuation Lyot = 200  
attenuation 4QPM = 10

=> lower sensitivity at large radii  
=> better sensitivity at small radii

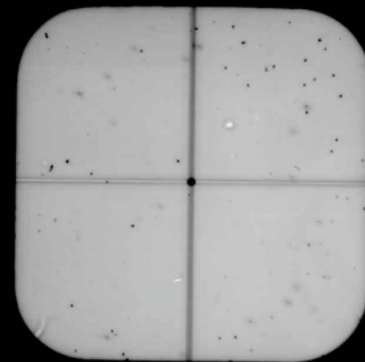
# Implementation of the new 4QPMs



4QPM\_K + Ks filter



4QPM\_H + H filter



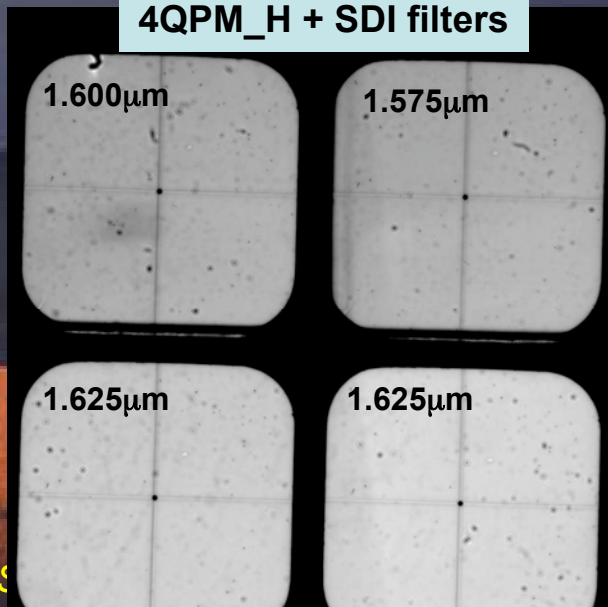
4QPM\_H + SDI filters

1.600 $\mu$ m

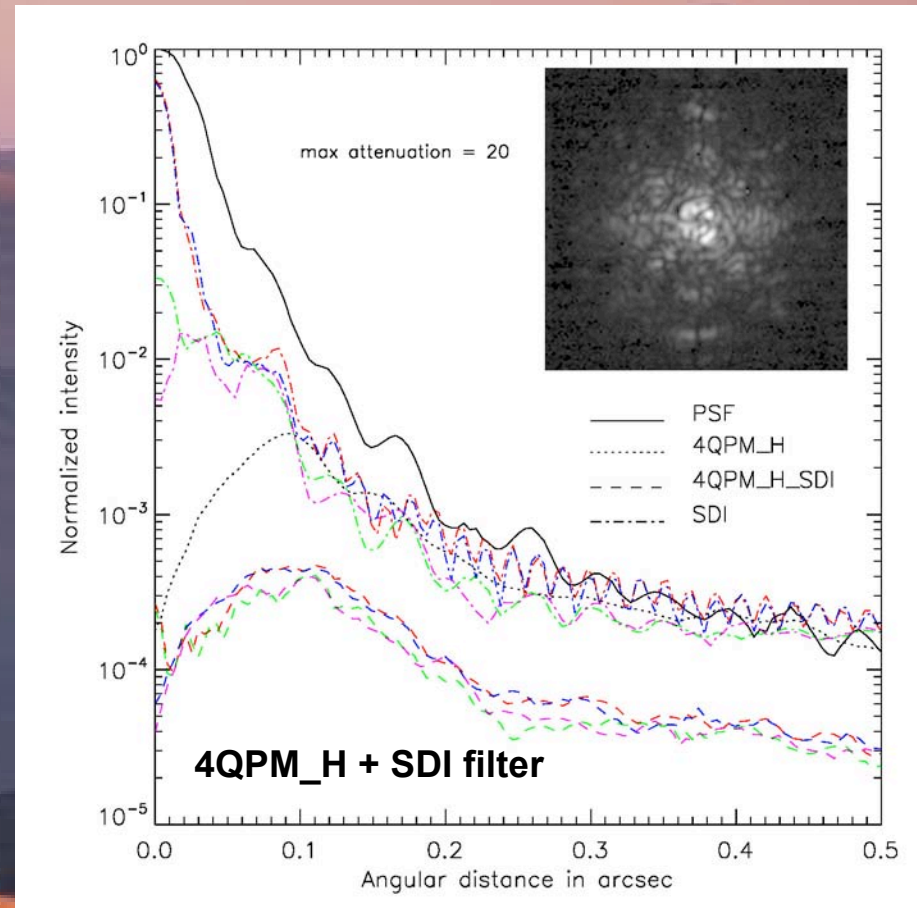
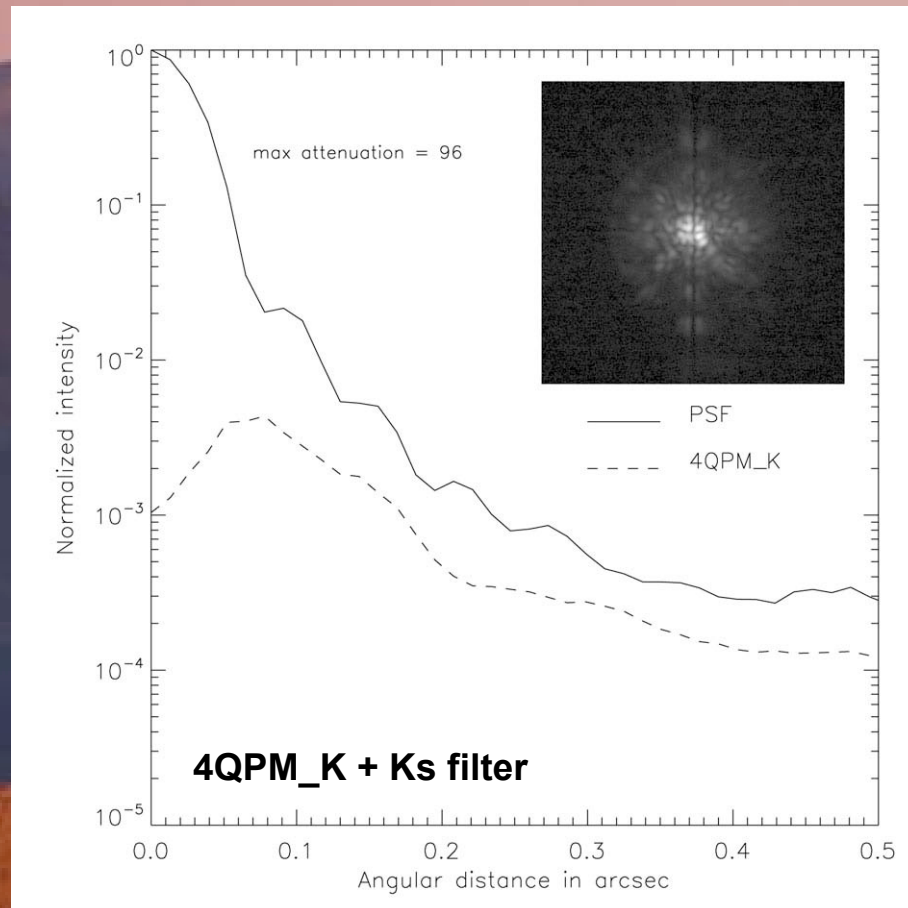
1.575 $\mu$ m

1.625 $\mu$ m

1.625 $\mu$ m

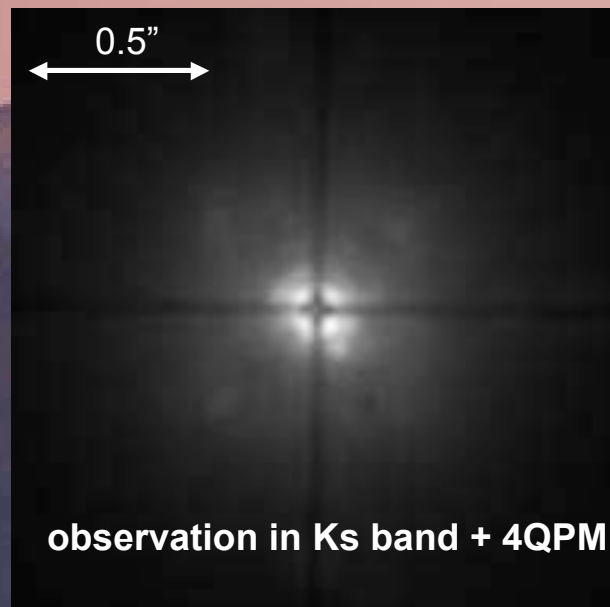


# Perf. on artificial source

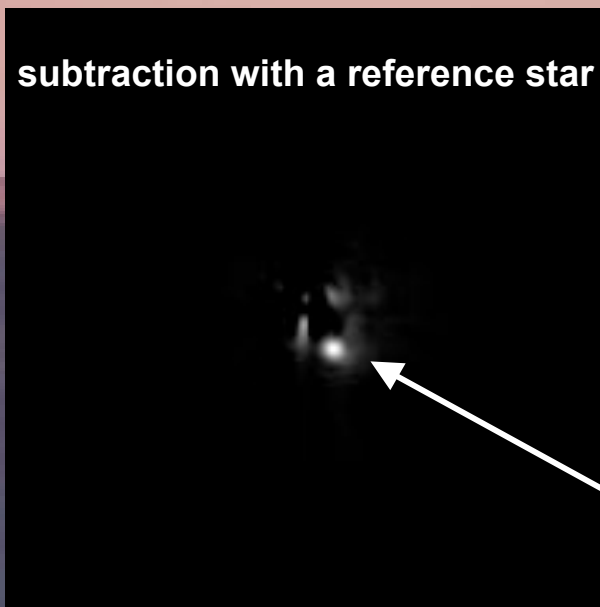




# AB Dor as a first test - Ks band



subtraction with a reference star



$$M_K = 8.37 \pm 0.29$$

Close et al. 05:  $8.57 \pm 0.15$

07:  $8.62 \pm 0.16$

Luhman 06:  $8.92 \pm 0.35$

## Photometry

difficult to measure owing to the stellar residual

=> Calibration of the stellar residu is needed

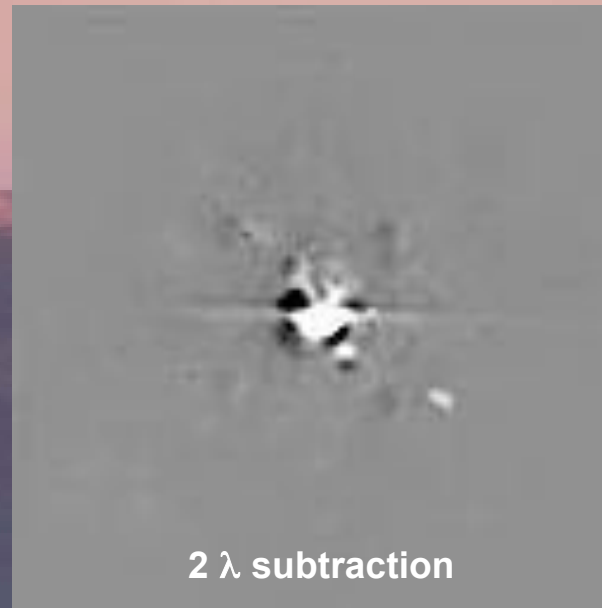
Source of errors :

intensity factor star/ref => 0.10 - 0.13mag

ND required PSF/corono image => 0.11mag

stop is different for PSF/corono image => 0.04mag

# AB Dor - H band



2  $\lambda$  subtraction



2 angle subtraction

companion is self-subtracting on the 2  $\lambda$  subtraction => not useful  
instead we use the 2 angle subtraction

$$M_H = 8.65 \pm 0.17 \quad (\text{from } 1.625\mu\text{m image})$$

$$M_H = 8.62 \pm 0.18 \quad (\text{from } 1.575\mu\text{m} + 1.6\mu\text{m} + 1.625\mu\text{m images})$$

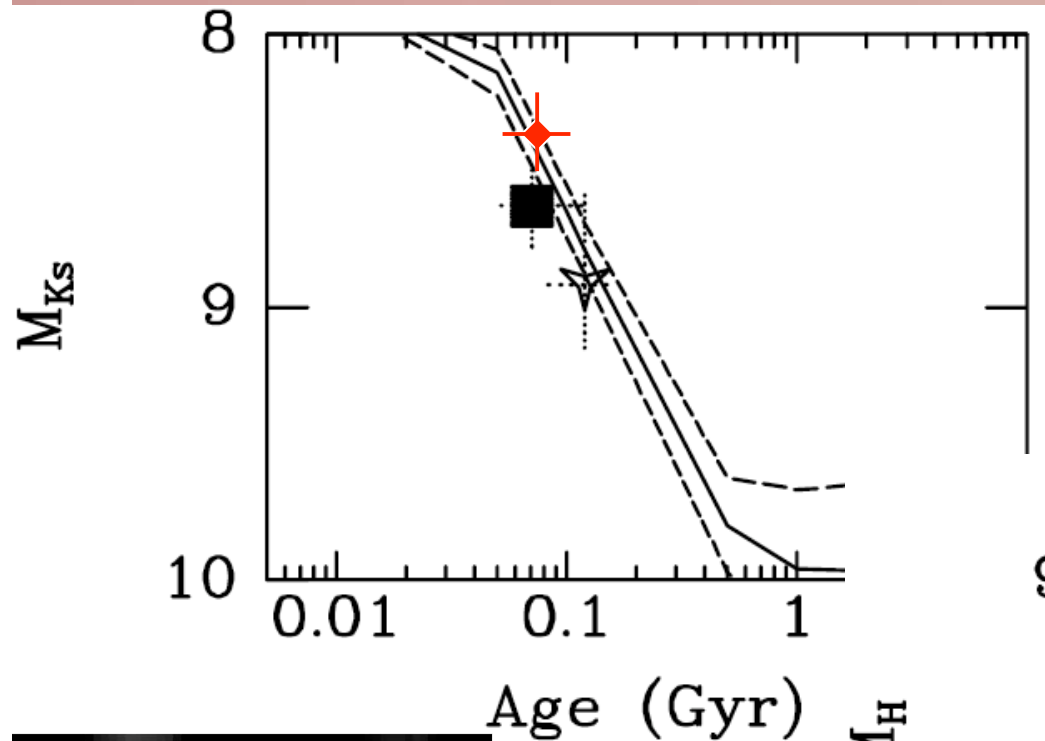
$$\text{Close et al. 05: } 9.19 \pm 0.15$$

$$\text{Luhman 06: } 9.30 \pm 0.35$$

=> companion is brighter

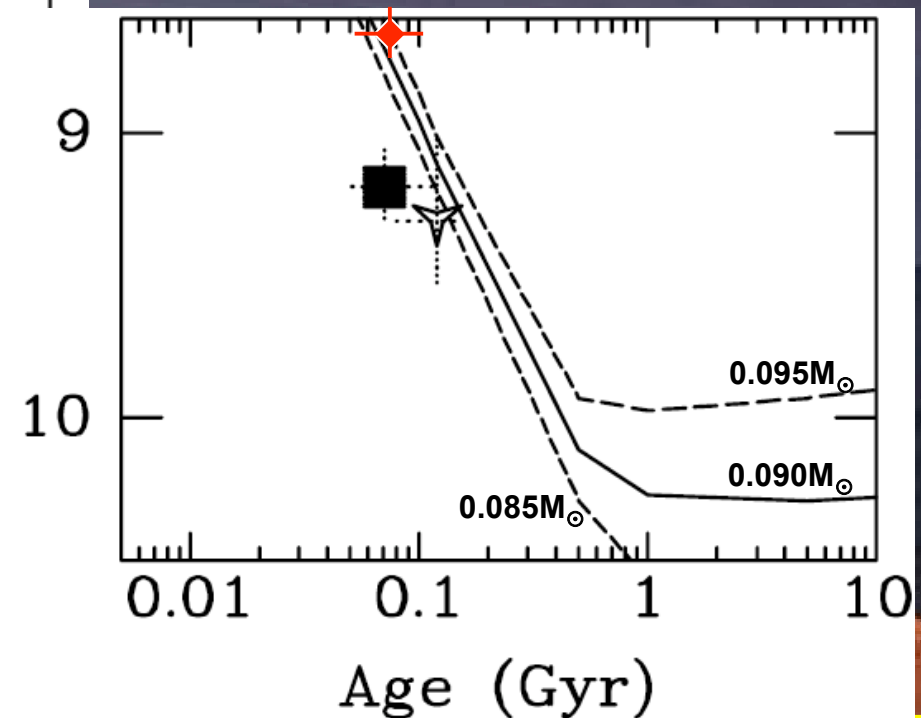
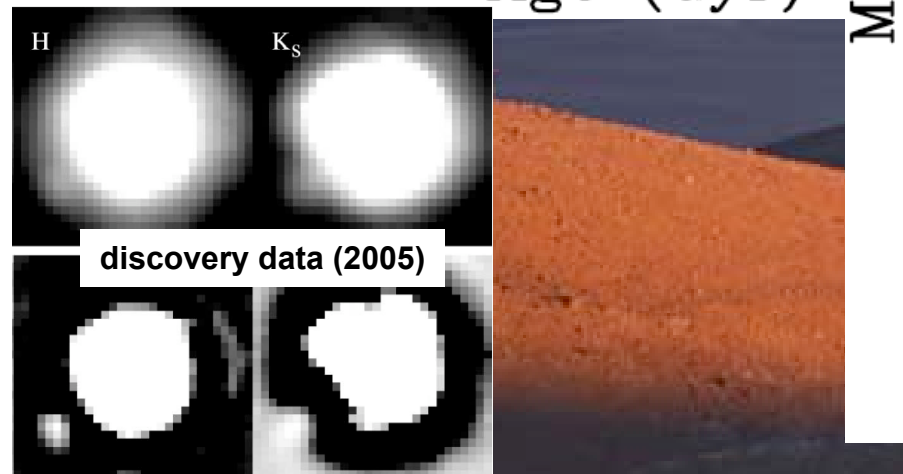


# Magnitude vs. Age



M vs . age from Close et al. 2007  
DUSTY models from Chabrier et al. 2000

our broad band photometry agrees  
with evolutionnary models  
so as IR spectra from Close et al. 2007



In Spirit of Bernard Lyot, Berkeley, 2007

# Summary

- first 4QPM implemented on NACO was able to deliver scientific results
- 4QPM BB imaging in Ks and H are opened in P80 (1/10/07)
- 4QPM + SDI not yet offered (open to collaboration)
- capability of corono. + SDI demonstrated : testbed for SPHERE
  - => some coronagraphs are in development  
(see poster about SPHERE coronagraphs)
- coronagraphic observations help to determine precisely the BB photometry of low mass companions (calibration on AB Dor was successful)