“MAD observations of giant proplyd candidates in NGC 2244 and NGC 2264”

- Preliminary qualitative results -

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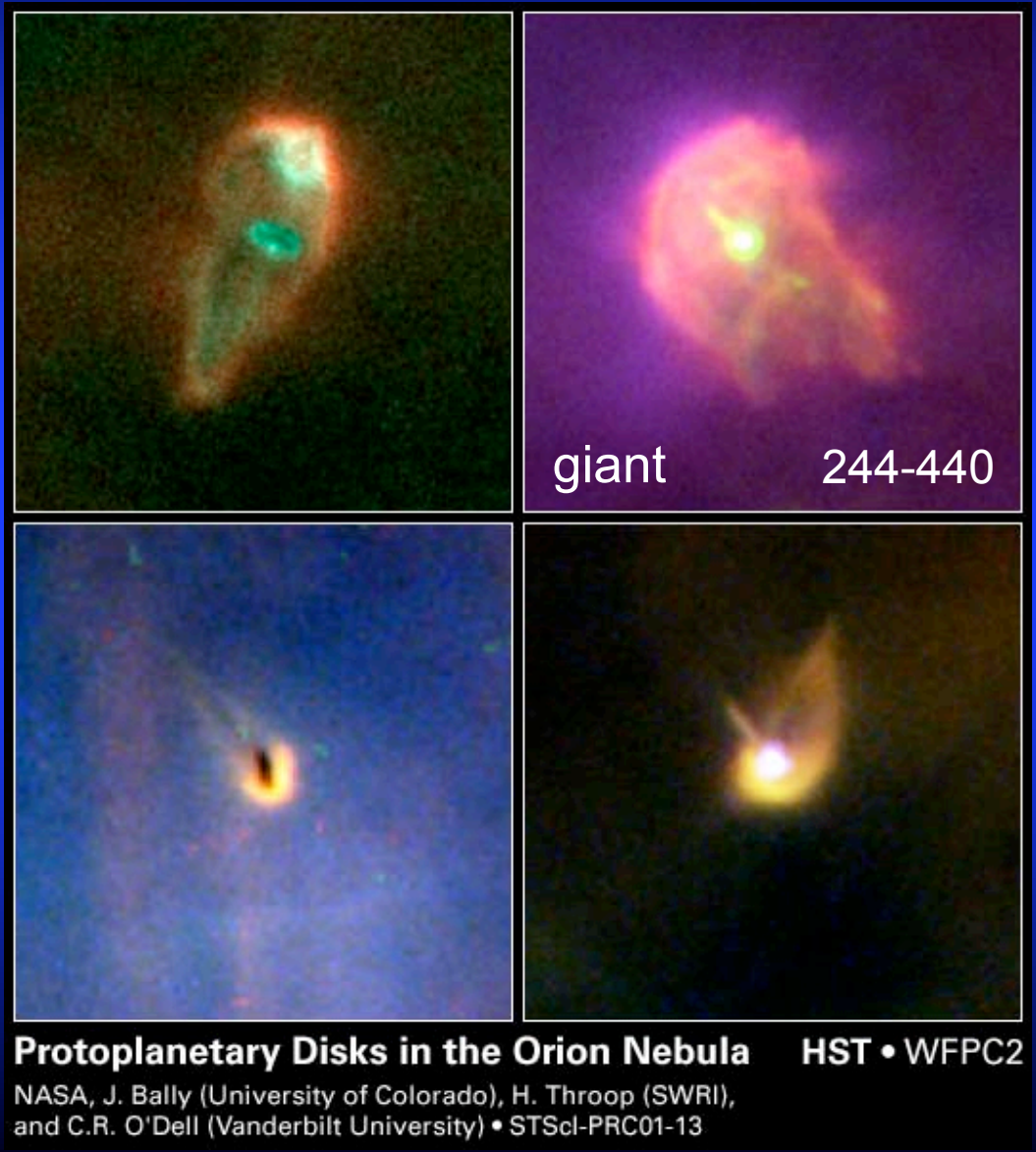
MAD SD proposed program:

(1st run)

to observe a sample, in H and Ks, of 8 “giant” proplyd candidates located in different cluster environments (age, distance, number of OB stars) and at different distances from their external ionizing sources.

PROPLYDS - externally illuminated protoplanetary disks

ORION (~450 pc, ~ 1 Myr) - typical IF diameters 200 - 400 AU, tails < 2 250 AU



Bally et al. 2005

The Beehive proplyd + HH540

Ionized gaseous envelope:

Hα, Paα, **Brγ (*Ks*)**, Brα (*L'*)

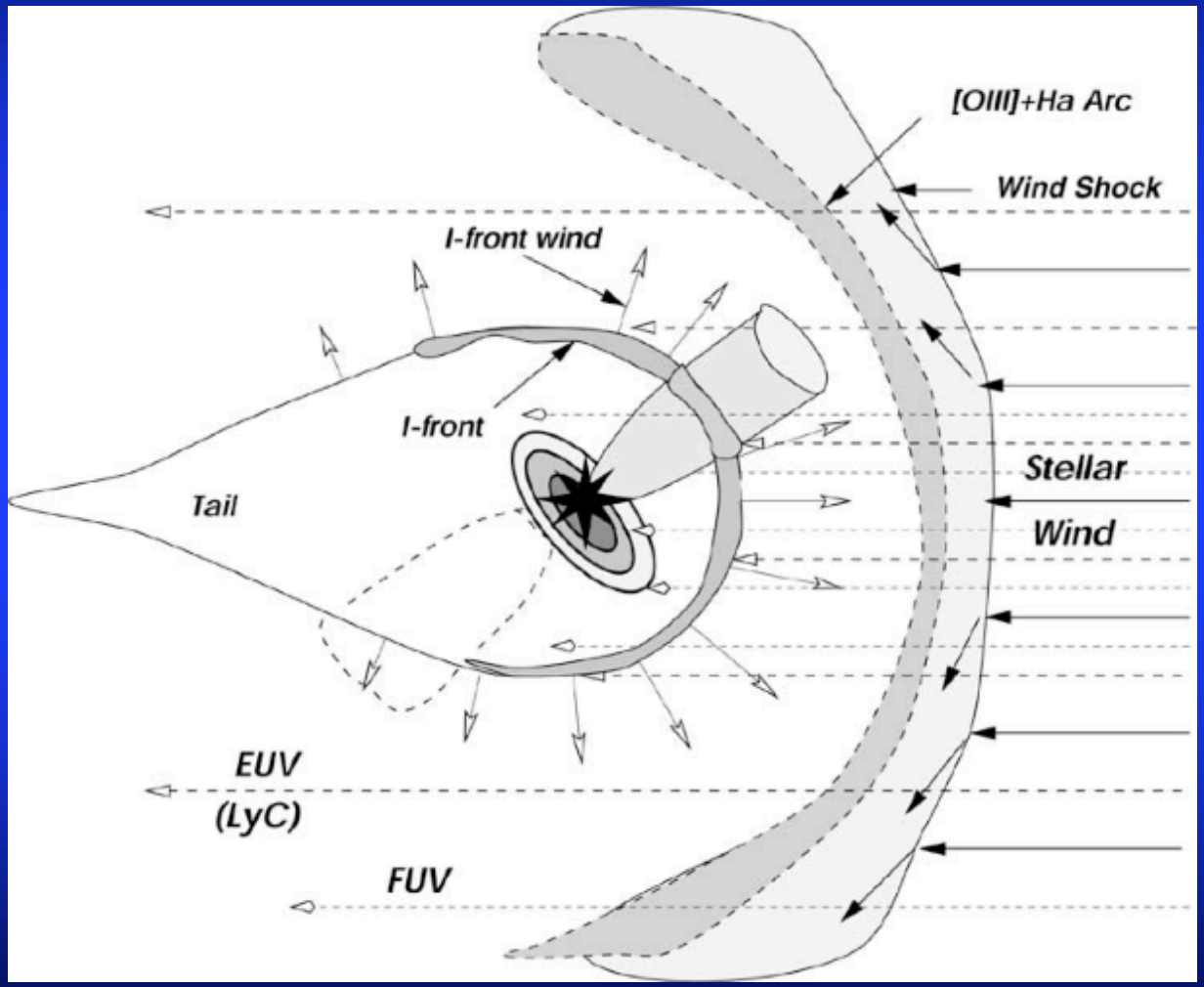
[OIII], [NII], [SII]

Irradiated jets and outflows:

[FeII] 1.26 μm (*J*)

1.64 μm (*H*)

PROPLYDS - photoevaporating protoplanetary disks



Proplyd schematics from Shuping et al. 2003

EUV (LyC; $h\nu \geq 13.6$ eV)

FUV (6 eV $\leq h\nu < 13.6$ eV)

IF size depends:

- disk radius, r_d

- external UV luminosity, Q_{UV} or FUV/EUV

↓ **and hence…**

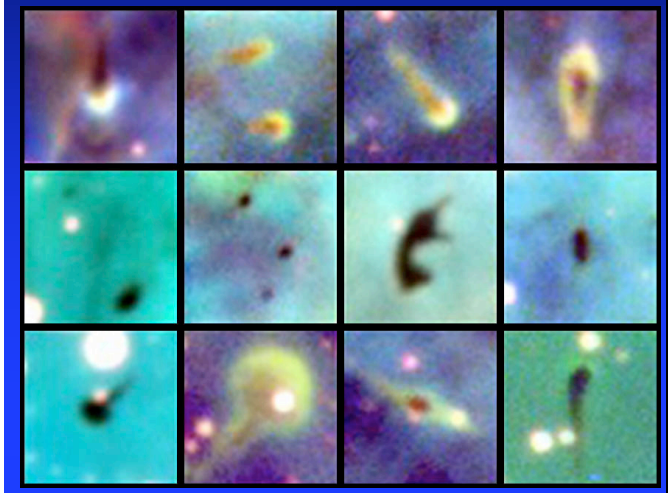
- distance to OB stars, d_{OB}

Photoevaporation models by

Johnstone et al. 1998

Stõrzer & Hollenbach 1999

“Giant” proplyd candidates in other clusters

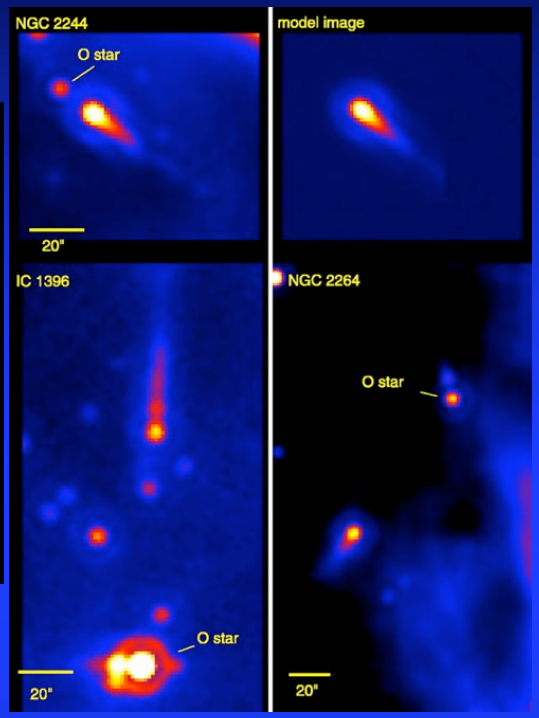


NGC 3372

HST/ WFPC2 & ACS

5 - 10 x larger

(Smith et al. 2003)



NGC 2244

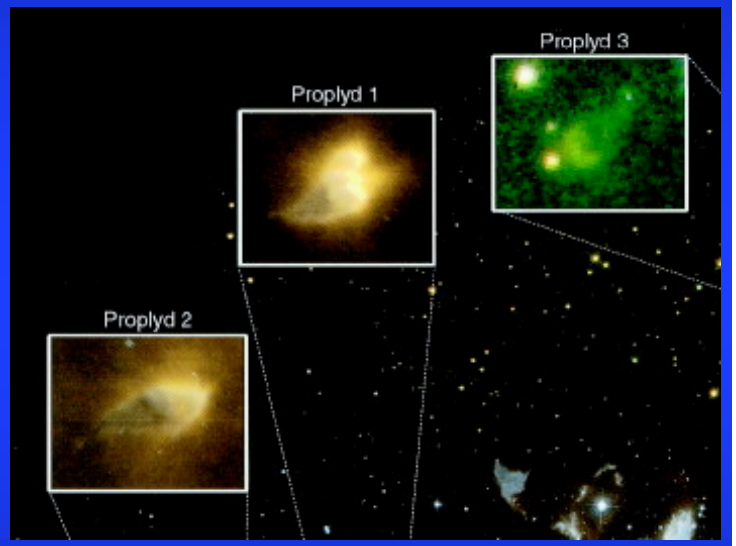
NGC 2264

IC 1396

***Spitzer*/ IRAC & MIPS**

10 - 20 x larger

(Balog et al. 2006)



NGC 3603

HST/ WFPC2 & VLT/ ISAAC

20 - 30 x larger

(Brandner et al. 2000)

Science goals of the SD program

Are the photoevaporation models of protoplanetary disks in Orion applicable to more extreme regions?

Investigate the globules morphology (IF, disk, outflows/jets and shocks) in the NIR with unprecedented spatial resolution and sensitivity

MAD represented an unique opportunity for this!

MAD SD program - phase II

4.5 h observing time

Selection criteria

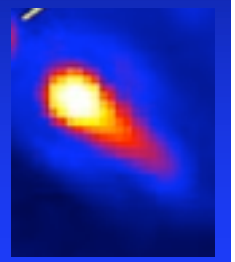
- **3 proplyd candidates (*Ks* > 14; significant S/N)**
- **good GS asterisms (bright, symmetric)**
- **nebular/star brightness**
- **no previous NIR obs.**
- **most interesting cases**

Selected targets

NGC 2244 (*Ks*)

(1.5 kpc, O6 star, 4 Myr)

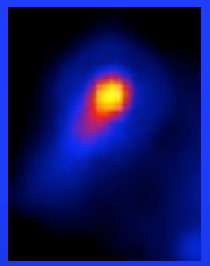
Completed!



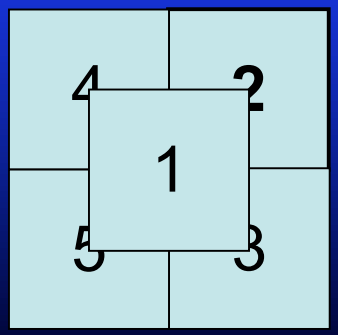
NGC 2264 (*Ks*)

(800 pc, O7 star, 4 Myr)

Completed! "C"



Observing strategy

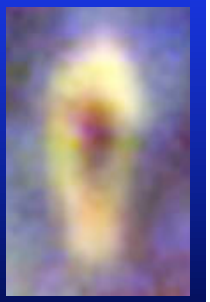


- small offsets 7" in RA, Dec
- targets on the right side of the CAMCAO 57" x 57" FoV
- OSSOOSSO…sequence
- τ_o > 2.5 ms, seeing < 0".8

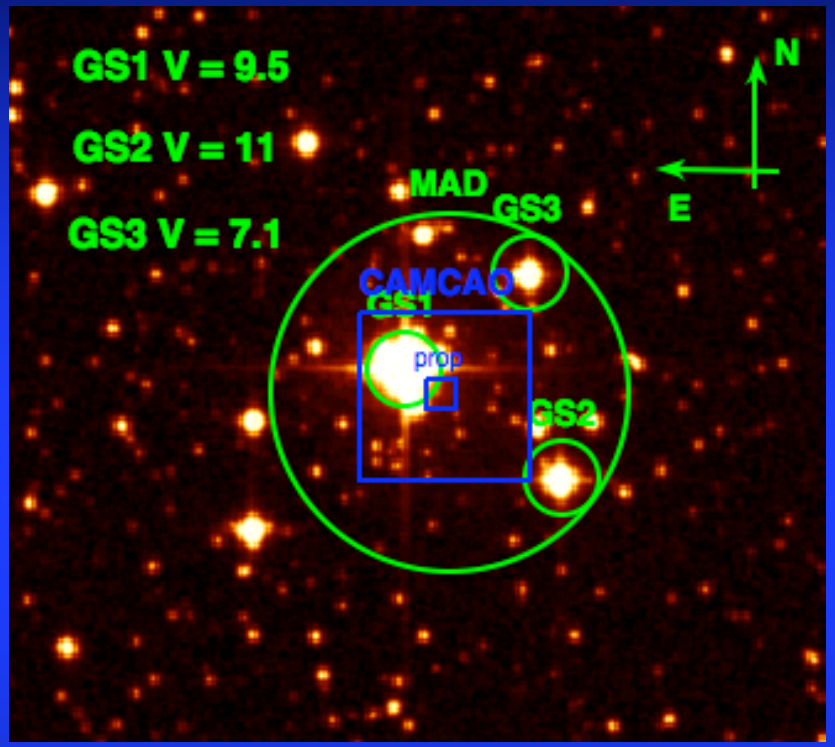
NGC 3372 (*H, Ks*)

(2.3 kpc, several OB stars, 1-3 Myr)

Not Executed!



NGC 2244 - observations and data reduction



α_{MAD}(J2000) = 06^h 31^m 54^s.6

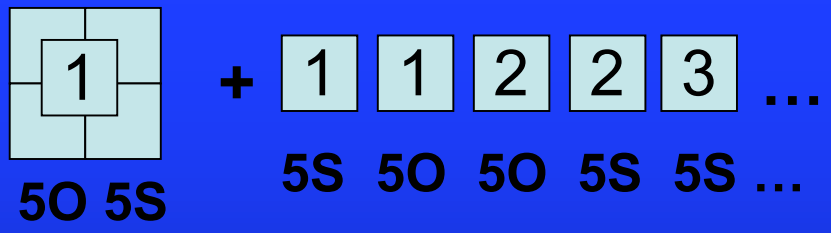
δ_{MAD} (J2000) = 04^o 56' 24".5

40 OBJECT + 40 SKY frames in *Ks*

DIT = 0.79 s, NDIT = 15, NINT = 5

Total exp. time = 474 s

5 pointings: (0,0), (7,7), (7,-7), (-7,7), (-7,-7)



28th Nov. 2007

Seeing (DIMM): 0".79 - 1".3

τ_o: 2.5 - 3.7 ms

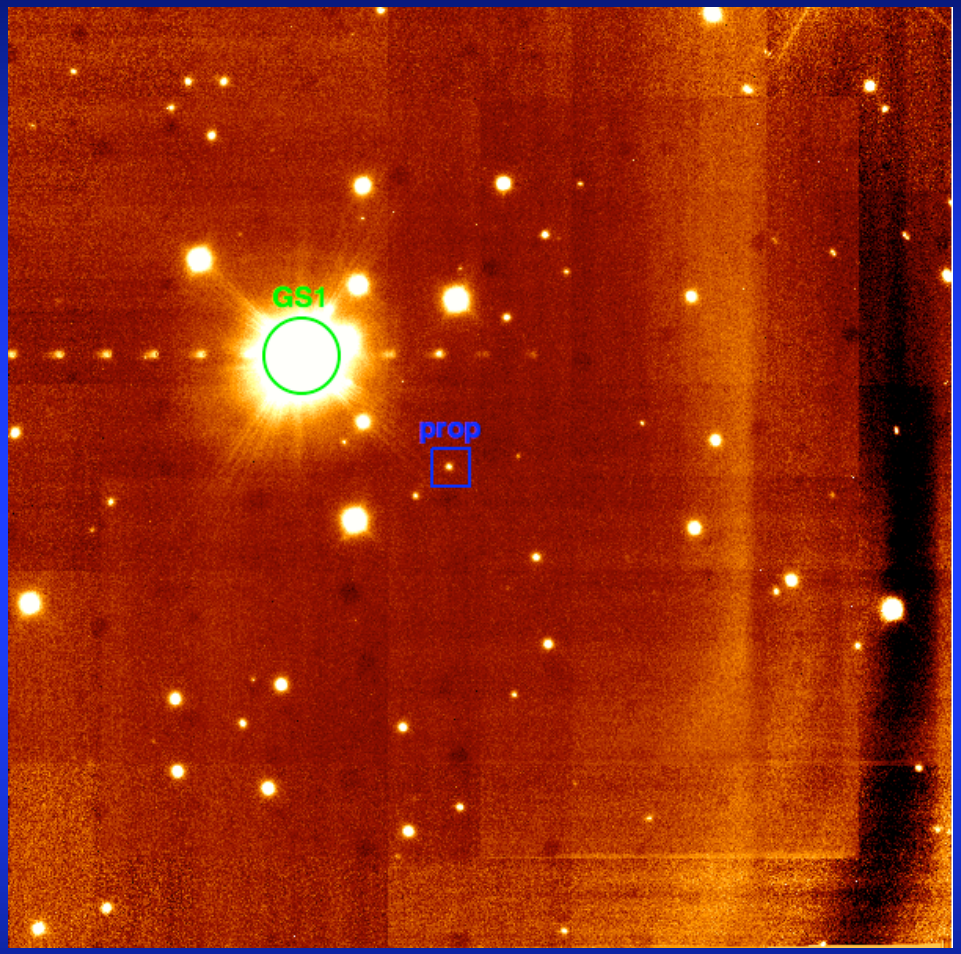
Airmass: 1.184 - 1.335, h ~ 55^o

IRAF and jitter/Eclipse

Median sky from all sky frames **(1)**

Median sky of each detector position **(2)**

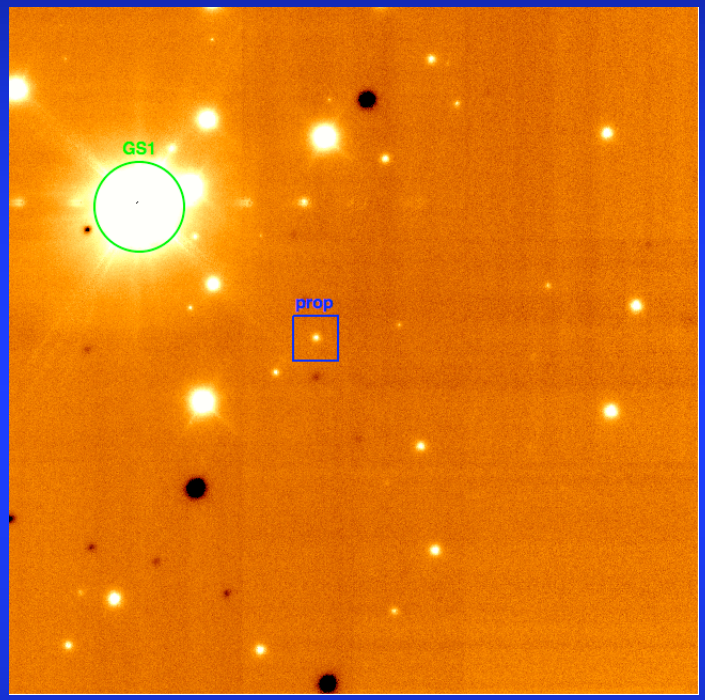
NGC 2244 - image results



(1) 71”.5 x 71”

$FWHM_{prop}$ ~ 2.72 pix, rms_{back} ~ 0.23

$Strehl_{prop}$ ~ 32% <FWHM> ~ 4.6 ± 2.0 pix

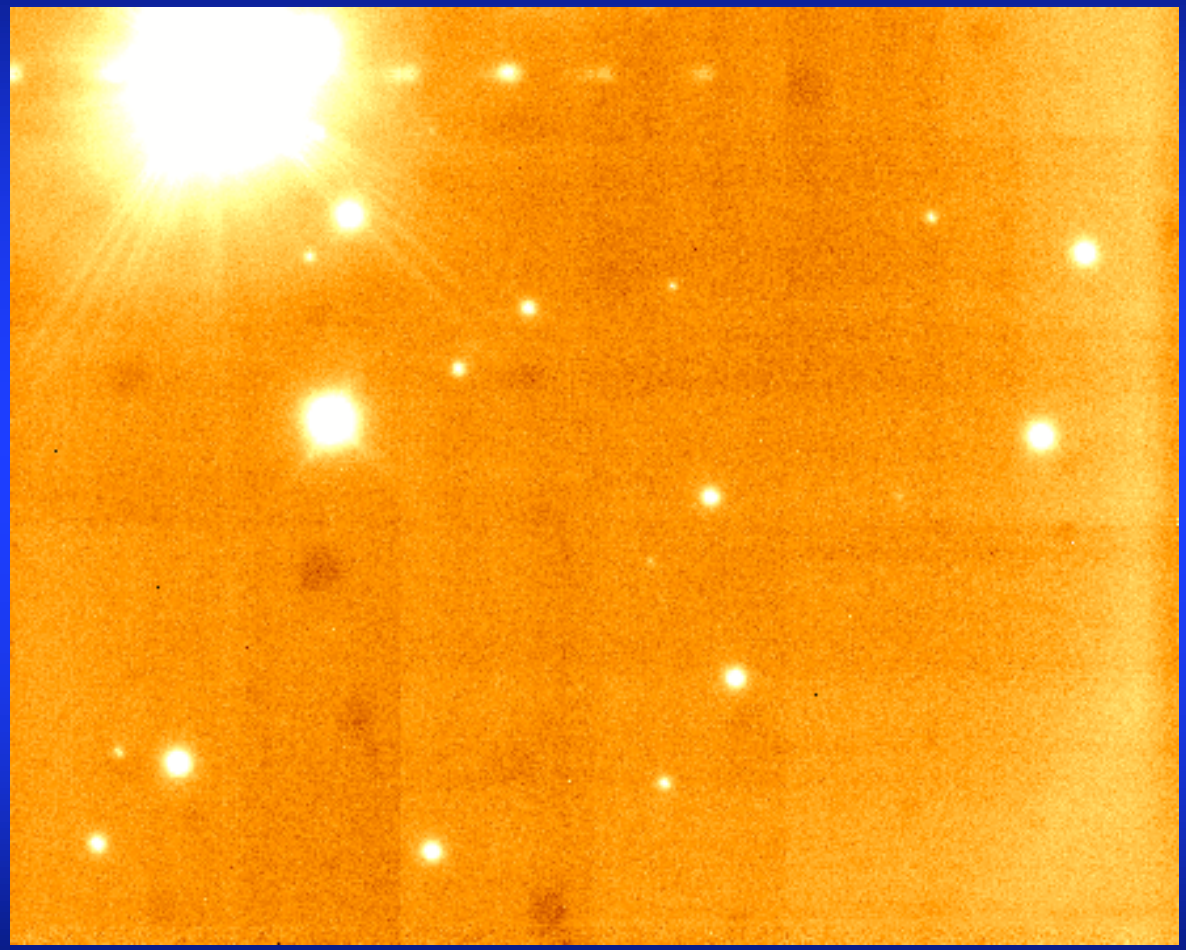


(2) 43” x 43”

$FWHM_{prop}$ ~ 3.39 pix, rms_{back} ~ 0.30

$Strehl_{prop}$ ~ 21% <FWHM> ~ 4.54 ± 2.1 pix

NGC 2244 - image results



<FWHM> ~ 128 mas

Dif. Limit *Ks* ~ 55 mas

d(GS1) = 14”.4

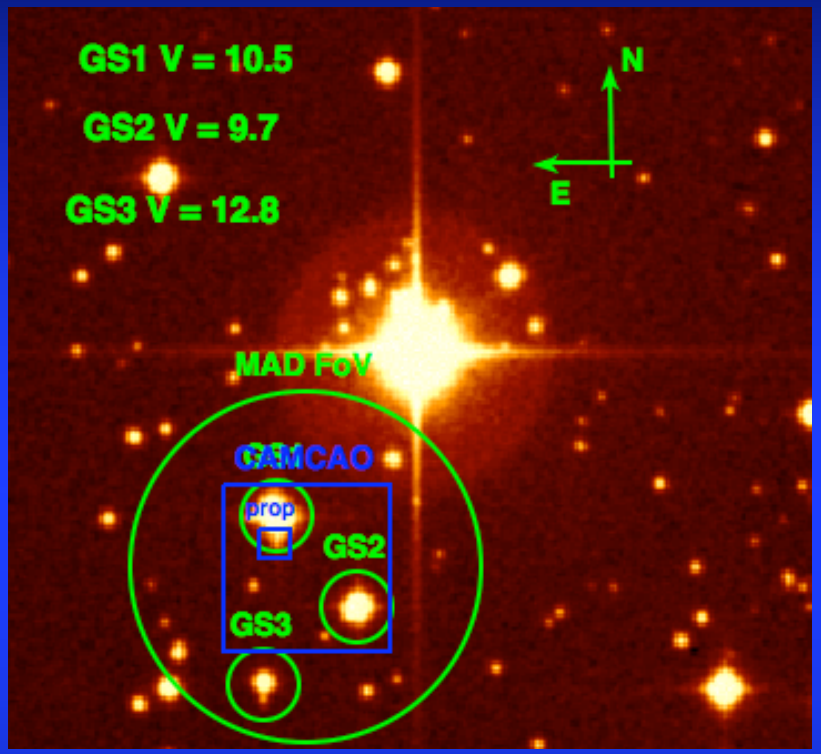
d(GS2) = 34”.2

d(GS3) = 48”.6

< 1’

Target inside the 3 GS triangle

NGC 2264 - observations and data reduction



α_{MAD}(J2000) = 06^h 41^m 01^s.2

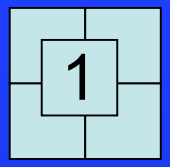
δ_{MAD} (J2000) = 09^o 52' 30".7

40 OBJECT + 35 SKY frames in *Ks*

DIT = 1.0 s, NDIT = 12, NINT = 5

Total exp. time = 480 s

5 pointings: (0,0), (7,7), (7,-7), (-7,7), (-7,-7)



5O 5S

x **7 repetitions**

5S 5O 5O 5S 5S …

IRAF and jitter/Eclipse

24th Nov. 2007

Seeing (DIMM): 2".27 - 3".34

τ_o: 0.5 - 0.8 ms

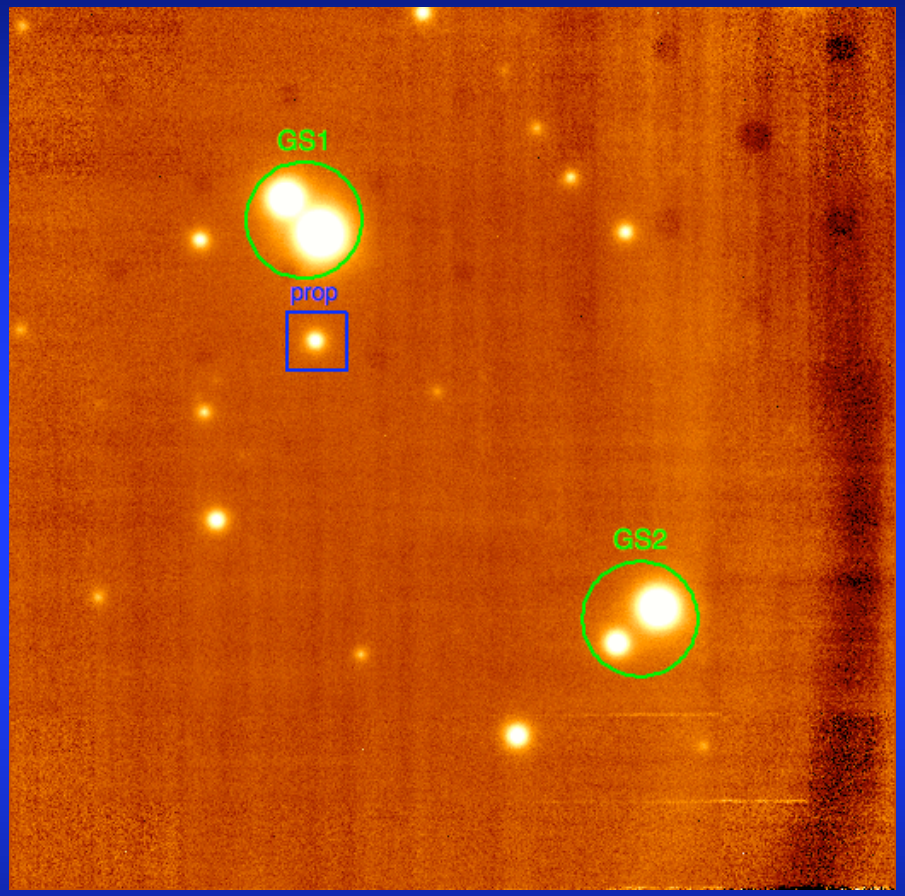
Airmass: 1.233 - 1.331, h ~ 55^o

"Classified as C" - quality not acceptable!

Median sky from all sky frames **(1)**

Median sky of each sequence of offsets **(2)**

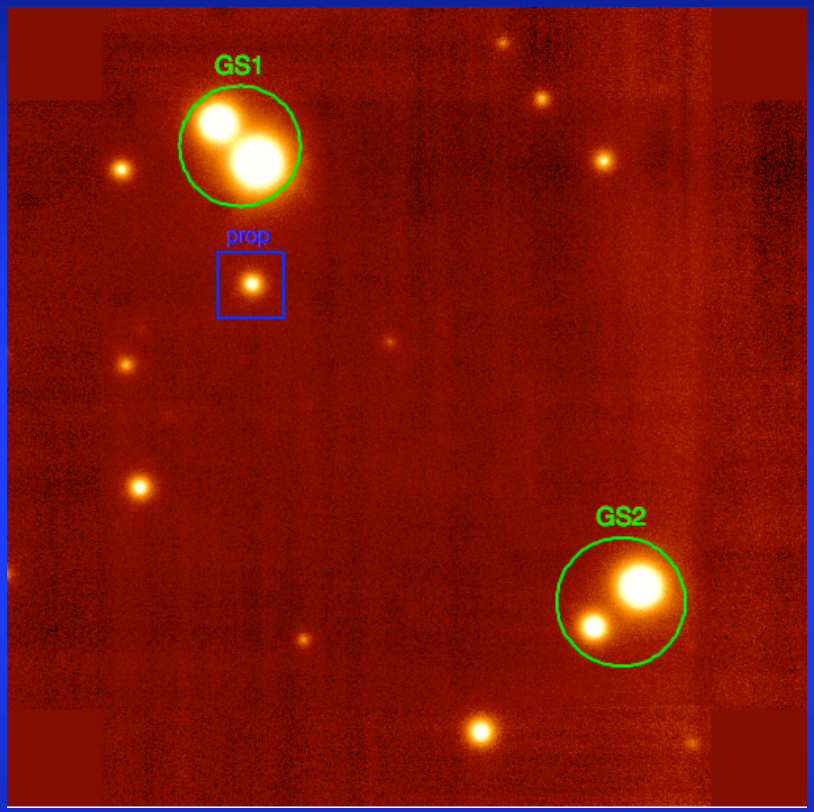
NGC 2264 - image results



(1) 71” x 71”

$FWHM_{prop}$ ~ 7.79 pix, rms_{back} ~ 1.6e-5

$Strehl_{prop}$ ~ 3.5% <FWHM>* ~ 14.6 ± 5.5 pix



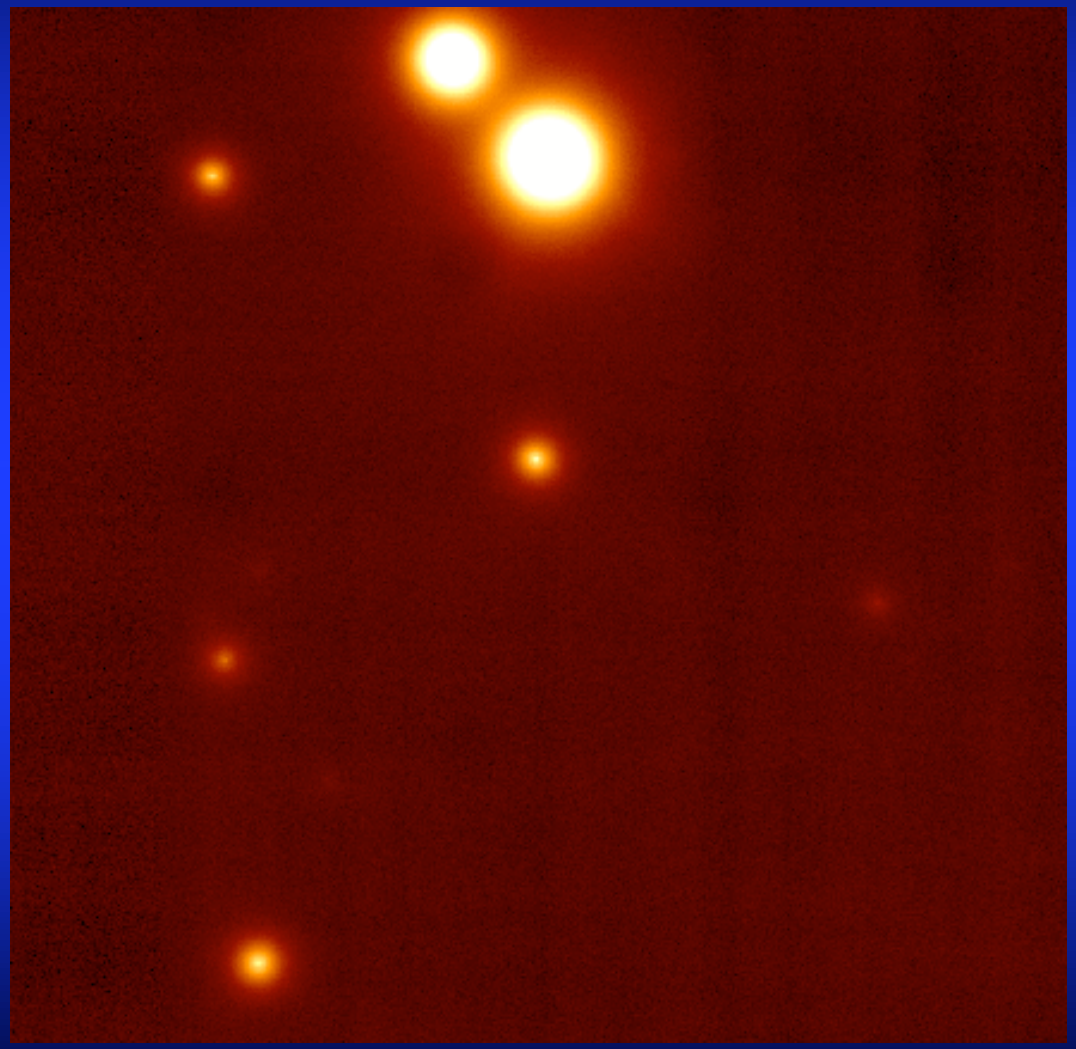
(2) 56”.5 x 57”

$FWHM_{prop}$ ~ 7.40 pix, rms_{back} ~ 1.6e-5

$Strehl_{prop}$ ~ 3.6% <FWHM>* ~ 13.3 ± 4.3 pix

* of the brightest sources

NGC 2264 - image results



<FWHM> ~ 400 mas

Dif. Limit *Ks* ~ 55 mas

d(GS1) = 10”.2

d(GS2) = 35”.4

d(GS3) = 34”.2

< 1’

Target inside the 3 GS triangle

Preliminary qualitative results

NGC 2244

Balog et al. 2006

α_{prop}(J2000) = $06^h\ 31^m\ 54^s.68$

δ_{prop}(J2000) = $04^o\ 56'\ 25''.0$

K = 13.53 mag (2MASS)

d(O star/prop) = 13".3

Comet's tail ~ 0.22 pc or 30".2

- observed in 5.8, 8 and 24 μm *Spitzer* images

D = 1.5 kpc, Age ~ 4 Myr

HD 46150 (O6 Ve)

Q_{UV} = 2.2 x 10^{49} photons s^{-1}

NGC 2264

α_{prop}(J2000) = $06^h\ 41^m\ 01^s.92$

δ_{prop} (J2000) = $09^o\ 52'\ 39''.0$

K = 13.18 mag (2MASS)

d(O star/prop) = 67"

Comet's tail ~ 0.12 pc or 30".9

- observed in 24 μm *Spitzer* images

D = 800 pc, Age ~ 4 Myr

S Mon (O7 Ve)

Q_{UV} = 1.3 x 10^{49} photons s^{-1}

Non-detection of extended faint structures in MAD *Ks* images!

Comparison with other results

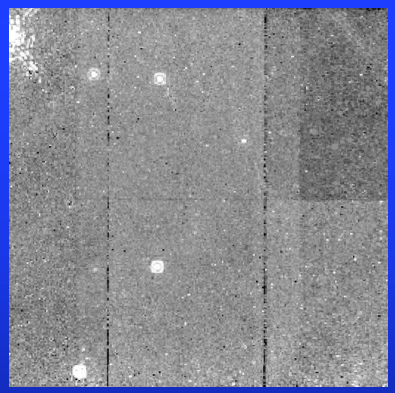
Consistency with results by Balog et al. 2008:

1) **no emission in Paα down to a flux limit of 4.2×10^{-16} (NGC 2244) and 2.9×10^{-16} (NGC 2264) ergs cm^{-2} s^{-1} arcsec^{-2}**

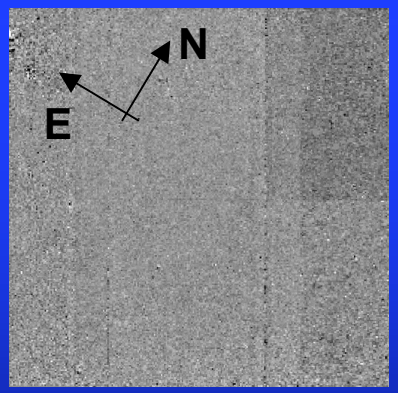
2) **Tails are essentially gas free and originated from reprocessed dust at the outer parts of the disk**

NGC 2244 images: 19" x 19" or 0.138 x 0.138 pc ($d_{NGC\ 2244}$ = 1.5 kpc)

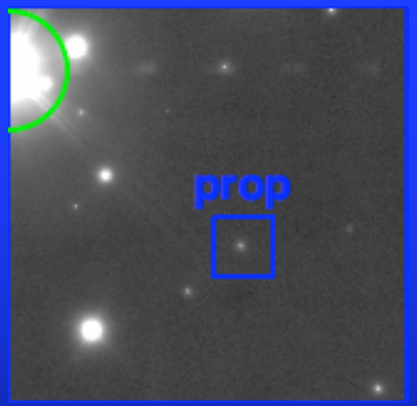
Spitzer/ MIPS 24 μm



HST/NIC2 Paα 272s



Paα **continuum subtracted,** 272s



MAD *Ks*, 474s

NEXT STEP: To calibrate the data get the new sources!

END