Simulations for the Science case S5: "Young stellar clusters and the Initial Mass Function"

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Giant-planet-mass objects in the LMC

DRM proposal by F. Comeron & H. Zinnecker

- Probe the complete substellar mass regime of a young star forming regions in LMC down to $5M_{jup}$
- Reveal opacity limit in a low-metallicity environment (such as the early Milky Way (MW)) & lowest-mass IMF (evol. of IMF)

-> Constrain volume density of evolved giant-planet-mass objects in MW galactic disk (now invisible)

Challenges:

- very small sizes of star forming regions (~2" at distance of LMC)
- crowding (~20 star/arcsec^2)
- **coexistence of main targets with much brighter stars** (Δmag ~ 11)

Need to reach J~29.1, H~28.7 and K~28.2 with S/N=10

✓ J, H, K-band, Seeing ≤ 0.8”, no requirements on Moon

✓ Diffraction Limited Imager, pixel scale = 5mas/pixel

J, H, K-band LTAO simulated PSFs (DRM technical database):

seeing = 0.8” at 0.5μm, D=42m, 6 LGS, zenith dist.= 0, pos. (0,0)

- Variable background due to stellar light reflected by dust:

1 -> uniform background level;

2 -> random value emission per pixel, from a uniform probability distr. from 0 background to twice [23.9(J),24.8(H),25.4(K)] mag/arcsec^2

- No contamination by field stars

- The PSF does not vary in the region (~3 squared arcseconds)

Input star catalogue:

- Chabrier (2005) Initial-Mass-Function + Baraffe (2003) evolutionary tracks for an age of 5 Myr: 100 stars from 2 to 0.003 $M_\odot$ (~ 3 M_{jup}) uniformly distributed in a circular area with R ≈ 1 arcsec

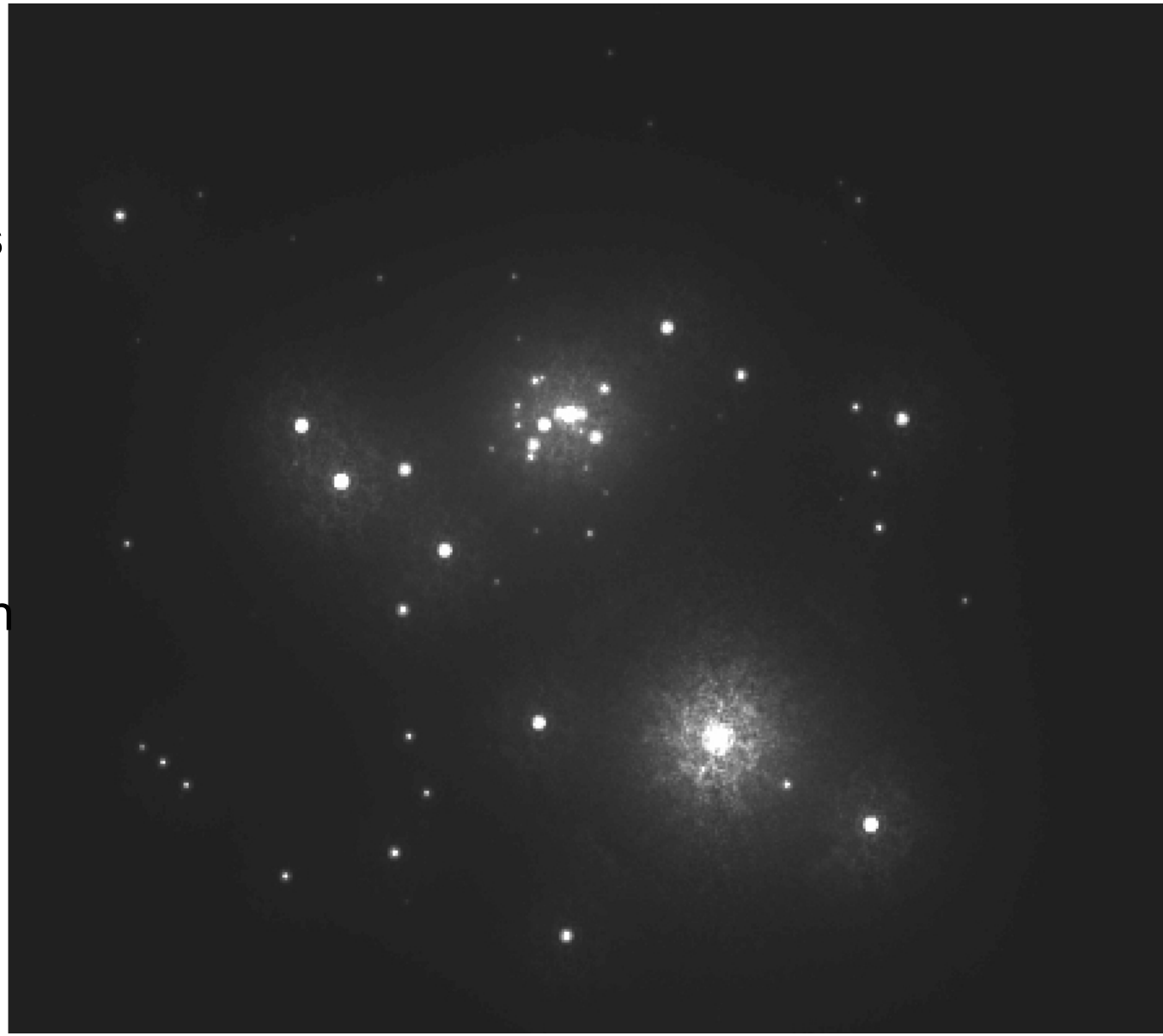
- DM_0 = 18.5 (LMC), random extinction from A_V = 0 to A_V = 10 mag

- One J-band image:

DIT*NDIT=20s*200= **4000s**

Sky :18 mag/arcsec^2

Perform PSF-photometry with DAOPHOTIV (Stetson 1987): adopt Moffat function with β = 2.5 + numerical matrix for the residuals

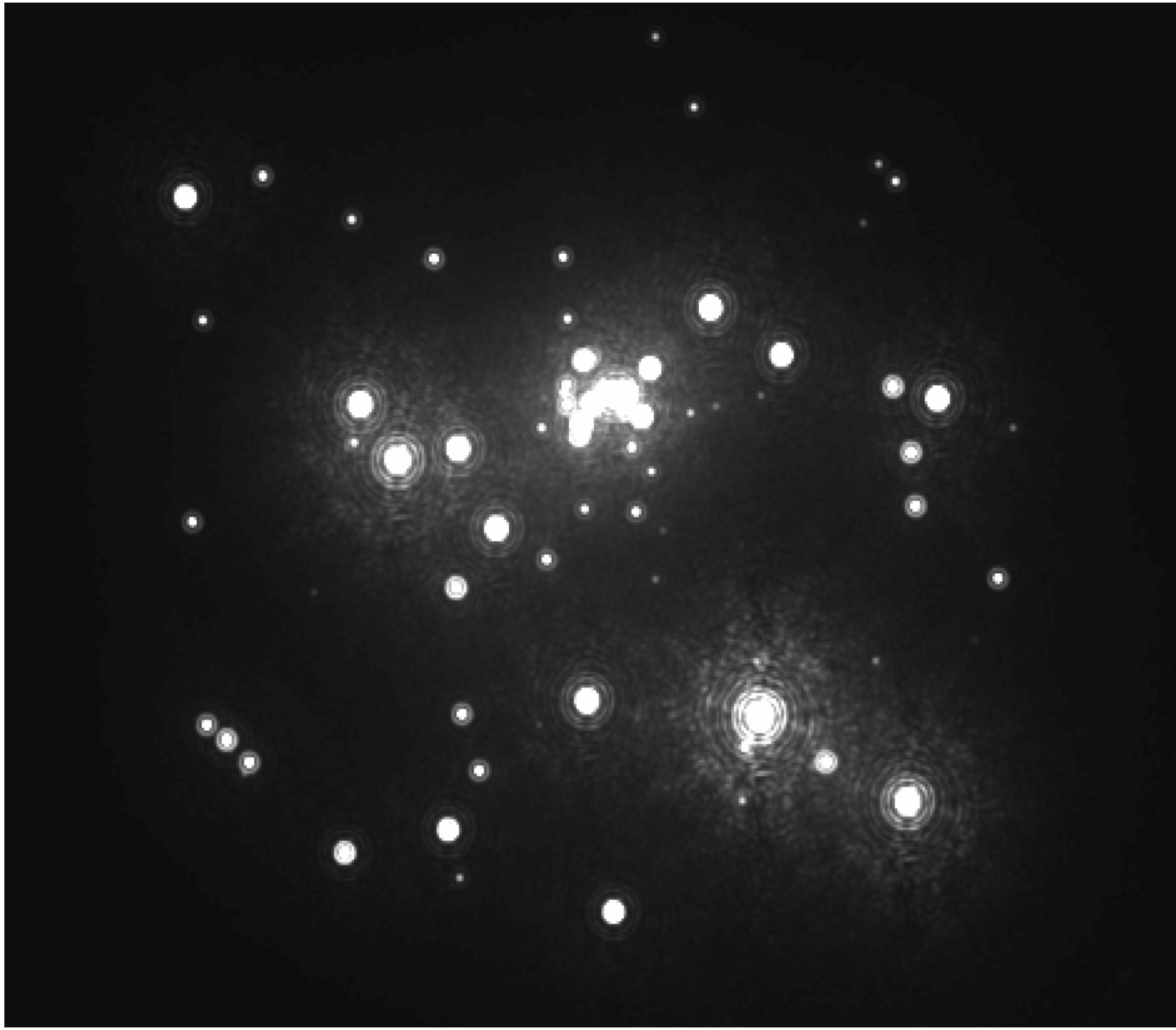


- One Ks-band image:

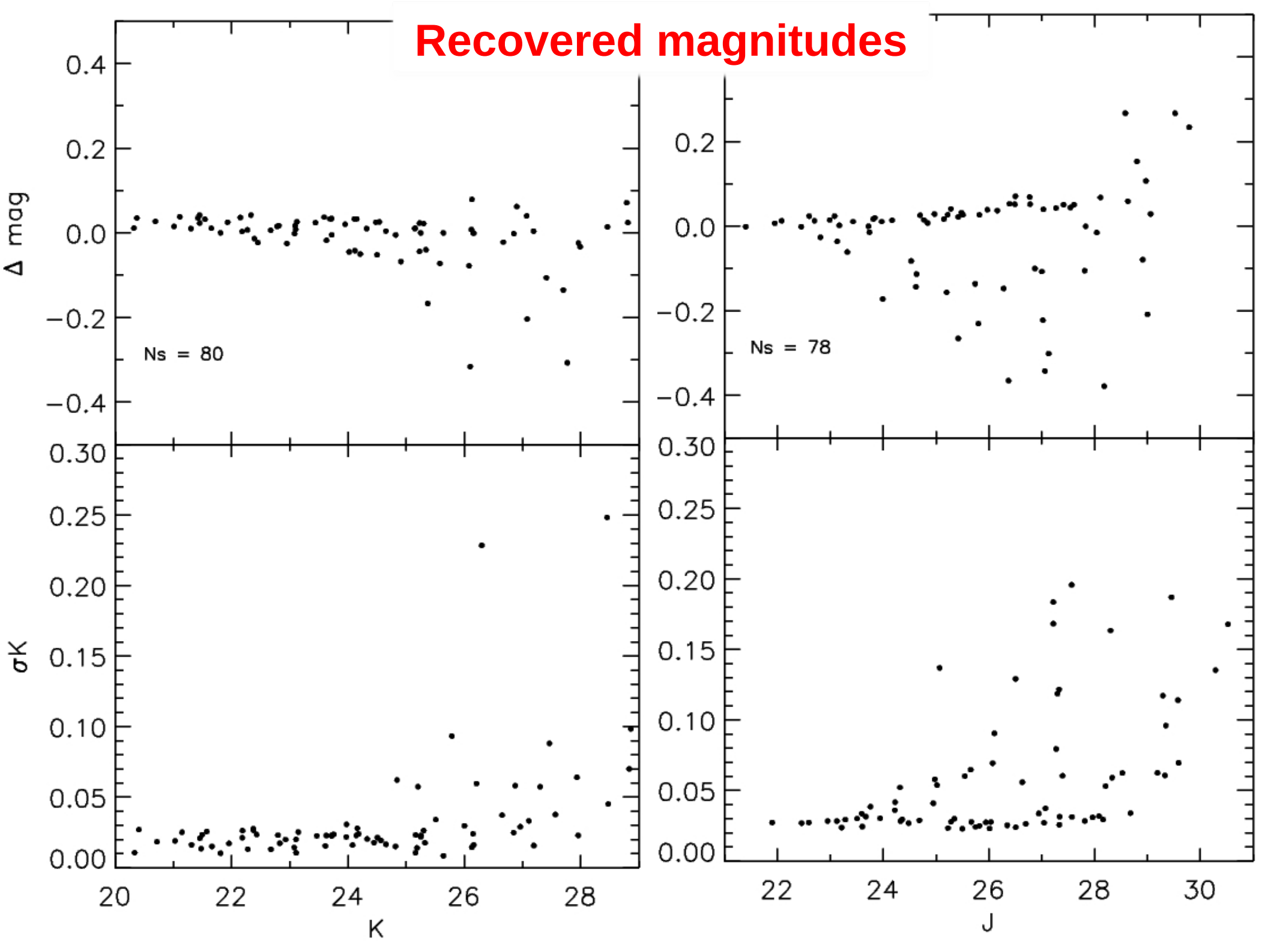
DIT*NDIT=30s*240= **7200s**

Sky: 15.7 mag/arsec^2

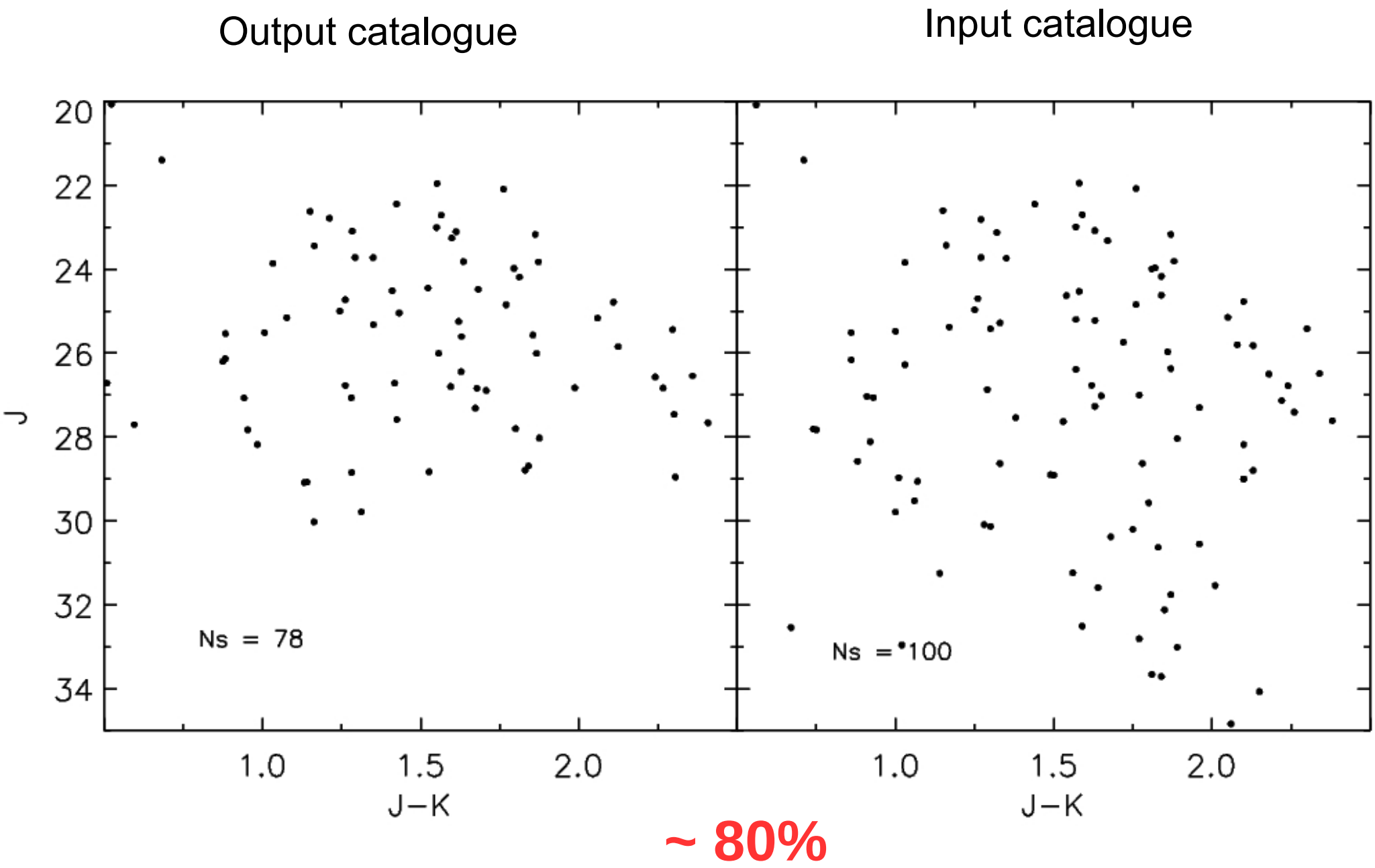
Perform PSF-photometry with DAOPHOTIV: adopt Moffat function with β = 2.5 + numerical matrix for the residual



Recovered magnitudes



CMD completeness



~ 80%

Limiting magnitudes for **S/N = 10**:

J≈28.5 mag and Ks≈28mag ⇒ **M ≈ 0.02M⊙ (0.005M⊙)**

But **only 2 images** (1.1 hours in J and 2 hours in Ks)

- Need 7 hours in J and 10 hours in Ks (E-ELT ETC)

- Need to use PSF fits instead of PSF images (see J. Liske talk)

- Try to use ROMAFOT to model PSF (compare with Starfinder and DAOPHOT)