The substellar binary fraction in the Pleiades open cluster

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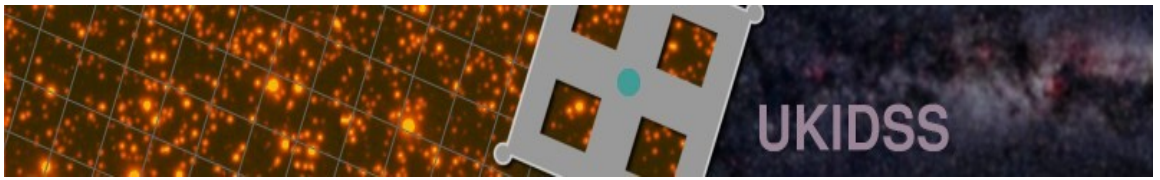


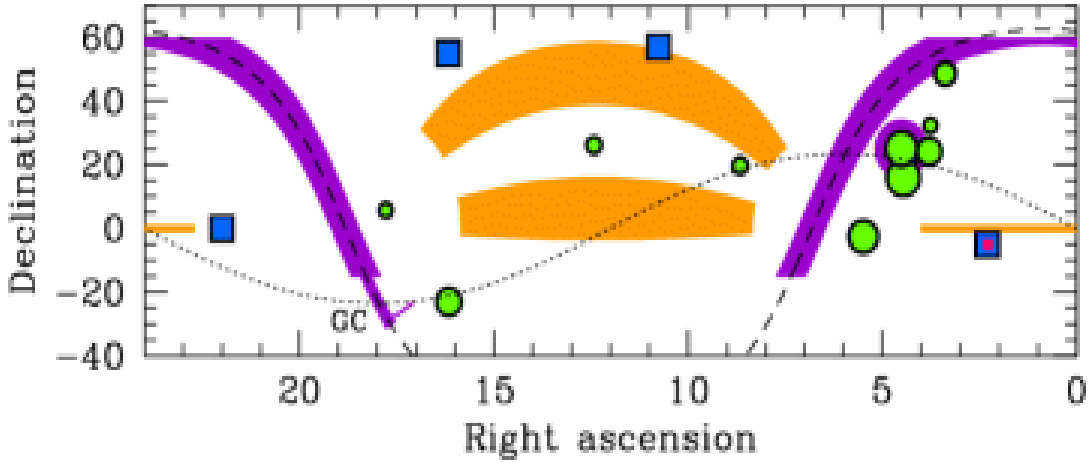
Seminar @ Toronto, 17 May 2007

The UKIRT Infrared Deep Sky Survey

UKIDSS

- New wide-field NIR survey with WFCAM on UKIRT *(Lawrence et al. 2006)*
- Pipeline-processed by CASU in Cambridge *(Irwin et al. 2007, in prep)*
- WFCAM Science Archive *(Hambly et al. 2007, in prep)*
- 5 components: LAS, GCS, GPS, DXS, and UDS
- Typical 5 sigma completeness limit is *K* ~ 18.0 mag (Vega)
- 3 Data Releases: EDR, DR1, DR2plus *(Dye et al. 2006; Warren et al. 2007)*

- Galactic Cluster Survey (GCS)

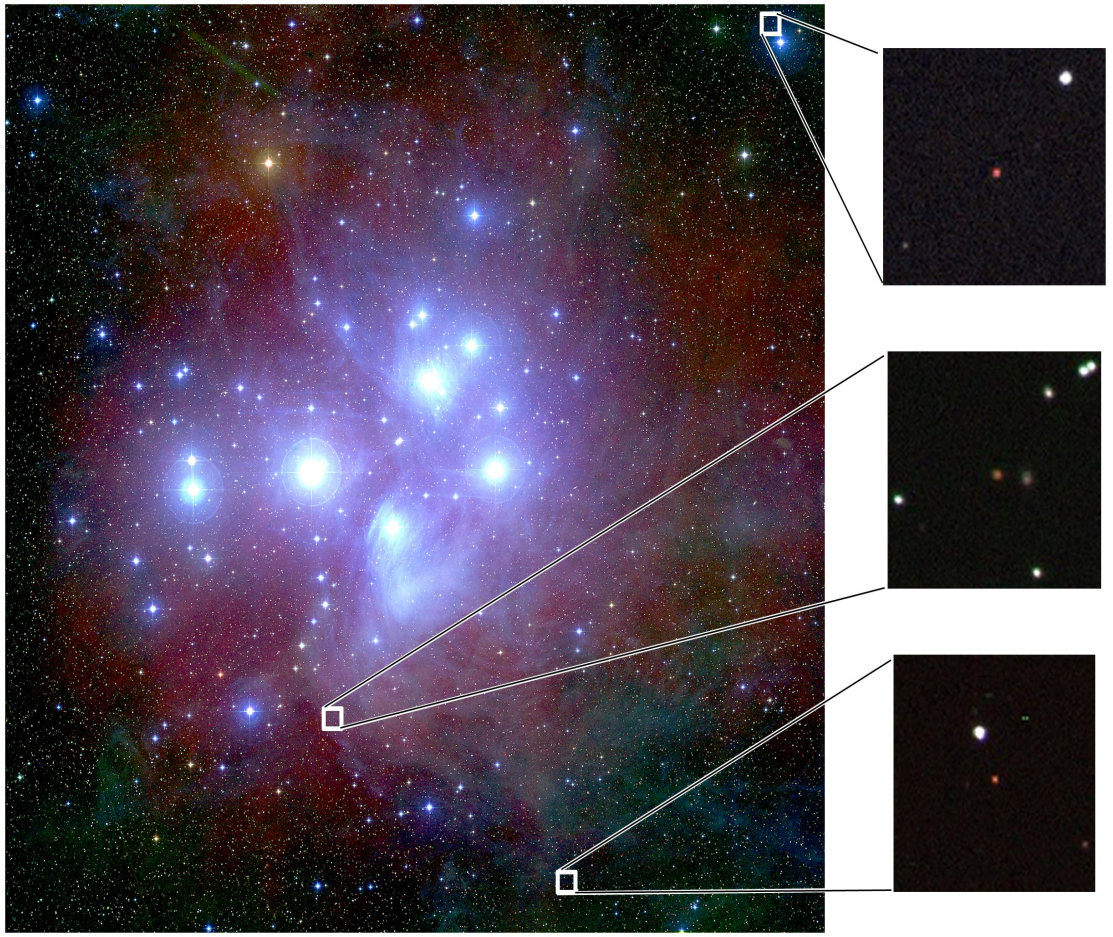


  - *ZYJHK* observations
  - 1000 square degrees
  - 10 star-forming regions and open clusters
  - 2 epochs in the *K*-band
  - 5 sigma completeness limits: *Z* ~ 20.0, *J* ~ 18.6, *K* ~ 17.5 mag

The Pleiades open cluster

Lodieu, Dobbie, Deacon, Hodgkin, Hambly, Jameson 2007, submitted to MNRAS

Pleiades: overview



Credit: UKIDSS and Palomar Observatory Sky Survey Schmidt plates

Brown Dwarf Candidates in the Pleiades Cluster (UKIDSS)

ESO Press Photo 26b/06 (21 July 2006)

Pleiades:

- ✔ d = 130 pc
- ✔ Age = 125 Myr
- ✔ E(B-V) = 0.03
- ✔ PM = (+19.7,-45.5) mas/yr

Surveys:

Teide+Calar *(Rebolo, Martin, Zapatero Osorio)*

CFHT *(Bouvier, Moraux)*

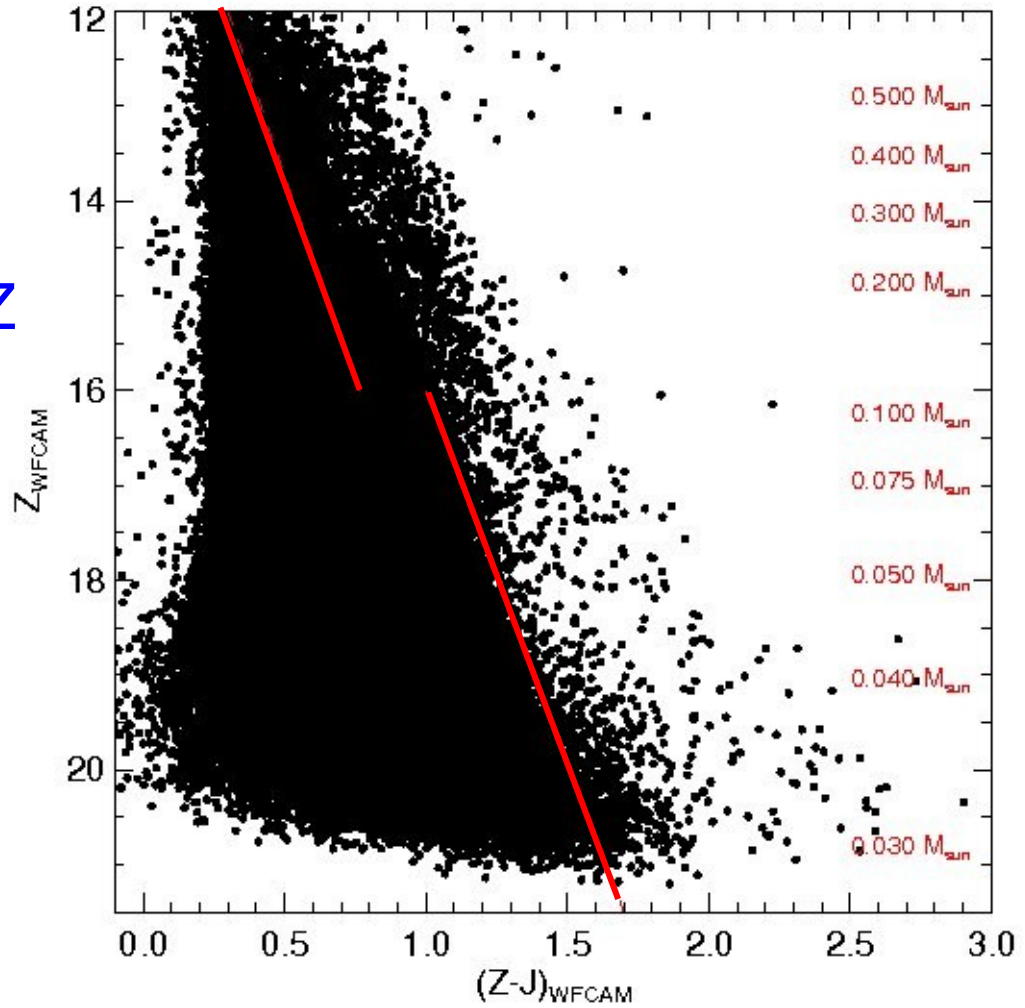
INT *(Dobbie, Pinfield, Jameson)*

SuperCOSMOS *(Deacon & Hambly 2004)*

2MASS *(Adams et al. 2001)*

and many other surveys...

Pleiades: selection of candidates



Z

$(Z-J)_{WFCAM}$

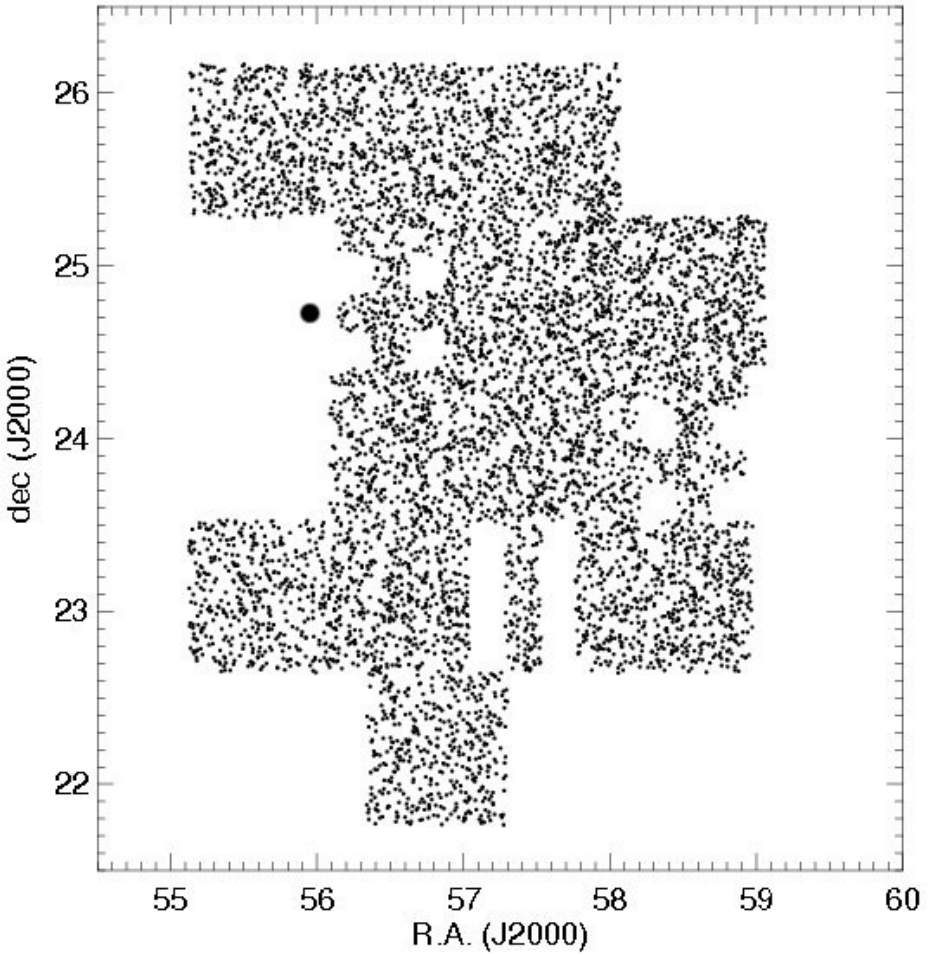
The Pleiades in the GCS:

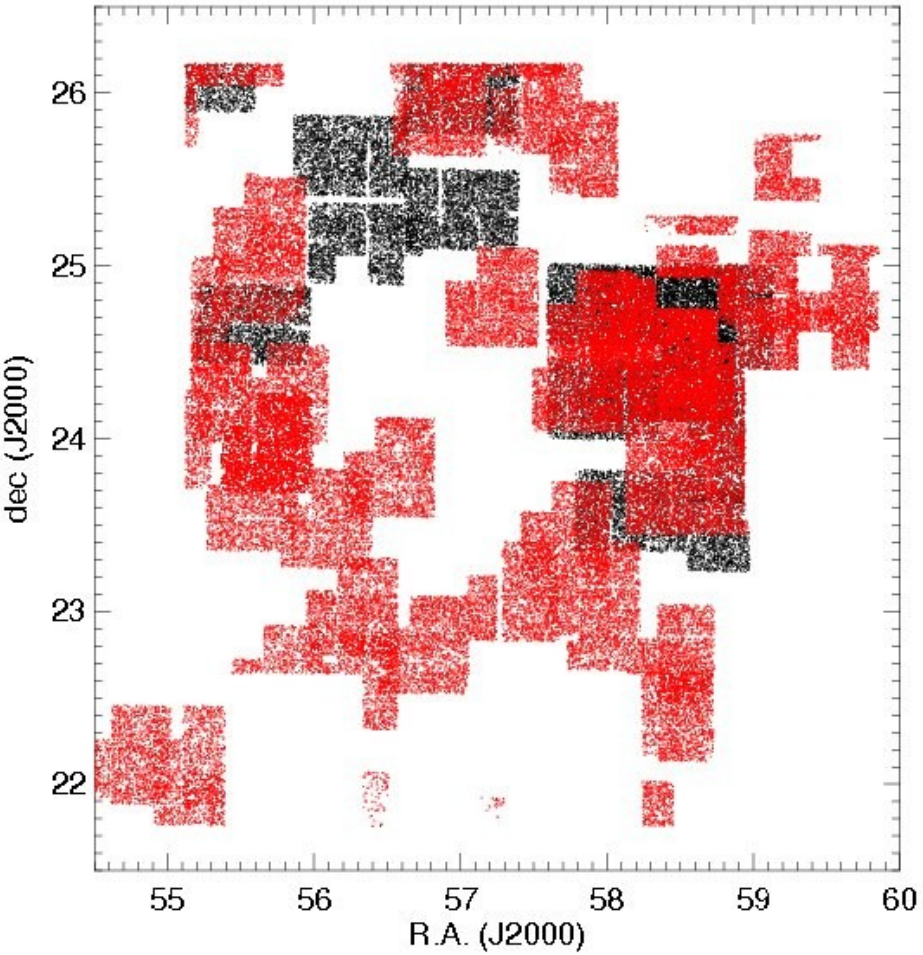
- Point sources only
- 105092 sources in ~12 sq. deg.
- Z = 12.0-21.5 mag
- 0.6-0.03 Msun mass range

Selection procedure:

S) Conservative photometric selection
e) Derive proper motions for bright & faint sources
f) Derive membership probabilities for both samples
b) Derive luminosity and mass functions for members with probabilities
f) Extract high-probability members
E) Select new photometric members outside the optical coverage
o) Identify lower mas brown dwarfs in the (Y-J,Y) and (J-K,J) diagram

Pleiades: coverage



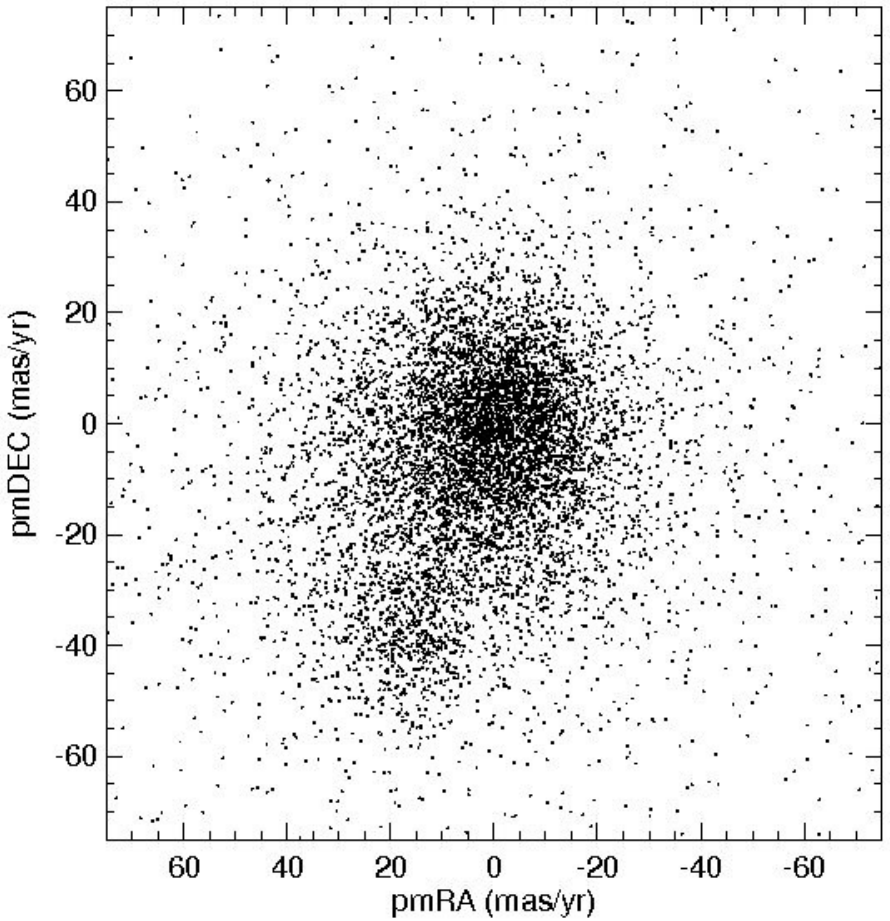


GCS coverage: 12 sq. deg.

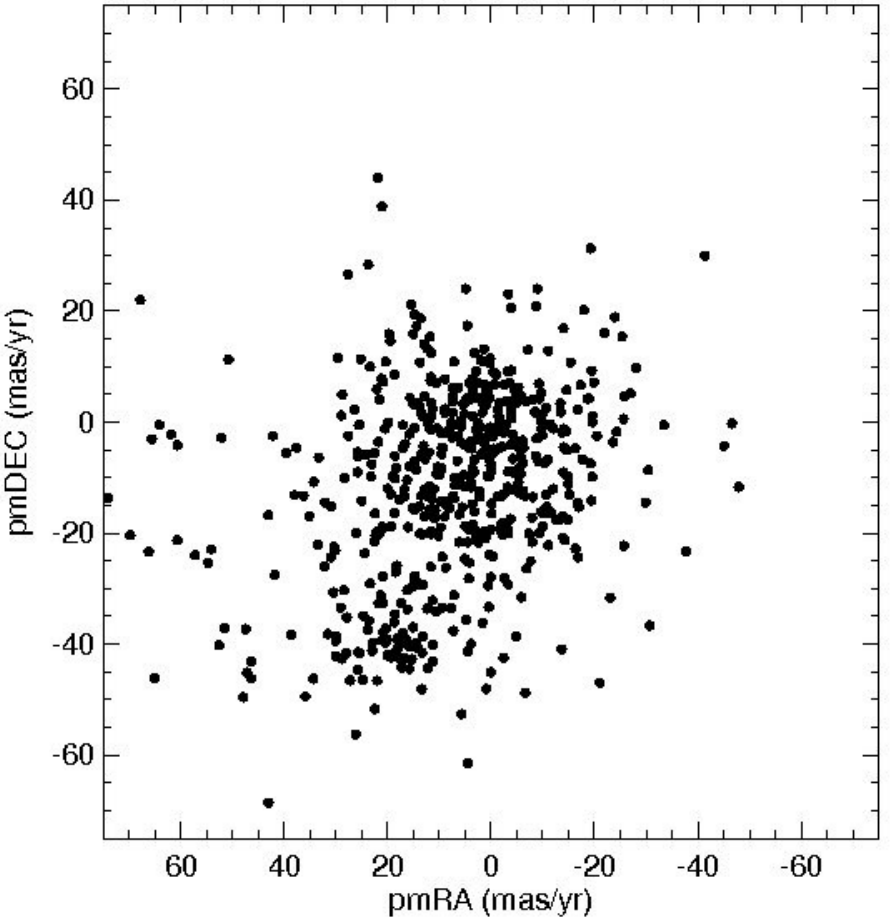
CFHT + INT coverage

=> Large number of stellar and substellar with accurate optical-to-infrared proper motions

Pleiades: proper motion & probabilities



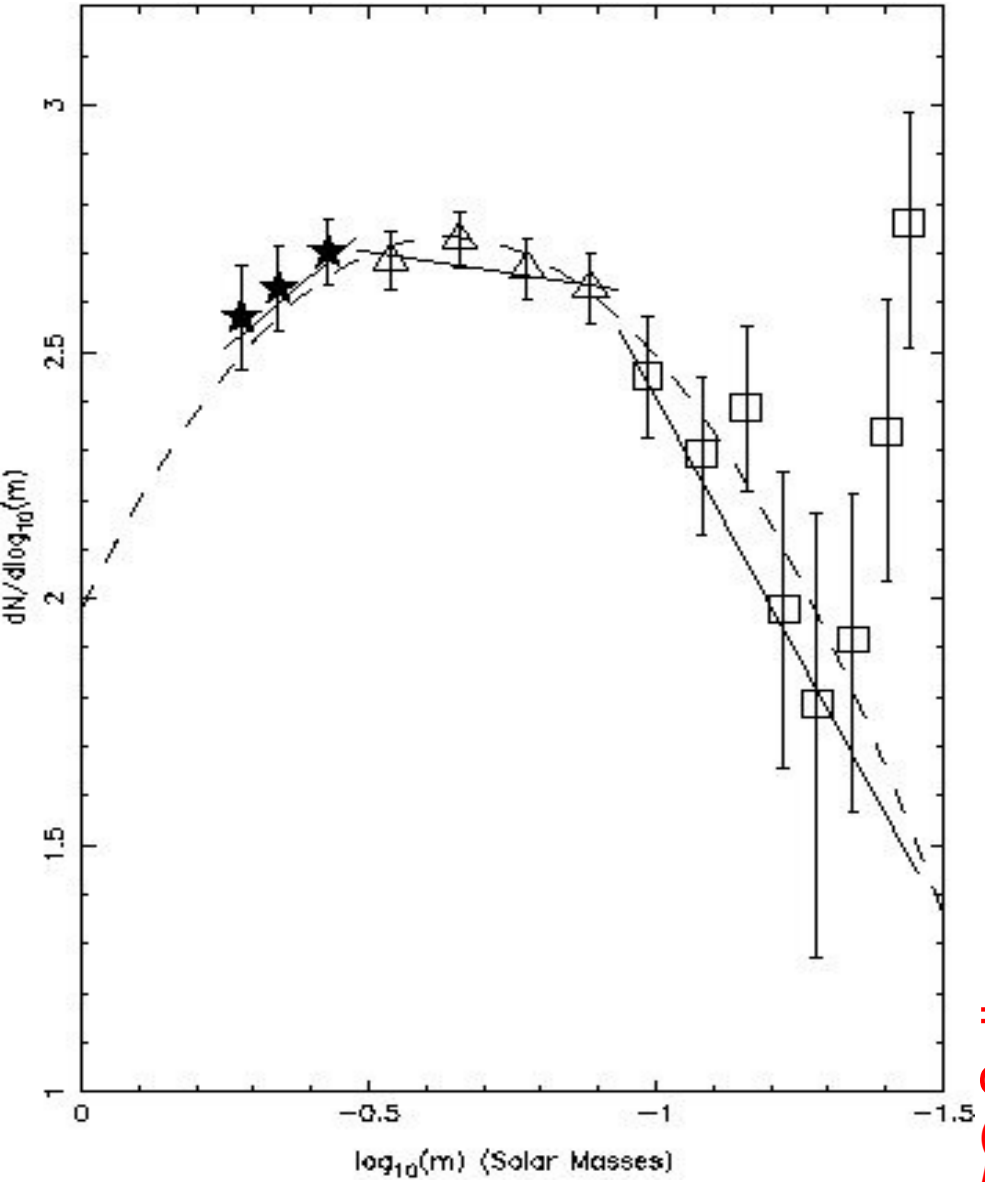
Bright sources: 2MASS vs GCS



Faint sources: (INT+CFHT) vs GCS

Membership probabilities calculated using the method described in Deacon & Hambly (2004). Cluster and field star contributions modelled as a gaussian and a gaussian with declining exponential. Several magnitude bins used to compute membership probabilities from Z=12.0 to Z=21.5 mag.

Pleiades: Mass function



The cluster mass function:

- Number of candidates with membership probabilities is 1061
- About 100 BDs in this sample
- *Z* = 12.0-21.5 mag
- Mass range = 0.560-0.035 Msun
- NextGen+DUSTY models @ 120 Myr
- Sum of probabilities for each 0.5 mag bin

Results:

1) M=0.563-0.333 Msun α_1=+0.98±0.87

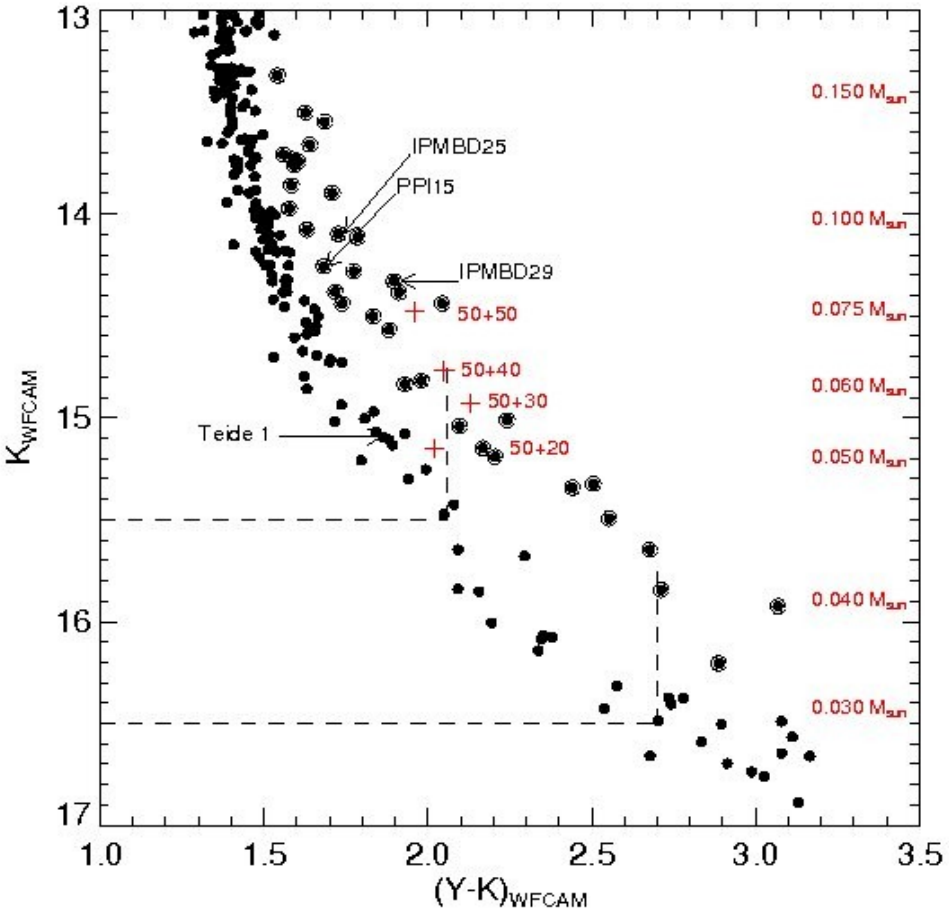
2) M=0.333-0.116 Msun α_2= -0.18±0.24

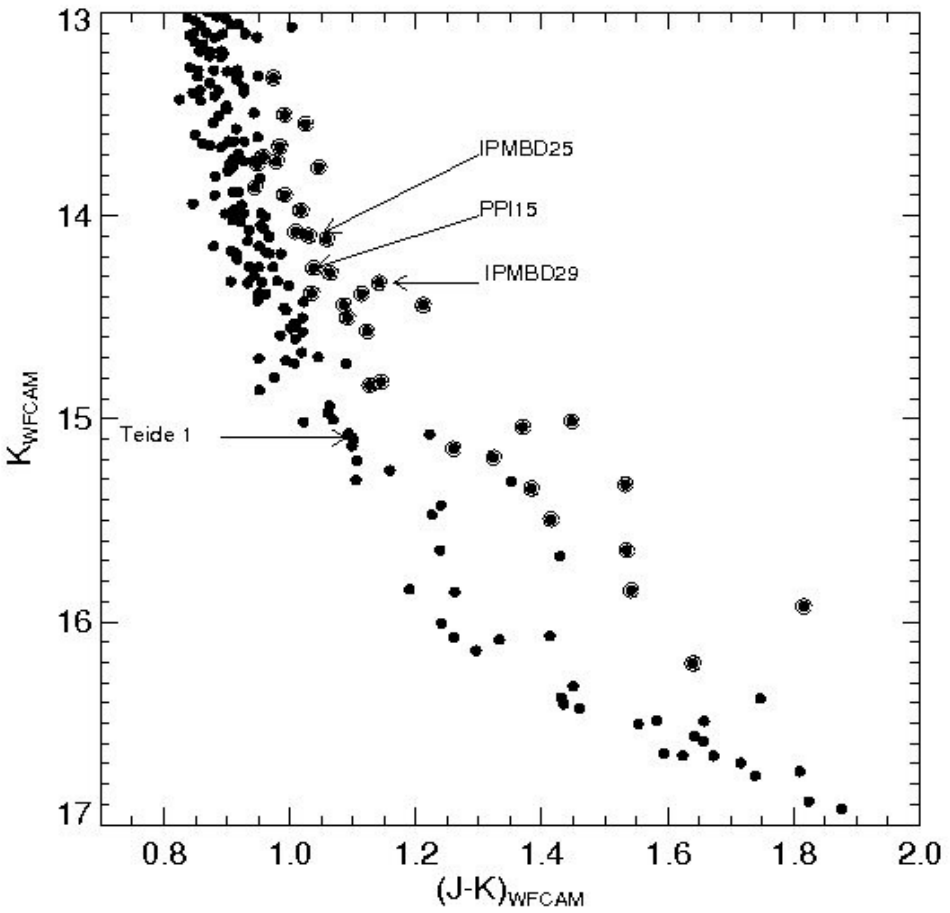
3) M=0.116-0.035 Msun α_3= -2.11±1.20

=> Lognormal fit with m_{core}=0.24 Msun

=> Results consistent with previous determinations of the Pleiades mass function *(Martin et al. 1998; Hambly et al. 1999;Tej et al. 2002; Moraux et al. 2003; Deacon & Hambly 2004; Chabrier 2003)*

Pleiades: binary fraction





Selection of photometric multiple systems from the (*Y*-*K*,*Y*) CMD

BF = $N_B/(N_S+N_B)$ = 23/(40+23) = 36.5±8.0% over the 0.075-0.030 $M_\odot$ mass range

Bouy et al. (2006): 9-26%; Pinfield et al. (2000): 40-60%; Maxted & Jeffries (2005): 32-45%;
Basri &Reiners (2006): 26±10%; Field dwarfs (Burgasser et al. 2007): 10-30%

The power of the GCS

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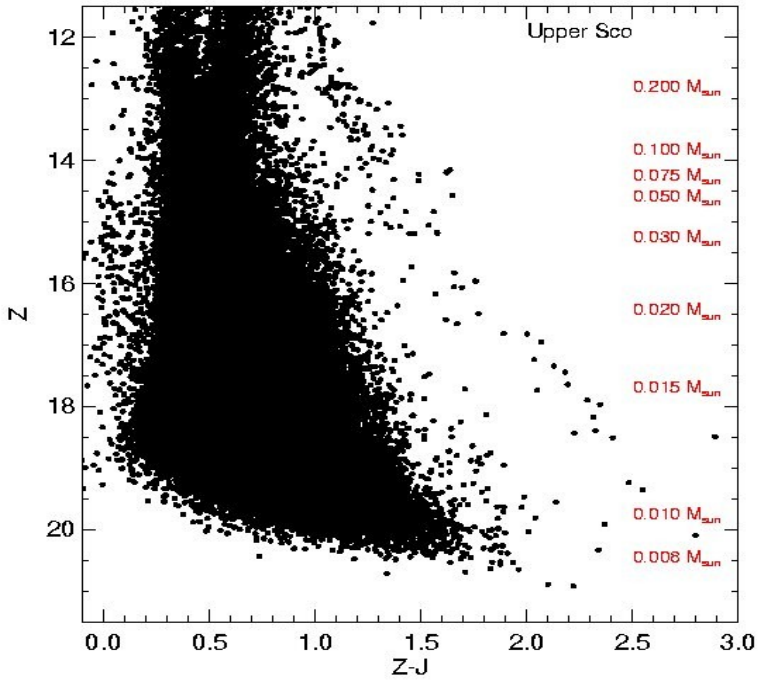

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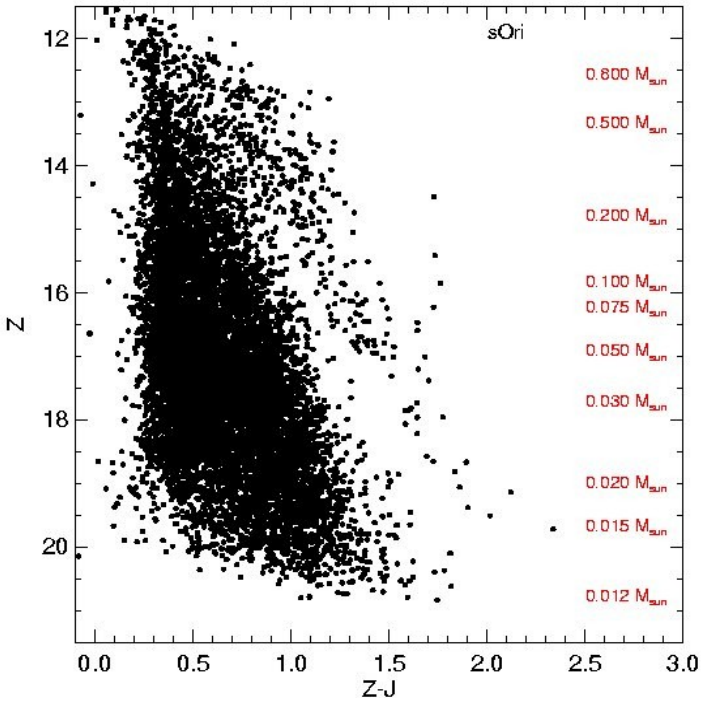
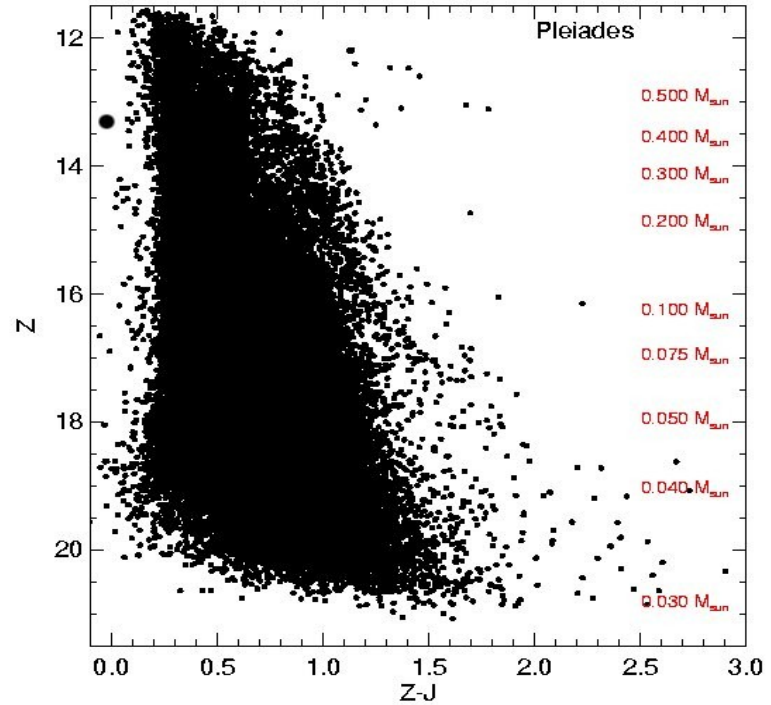


Pleiades



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