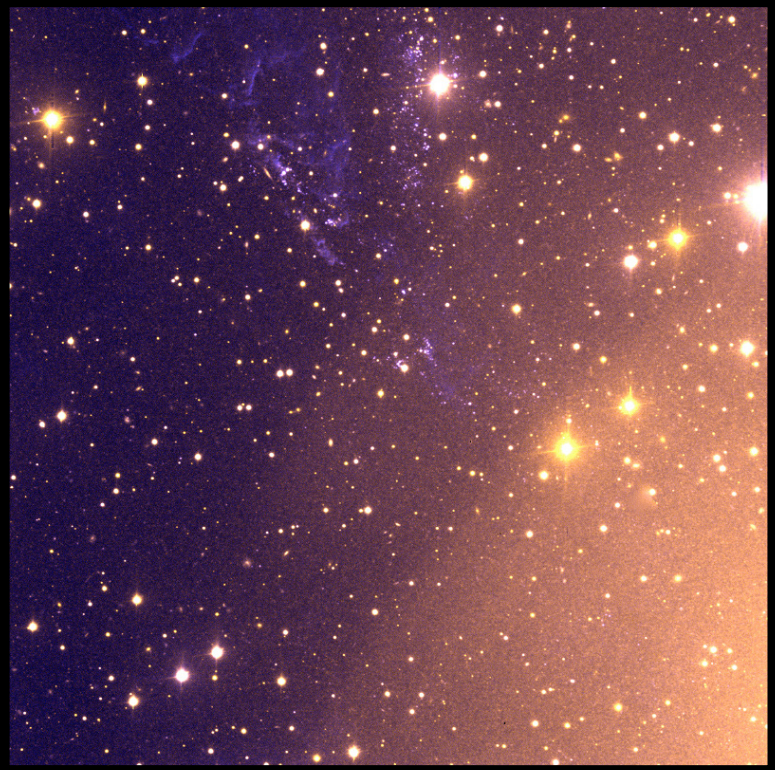
RESOLVED STELLAR POPULATIONS IN THE ELT ERA

L. Greggio, R. Falomo, S. Zaggia, D. Fantinel, M. Uslenghi
(INAF, OAPd & IASF-Mi)

Elliptical Galaxy Centaurus A



ESO for the Public

Dwarf Irregular Galaxy NGC 1705

Hubble Heritage

TO DERIVE THE SFH FROM THE CMD OF
RESOLVED STELLAR POPULATIONS
WE NEED

DEPTH & PHOTOMETRIC ACCURACY

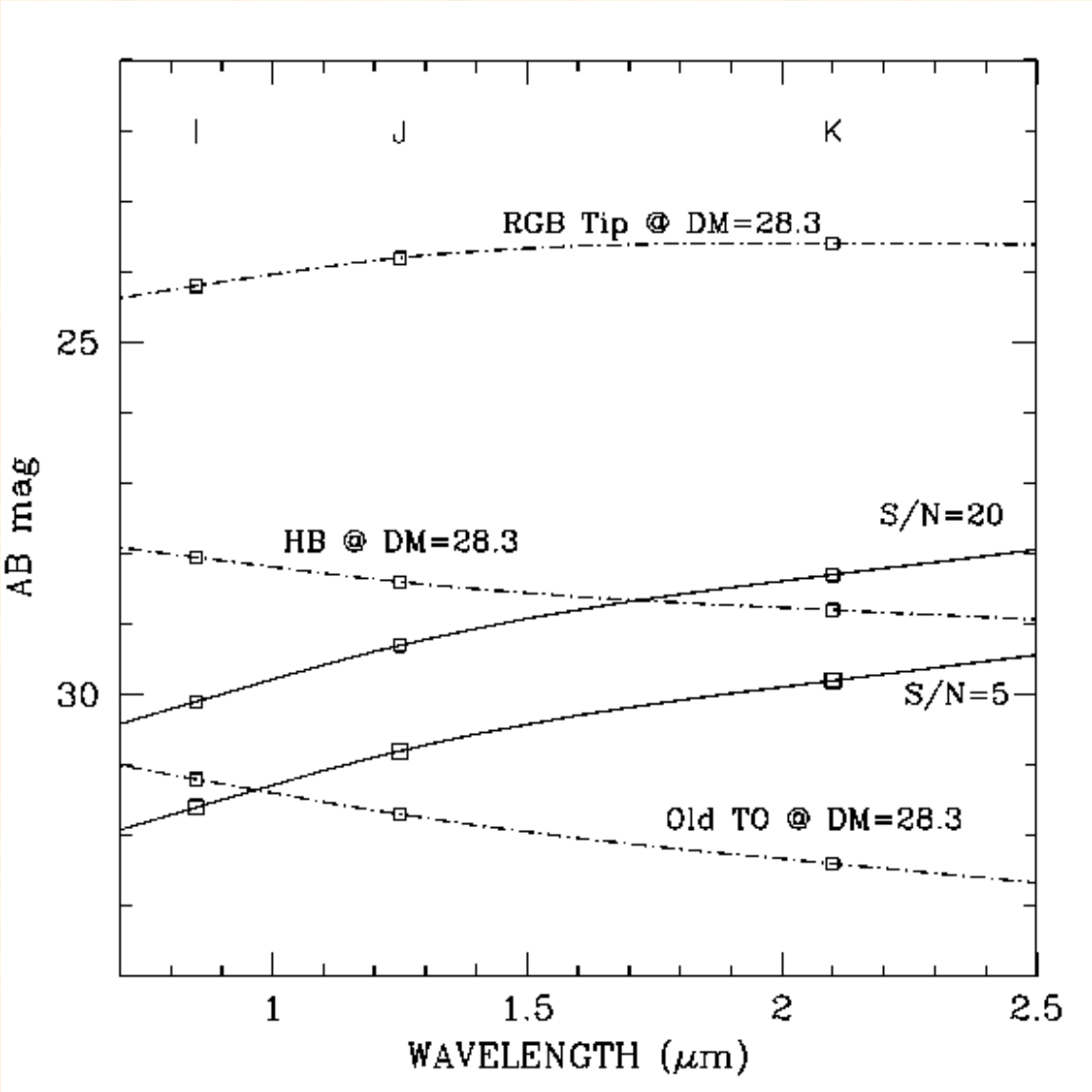
BOTH ARE CRUCIAL

PERSPECTIVES FOR ELTs ARE EXTREMELY
INTERESTING BECAUSE OF THEIR LARGE
COLLECTING AREAS AND HIGH RESOLUTION

SFH TRACERS

Reasonable exposure: 5 hours integration

Reasonable S/N : 5 - 10



We can measure:

OLD (~ 10 G) MS Tos up to MOD=26.5

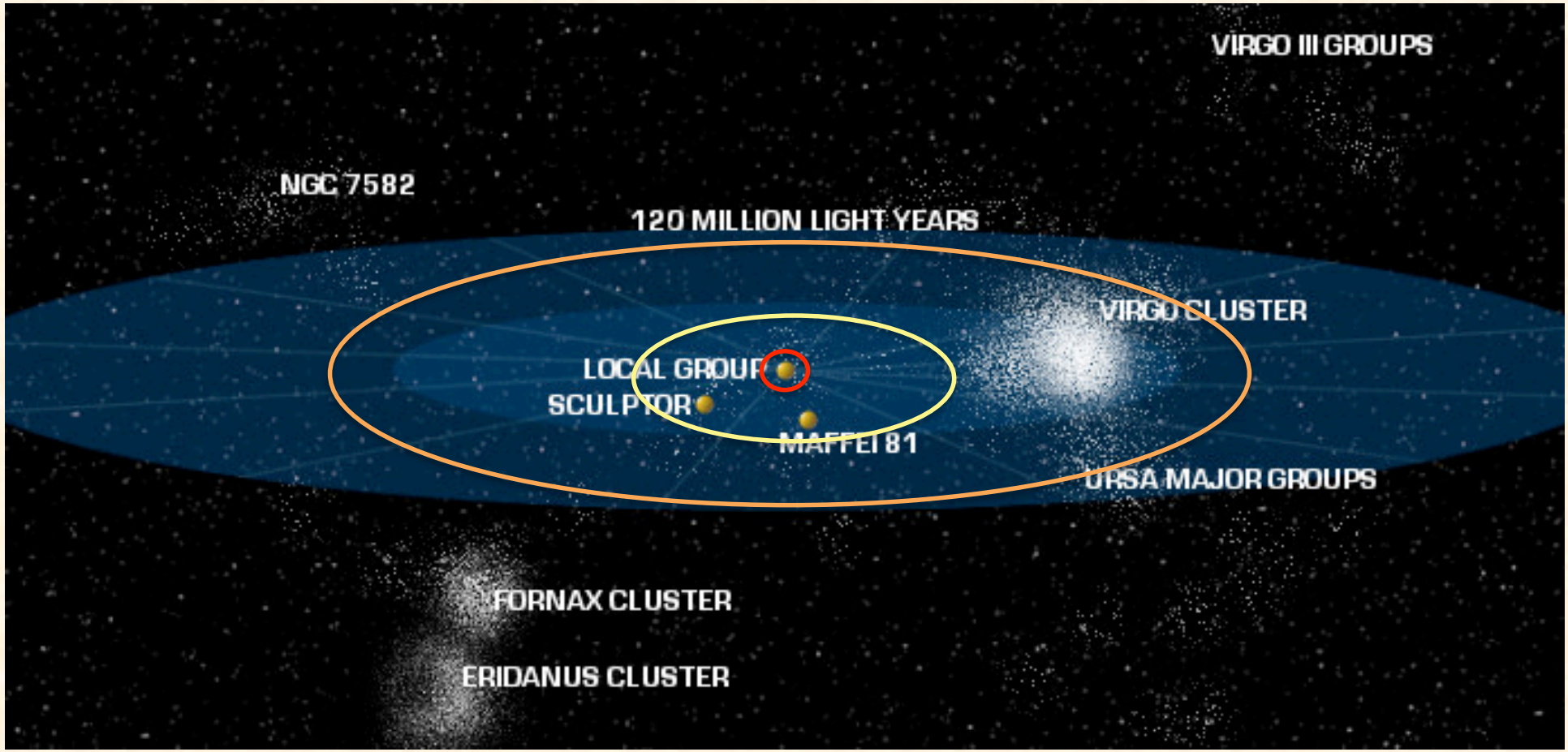
RED HBs up to MOD = 30

RR Lyraes up to MOD = 27.5

RGB Tip stars up to MOD = 34.5

(this applies to isolated stars)

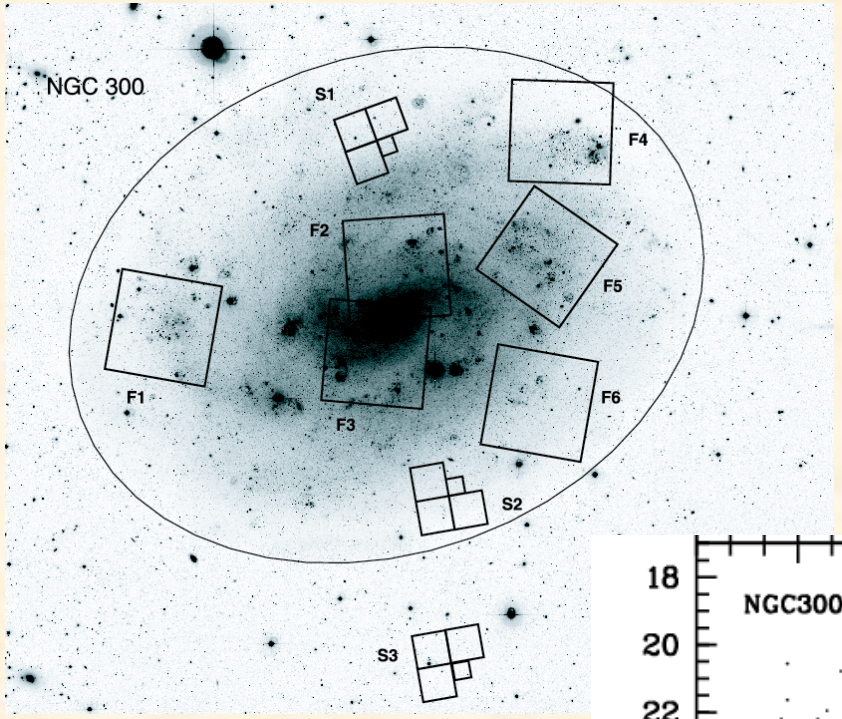
THE GALAXIES AROUND US



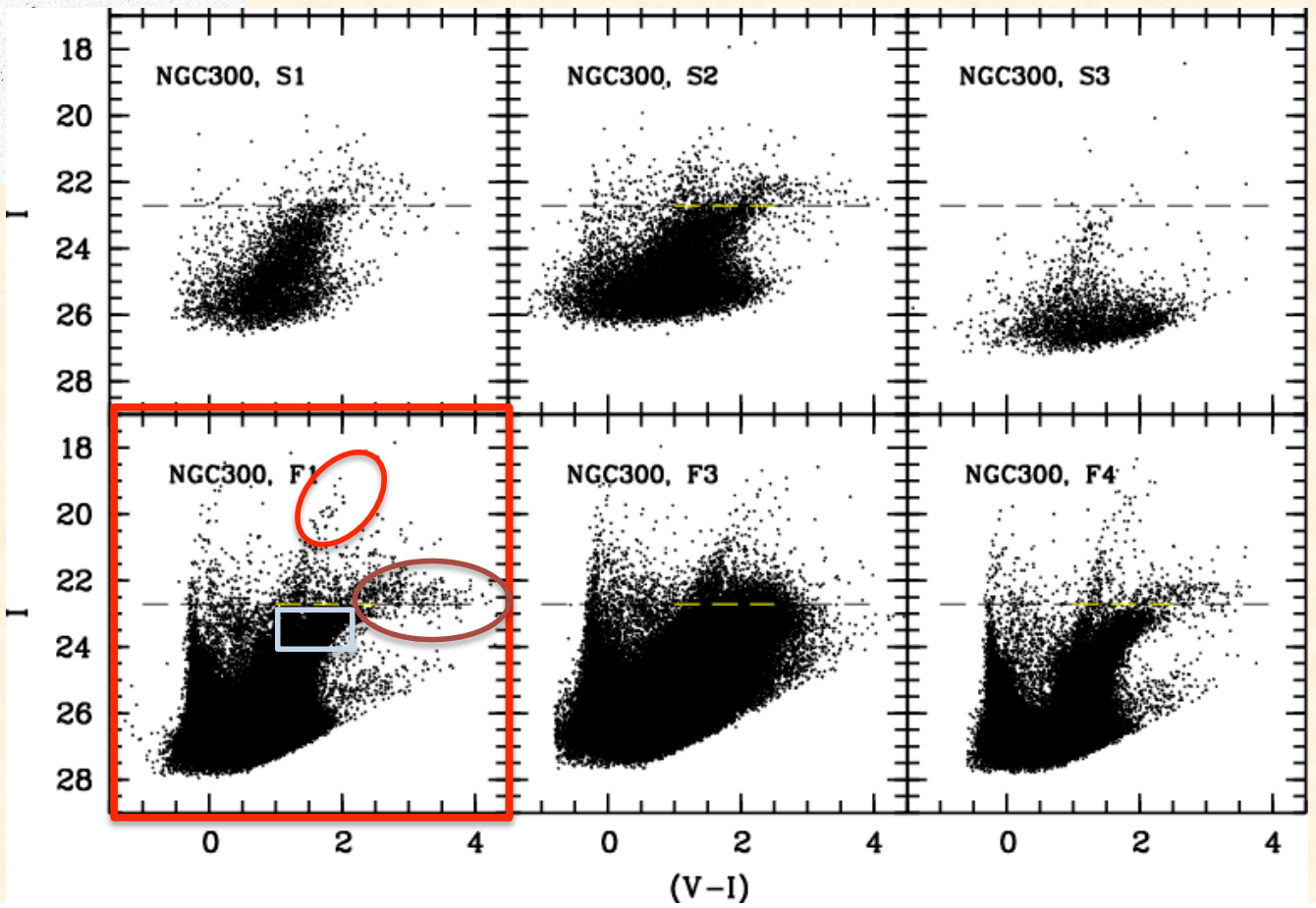
A SIGNIFICANT SAMPLING OF THE SFH IN THE UNIVERSE REQUIRES THAT WE USE THE LUMINOUS PART OF THE CMD TO DERIVE SFH

SFH in NGC 300

(from Tikhonov et al. 2005)

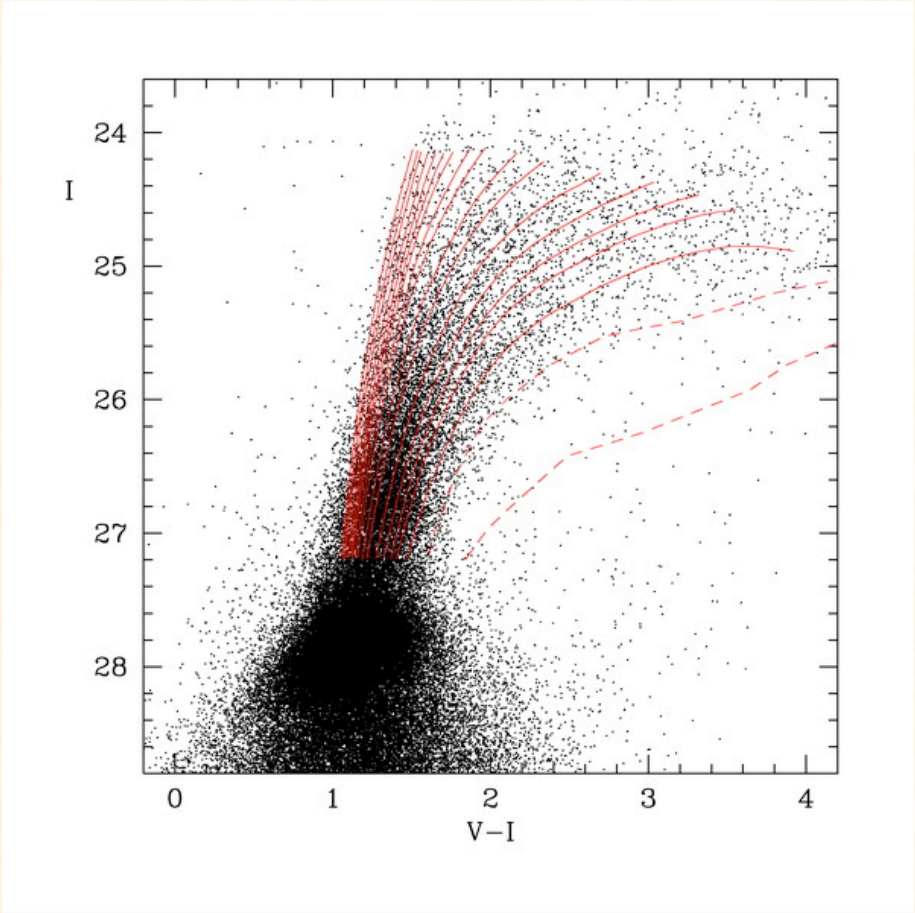


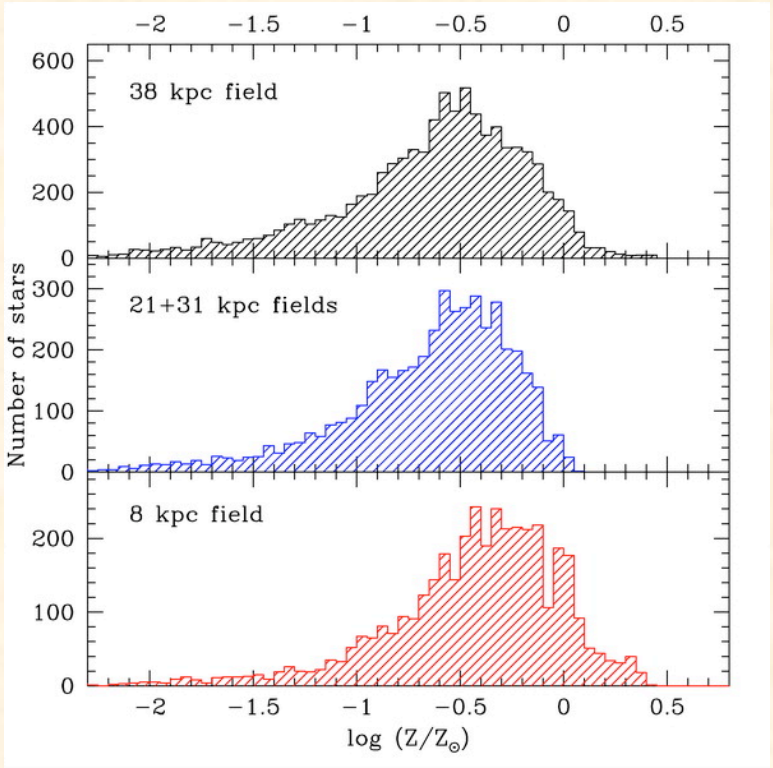
AGEs ~ 10-100 Myr
AGEs ~ 100-1000 Myr
AGEs > 1000 Myr



METALLICITY DISTRIBUTION IN ELLIPTICAL GALAXIES

Rejkuba et al 2005.
A stellar field in the halo of Centaurus A





TWO SPECIFIC SCIENCE CASES

(Greggio L., et al., 2011, in prep)

- A DISK GALAXY IN THE CENTAURUS GROUP

  MOD = 28.3 5 hr EXPOSURE IN I J K

  DERIVE THE STAR FORMATION HISTORY

  IN THE CENTRAL PART OF THE DISK

M 83, by W. Keel, KPNO,4m Mayall

- AN ELLIPTICAL GALAXY IN THE VIRGO CLUSTER

  MOD = 31.3 5 hr EXPOSURE IN I J K

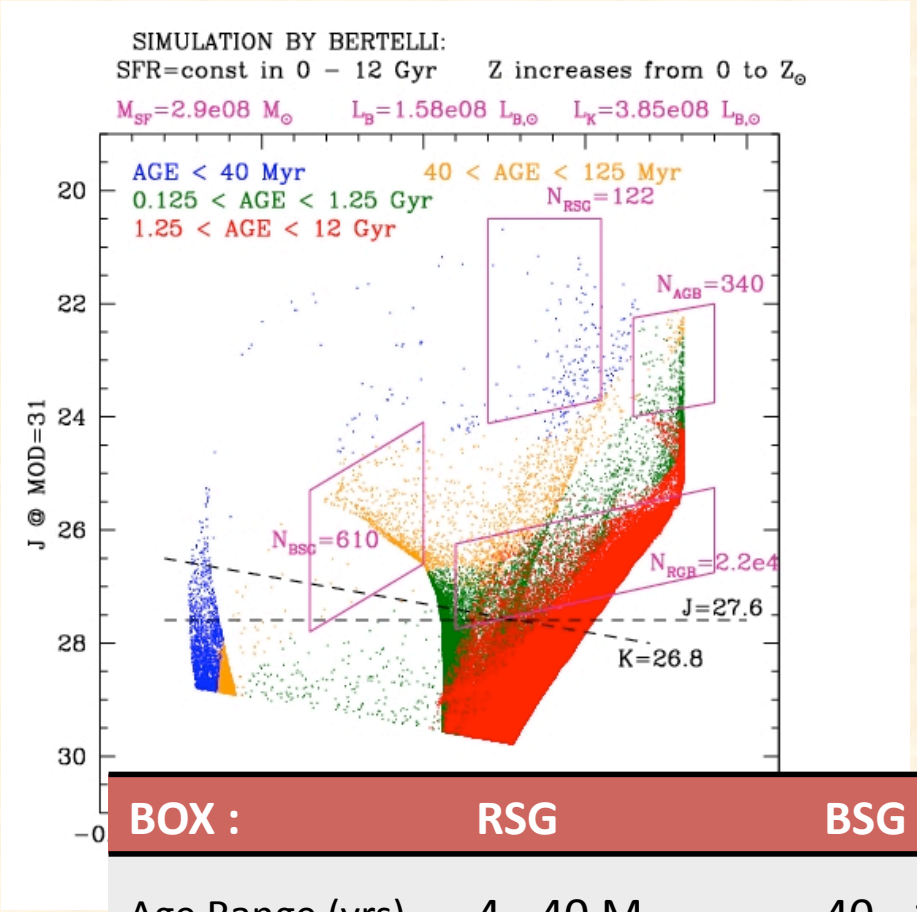
  DETERMINE THE METALLICITY

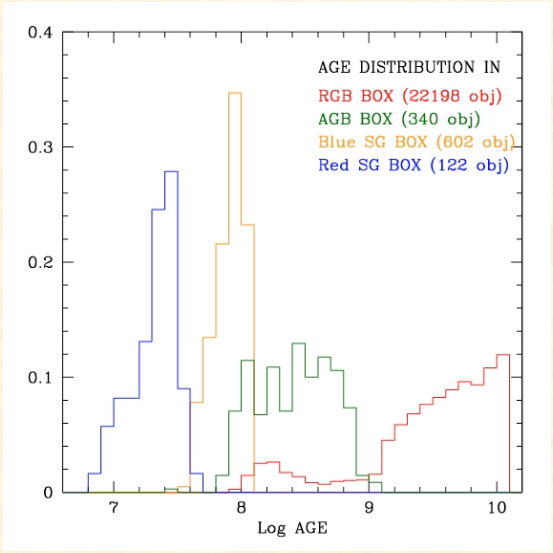
  DISTRIBUTION OF THE STARS

  IN A REGION AT 0.5 Re

M 89, from http://thebigphoto.com

STAR FORMATION HISTORY IN DISK GALAXIES



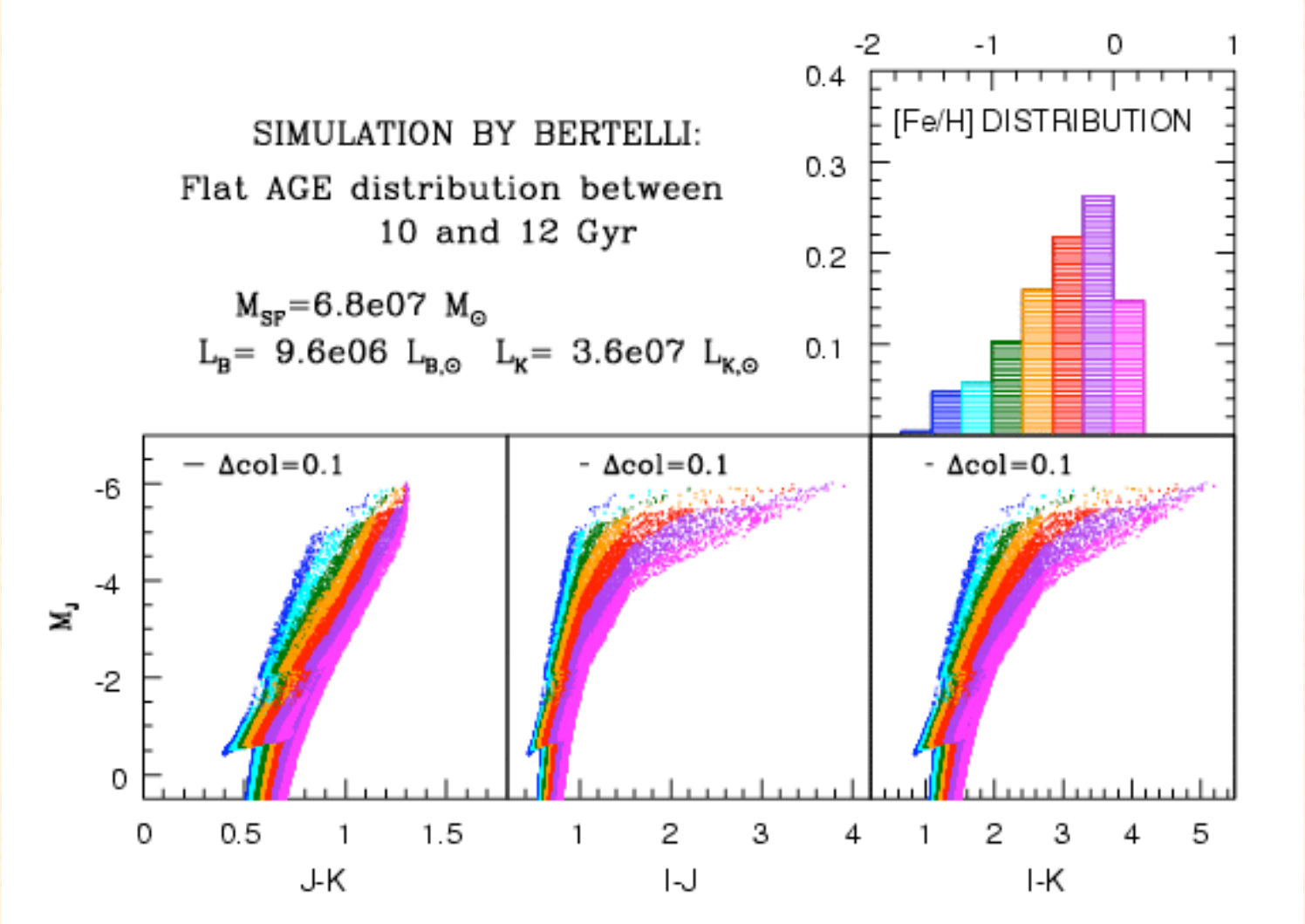


$$N_{BOX} = \delta n_{BOX} \left\langle M_{SF} \right\rangle_{\Delta\tau_{BOX}}$$

THE SIMULATION HAS: SFR=2.4 X 10^{-2} Mo/yr

BOX :	RSG	BSG	AGB	RGB
Age Range (yrs)	4 - 40 M	40 - 125 M	125 M –1G	1 – 12 G
ΔM_{SF} (M_o)	0.96 M	2.04 M	21 M	264 M
$\langle\delta n\rangle_{BOX}$(#/Mo)	1.3 x 10^{-4}	3 x 10^{-4}	1.6 x 10^{-5}	8.4 x 10^{-5}

METALLICITY DISTRIBUTION IN ELLIPTICAL GALAXIES



Advanced Exposure Time Calculator

M_{GAL} MOD
R_e r/R_e FoV

INPUT
STELL. POP.

MODEL
STELL. POP.
SAMPLED by the FoV

OBSERVAT.
SET UP

SYNTHETIC FRAMES
(I J H K)

DATA REDUCTION
(DAOPHOT)

COMPARISON
INPUT – OUTPUT
MAGS

@ http://aetc.oapd.inaf.it

MICADO

Multi-AO Imaging Camera for Deep Observations

Main characteristics

- FoV 53” across, 3mas pixels
- high throughput (>60%) over the range 0.8-2.5 μm
- sensitivity (5σ) for point sources m(AB) > 30.5 in 5h
- 4×4 HAWAII 4RG detectors
- 20 filter slots

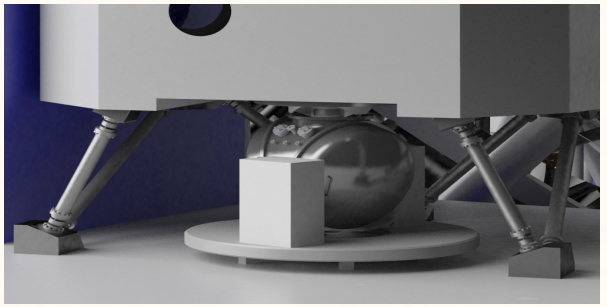
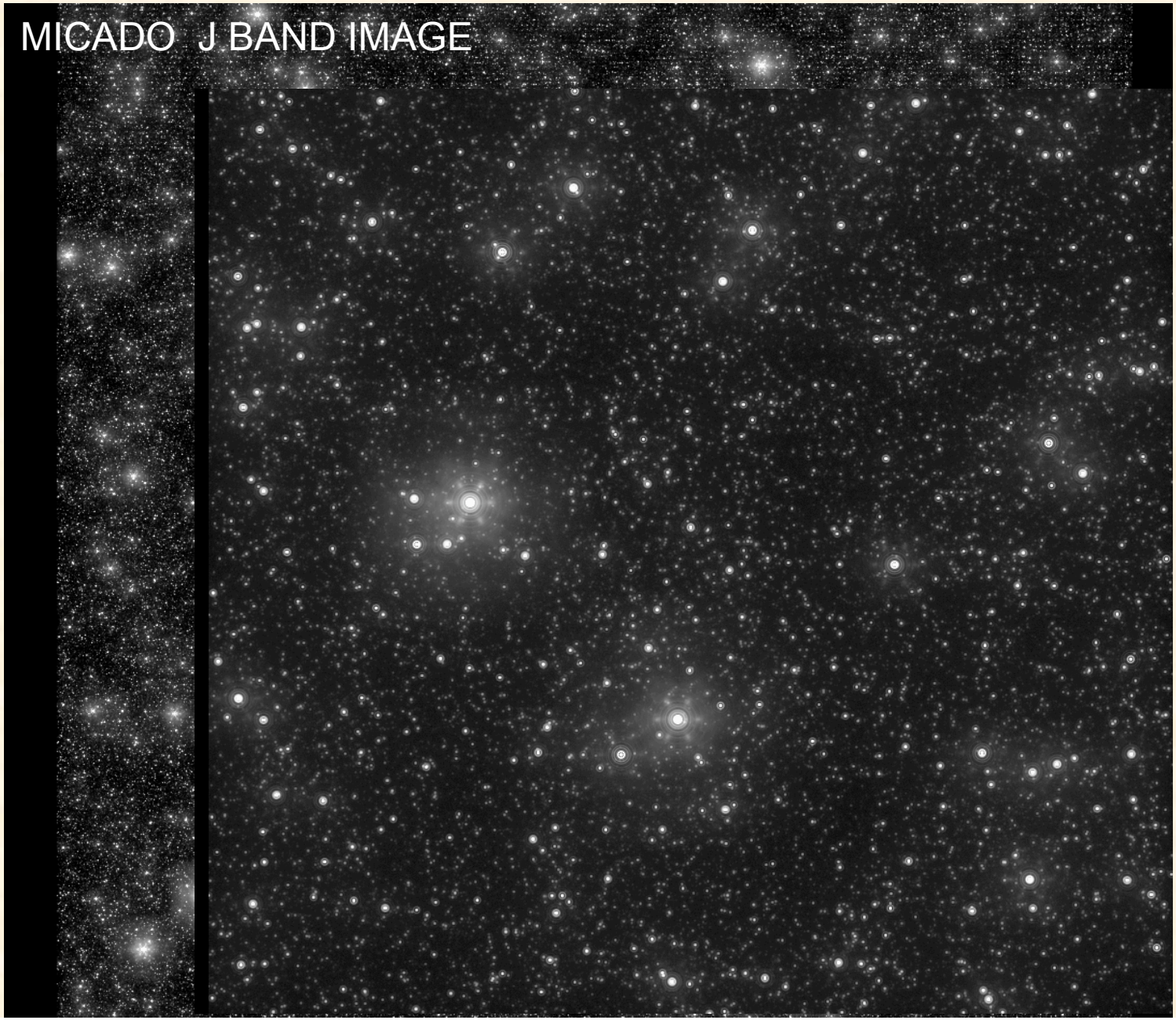


Illustration of how MICADO will look when mounted underneath the multi-conjugate adaptive optics system MAORY.

http://www.mpe.mpg.de/ir/instruments/micado/micado.php

DISK GALAXY IN THE CENTAURUS GROUP

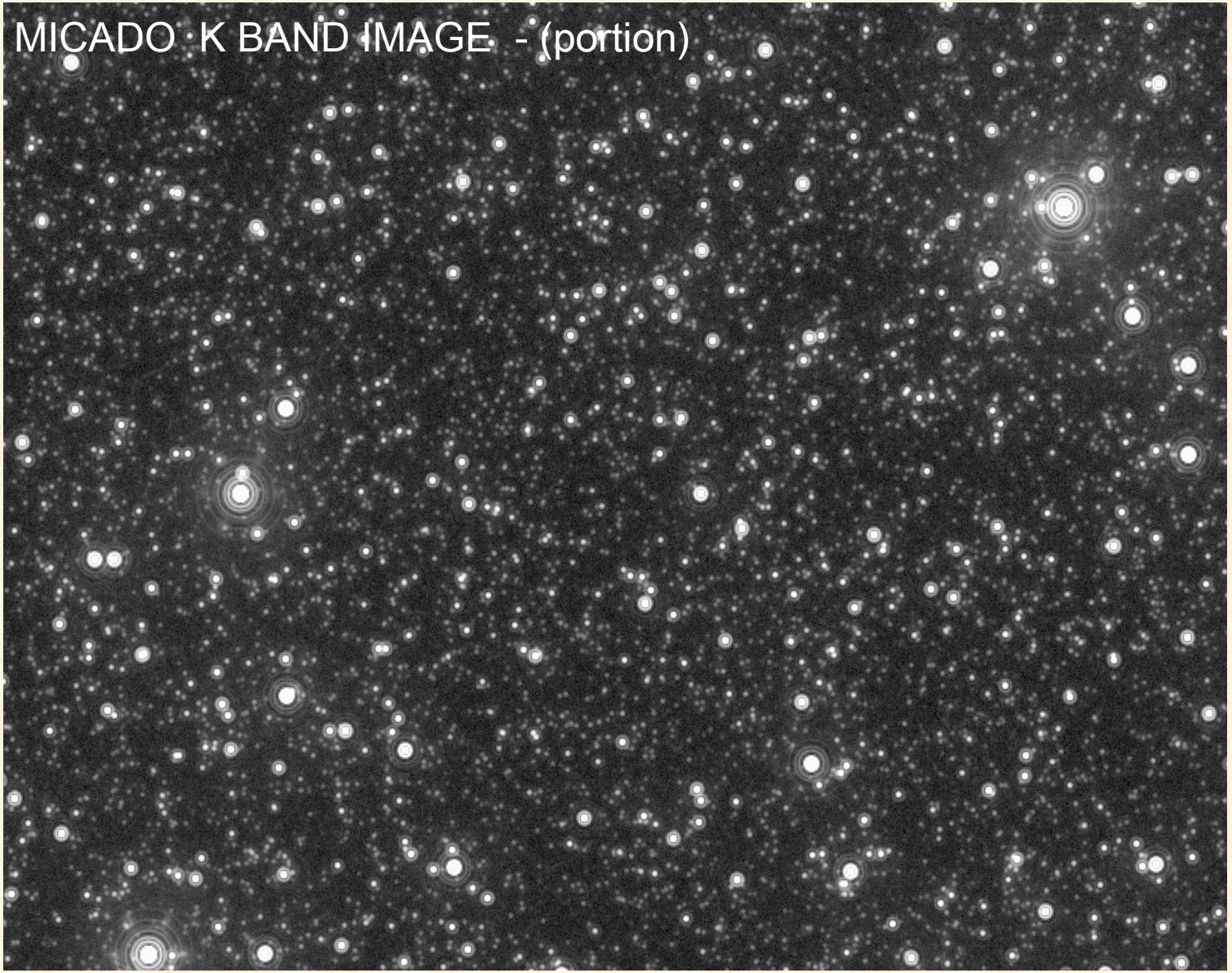


$M_{B,GAL}$ = -20
R_e = 3 Kpc
r/R_e = 0

MOD = 28.3
μ_B = 21.07
μ_I = 19.8
μ_J = 18.9
μ_K = 18.1

FoV = 12” x 12”
$L_B = 17.5\ 10^6\ L_{B,o}$
$L_I = 15.7\ 10^6\ L_{I,o}$
$L_J = 23.6\ 10^6\ L_{J,o}$
$L_K = 35.2\ 10^6\ L_{K,o}$
$M_{SF} = 26.6\ 10^6\ M_o$

DISK GALAXY IN THE CENTAURUS GROUP

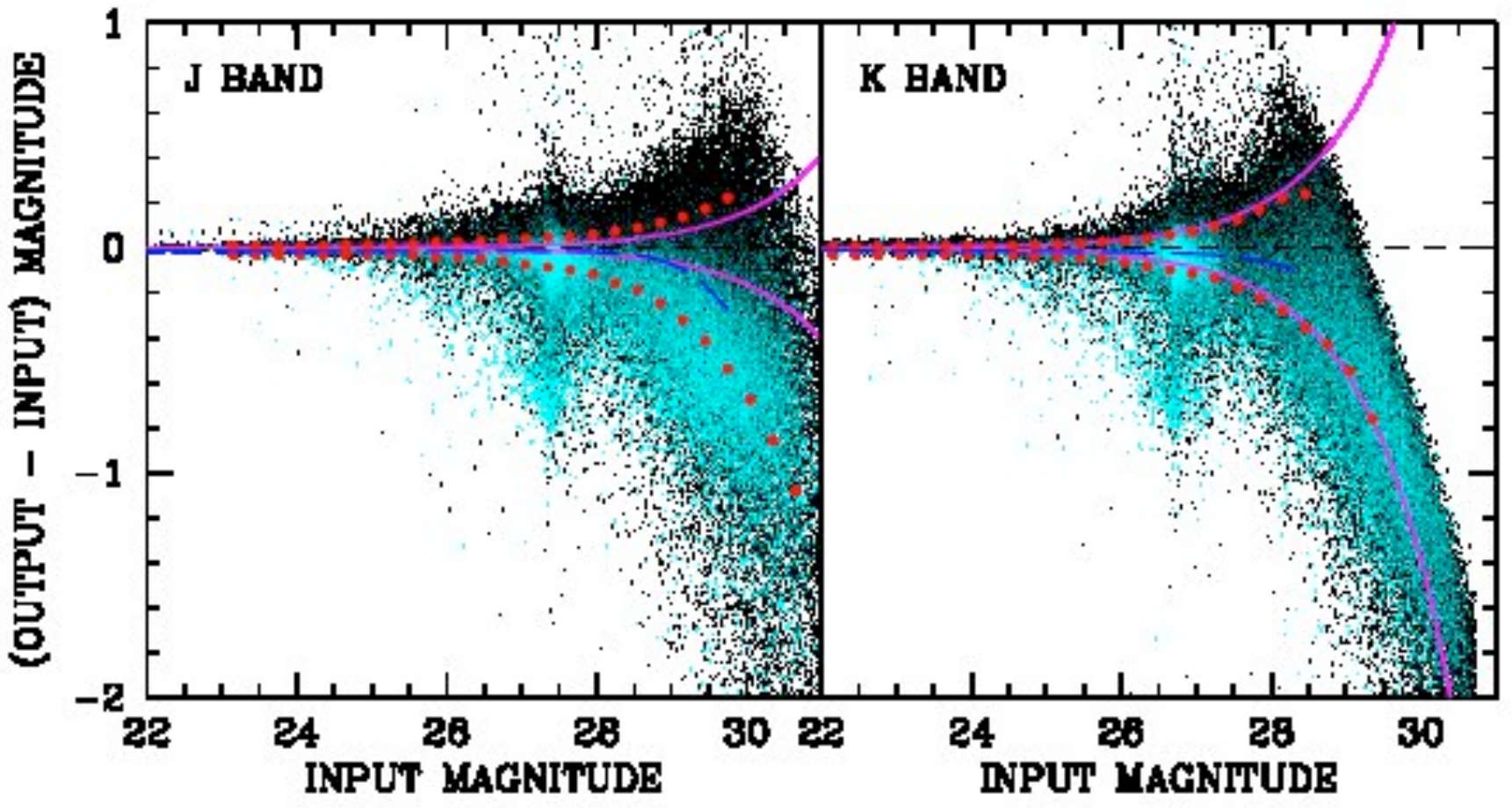


$M_{B,GAL}$ = -20
R_e = 3 Kpc
r/R_e = 0

MOD = 28.3
μ_B = 21.07
μ_I = 19.8
μ_J = 18.9
μ_K = 18.1

FoV = 12” x 12”
$L_B = 17.5\ 10^6\ L_{B,o}$
$L_I = 15.7\ 10^6\ L_{I,o}$
$L_J = 23.6\ 10^6\ L_{J,o}$
$L_K = 35.2\ 10^6\ L_{K,o}$
$M_{SF} = 26.6\ 10^6\ M_o$

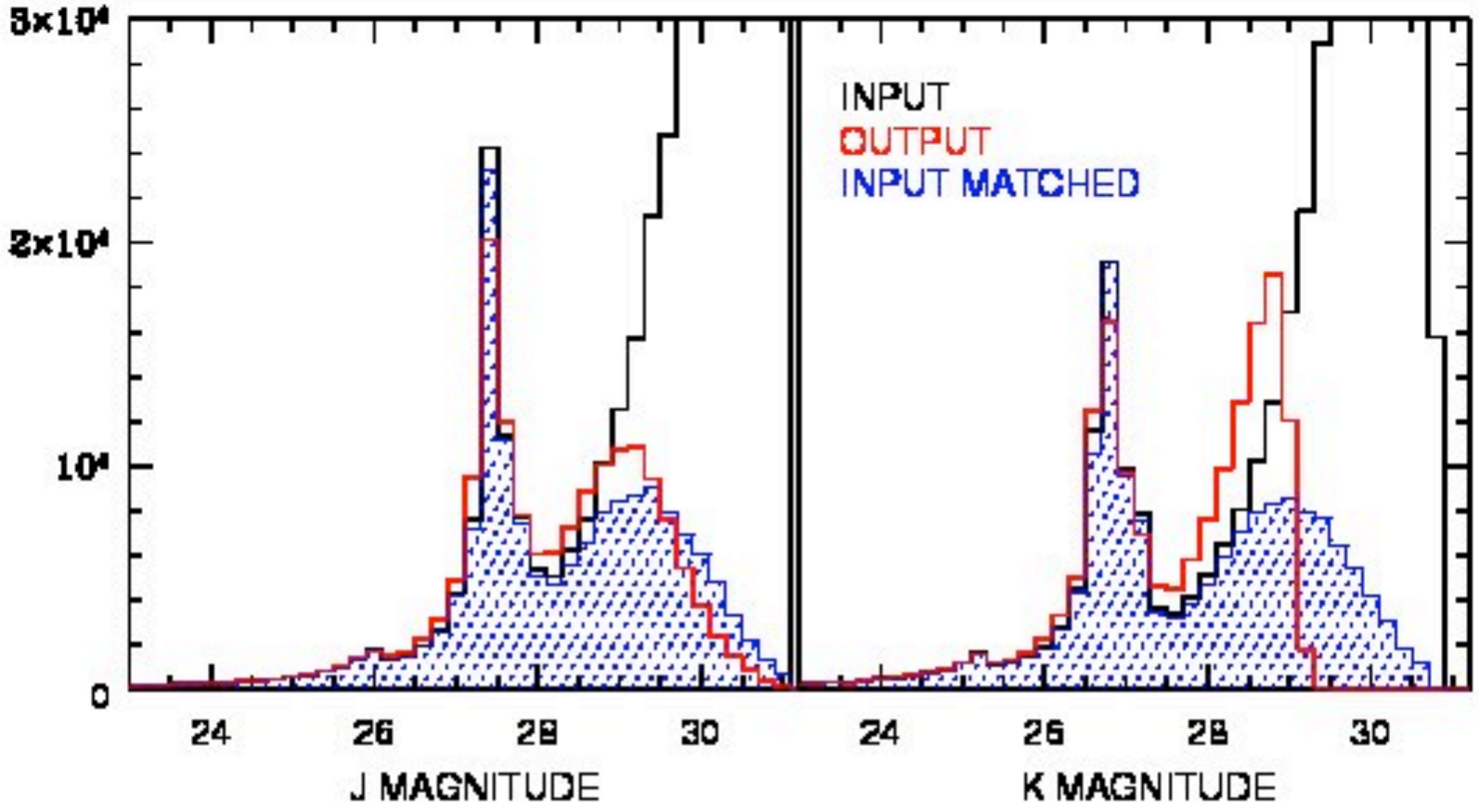
PHOTOMETRIC ACCURACY



NOTICEABLE ASYMMETRY OF THE ERROR DUE TO CROWDING

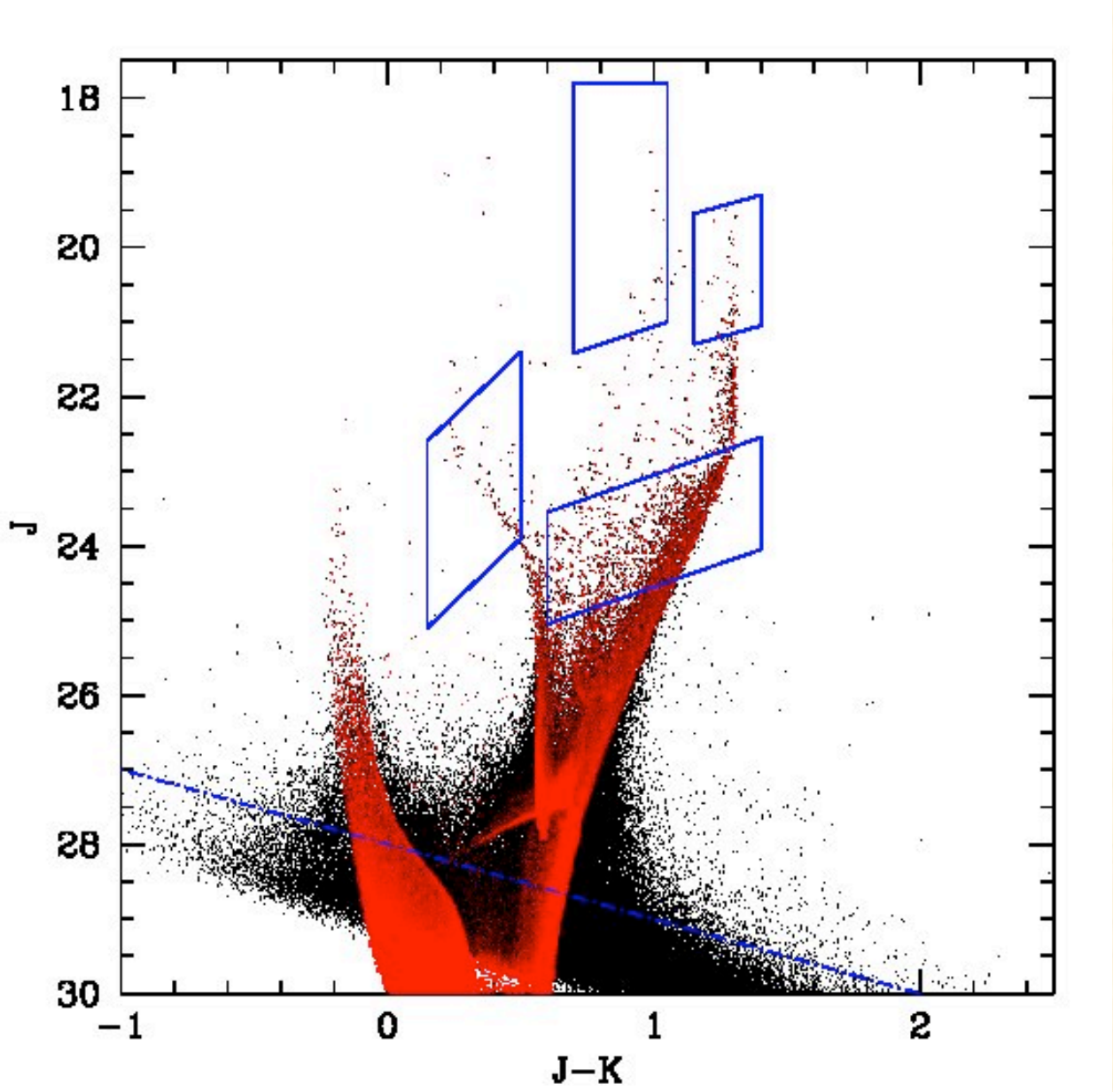
STARS HAVE GREATER PROBABILITY OF BEING DETECTED BRIGHTER THAN THEY ARE

COMPLETENESS



BLENDING CAUSES MIGRATION OF STARS TOWARDS BRIGHTER BINS AT INTERM. MAGNITUDES WE GET MORE STARS THAN WE PUT IN

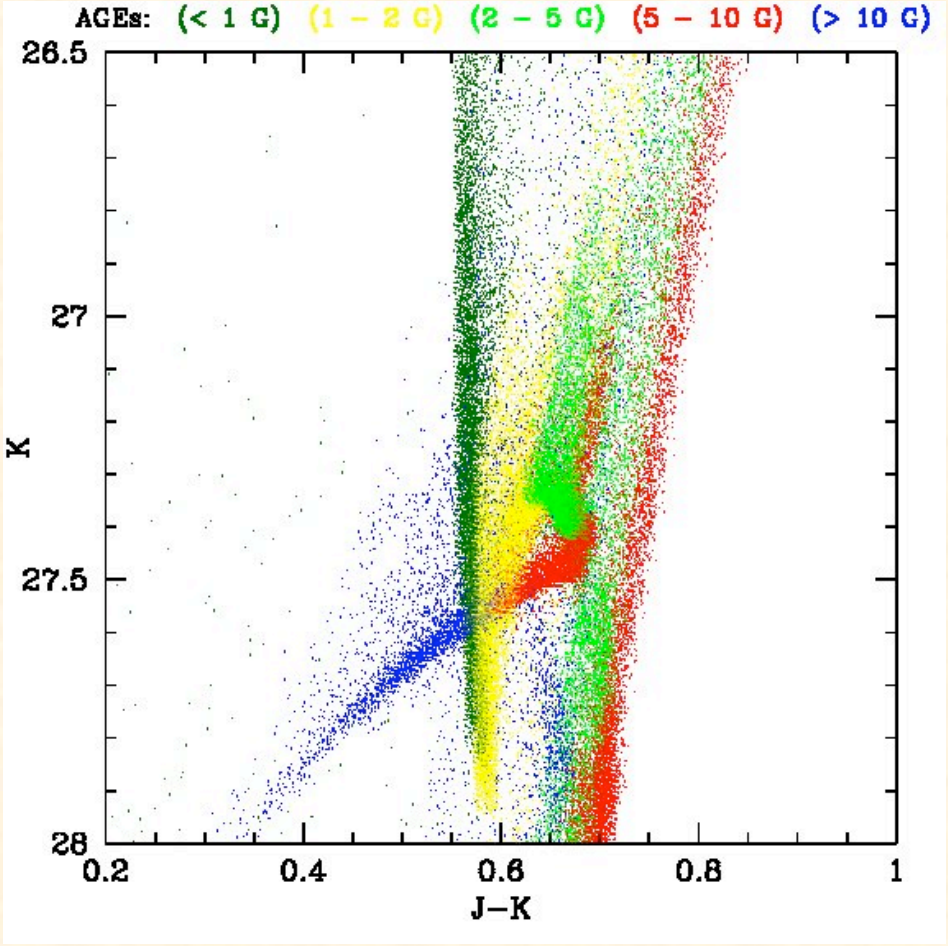
OUTPUT vs INPUT CMDs

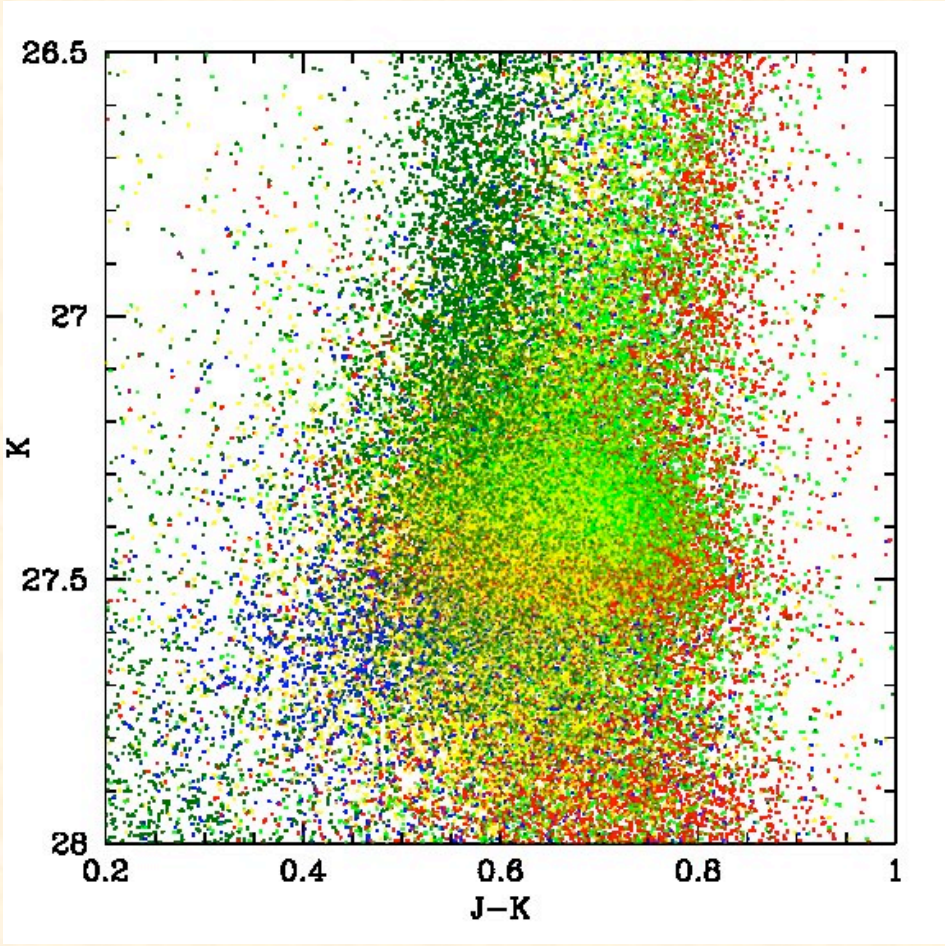


STAR COUNTS IN BOXES

RGB	1929	vs	1933
AGB	33	vs	35
BSG	59	vs	59
RSG	14	vs	14

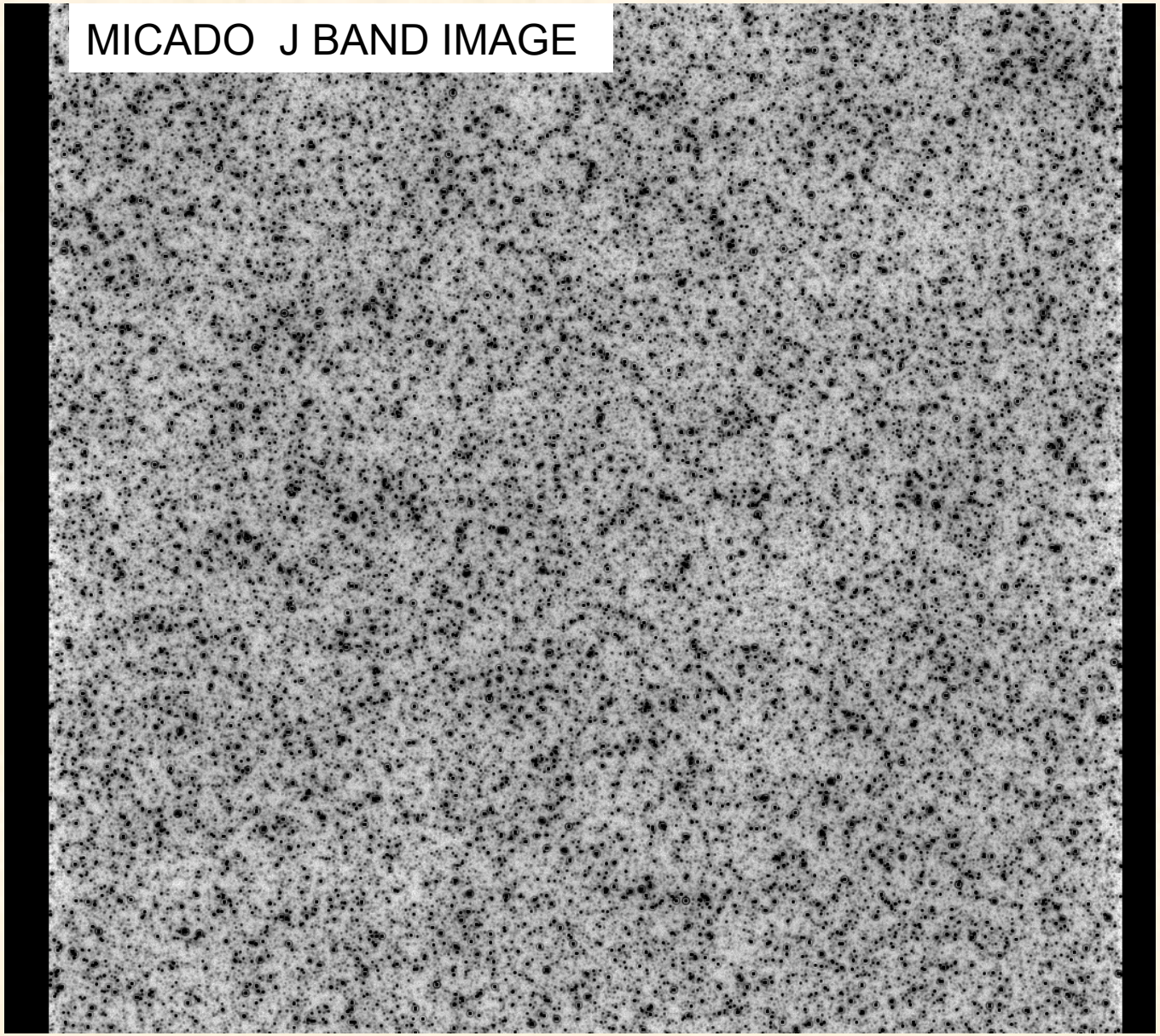
THE HB / RED CLUMP REGION





WITH THIS CROWDING THE DIFFERENT AGE COMPONENTS ARE BARELY DISTINGUISHED
MODELLING OF THE ERRORS IS MANDATORY TO EXTRACT INFORMATION FROM AN OBSERVED CMD
WORK IN PROGRESS: QUANTITATIVE ASSESSMENT OF THE FEASIBILITY OF THIS SCIENCE CASE AT A LOWER CROWDING (i.e. FAINTER SB)

ELLIPTICAL GALAXY IN THE VIRGO CLUSTER

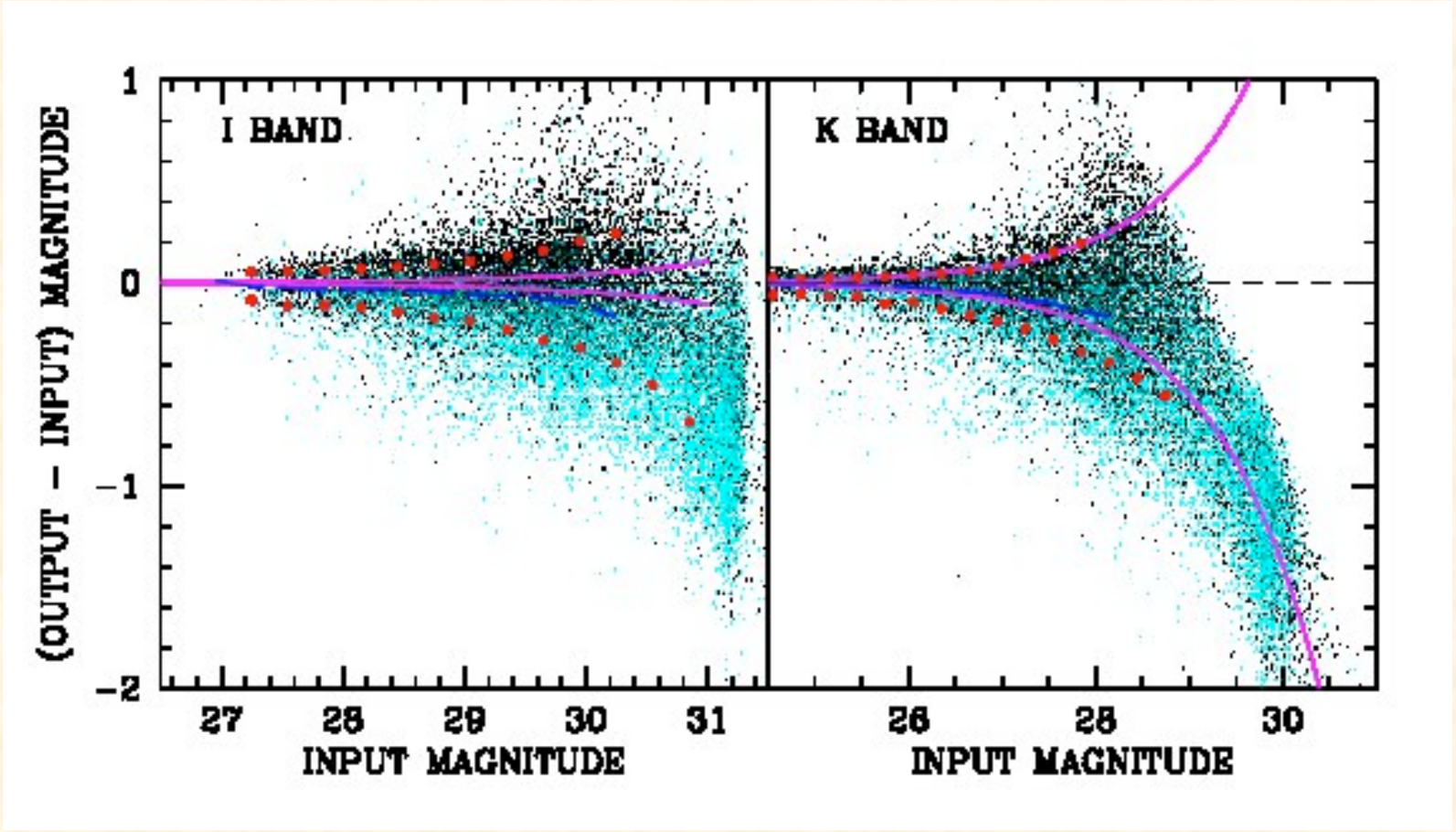


$M_{B,GAL}$ = -22
R_e = 10 Kpc
r/R_e = 0.5

MOD = 31.3
μ_B = 21.6
μ_I = 19.6
μ_J = 18.8
μ_K = 17.9

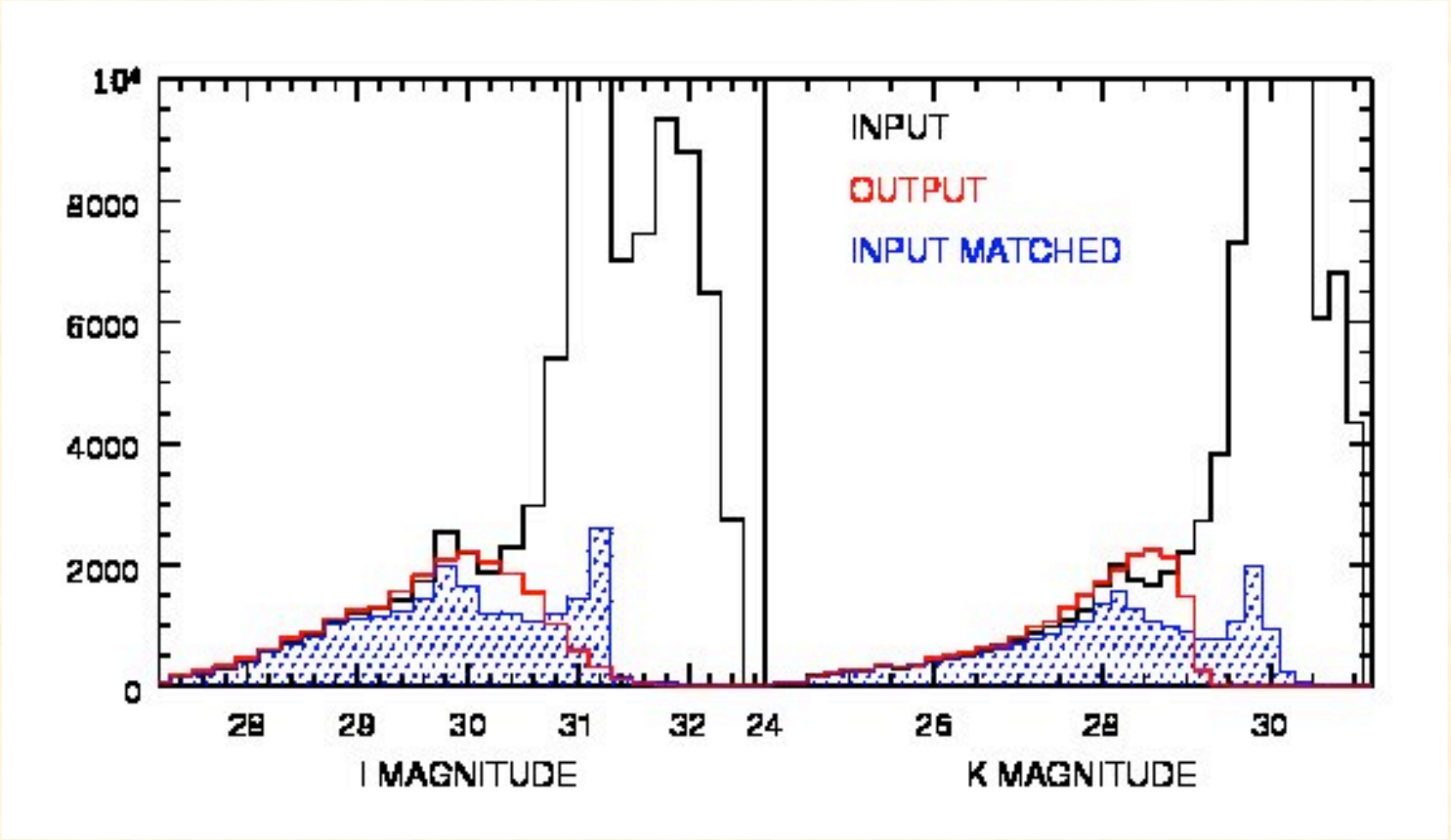
FoV = 3" x 3"
$L_B = 10.6\ 10^6\ L_{B,o}$
$L_I = 17.8\ 10^6\ L_{I,o}$
$L_J = 26.8\ 10^6\ L_{J,o}$
$L_K = 39.7\ 10^6\ L_{K,o}$
$M_{SF} = 75.3\ 10^6\ M_o$

PHOTOMETRIC ACCURACY



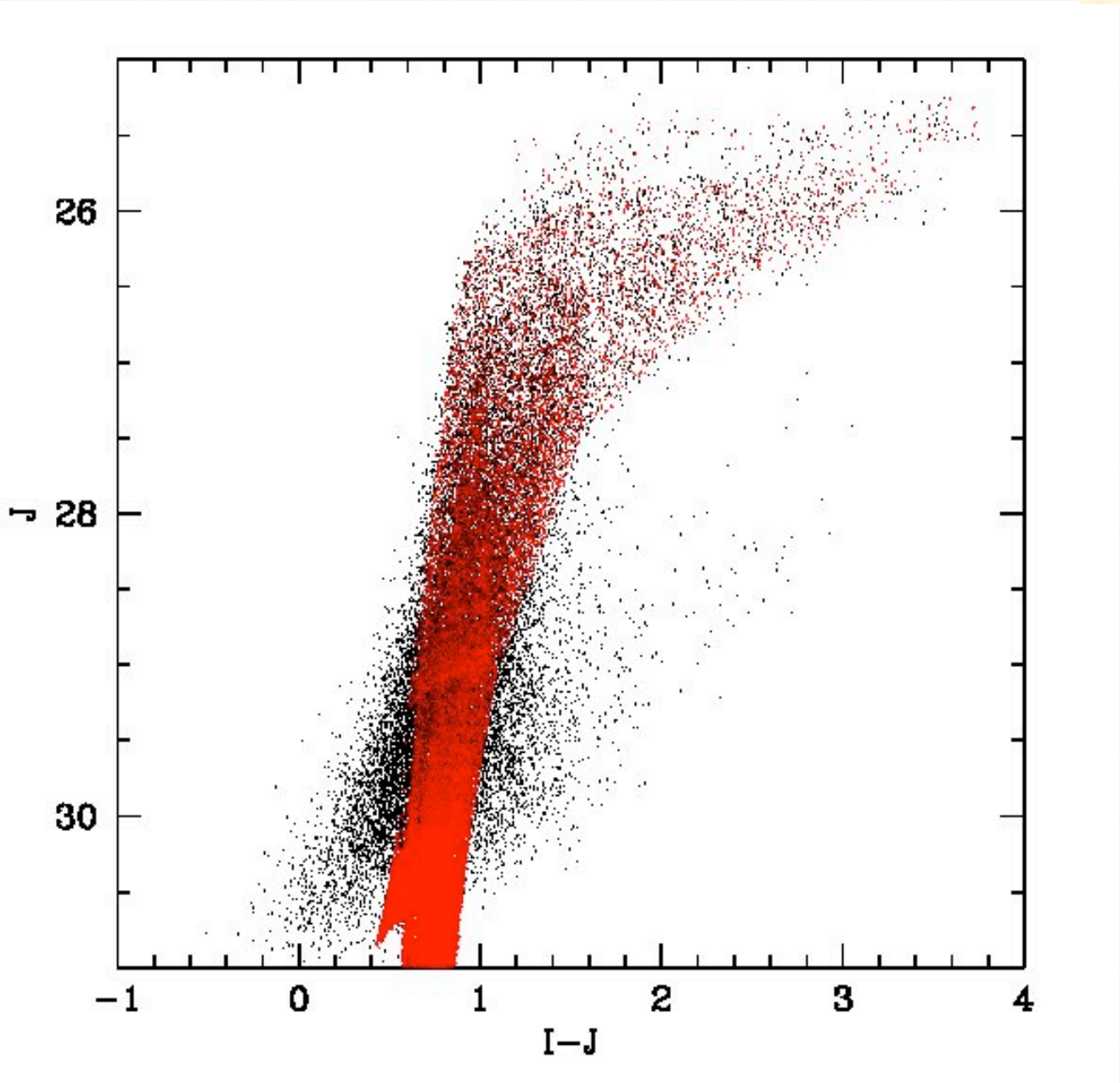
IN THE I BAND THE RELATIVE EFFECT OF THE UNDERLYING POPULATION IS VERY PRONOUNCED, BUT THE BKG IS VERY LOW: THE GLOBAL PHOTOMETRIC ACCURACY IS SIMILAR TO THE K BAND

COMPLETENESS



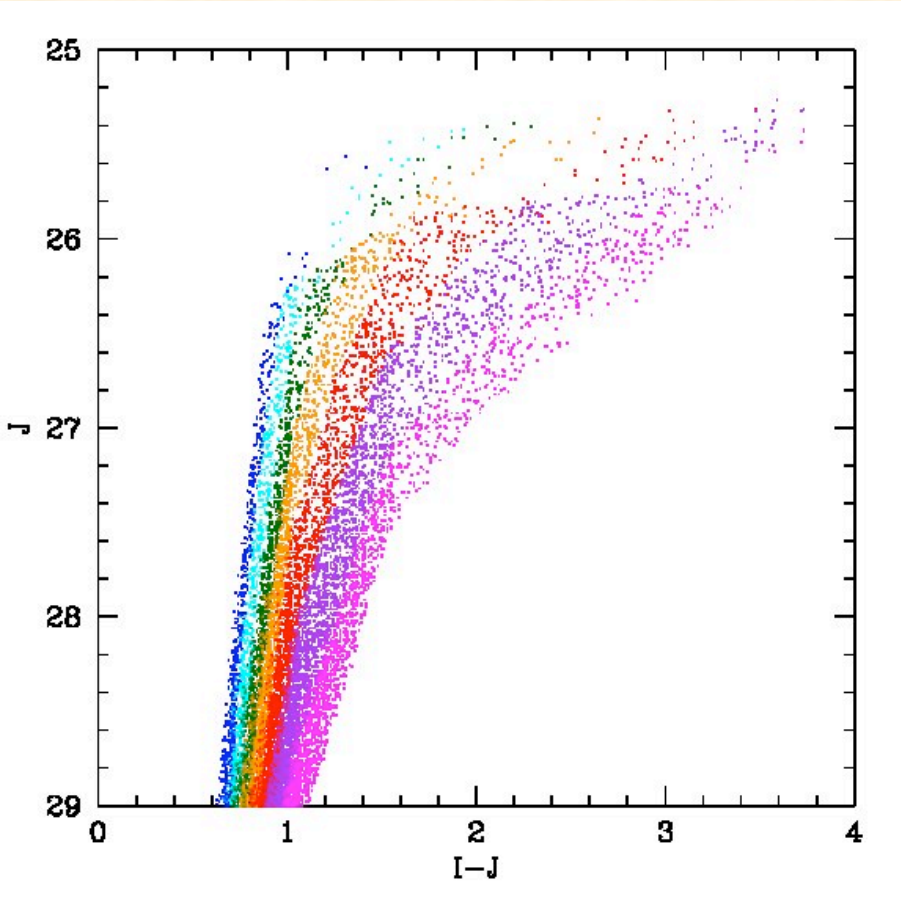
CLUMP STARS ARE PRESENT IN THE INPUT LUMINOSITY FUNCTION, SOME ARE DETECTED BUT ONLY WHEN THEIR LUMINOSITY IS BOOSTED BY BLENDING, ONLY WHEN THEIR MAGNITUDE IS MEASURED WRONG

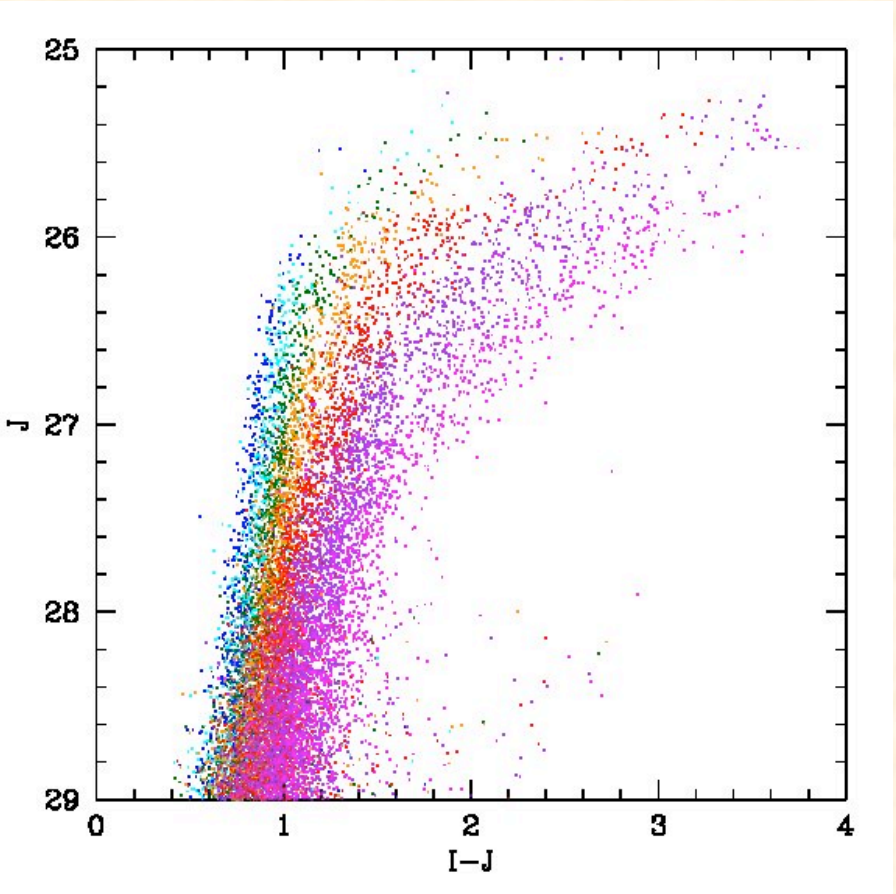
INPUT AND OUTPUT CMDs



THE COLOR WIDTH
OF THE BRIGHT RGB
(at J <~ 28) IS
WELL REPRODUCED

METALLICITY DISTRIBUTION FROM THE CMD





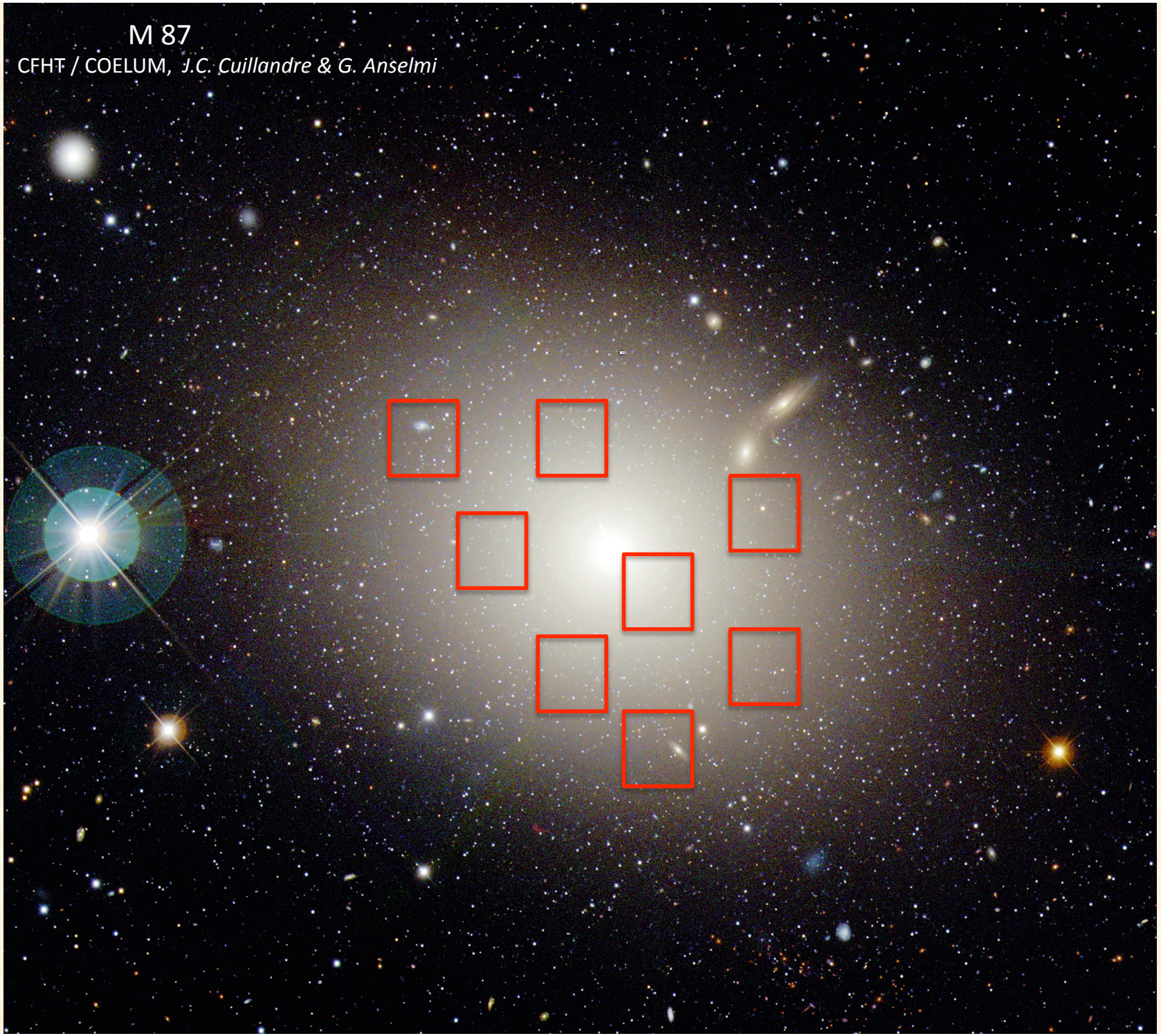
THE METALLICITY BINS ARE SEPARATED IN COLOR
IN SPITE OF THE PHOTOMETRIC ERROR

CONCLUSION

WITH MICADO@E-ELT WE WILL BE ABLE ABLE TO EFFICIENTLY MAP THE RESOLVED STELLAR POPULATIONS OF ENTIRE GIANT GALAXIES IN NEARBY GROUPS AND IN THE NEAREST CLUSTER

WE MAY DERIVE GLOBAL STAR FORMATION HISTORIES AND STUDY STELLAR POPULATION GRADIENTS ALL OVER THE GALAXY AREA WITH A FEW SHOTS

BY ANALYSING A REPRESENTATIVE SAMPLE OF GALAXIES IN VIRGO WE MAY EFFECTIVELY ADDRESS ISSUES LIKE GALAXY FORMATION PROCESS AND THE EFFECT OF GALAXY INTERACTIONS ON STAR FORMATION


M 87
CFHT / COELUM, J.C. Cuillandre & G. Anselmi