STELLAR PHOTOMETRY IN THE LOCAL GROUP DWARF GALAXY CETUS

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Introduction – Nataliya Kovalenko

Data reduction and PSF photometry - Maria Morales

Aperture photometry - Loredana Spezzi

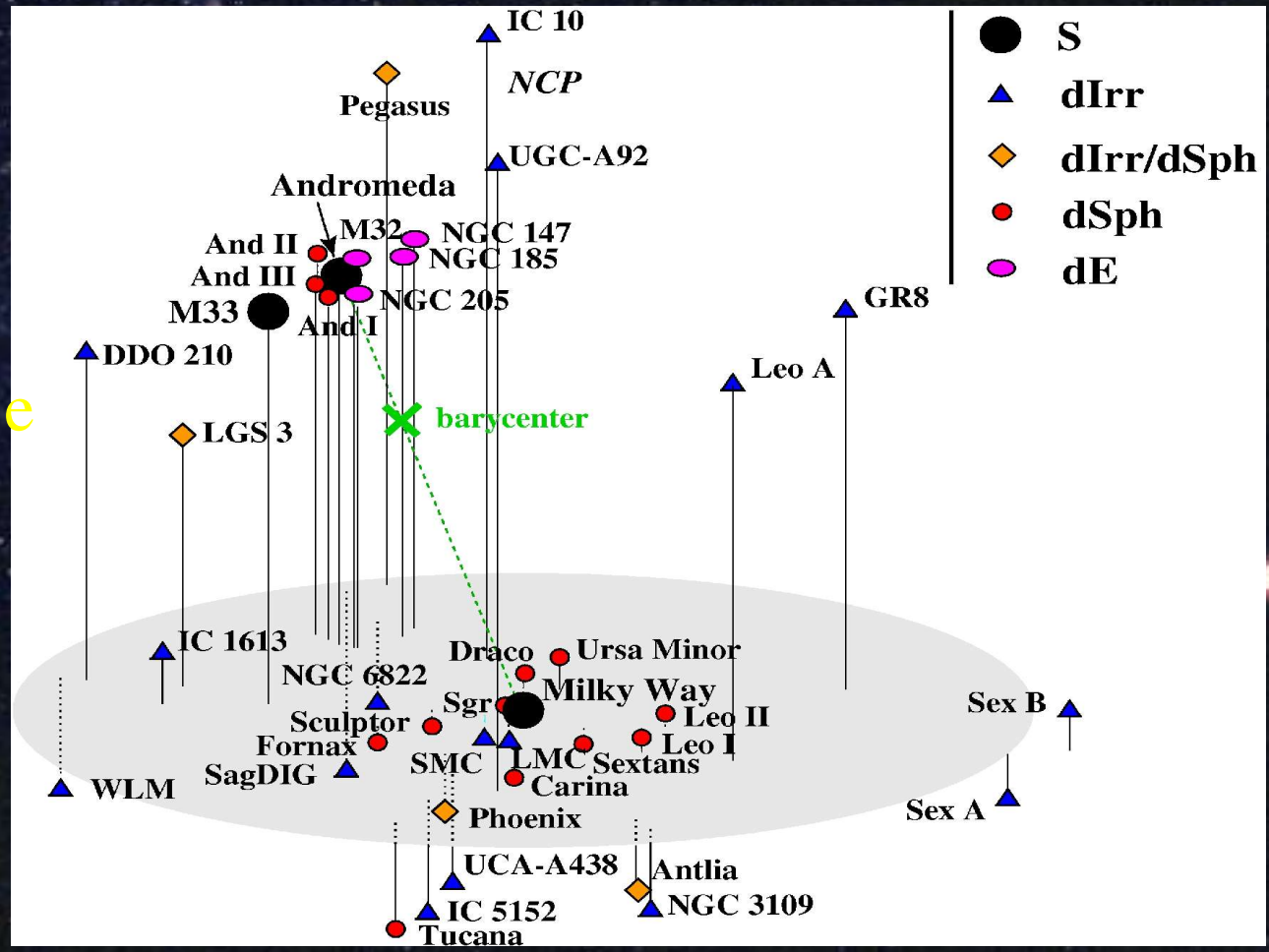
Results and conclusions - Dimitrios Gouliermis

Local Group:

about 40 galaxies with $-21^m < M_v < -8.5^m$

and masses in the range $10^7 M_o$ - $10^{12} M_o$

dwarfs: $M_v > -18^m$



Why are dwarf galaxies of interest to us?

- They are most numerous galaxies in the Universe

- Possibly they are first structures to form in the early Universe, and play a key role in formation and evolution of bigger systems

- Local Group dwarf galaxies provide us a unique opportunity to study them in detail

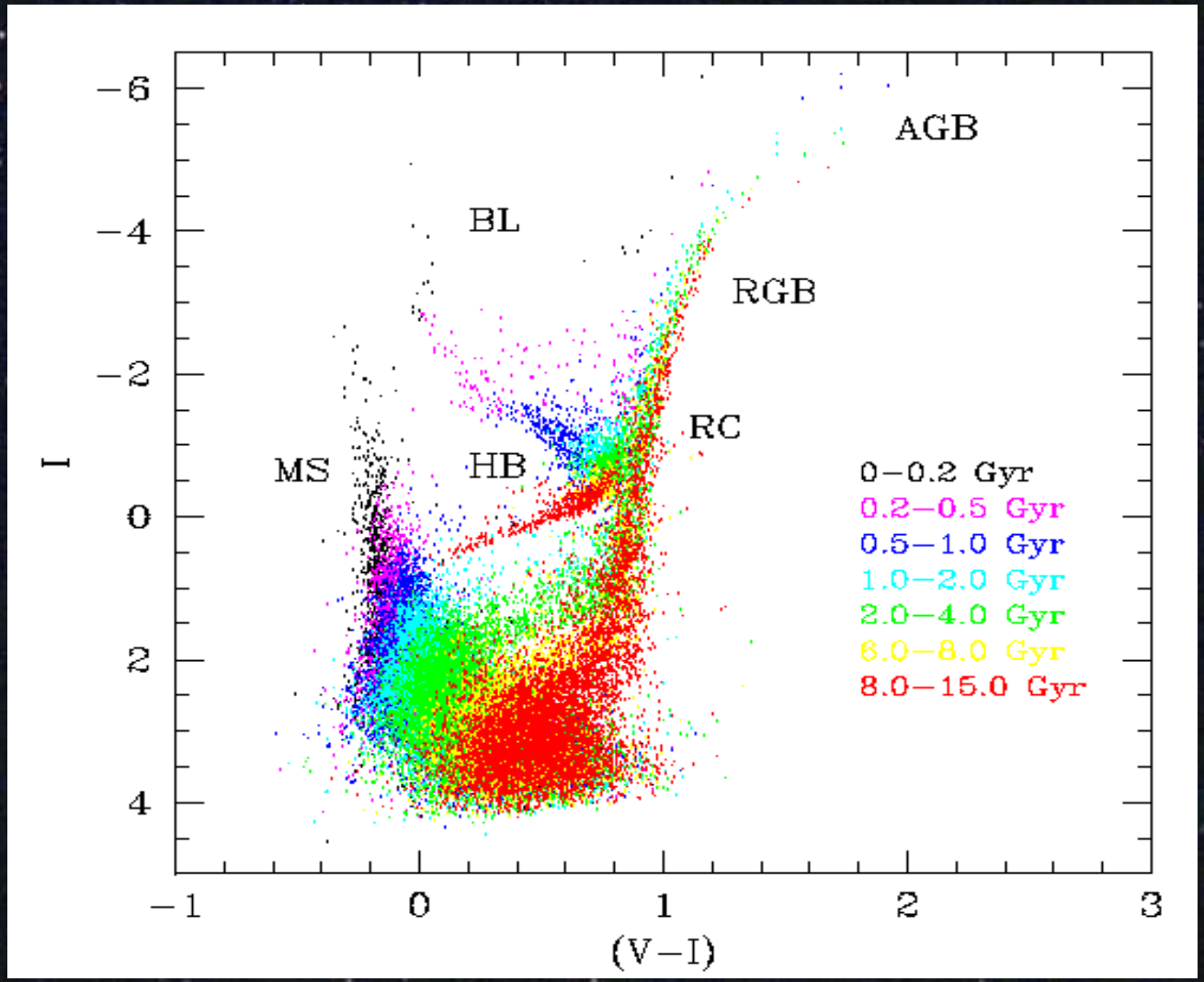
How can we study Local Group dwarf galaxies?

- By studying Star Formation History

- A tool: Color-Magnitude Diagram (CMD), which is observable counterpart to HRD

- CMD shows whether stars of different types, metallicities, and ages are present in the galaxy

Typical Color-Magnitude Diagram for a dwarf galaxy



What do we know about Cetus dwarf galaxy?

$M_v = -10.1^m$, $m_v = 14.5^m$

Distance 800 Kpc, so Distance Modulus is
$m_v - M_v = 5\lg D - 5 = 24.5^m$

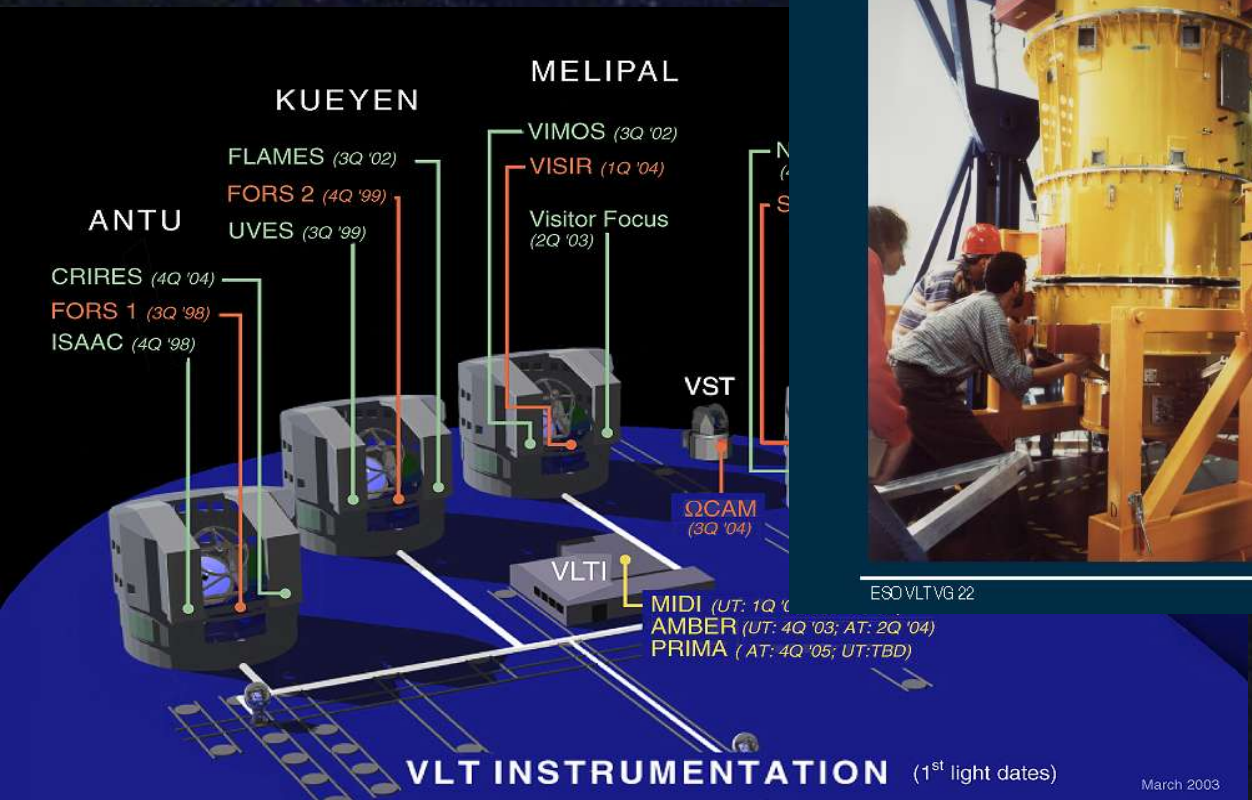
Apparent size 1-2 Kpc

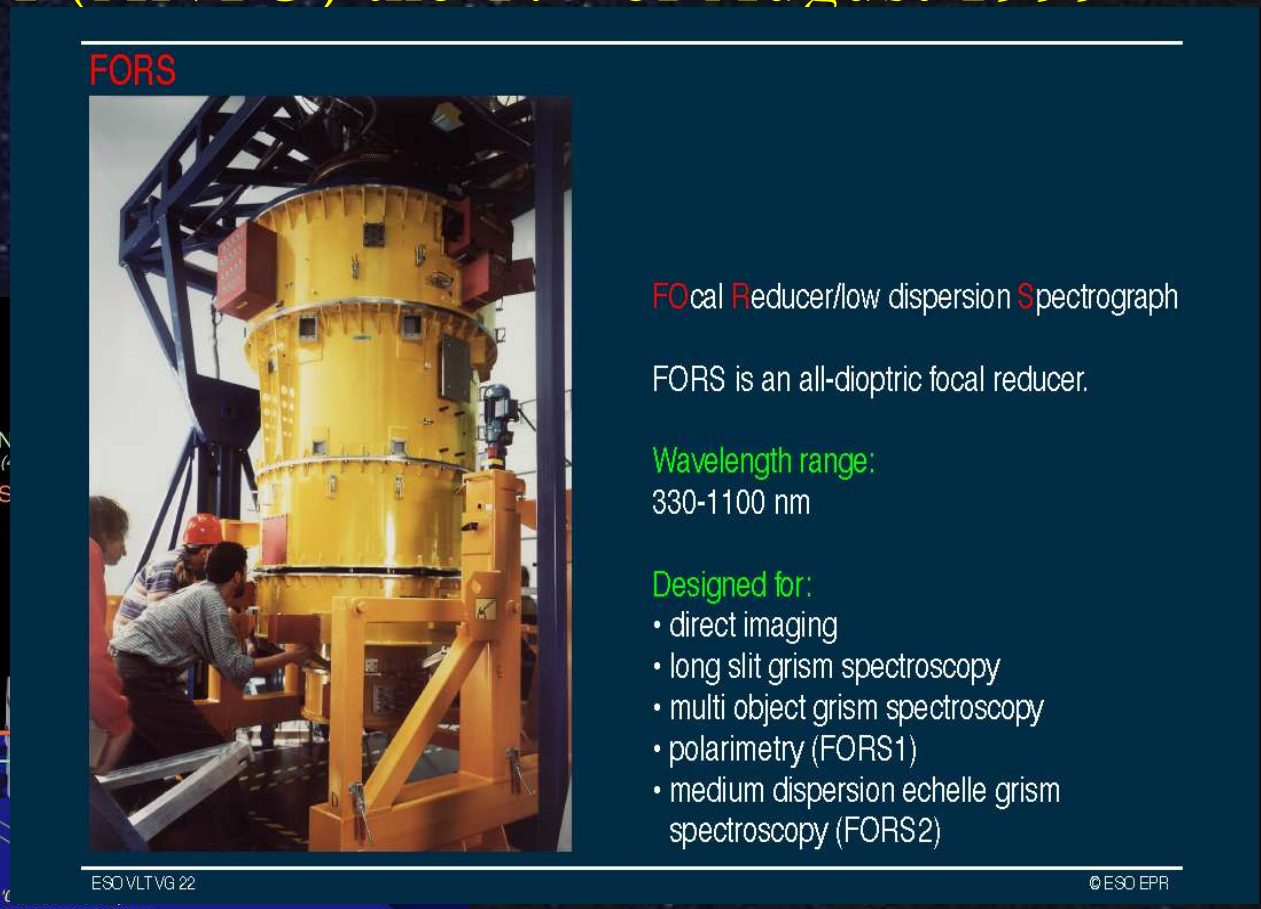
Metallicity [M/H]=-1.9±0.2

Discovered in 1999 by A.Whiting, G.Hau, and M.Irwin

Our archival data (images in B and R bands) were taken with FORS1 on UT1 (ANTU) the 17th of August 1999

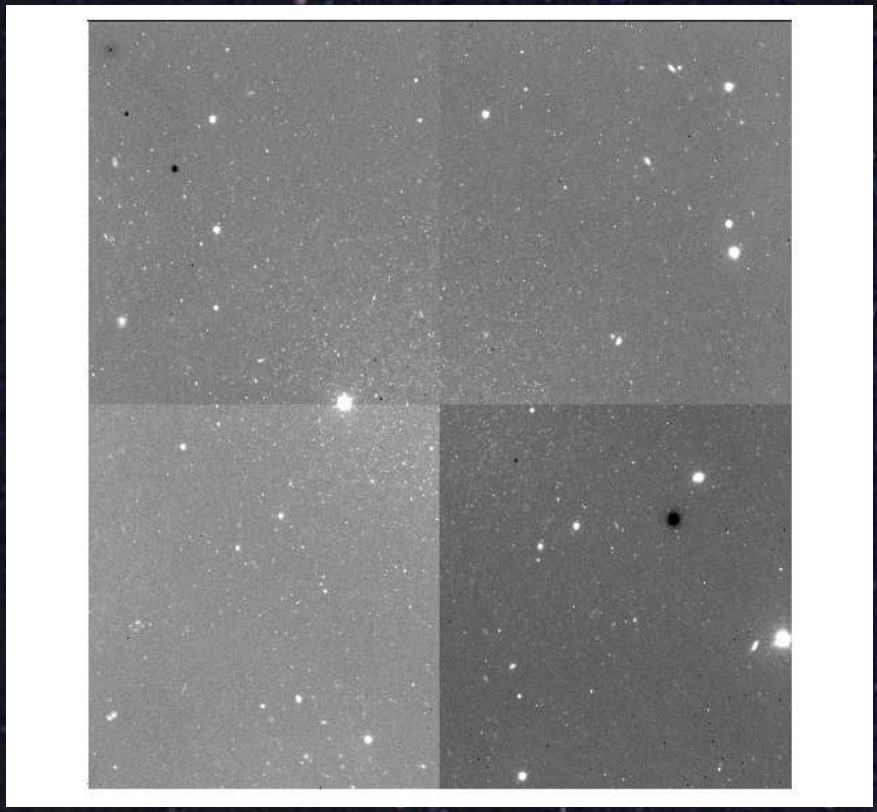
http://archive.eso.org/



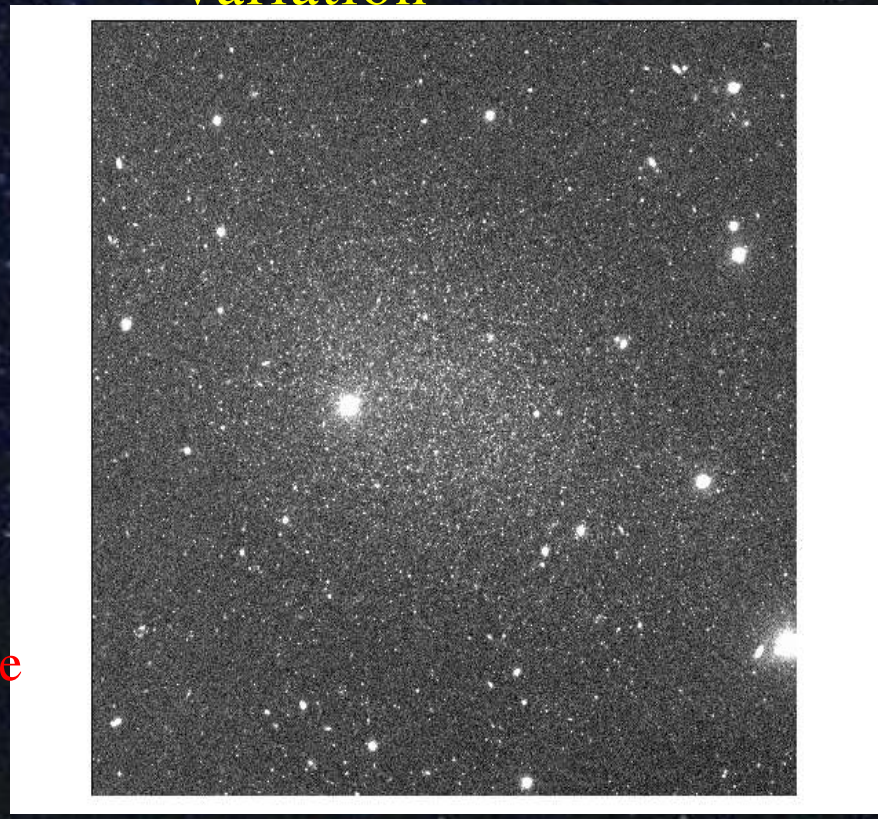


DATA REDUCTION

Removal of instrument signature:
BIAS: electronic offset
FLAT: position dependent sensitivi
variation



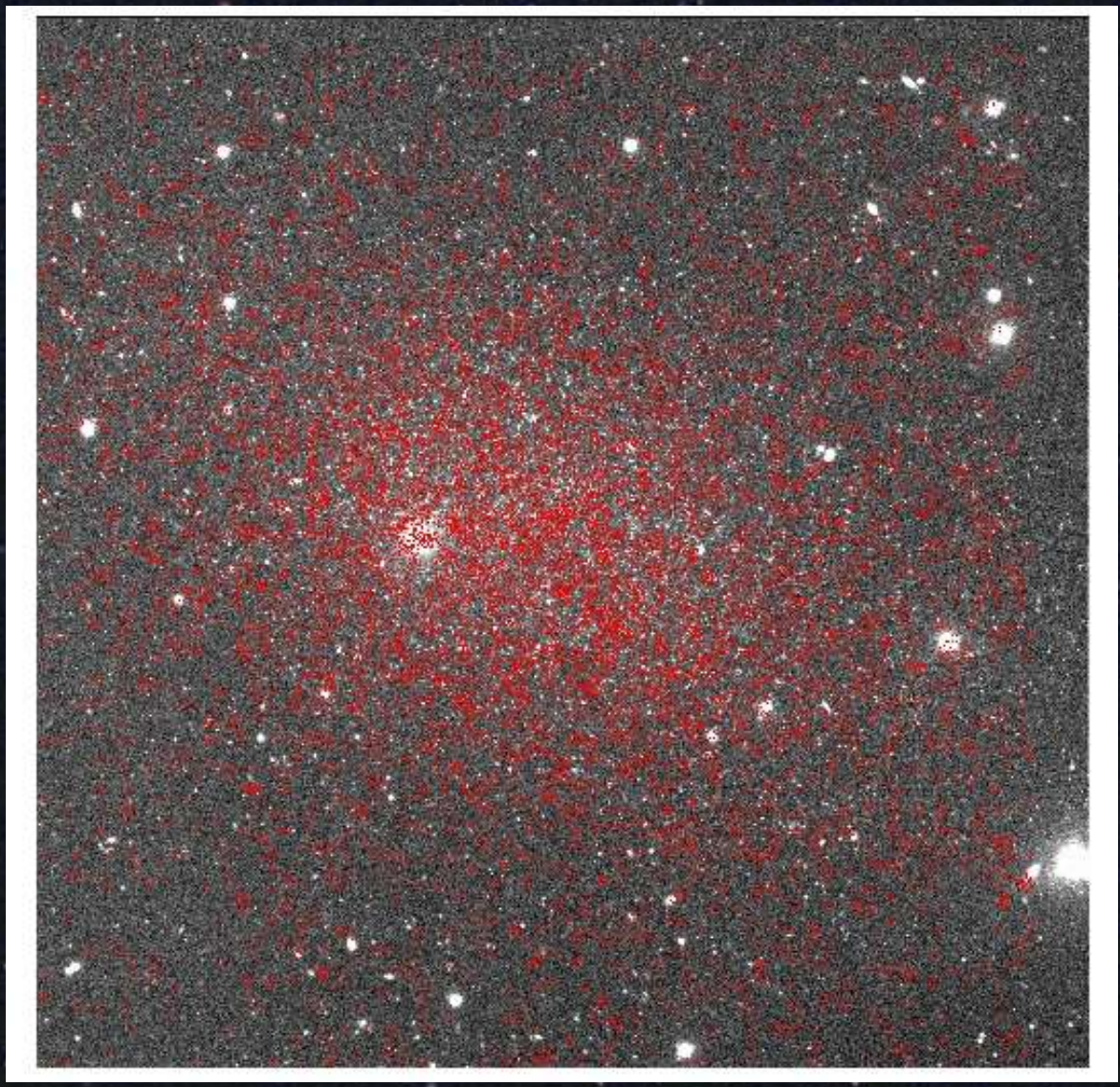
Raw Image



Reduced Image

The data reduction ecuation:
Science Image = (Raw Image – Master Bias)/(Master Flat)

FINDING STARS AND MEASURING MAGNITUDE

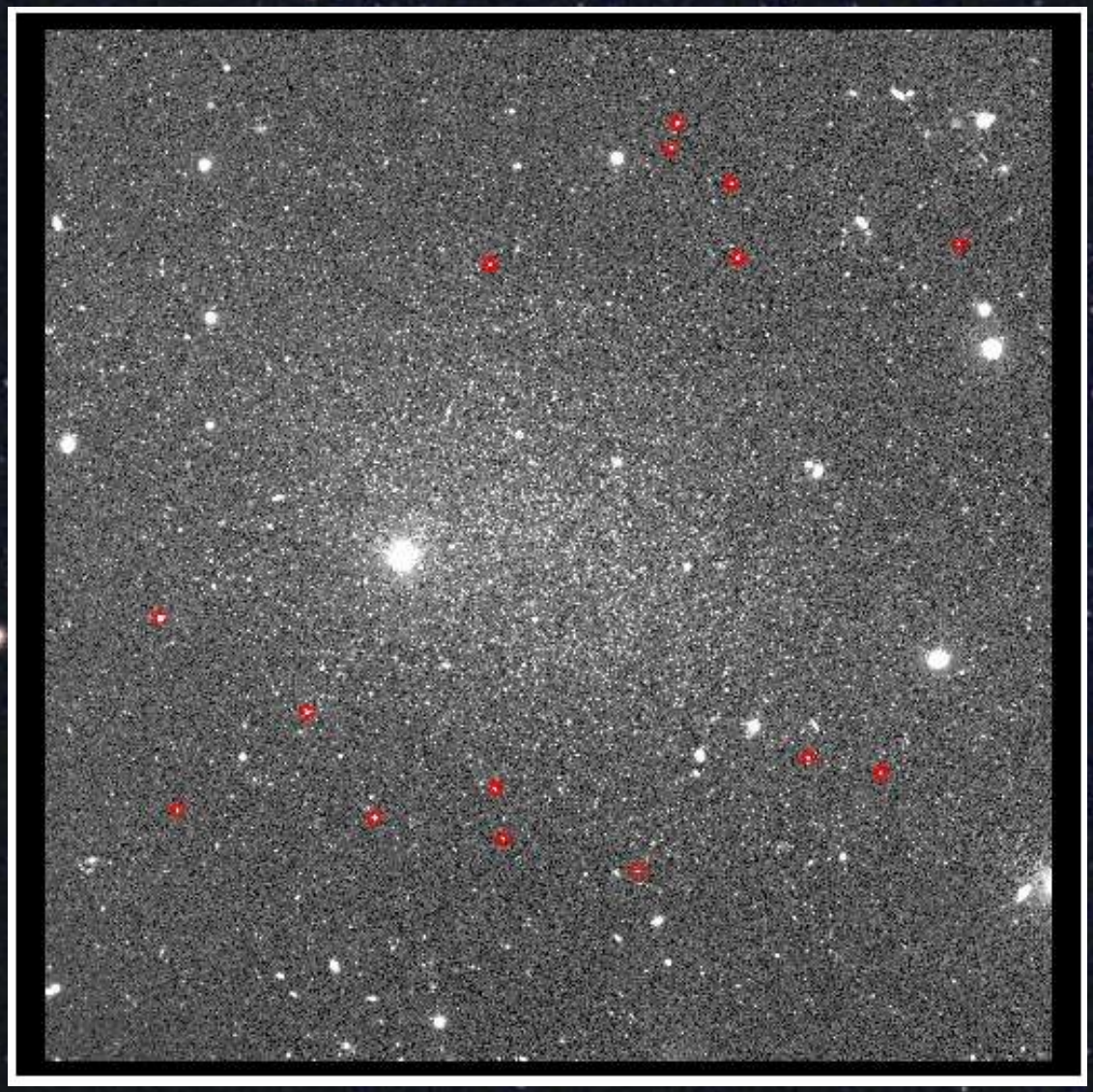


Measuring Magnitudes :

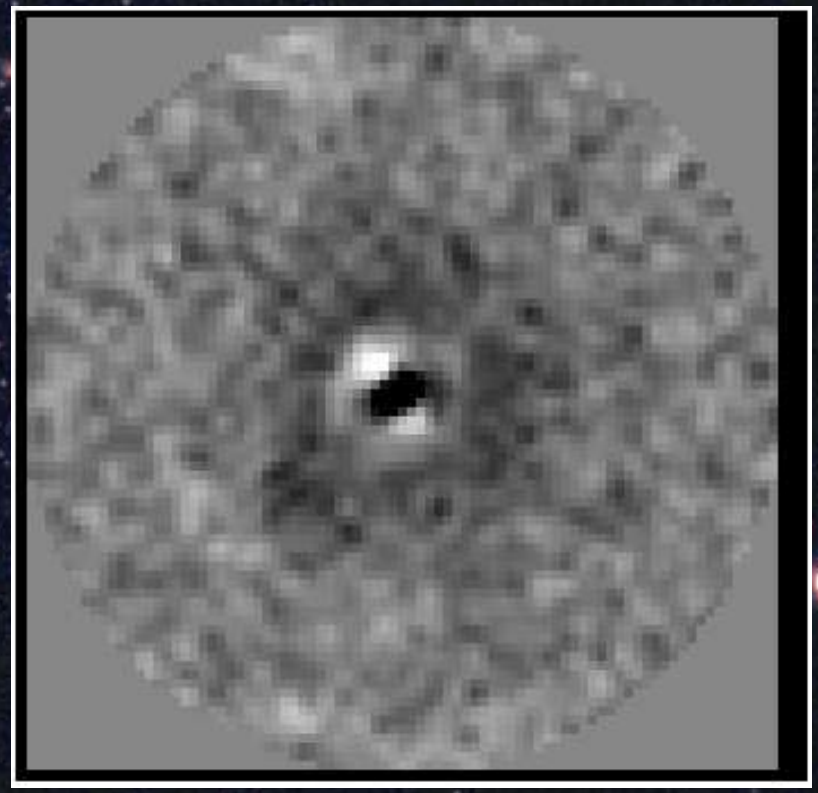
Crowded field =>

=> PSF Photometry

PSF PHOTOMETRY

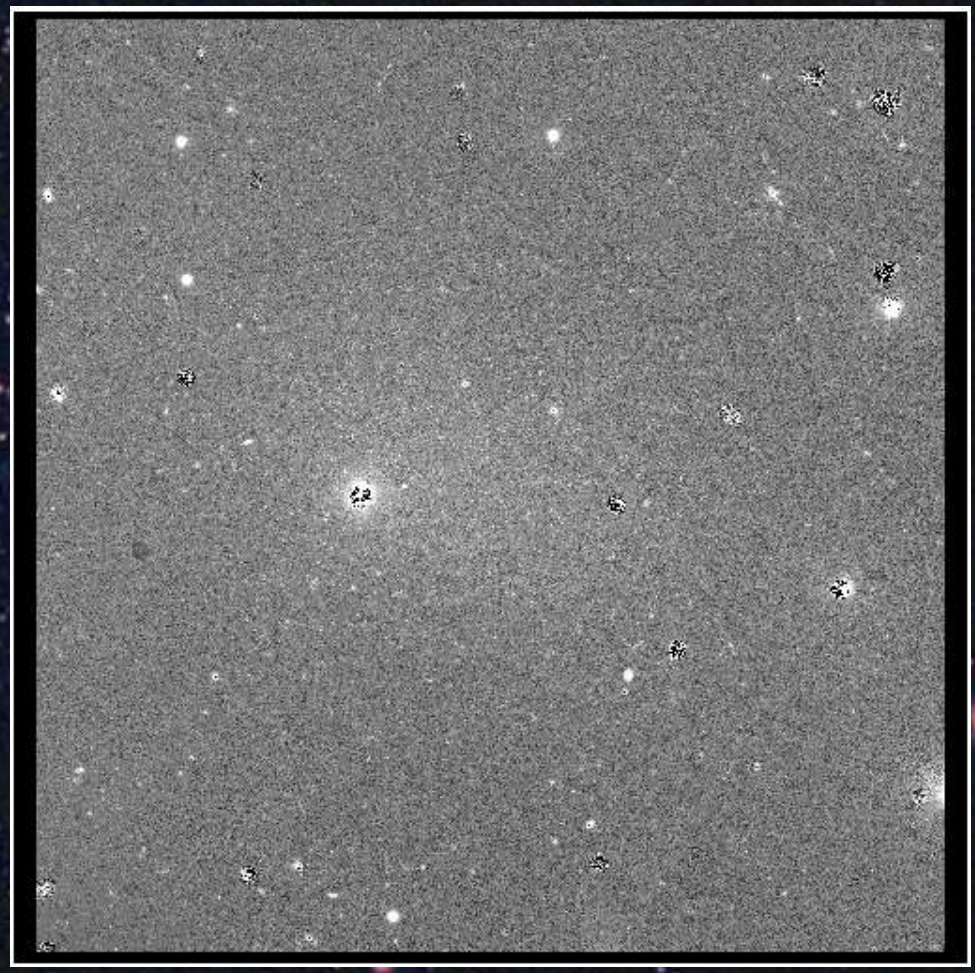


PSF Stars

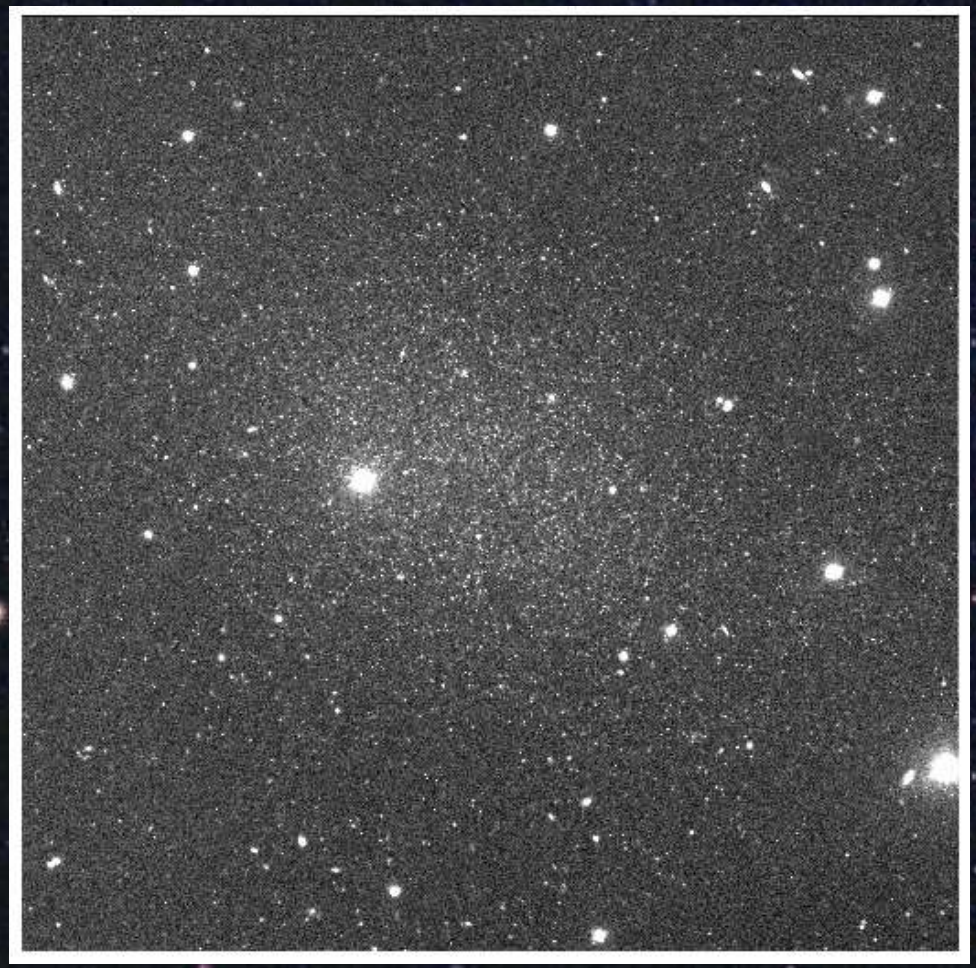


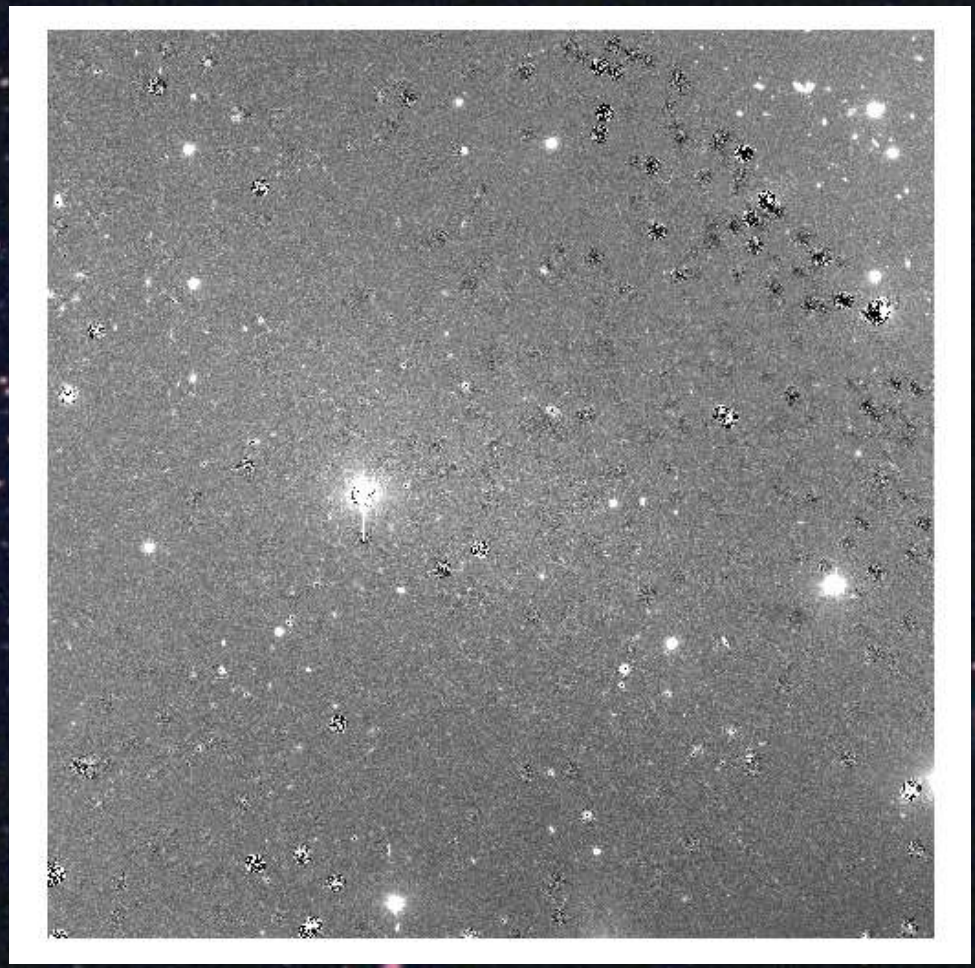
Final Residual Image of the PSF

PSF PHOTOMETRY



PSF PHOTOMETRY

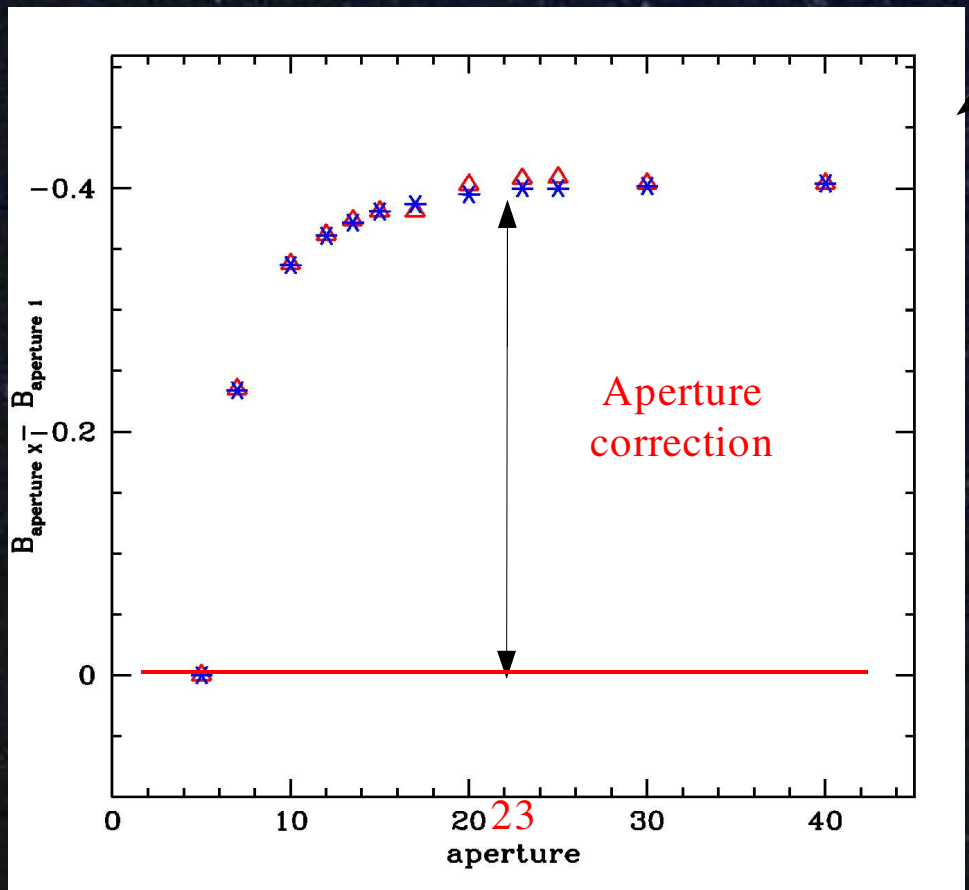




Photometry of Standard Fields (*IRAF*)

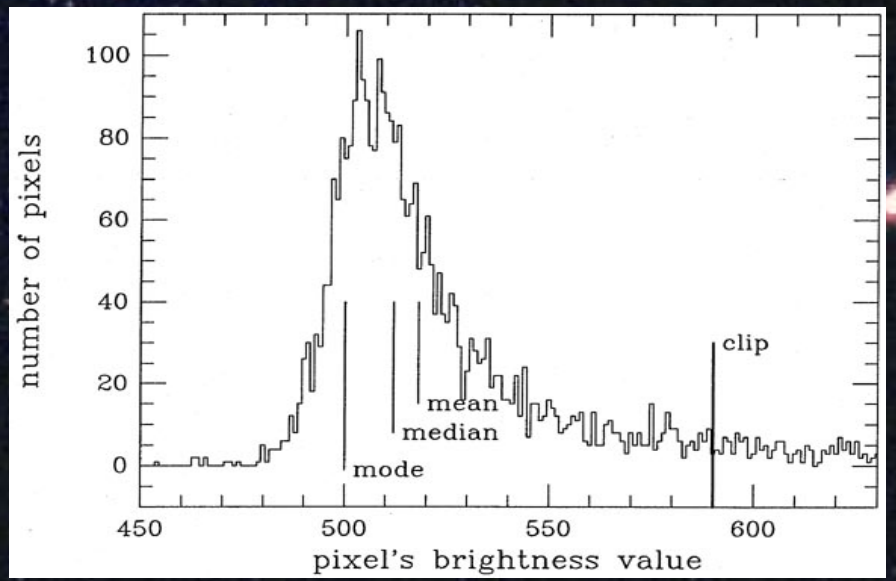
- **DAOFIND** Estimate star position and brightness
- **APPHOT** Aperture Photometry

↙ It is the most accurate flux measurement for non-crowded fields;



Integrate counts within a given circular aperture and subtract the background counts estimated in a nearby region.

mode = 3*median-2*mean



Photometric Calibration

Two standard fileds:

PG2331 *(23:33:47.9,+05:46:16.8)*

PG1657 *(16:59:32.4,+07:42:52.0)*

Standard Catalog:

Stetson photometric sequence

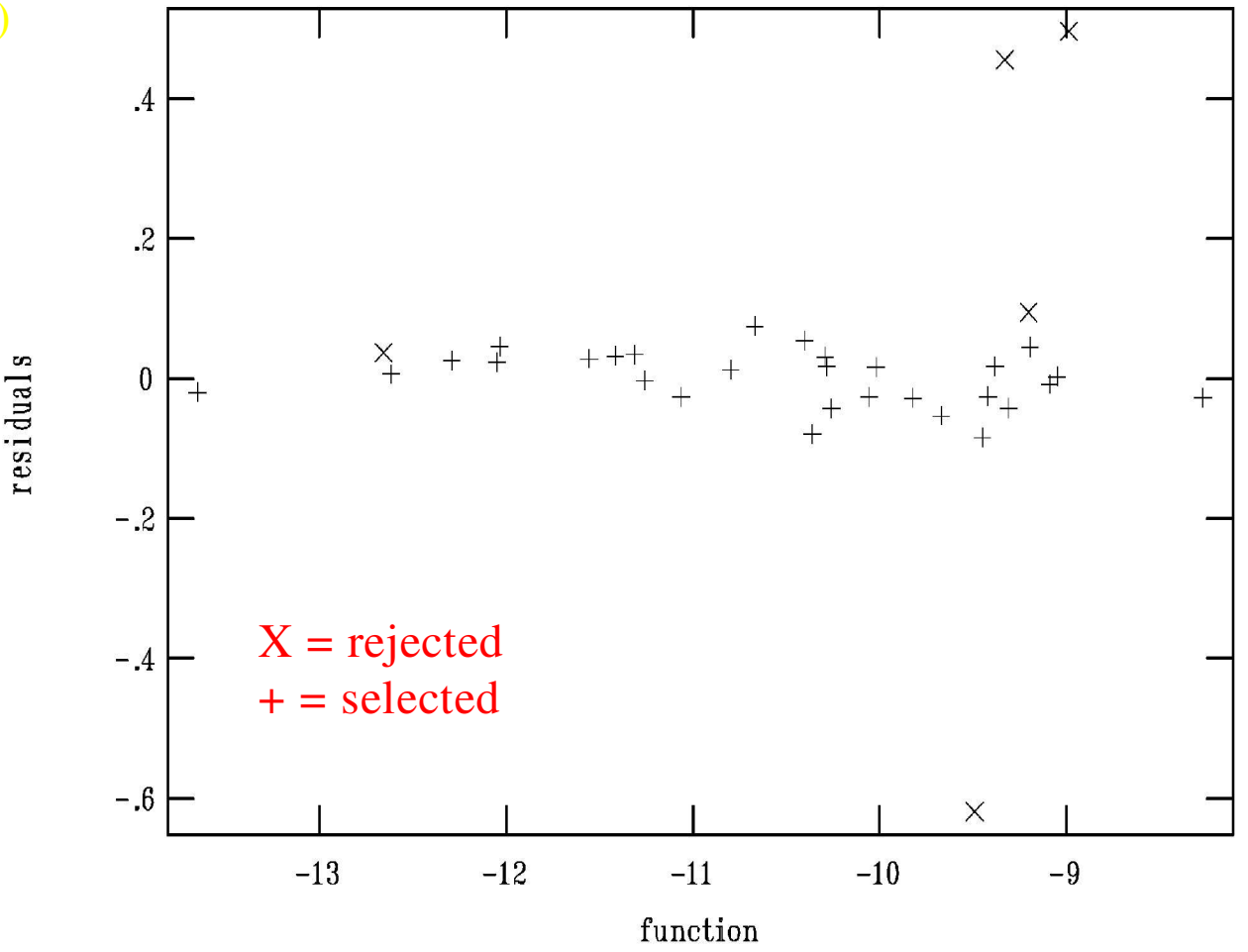
(Stetson P. 2000,PASP,112,773)

$$B_{instr} = B_{cat} + k_B * X + Z_B + C_B * (B_{cat} - R_{cat})$$

$$R_{instr} = R_{cat} + k_R * X + Z_R + C_R * (B_{cat} - R_{cat})$$

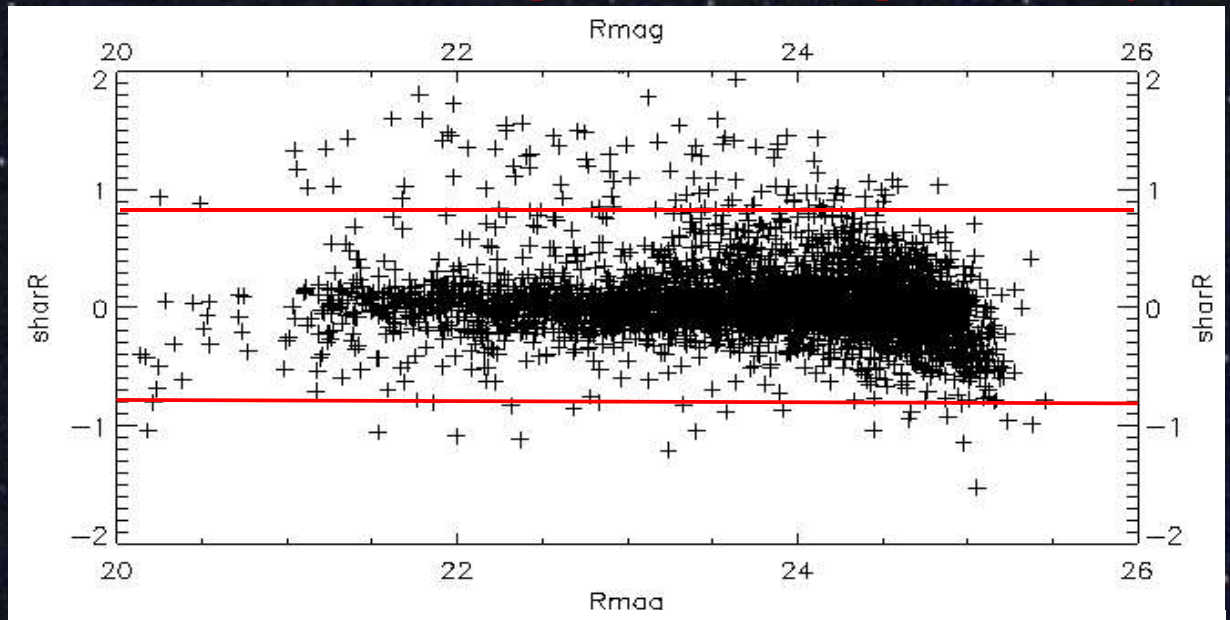
K= extinction coefficient
X= air mass
Z= zero point
C= color term

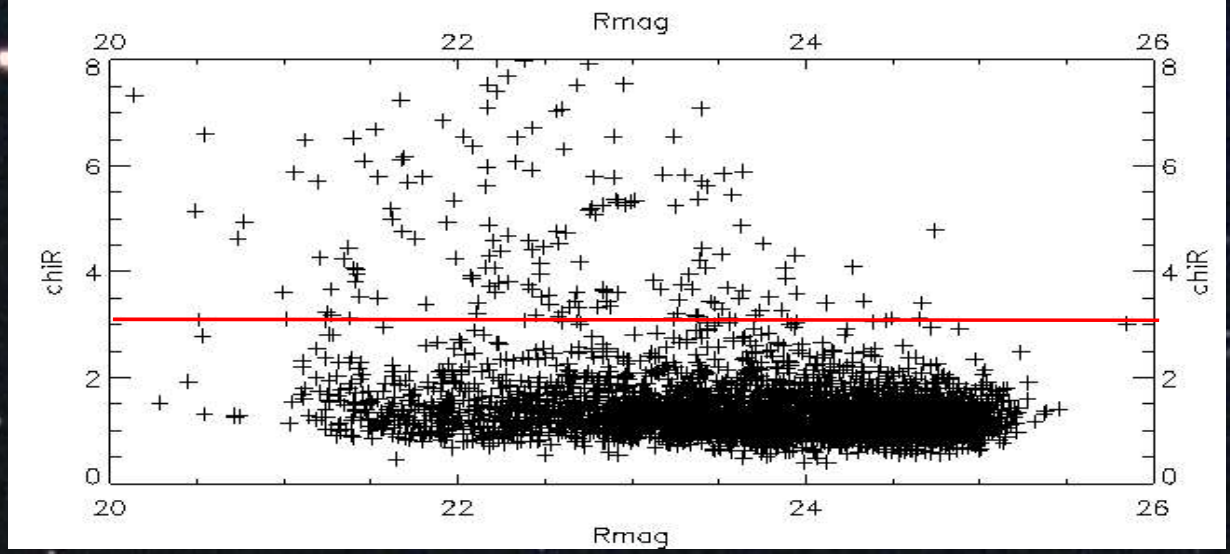
	FORS1 Phot. Coeff.	Our Phot. Coeff.
k_B	0.229±0.007	0.232±0.023
k_R	**0.073±0.007**	0.073
Z_B	-27.395±0.005	-27.427±0.043
Z_R	-27.695±0.006	-27.608±0.022



Star Selection

Two parameters to help eliminating non-stellar objects:





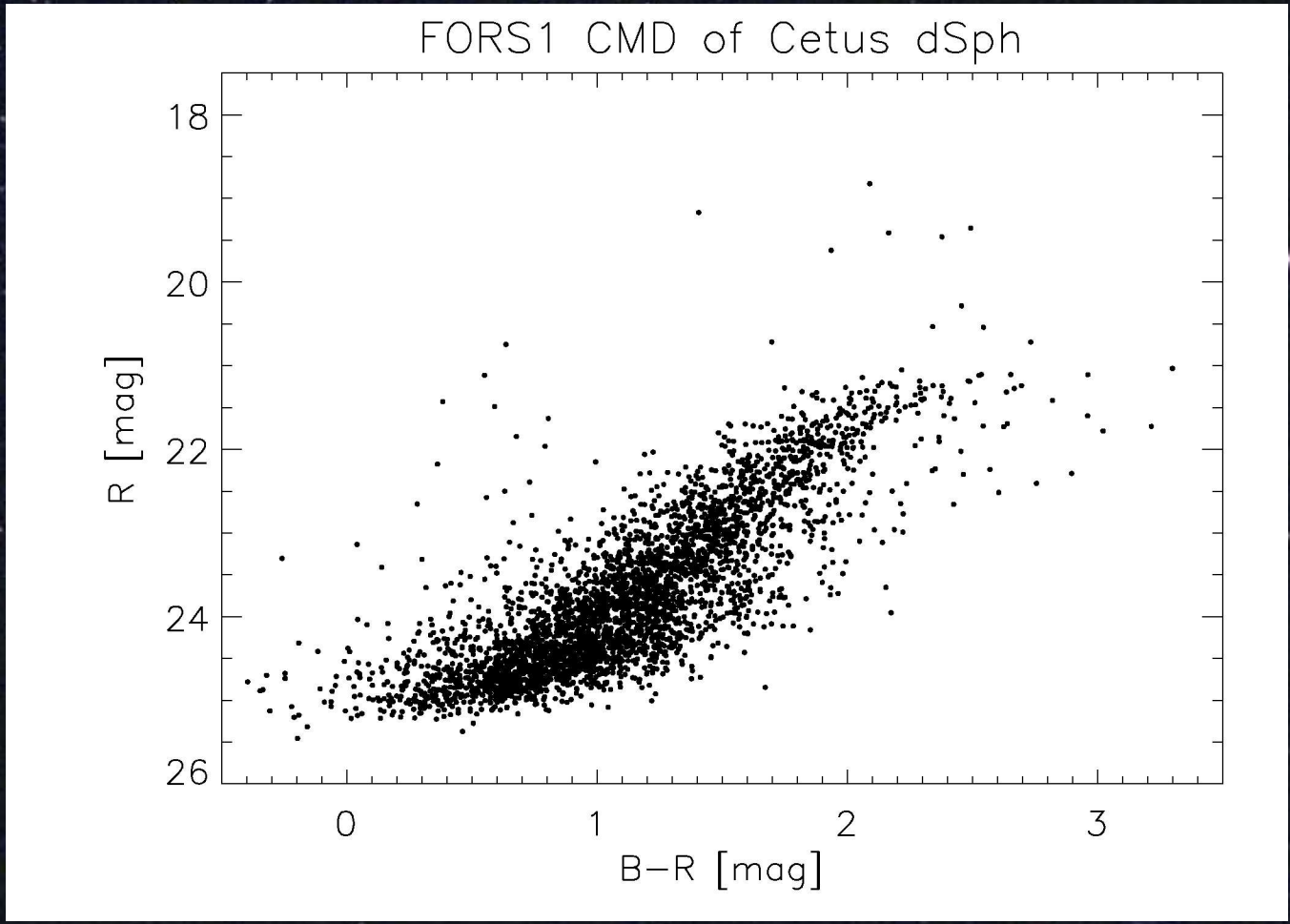
SHARPNESS--> Ideal value= 0

Selection: -0.8 < SHARP < 0.8

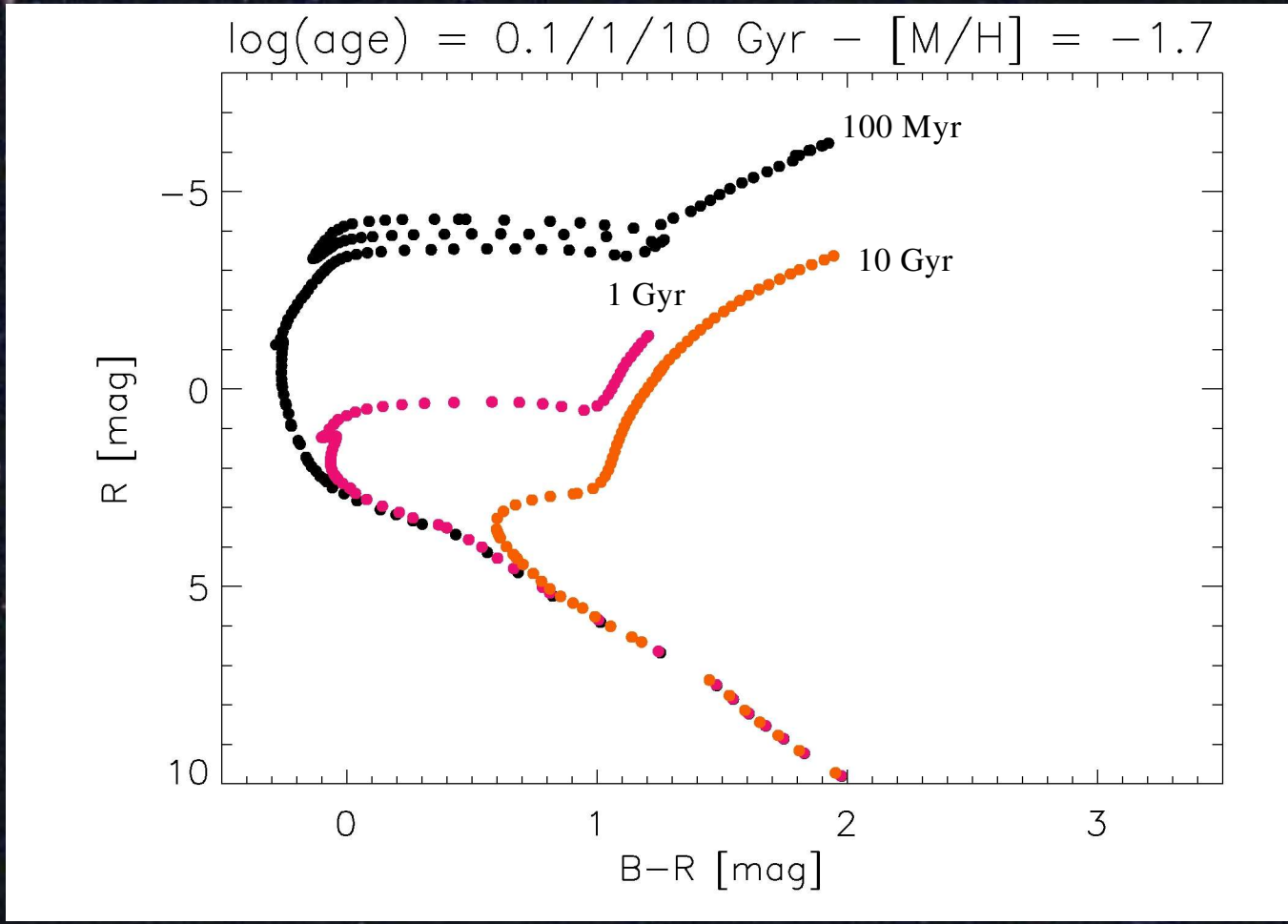
CHI--> Ideal value= 1

Selection: CHI<3

Color-Magnitude Diagram of Cetus Dwarf Galaxy

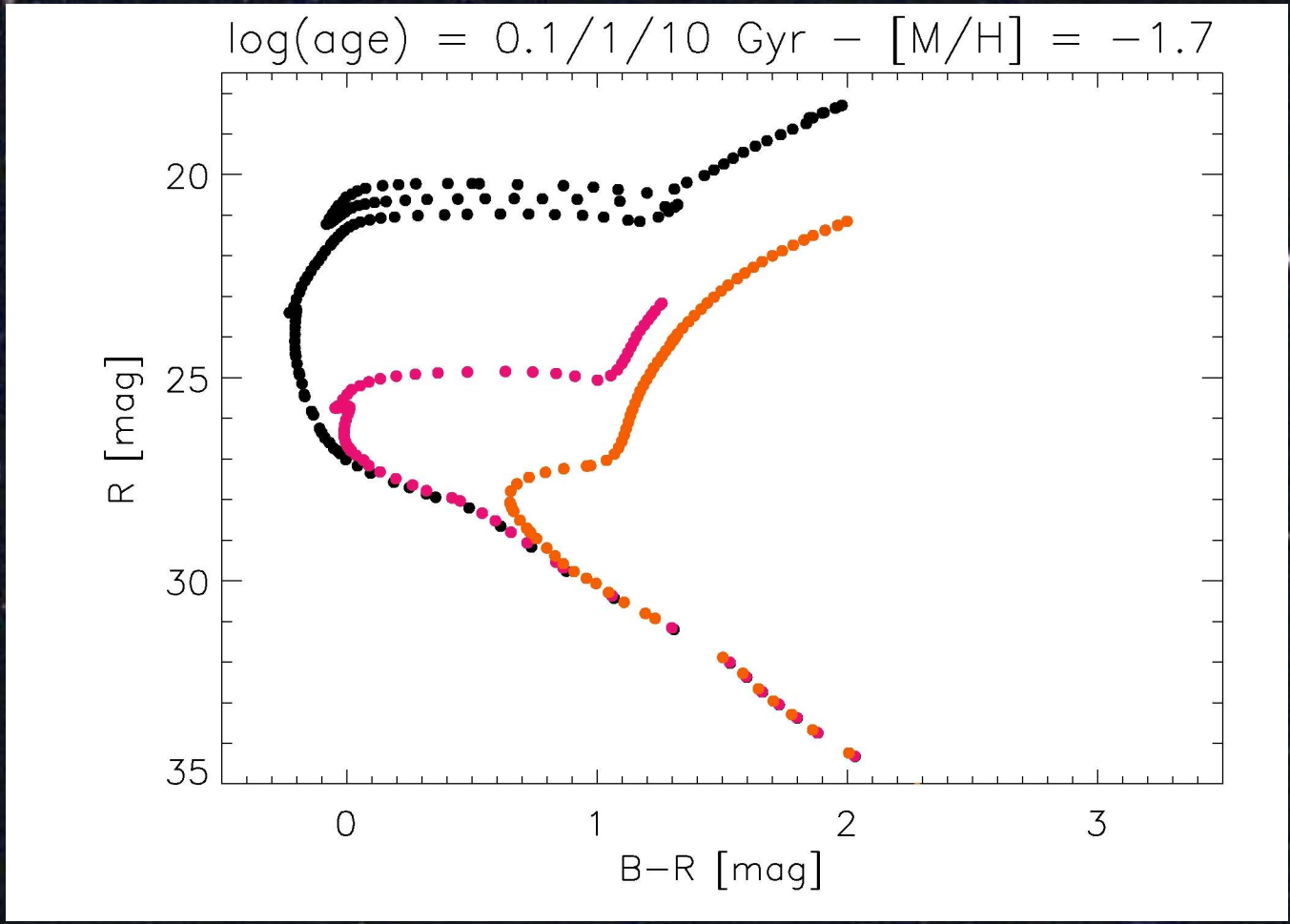


Isochrone Models



Models from Girardi et al. 2000 (http://pleiadi.pd.astro.it/)

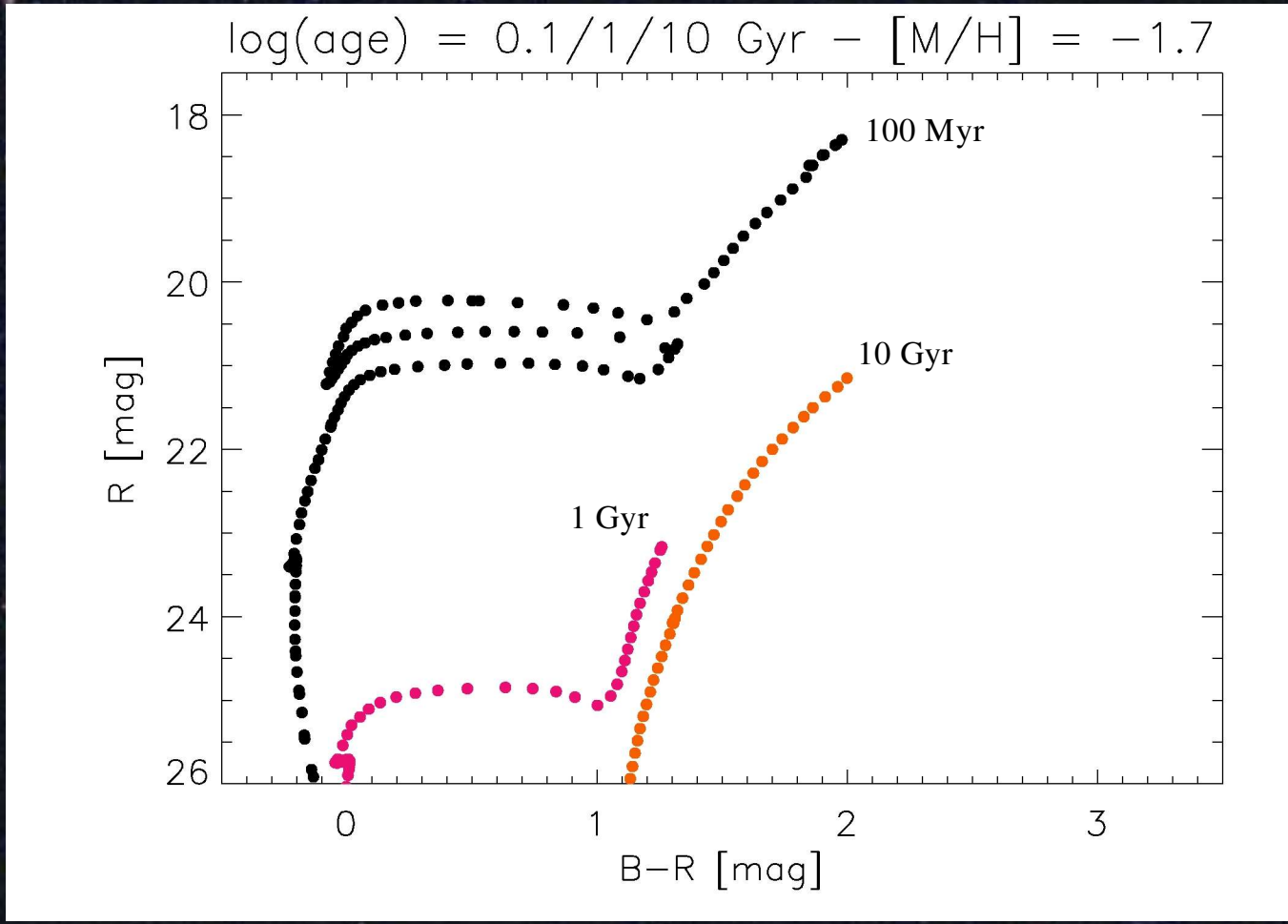
Isochrone Models



Reddening: E(B-V)~0.03 (Whiting, Hau & Irwin 1999)

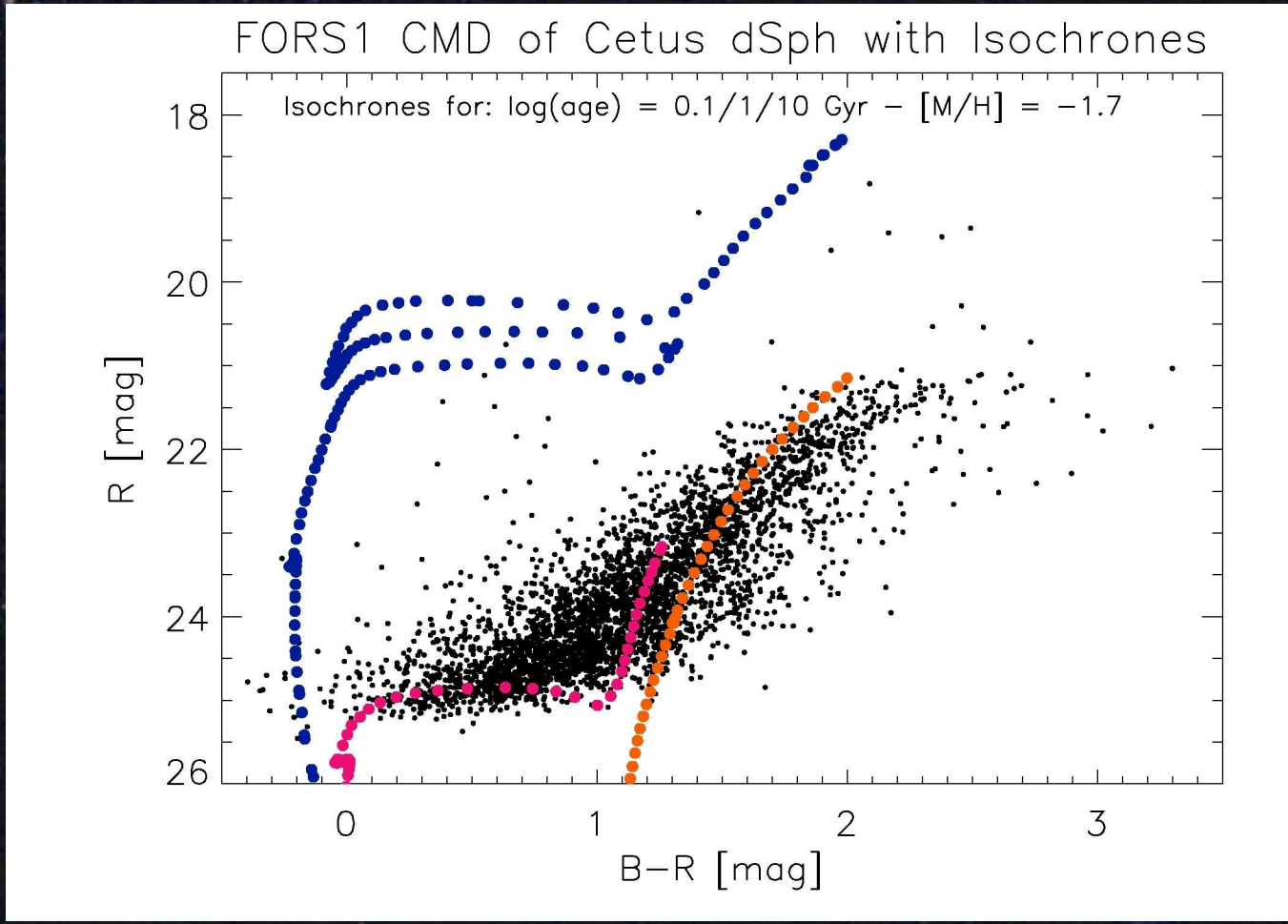
Distance Modulus $m_R - M_R = 24.45$ $[R - M_R + (m_R - M_R)$

Isochrone Models

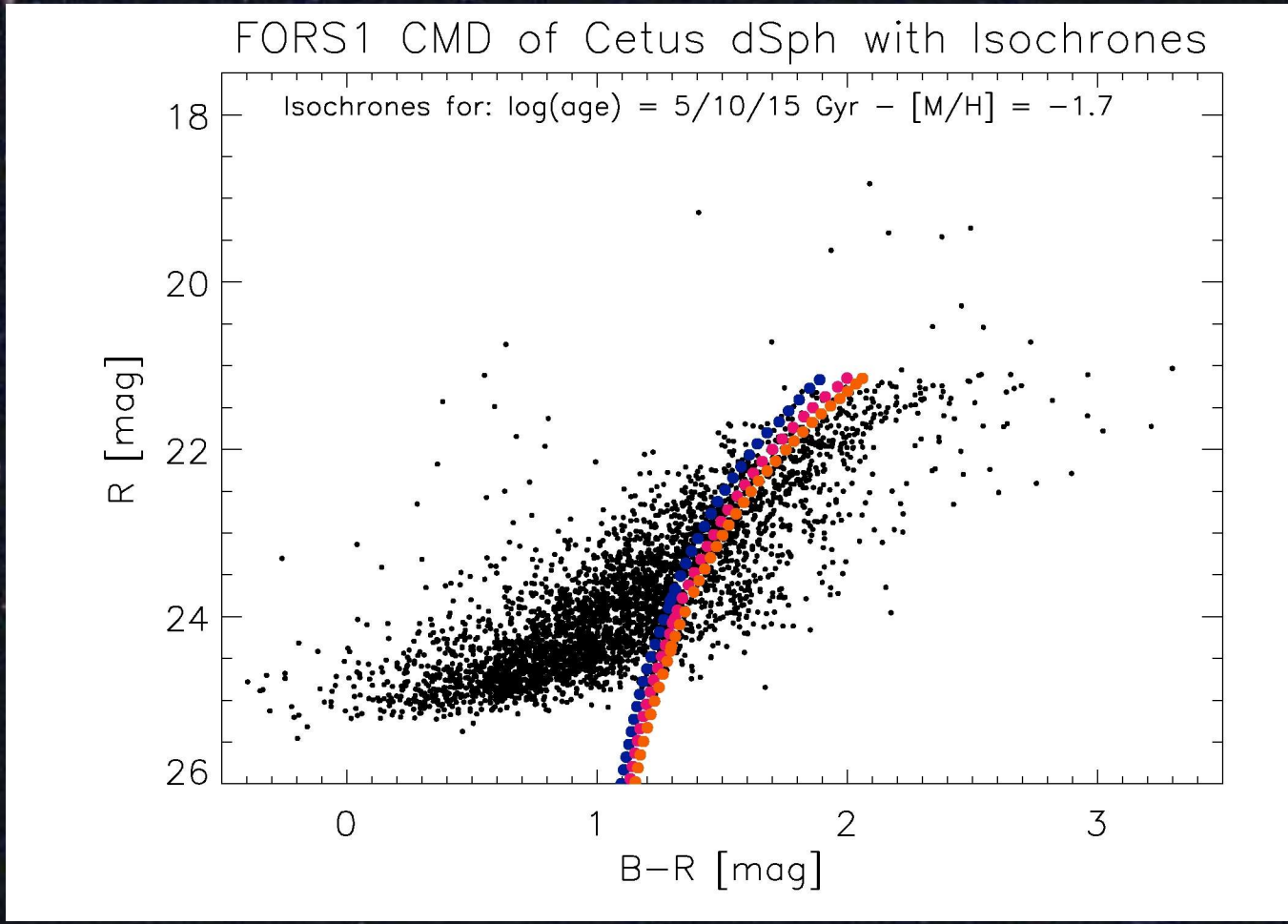


Red Giants Branch Area

Color-Magnitude Diagram of Cetus Dwarf Galaxy with Models

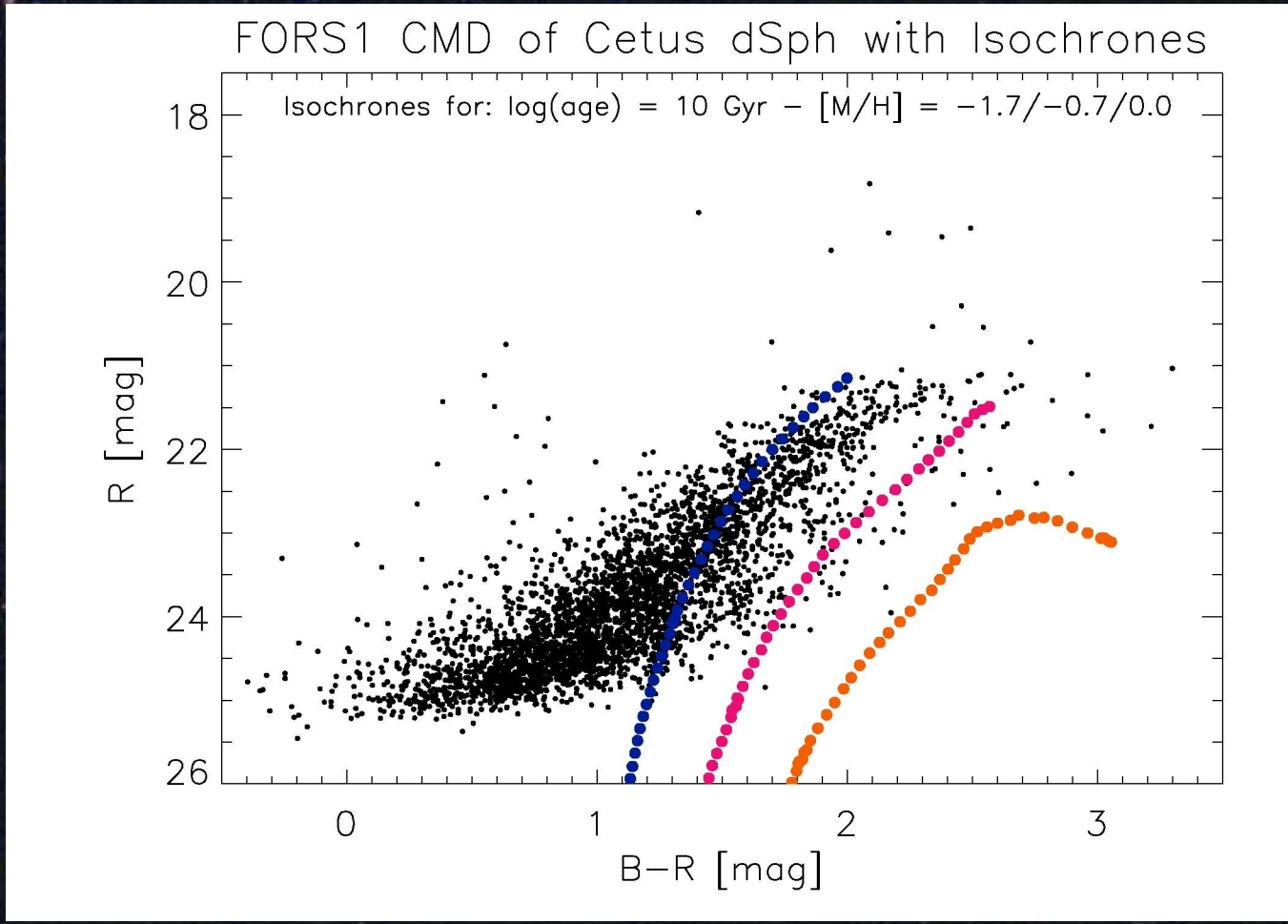


Color-Magnitude Diagram of Cetus Dwarf Galaxy with Models



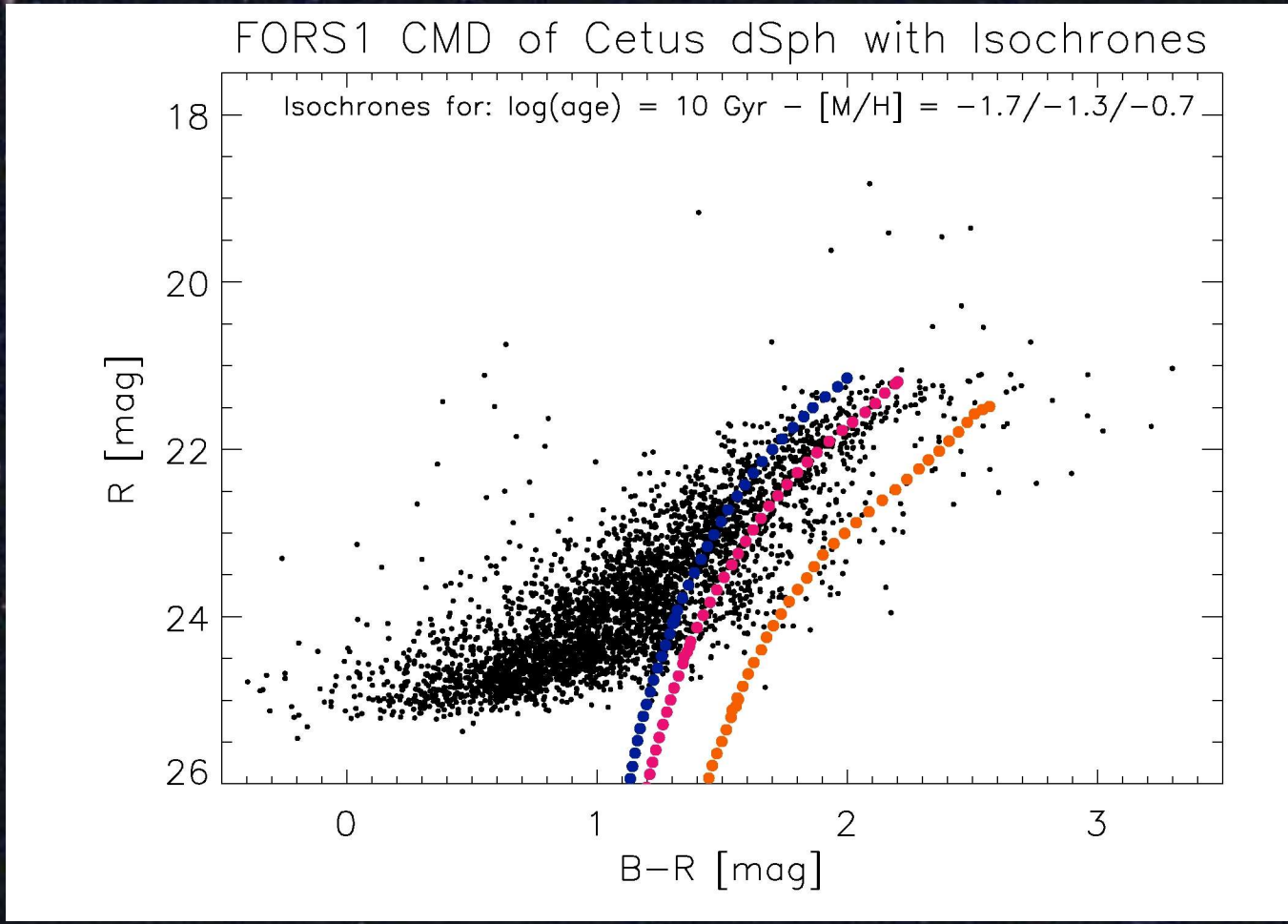
No Strong Age Dependence for the RGB

Color-Magnitude Diagram of Cetus Dwarf Galaxy with Models



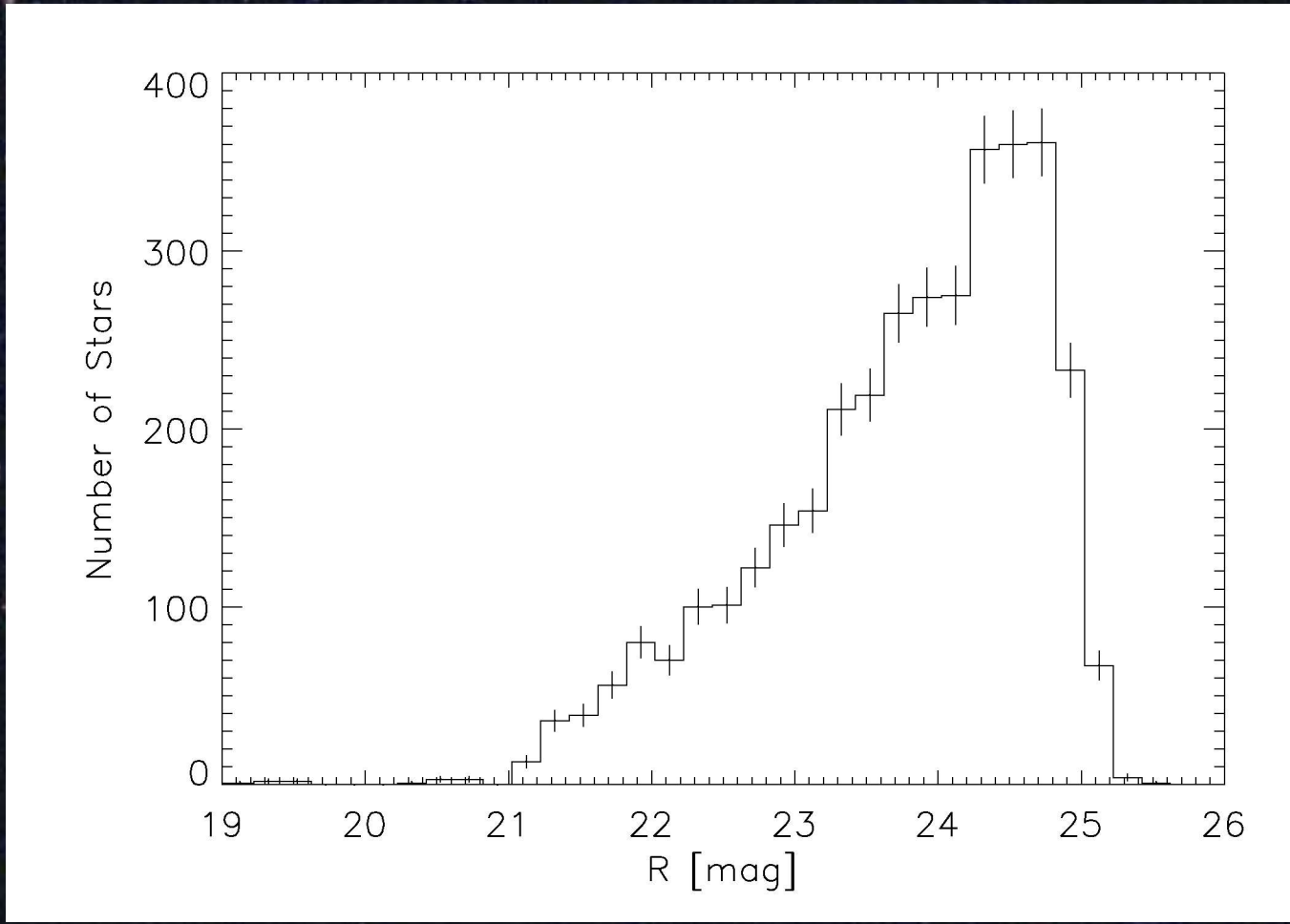
Metallicity Dependence of the RGB

Color-Magnitude Diagram of Cetus Dwarf Galaxy with Models



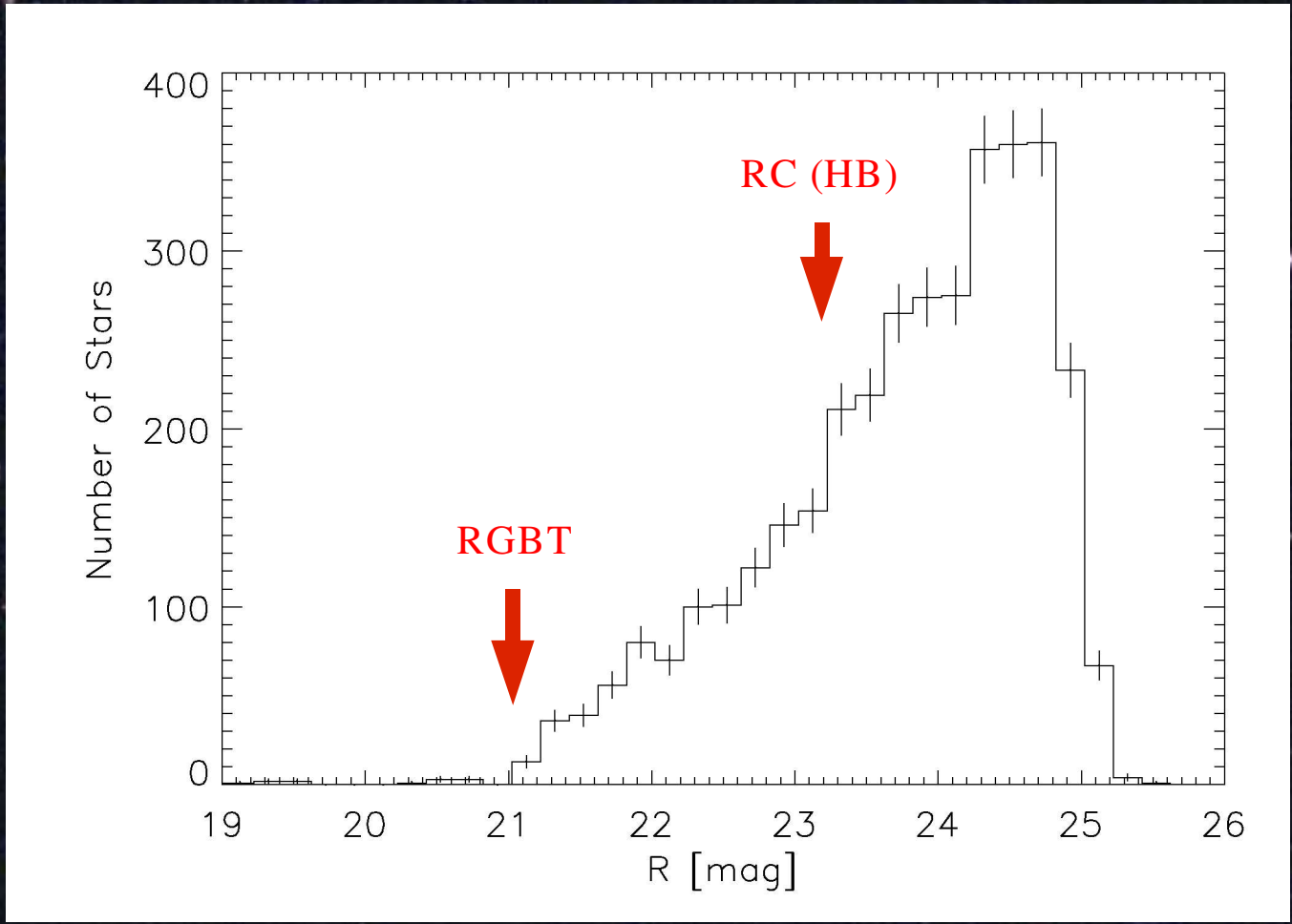
Defined Limits of Metallicity

Luminosity Function



Distribution of detected Stars in the R magnitude

Luminosity Function



Conclusions

- We Performed PSF Photometry on FORS1 Imaging Data on Dwarf Galaxy Cetus

- We constructed the R, (B-R) Color-Magnitude Diagram of the Observed Field

- Our limiting Magntide is R ~ 25

- Isochrone fit showed that the galaxy is populated by old stars

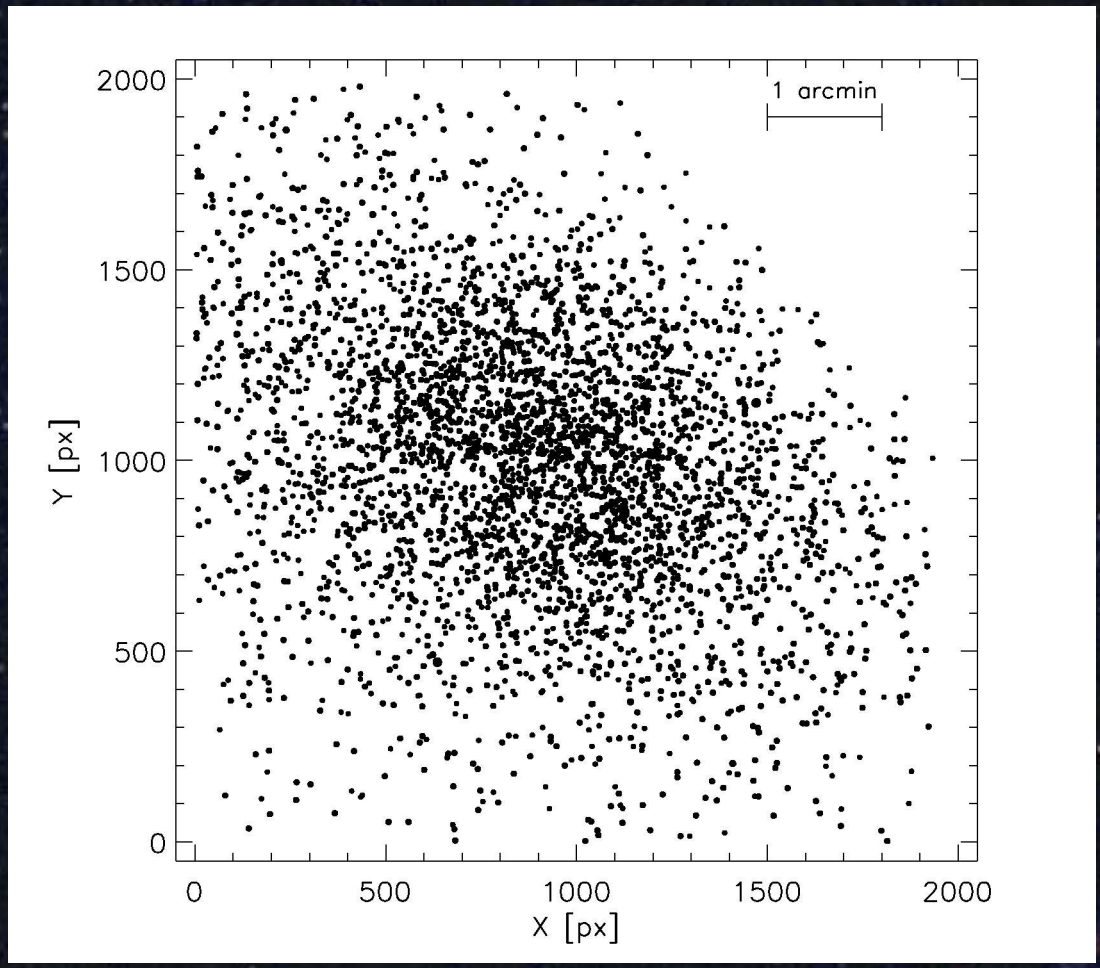
- Deeper observations are needed to reach the turn-off point for an accurate age estimation

- We verified the previously estimated Distance Modulus value: m-M ~ 24.45

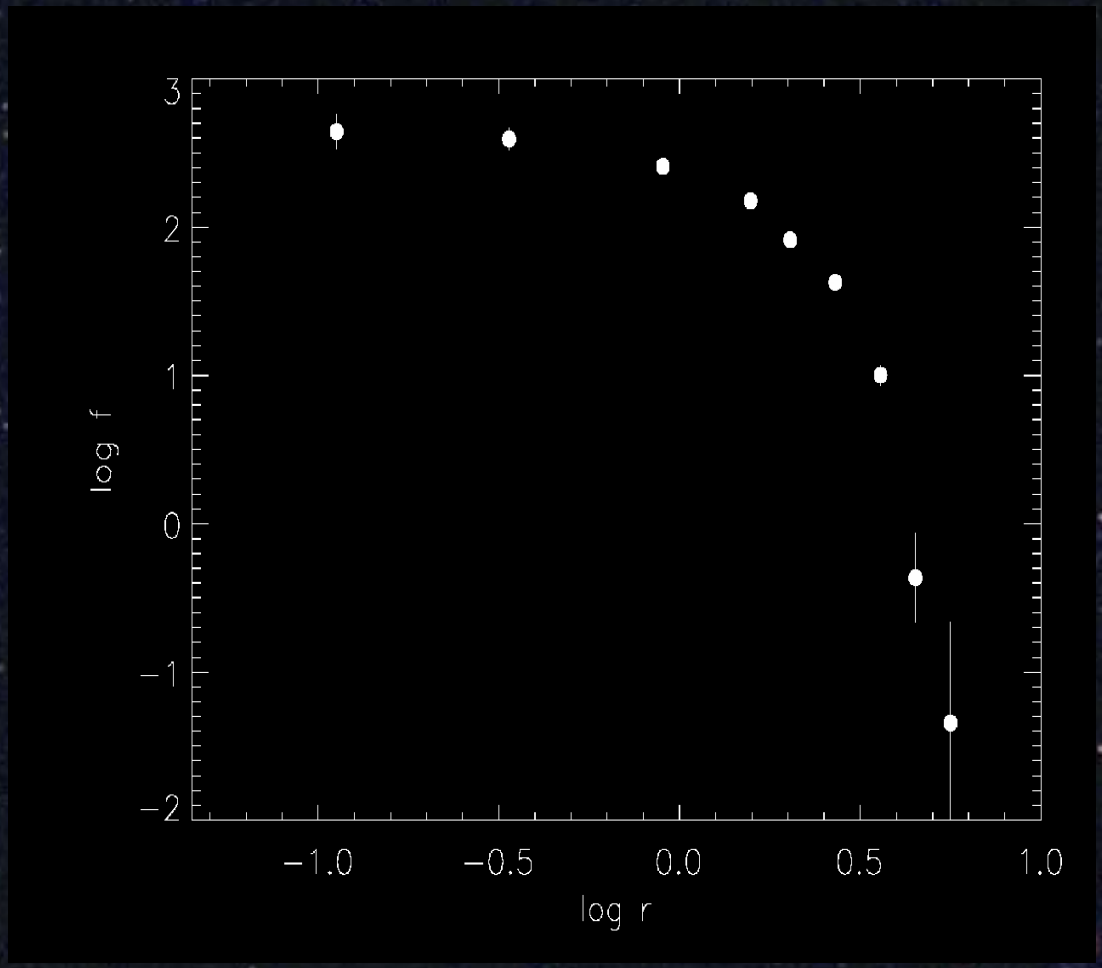
- We found that the galaxy is metall poor, as was previously found, but with a range of metallicities spreading toward higher values

- We cannot exclude the possibility of the co-existence of stellar populations of different ages in this galaxy.

Stellar Map of the Observed Field of View



Density Profile of the Stars



Stellar Photometry in the Local Group Dwarf Galaxy Cetus

The NEON Archive Observing School

ESO Garching, July 14 – 24