Resolved Stellar Halos of M87 and NGC 5128

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Baryons at low densities: The stellar halos around galaxies
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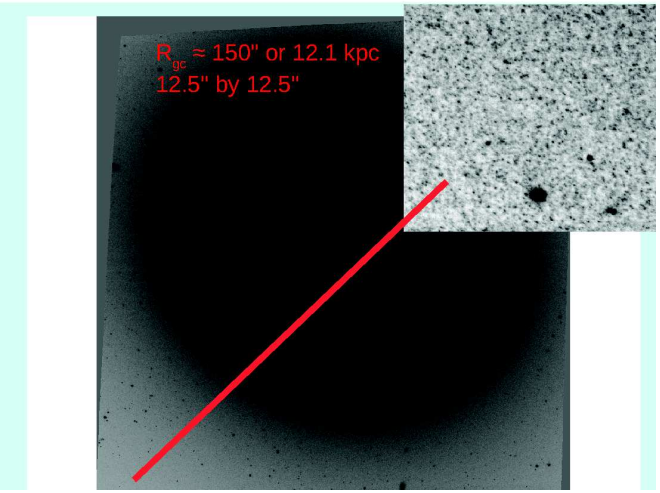
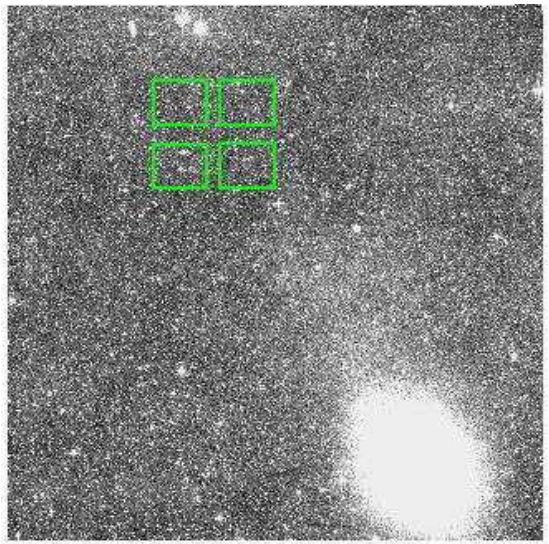
Contents

Galaxy Formation

- Relic stars should be found in a sparse and extended "outermost-halo" component.
- Difficulty lies in
  - Finding clear traces of this component in giant galaxies
  - Deconvolving it from the more obvious and metal-rich spheroid component generated later by mergers
- Images: halo of M87 and outer halo of Cen A





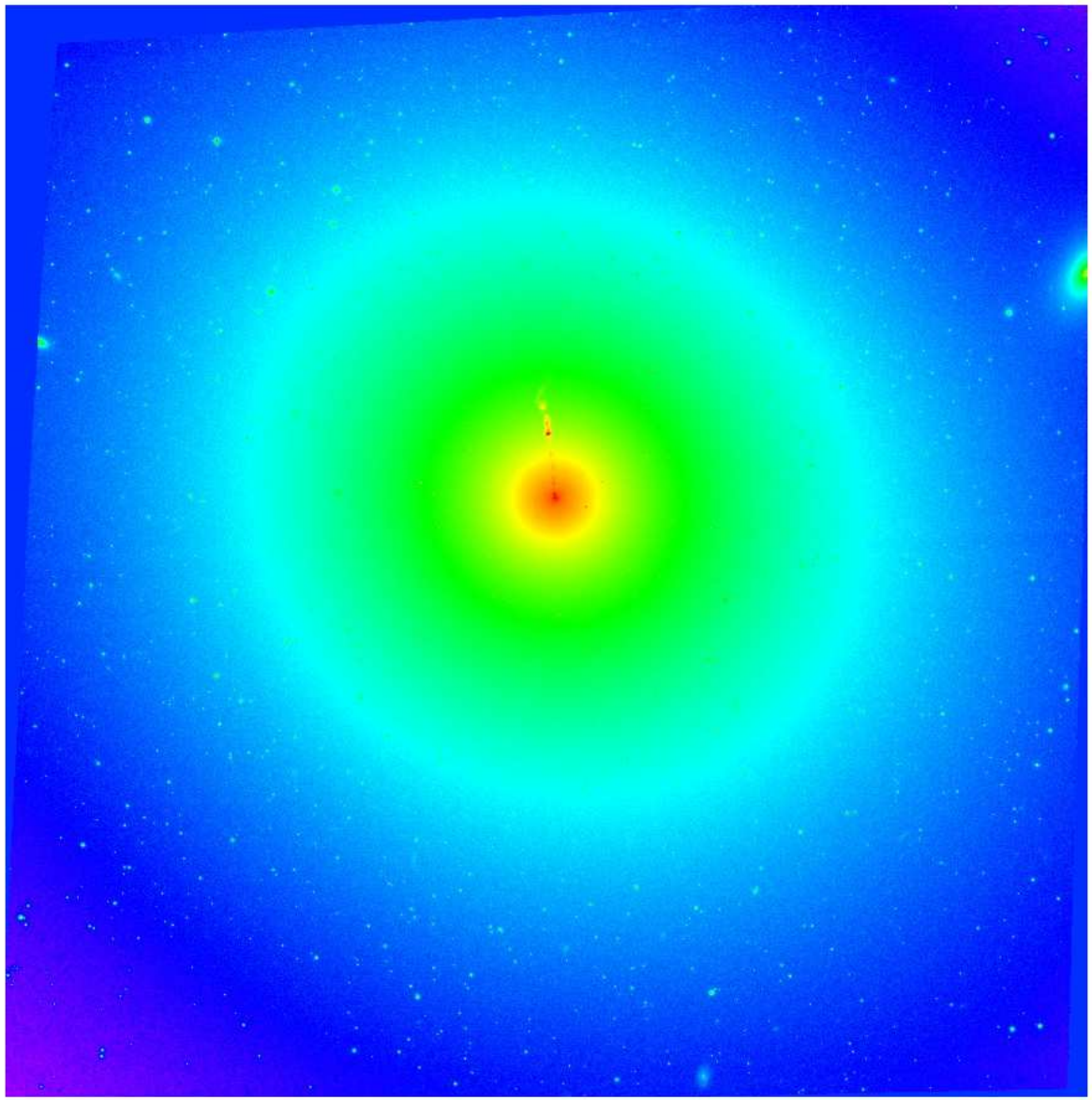
M87 and NGC 5128

Description	M87	NGC 5128
I_{TRGB} [mag]	27	24
Distance [Mpc]	16.7	3.8
z	0.004283	0.001825
R_{eff} [kpc]	6.3	5.8
R_{gc} [kpc]	12	65
Hubble Type	cD-gE	cD-gE/S0pec
Environment	Virgo Cluster	Centaurus Group
RA [$^{\mathrm{h}}$ $^{\mathrm{m}}$ $^{\mathrm{s}}$]	12 30 49.4	13 27 59
Dec [$^{\circ}$ $'$ $''$]	+12 23 28	−42 14 50
Telecope	HST	VLT
Instrument	ACS WFC	VIMOS
Area [arcmin^2]	2	224
RGB	33890	1581

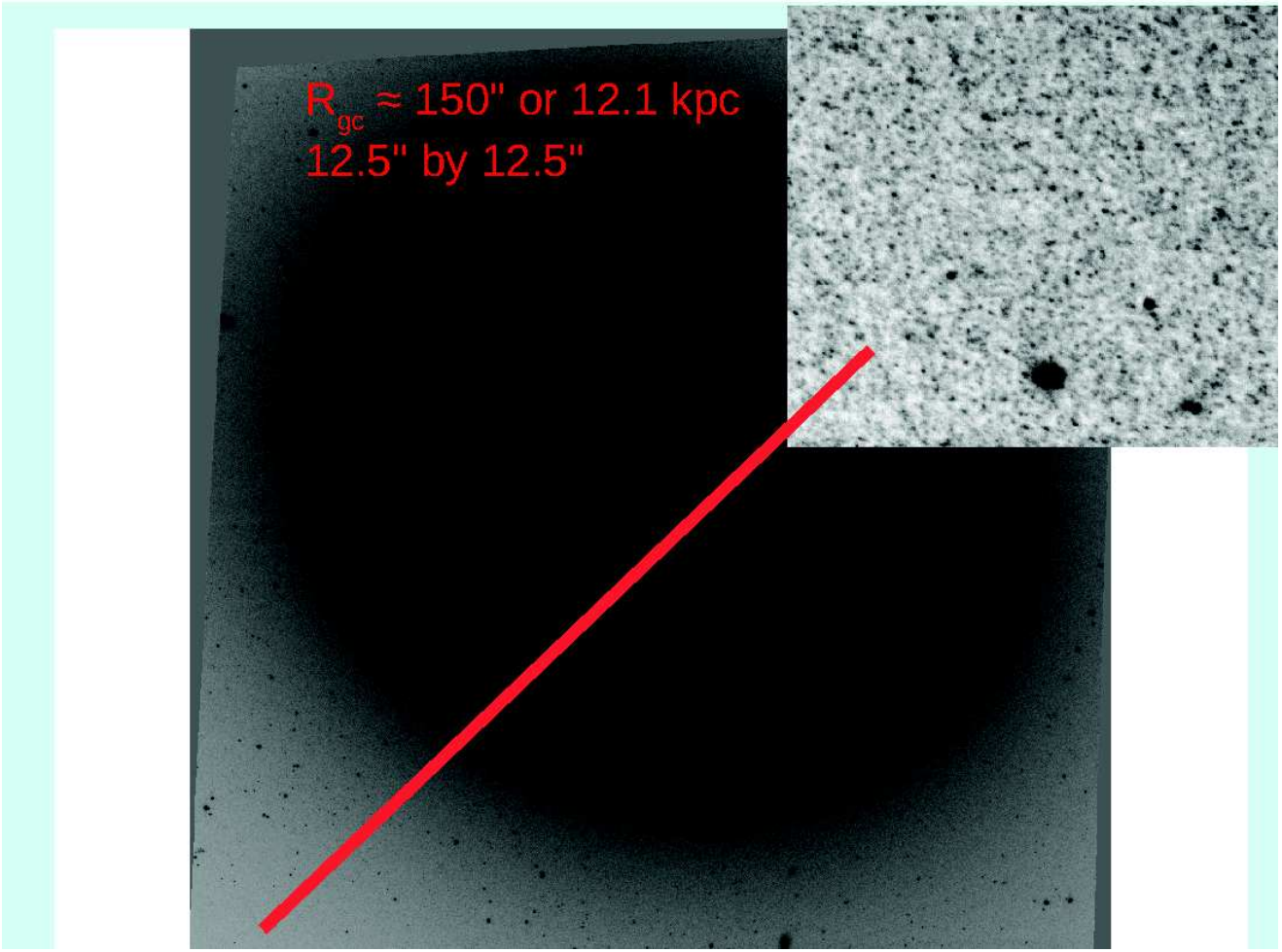
Contents

M87 Image

- archived HST ACS WFC image originally observed for the search of microlensing
- 3.4' by 3.4' field or 16 by 16 kpc
- V: 49 images totaling 24500 sec
- I: 205 images totaling 73800 sec

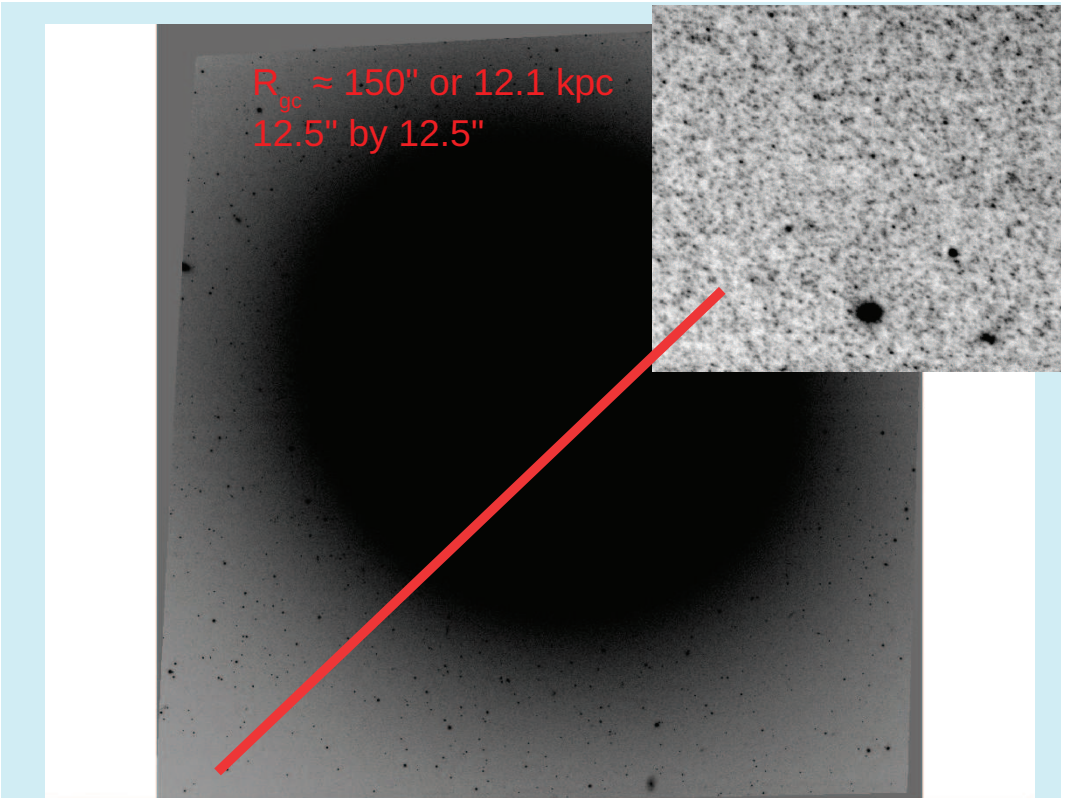


M87

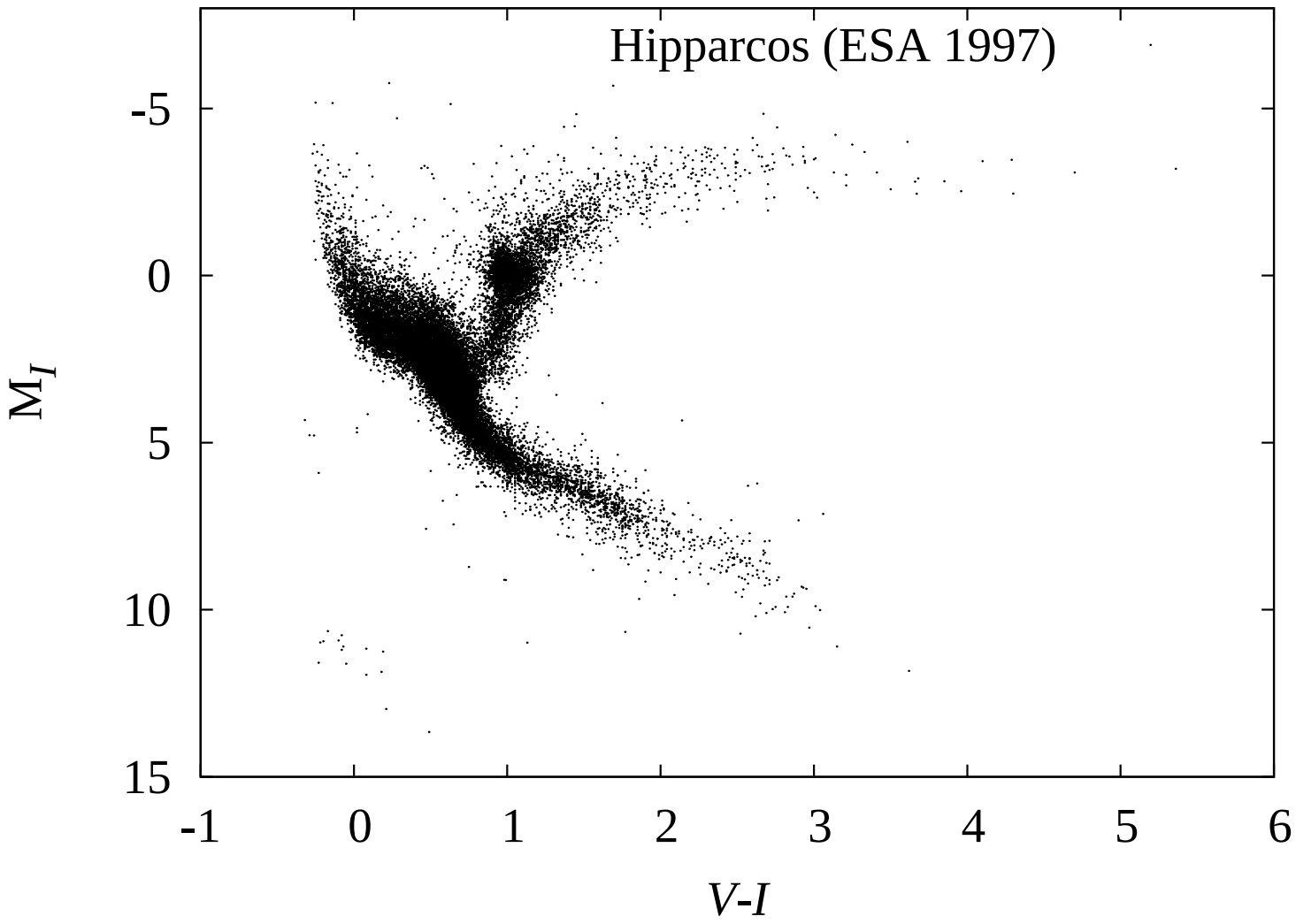


M87 Photometry

- IRAF (daofind, phot,allstar,two runs)
- brightest red-giant stars resolved
- limiting apparent magnitude of $I = 29$ and $V = 30$
- 33890 stars from outer $R_{\rm gc} = 115'' - 155''$



Color Magnitude Diagram from the Hipparcos Mission



Color Magnitude Diagram Comparisons

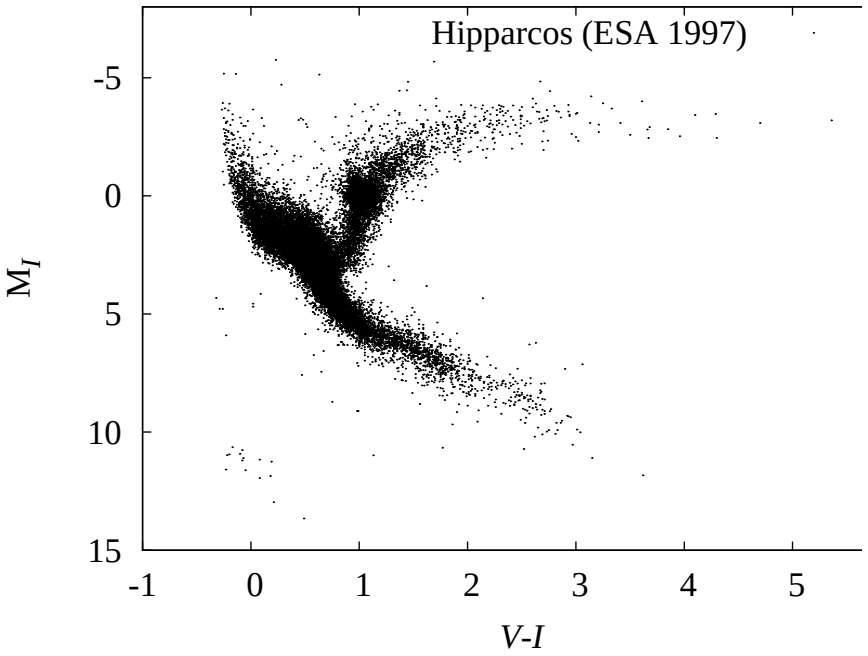


Figure: Hipparcos Satellite

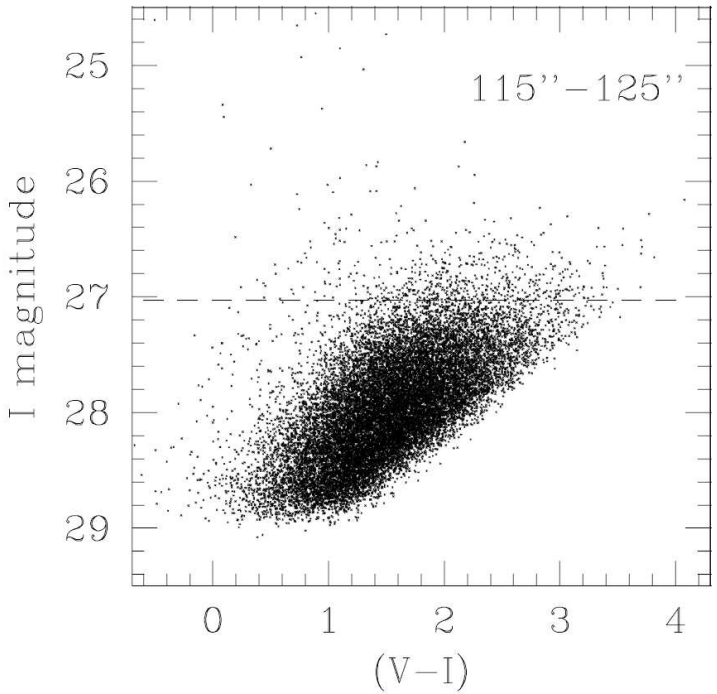


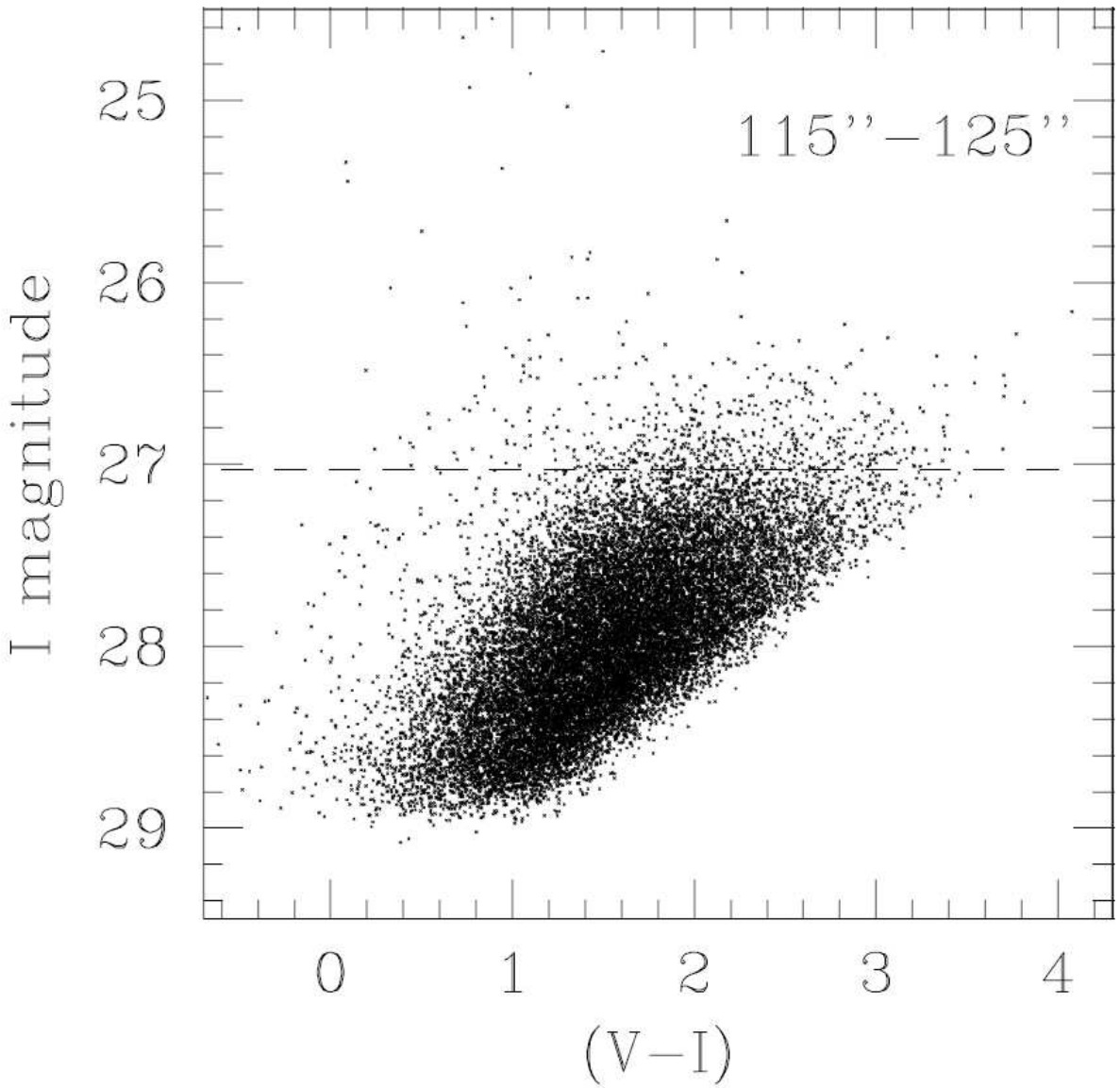
Figure: Only the tip of the red-giant branch is seen in our M87 images

Tip of the Red-Giant Branch (TRGB) Method

- TRGB characteristically reaches $M_I = -4.05 \pm 0.10$

  (Rizzi+07)
- Measured TRGB distance of $d = (16.7 \pm 0.9)$ Mpc

  (Bird, Harris, Blakeslee, and Flynn, 2010)



Contents

Cen A Observations

- Telescope: ESO VLT-UT3 Melipal, 8.2 m diameter mirror, located in Chile on Cerro Paranal
- Instrument: VIMOS
- Filters: V and I
- Observing periods: 83 and 87
- Detector changed between periods
- 14 exposures: 4×705 sec or 47 min in I, $9 \times 965 + 88$ sec or 2.4 h in V
- 4 CCD chips, thus $4 \times 14 = 56$ frames

Cen A Observations

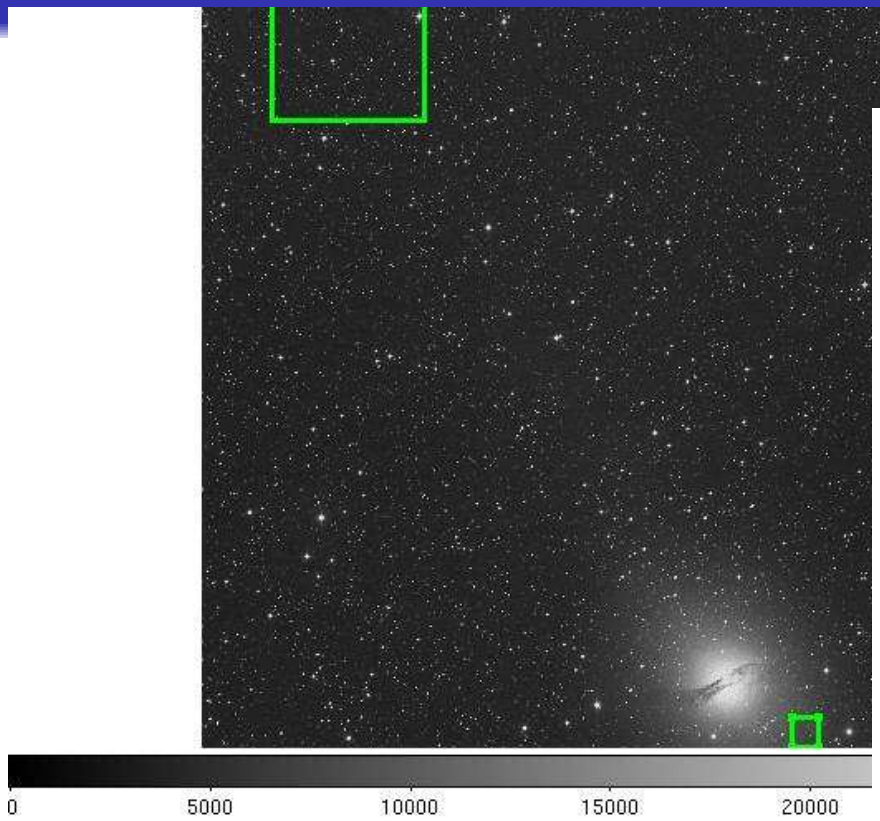


Figure: 65 kpc (Bird, Flynn, Harris, and Valtonen, in press) and 8 kpc fields (Harris+02)

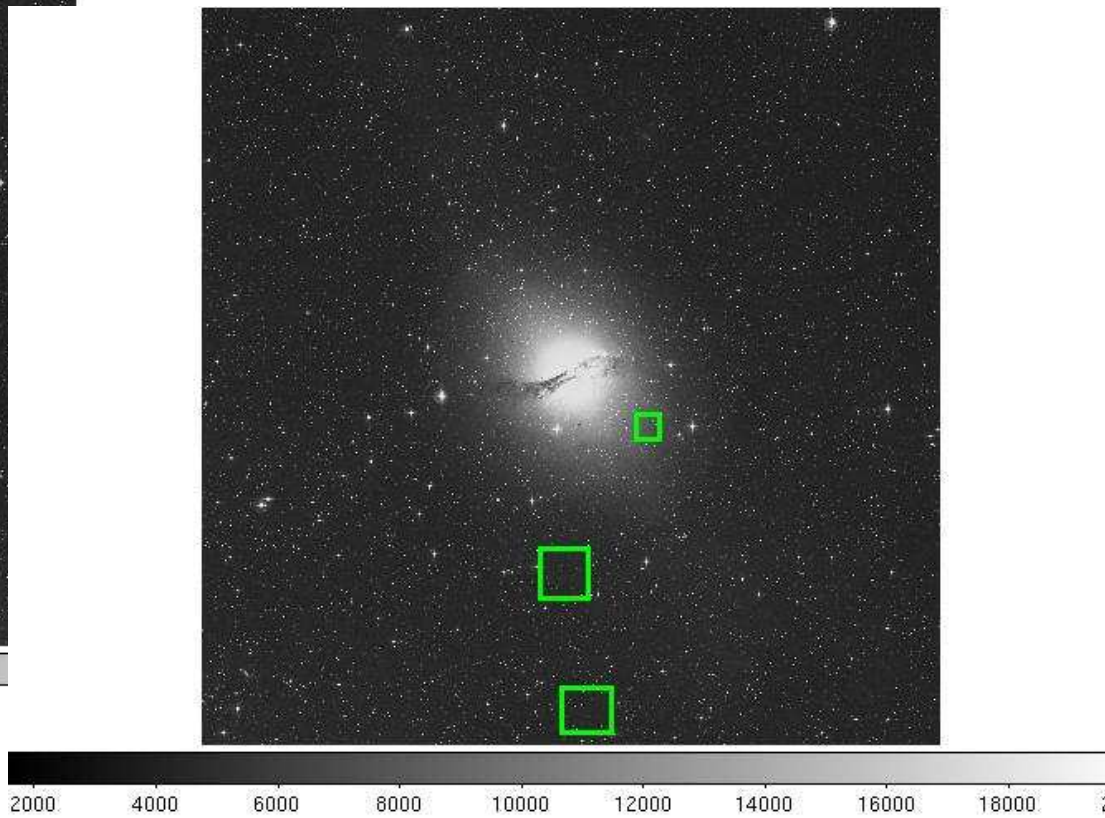
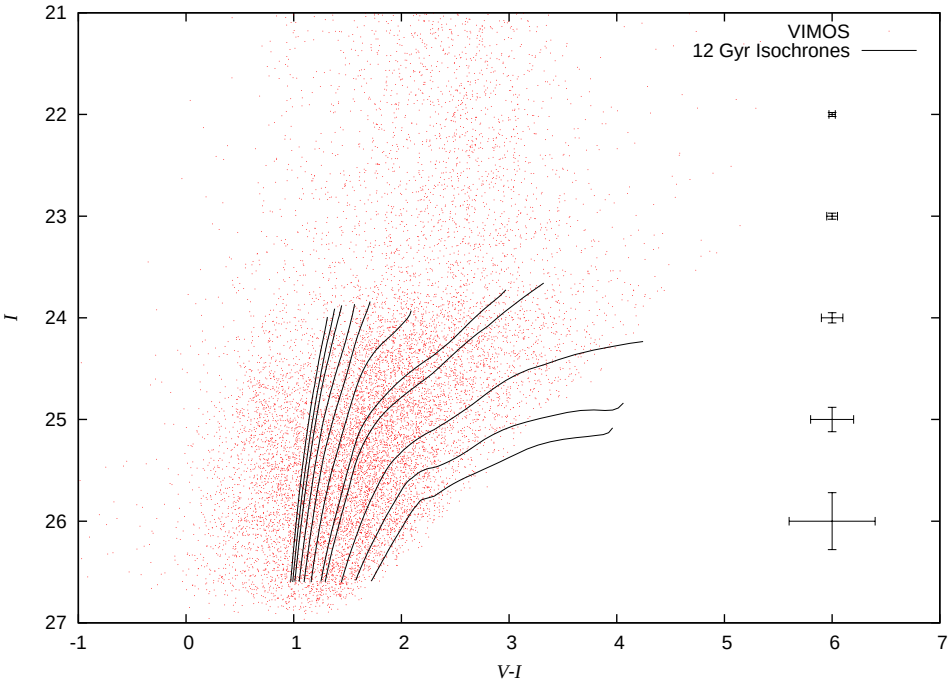


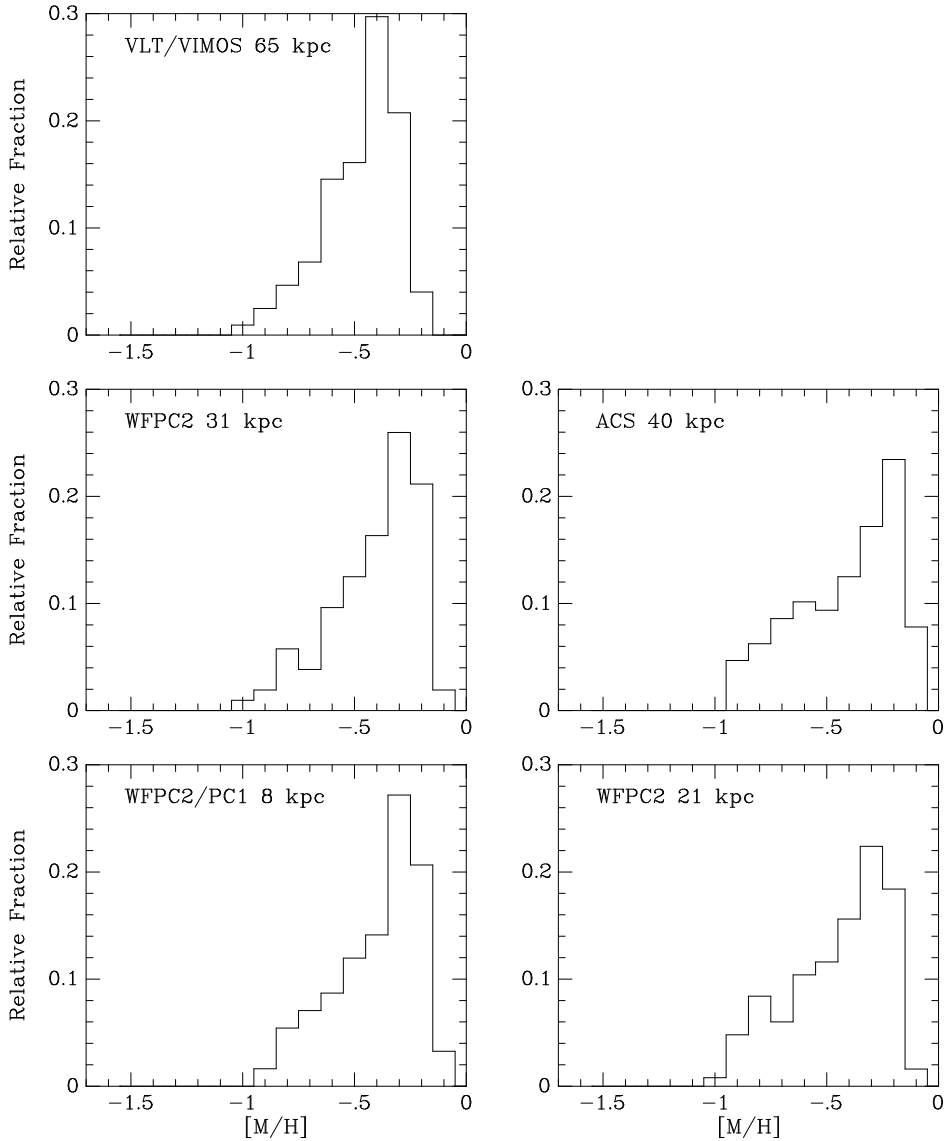
Figure: 8, 21, and 31 kpc fields (Harris+02, Harris+99, Harris+00)

Cen A Color Magnitude Diagram

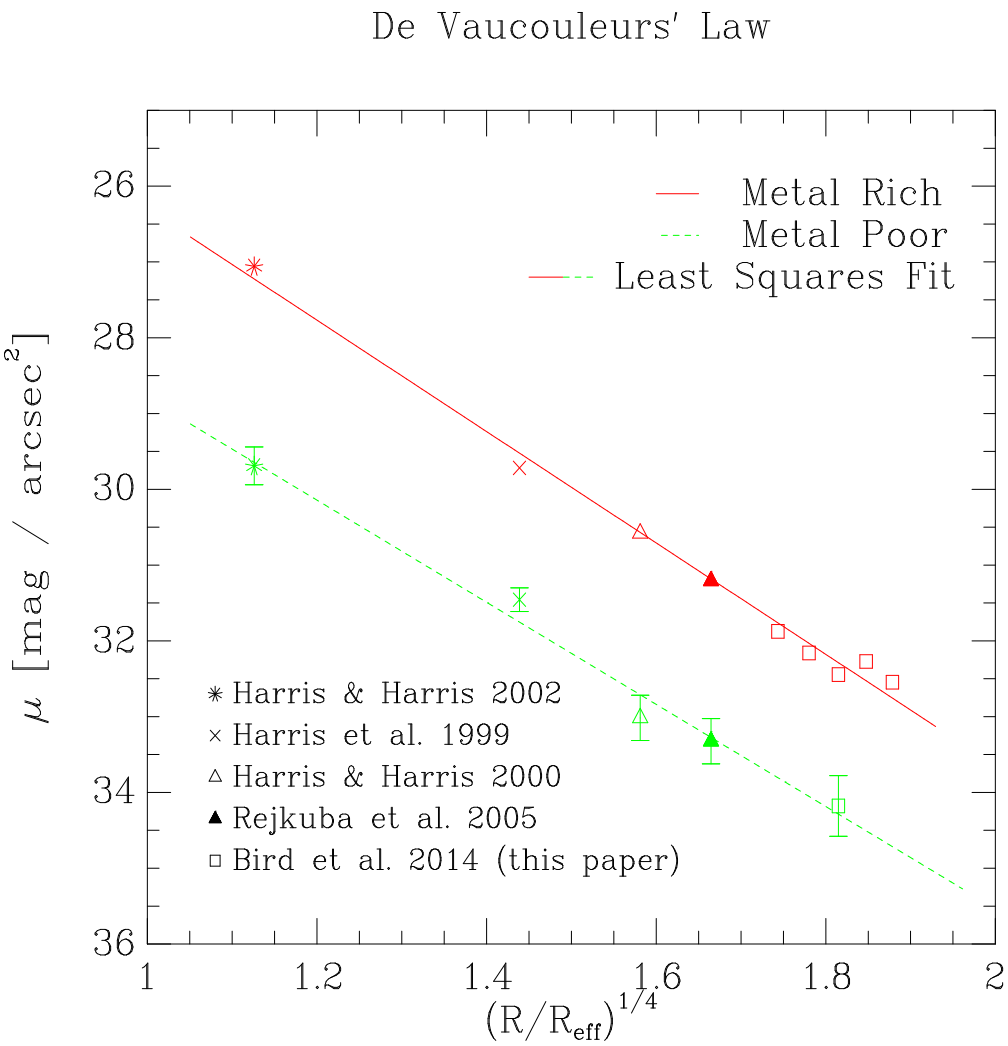
- Tip of the Red-Giant Branch at $I = 23.9$
- Milky Way foreground contamination above isochrones
- Background galaxy contamination left of isochrones



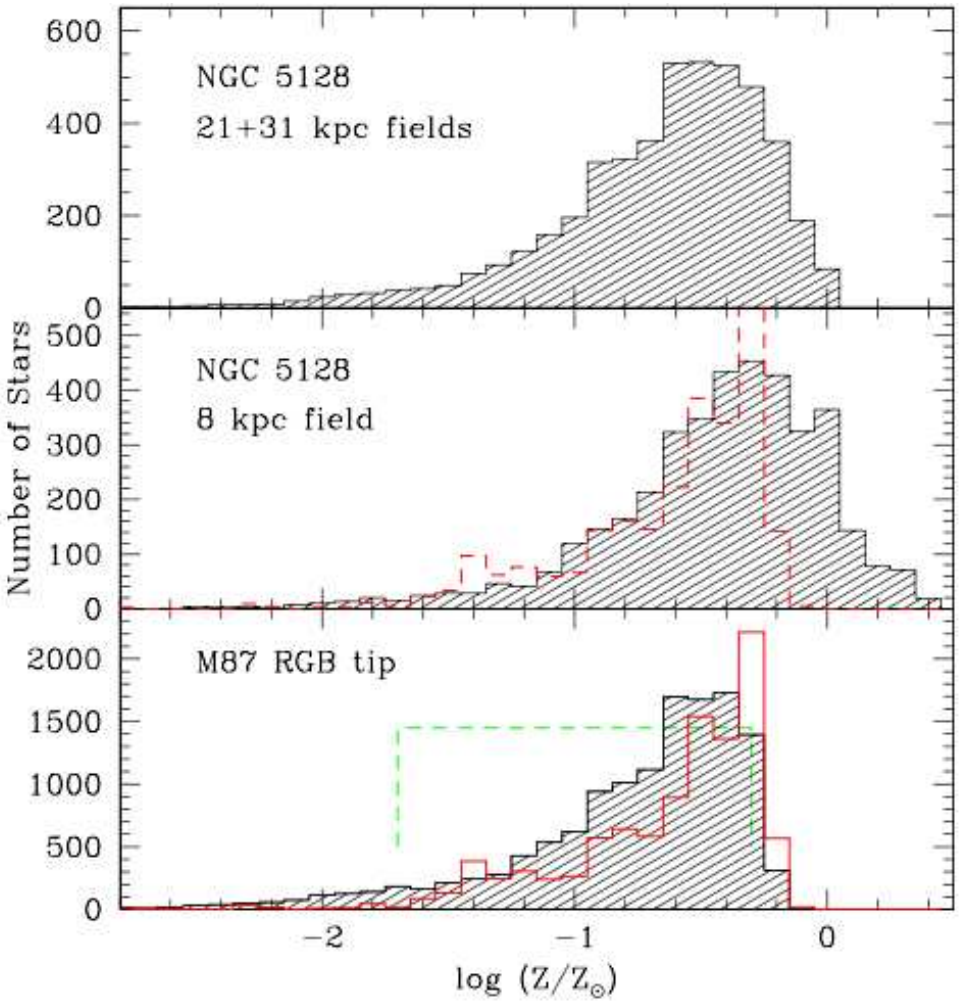
Cen A Metallicity Distribution Function



Cen A Density Distribution



Cen A and M87: Similar Metallicity Distribution Function



Resolving Stellar Halos

Summary:

- TRGB distance= 16.7 Mpc to M87
- Equal density falloff of the metal-rich and -poor stars reaching the outer halo of NGC 5128
- Similarity between halos of M87 and NGC 5128

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