Cen A - The Transition

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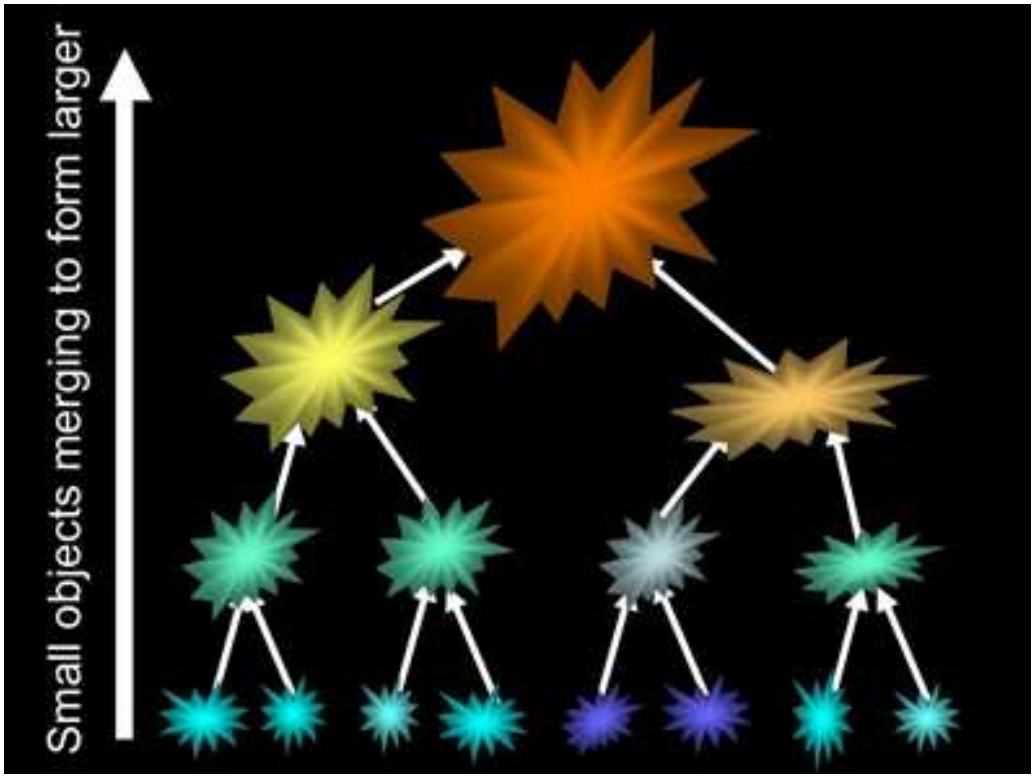
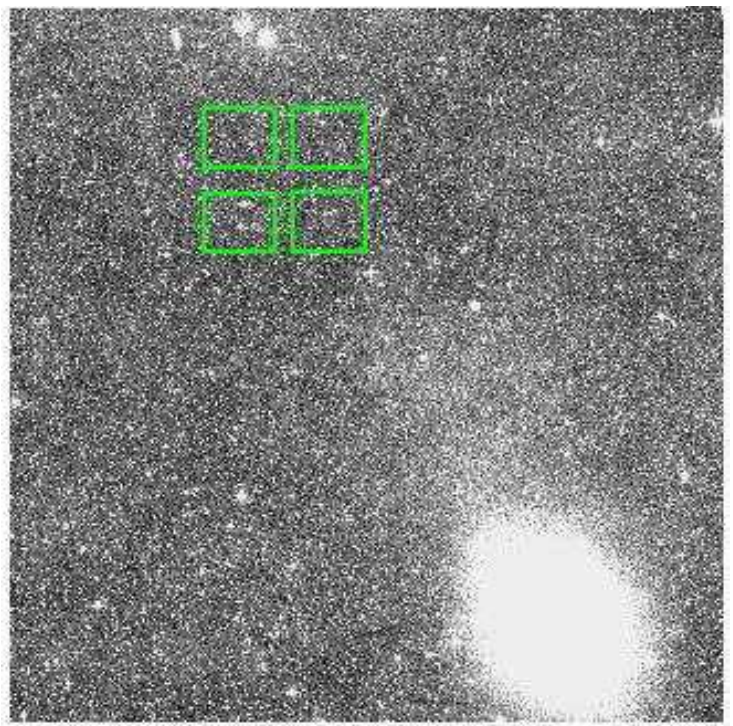
Contents

- Most metal-poor halo stars date back before hierarchical merging
- Image credit: Swinburne University of Technology



- Today, these relic stars should be found in a sparse and extended "outermost-halo" component.
- Finding clear traces of this component in other giant galaxies, and deconvolving it from the more obvious and metal-rich spheroid component generated later by mergers, has been extraordinarily diffcult.
- Image: present work, outer halo of Cen A

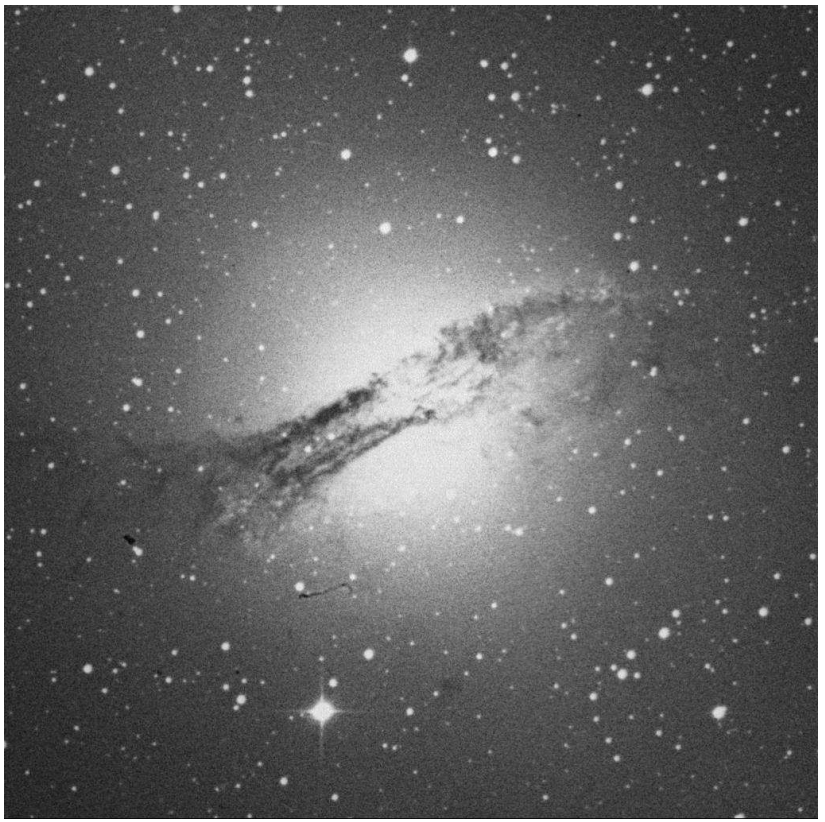


- Now, striking evidence discovered in M31 and NGC 3379 suggests that the metal-poor outermost halo can be isolated at very large radii, $R > 12R_{eff}$.

Figure: M31. credit: Adam Evans

Figure: NGC 3379. credit: Kopernik Observatory

- We have a new deep imaging study with VLT of the nearest giant elliptical and merger remnant, Centaurus A, to search for this extended remnant of the galaxy's earliest history
- Image credit: ESO

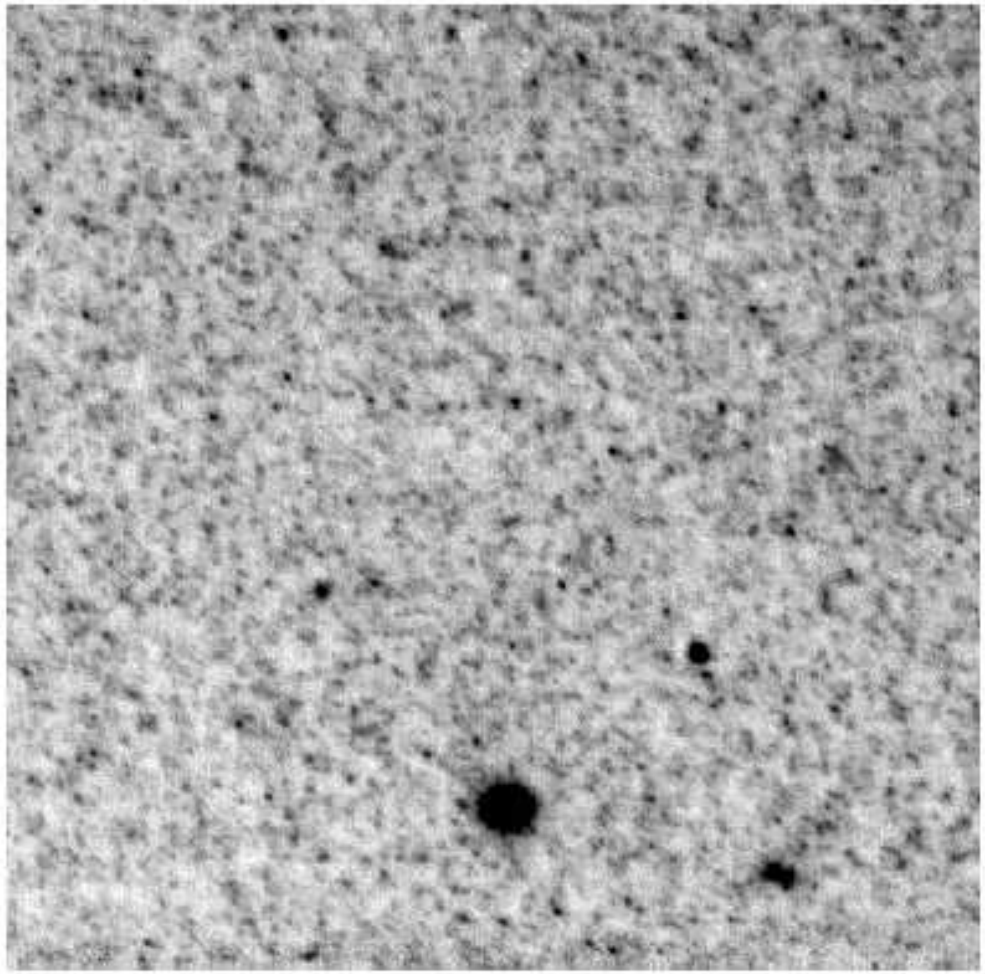


Contents

- What we are looking for is the transition from metal-rich stars to metal-poor stars around $12R_{eff}$
- R_{eff} is the radius within which half the light of the galaxy is located
- At the transition, the dominating metal-rich stars fall off and the metal-poor stars begin to dominate

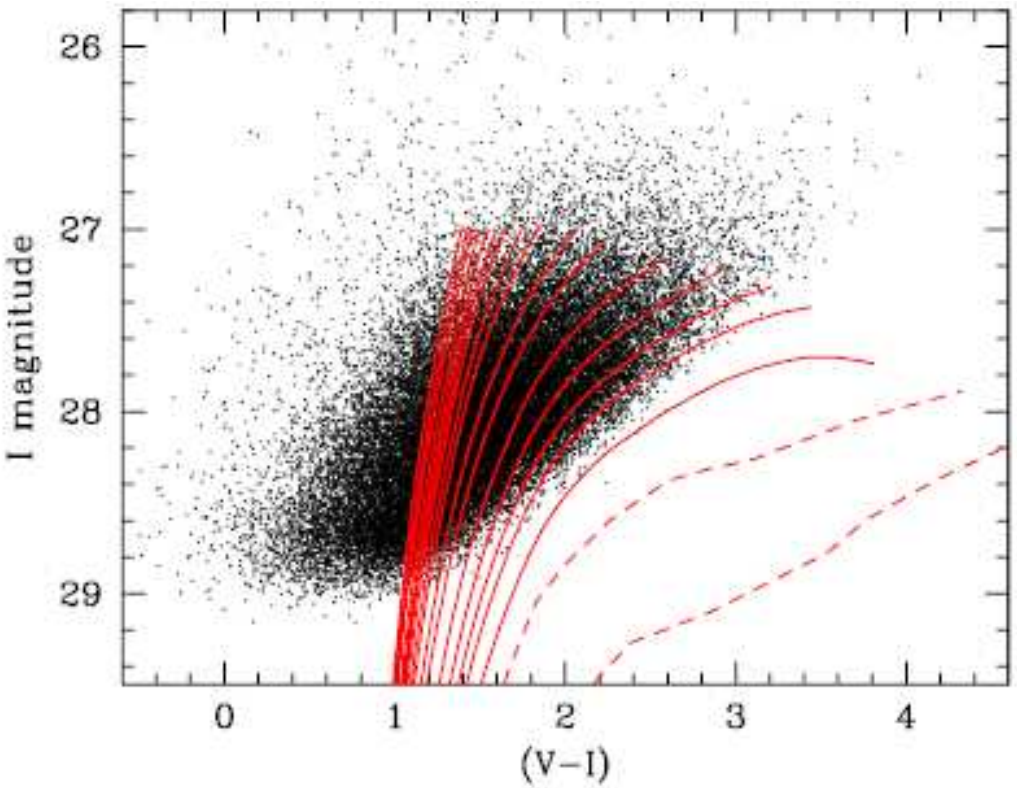
M87 [Bird et al., 2010]

- Very deep imaging
- Individual star photometry for galaxies outside the Local Group
- M87 is the furthest example at 16.7 Mpc using HST
- Only the brightest red giant stars can be measured



M87 [Bird et al., 2010]

- Over 33,000 stars
- Color of the tip of the red giant branch is sensitive to metallicity



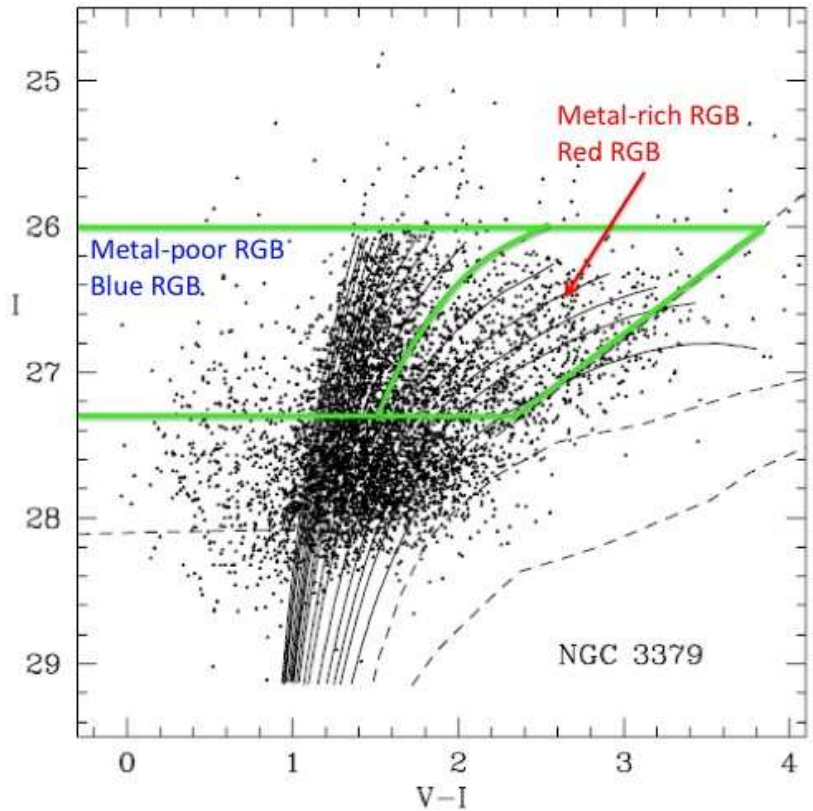
The transition from metal-rich stars to metal-poor stars has been found in M31 and NGC 3379 around $12R_{eff}$

Figure: M31. credit: Adam Evans

Figure: NGC 3379. credit: Kopernik Observatory

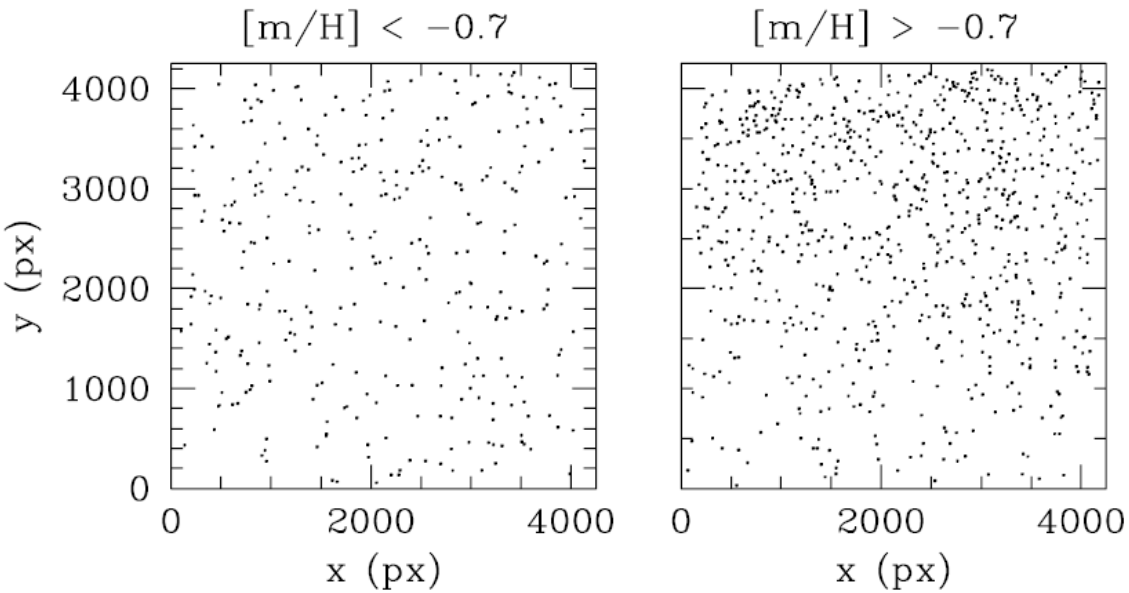
Transition in NGC 3379 (Messier 105) [Harris et al., 2007]

- Color Magnitude Diagram with model red giant metallicity tracks superimposed
- Tracks are for ages of 12 Gyr
- Total metallicity grid extends from $\log(Z/Z_{\odot}) = -2.0$ to 0.4



Transition in NGC 3379 (Messier 105) [Harris et al., 2007]

- Positions of the bright stars in the magnitude range $26.0 < I < 27.3$
- Center of NGC 3379 is off the diagram at the top
- Left panel shows metal-poor RGB stars ($[m/H] < -0.7$)
- Right panel shows metal-richer giants ($[m/H] > -0.7$)
- The metal-rich population exhibits a much stronger gradient in number density across the frame



- The transition from metal-rich stars to metal-poor stars has been found in M31 and NGC 3379 around $12R_{eff}$
- Can the transition be found in other galaxies?

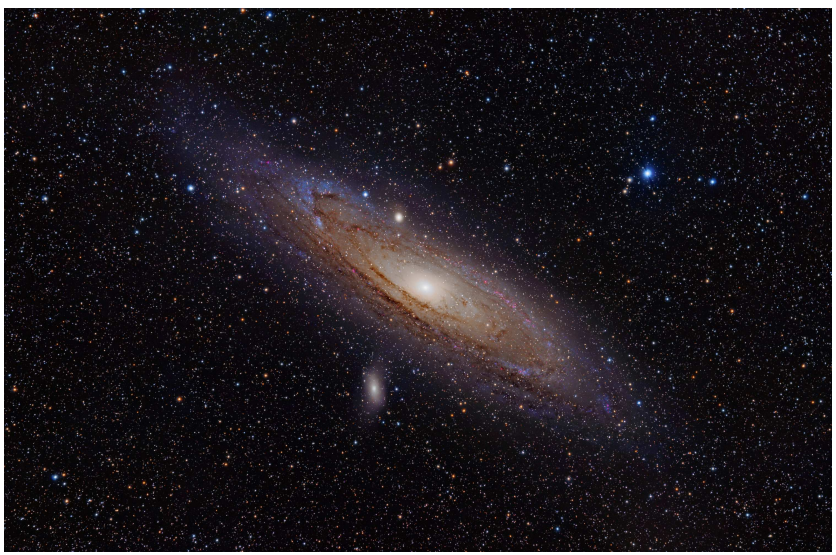


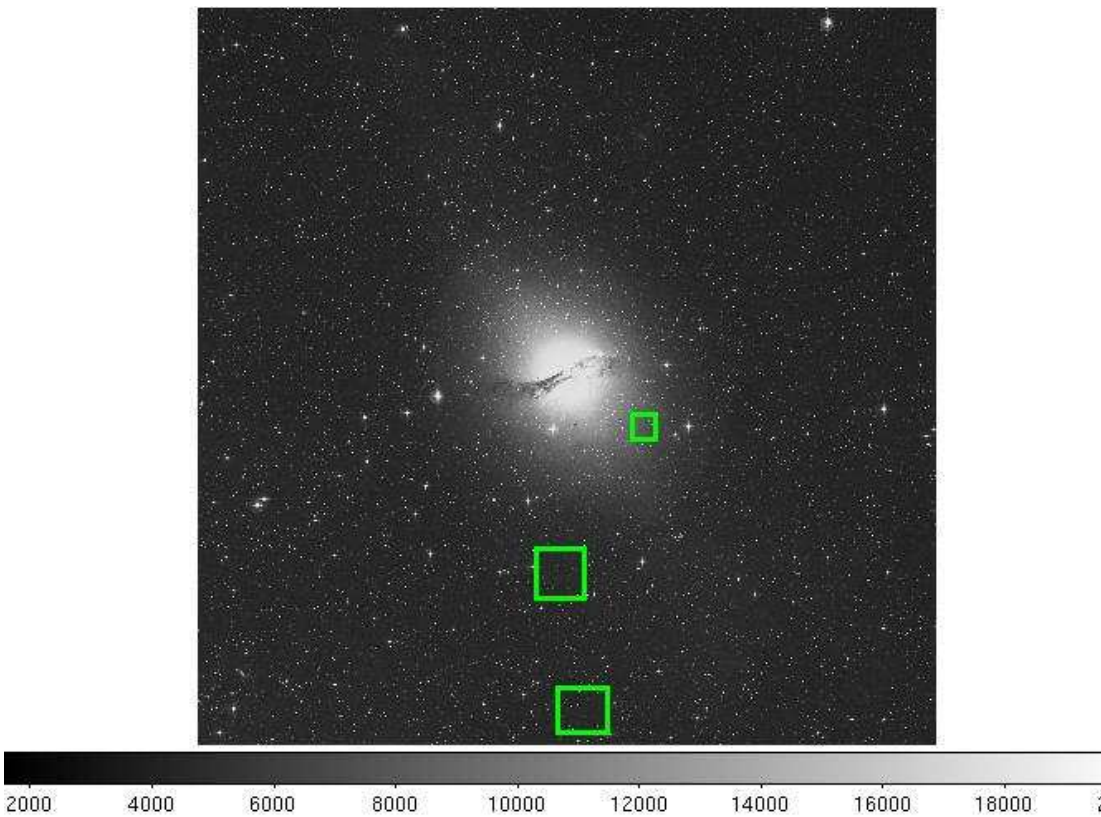
Figure: M31. credit: Adam Evans

Figure: NGC 3379. credit: Kopernik Observatory

Contents

Cen A Observations

- Elliptical galaxy with many mergers history
- Radius at half light of Cen A: $R_{eff} = 5.5$ kpc$= 4.7'$
- Distance to NGC 5128: 3.8 ± 0.1 Mpc [Harris et al., 2010]
- Brightness of the tip of the red giant branch: $M_I^{TRGB} = -4.05 \pm 0.10$
- Previous studies marked with green boxes ([Harris and Harris, 2002], [Harris et al., 1999], [Harris and Harris, 2000])



Cen A Observations

- Telescope: ESO VLT-UT3 Melipal, 8.2m 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: 4x705sec or 47min in I, 9x965+88sec or 2.4h in V
- 4 CCD chips, thus $4 \times 14 = 56$ frames

Cen A Observations

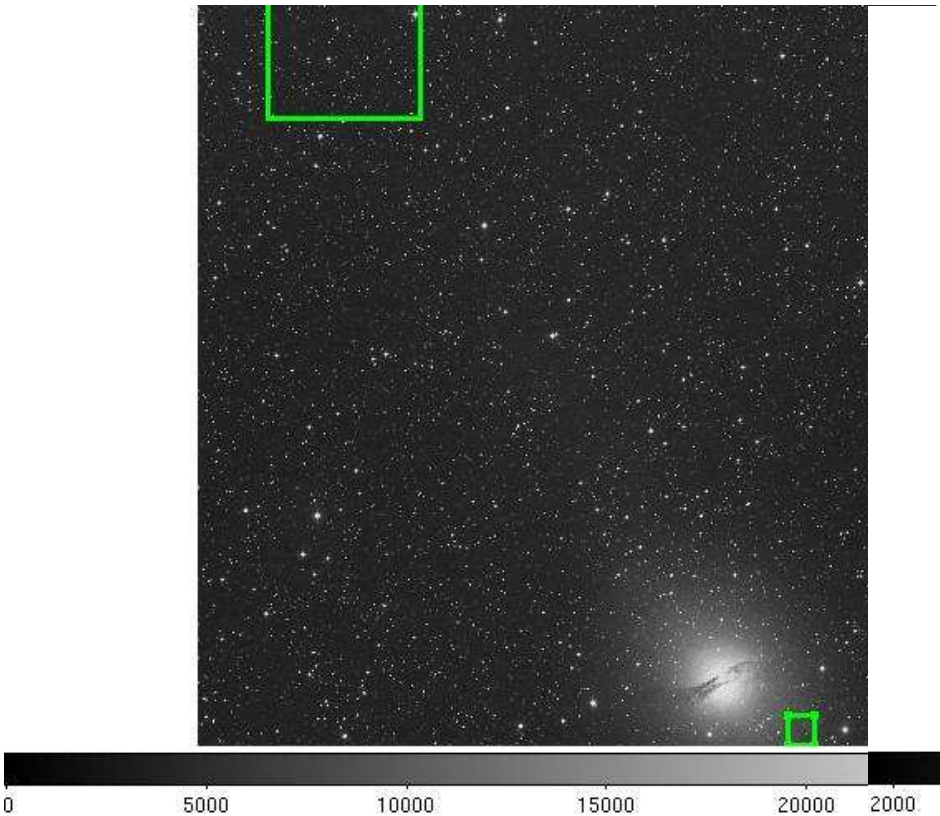


Figure: 65 and 8 kpc fields

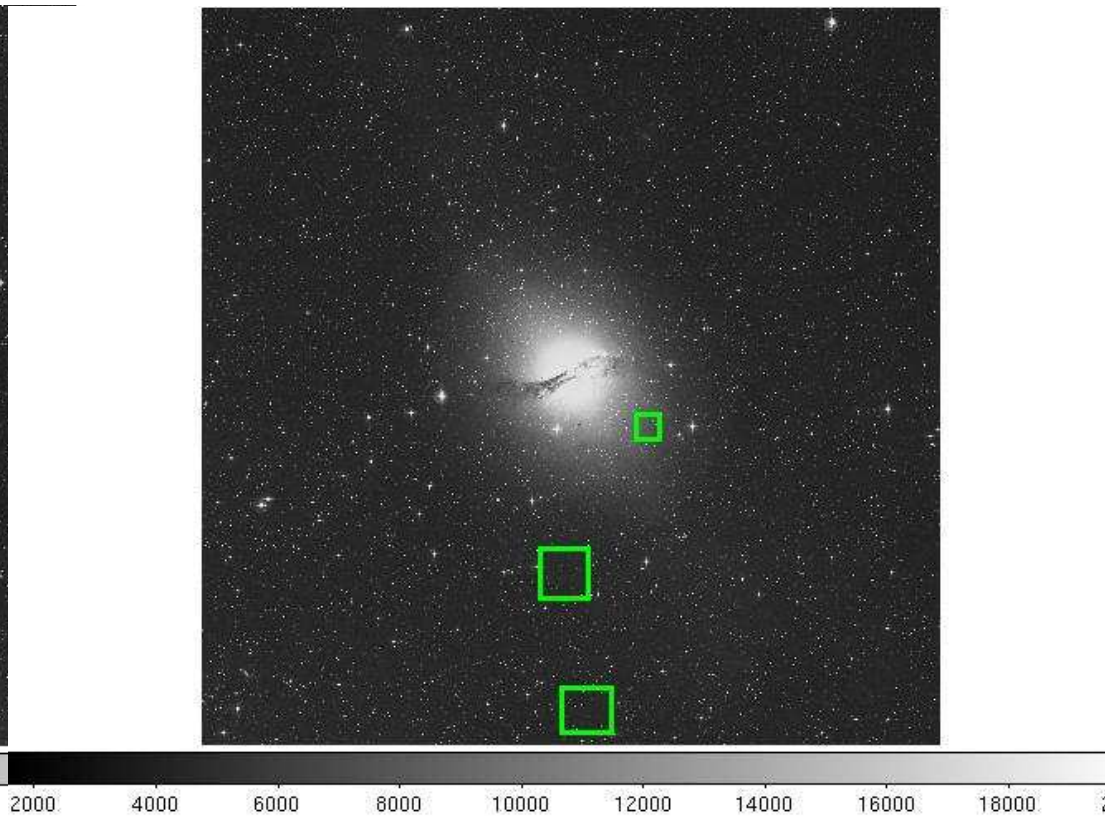
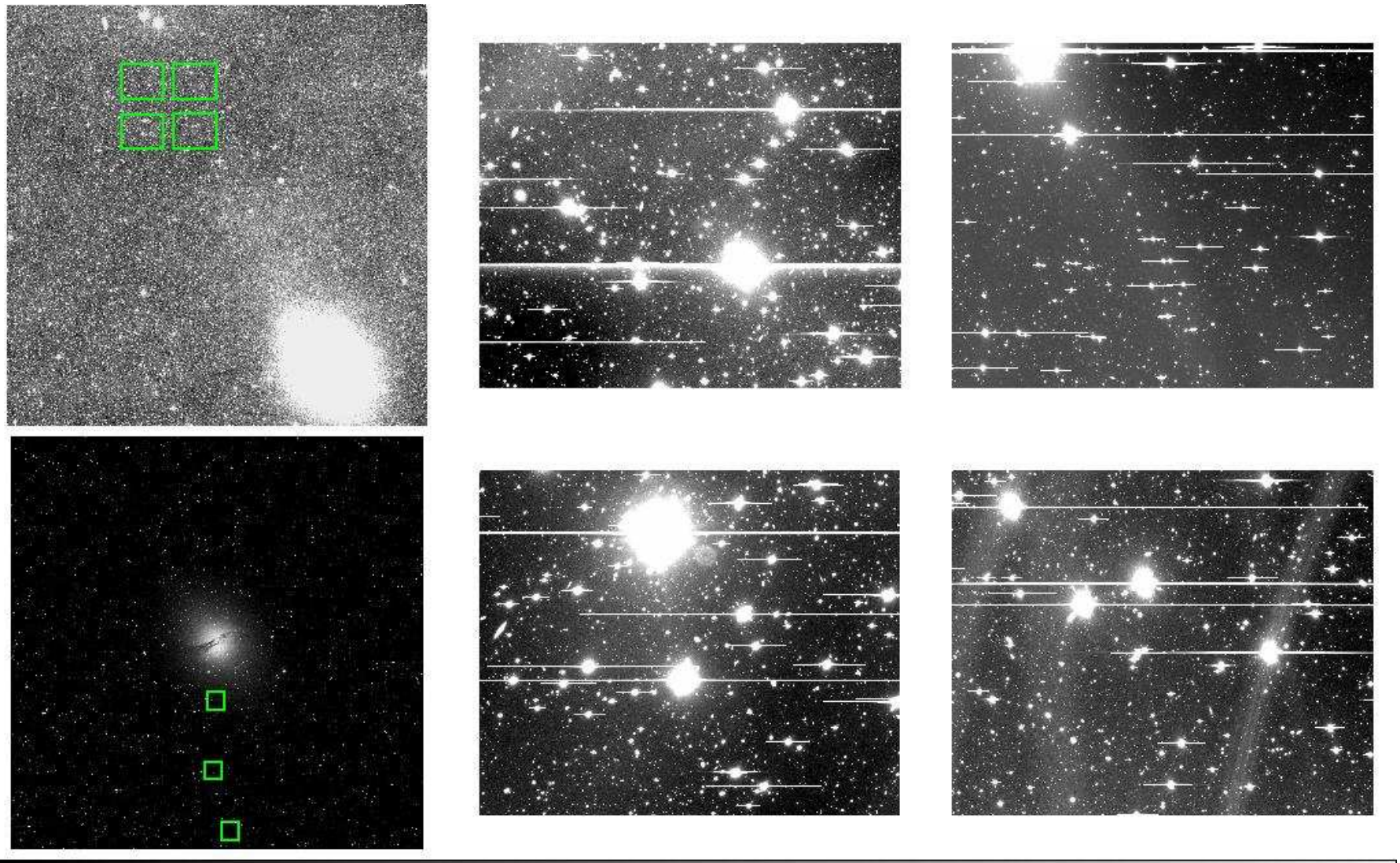


Figure: 8, 21, and 31 kpc fields

Cen A



Cen A Observations

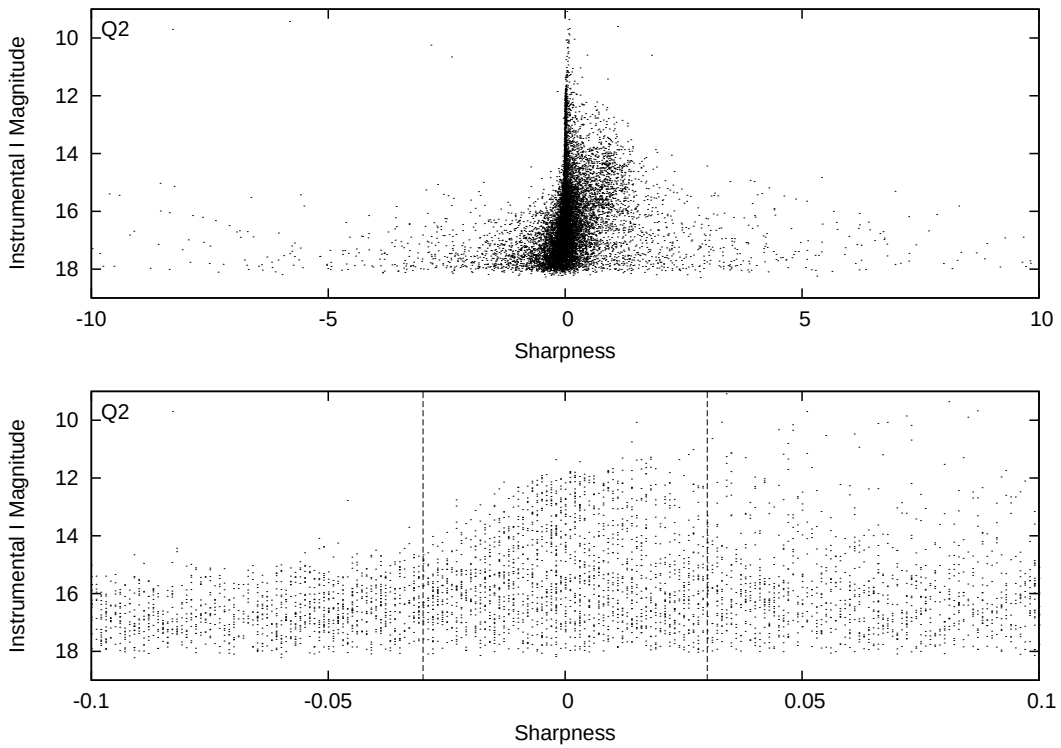
- Distance to Observation Field: $12R_{eff} = 65\text{kpc} = 3000''$ from the center of NGC5128
- The four panels on the right show the four CCD quadrants of our field NGC5128-F1. Each quadrant is $7' \times 8'$ with $2'$ gaps.
- Top left panel shows the location of the four quadrants (green boxes) relative to the center of Cen A (the image is $70' \times 70'$)
- Lower left panel shows Cen A (also $70' \times 70'$) along with three green boxes marking three previous studies in fields at 8, 21, and 31 kpc from the center of the galaxy ([Harris and Harris, 2002], [Harris et al., 1999], [Harris and Harris, 2000])

Photometry using Cen A Observations

- Combine individual exposures to make one V and one I image
  - Align stars
  - Use IRAF to combine the images
- Calculate zeropoints
  - Over 1000 standard stars from ESO
  - Achieve accuracy of ± 0.03 in I and ± 0.02 in V

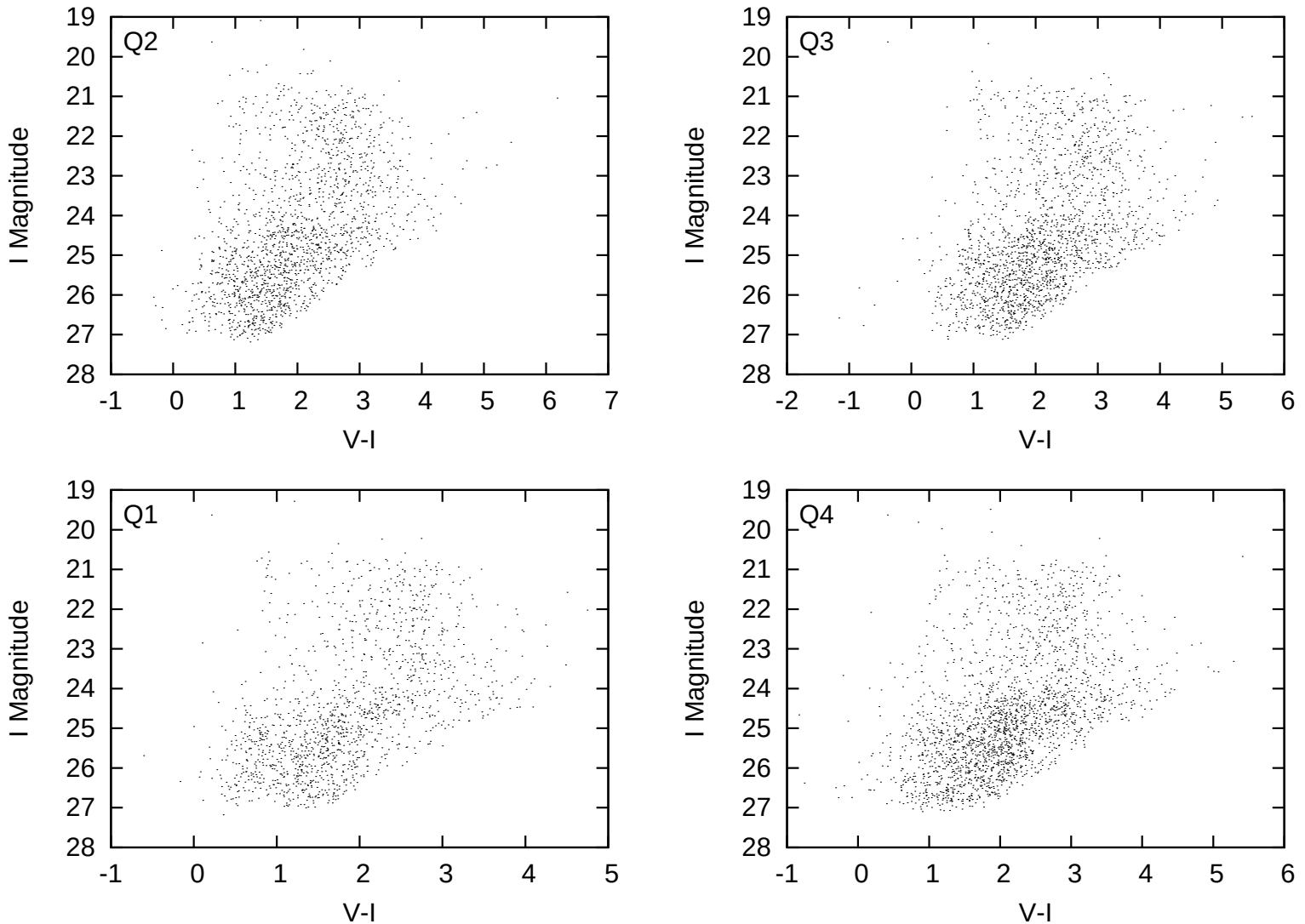
Cen A Observations

- Define sharpness values to find stars
- Over 7000 stars found in the field

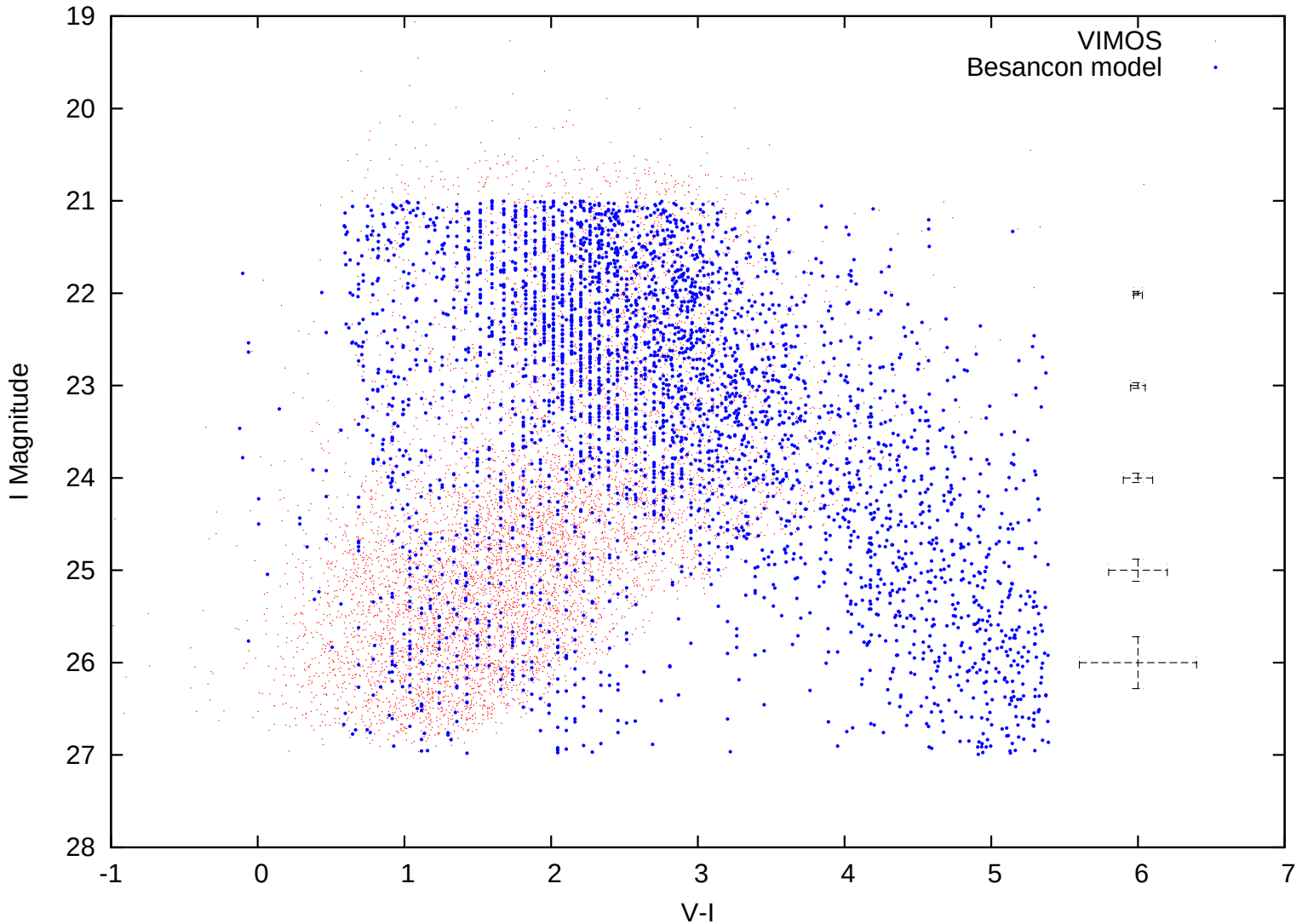


Contents

Cen A Color Magnitude Diagrams



Model Field Stars and VIMOS Data



Thanks!

Summary and Future Work:

- Understand effects of galaxy and field star contamination
- Use isochrones to determine metallicity of stars
- Search Cen A for the transition between metal-rich and metal-poor stars around $12R_{eff}$ which has already been found in M31 and NGC 3379

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Figure: The cliffhanger

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