

A Deep, High Resolution Study of the Core of 47 Tucanae

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- Extreme mass segregation
- Binary main sequence
- Blue stragglers

Collaborators:

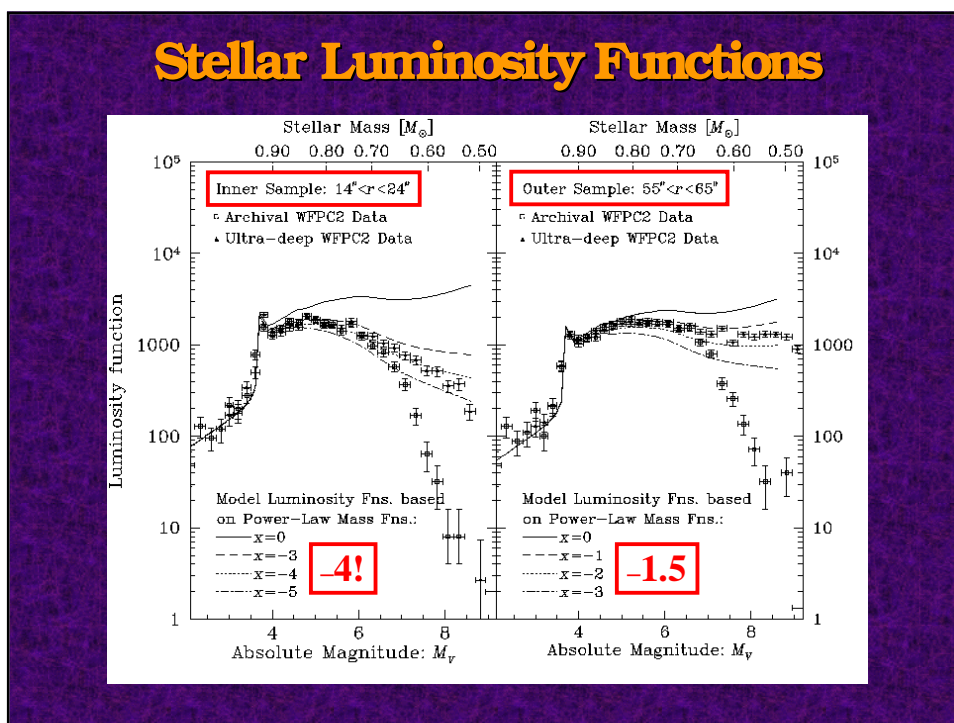
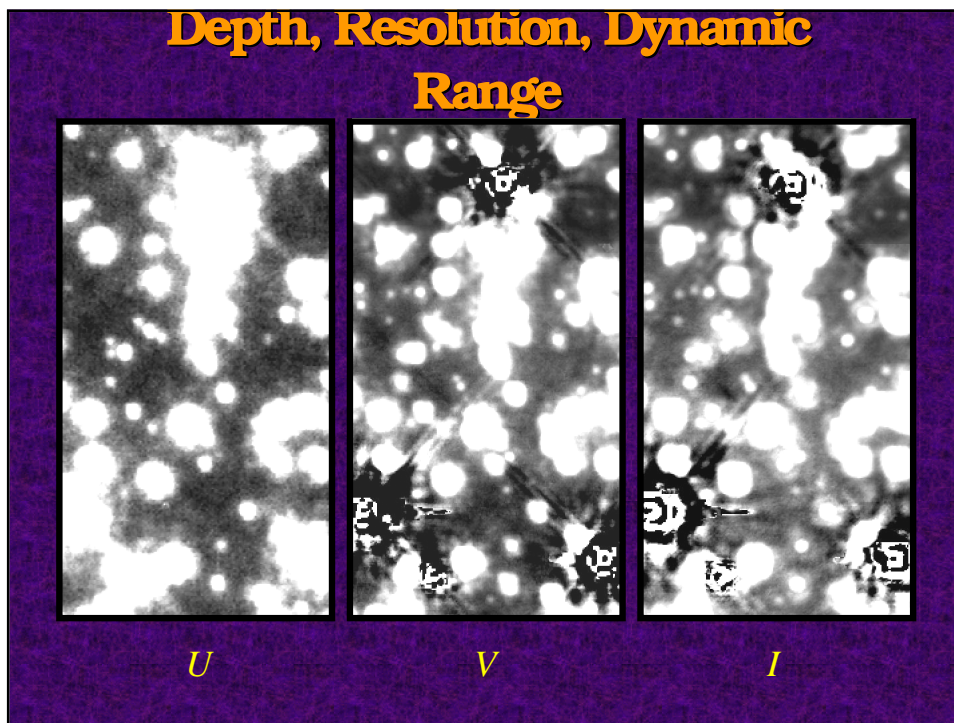
James Clem (University of Victoria), *Justin Howell* (UCSC),
Peter Stetson (HIA/DAO), & *Ron Gilliland* (STScI)

KITP Globular Cluster Conference

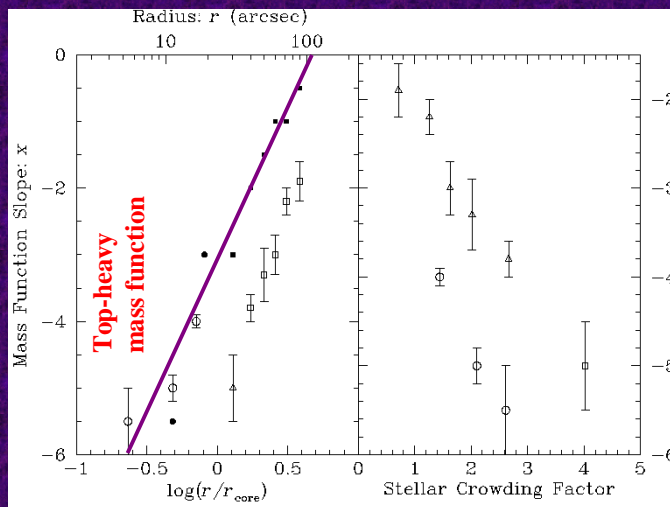
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The Core of 47 Tucanae

- Pre-core-collapse cluster: very high stellar density in the core; high degree of concentration
- Search for planetary transits (PI/Gilliland): 120 orbits with HST; large series of *V*- and *I*-band WFPC2 images, along with more limited set of *U*-band images; careful 10 x 10 sub-pixel dither pattern
- Co-added images are very deep and high resolution (super-sampled by a factor of 4 x 4) and are special even by HST standards
- Crowding in the cluster core makes identification and photometry of stars a challenge even on HST images; the controversy over the cluster core radius is a case in point:
 - > Ground-based studies: $r_{\text{core}} \sim 25$ arcsec
 - > Guhathakurta et al. (1992): $r_{\text{core}} \sim 23$ arcsec
 - > Calzetti et al. (1993) & De Marchi et al. (1999): $r_{\text{core}} \sim 7$ to 11 arcsec !!!
 - > Howell, Guhathakurta & Gilliland (2000): $r_{\text{core}} \sim 22$ arcsec (along with plausible reasons for previous discrepancies)



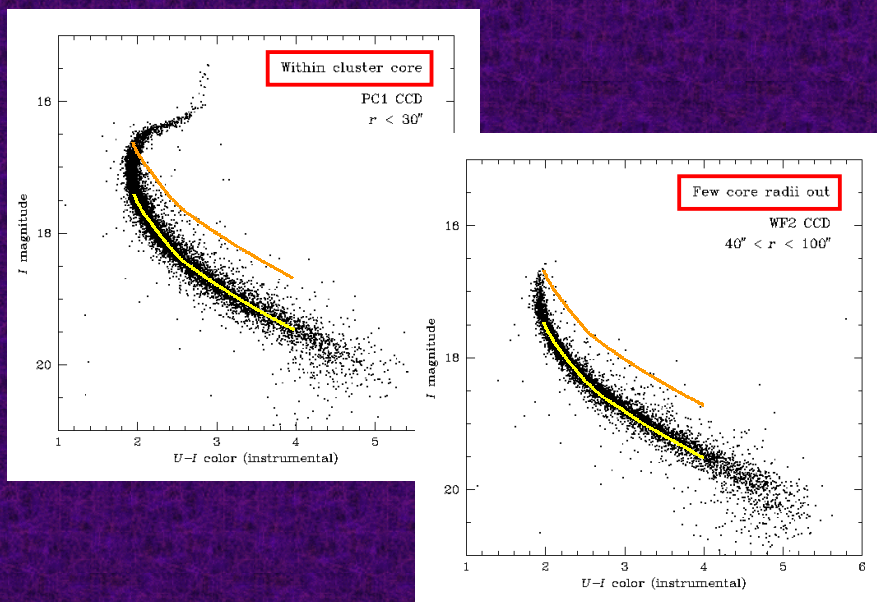
Extreme Mass Segregation

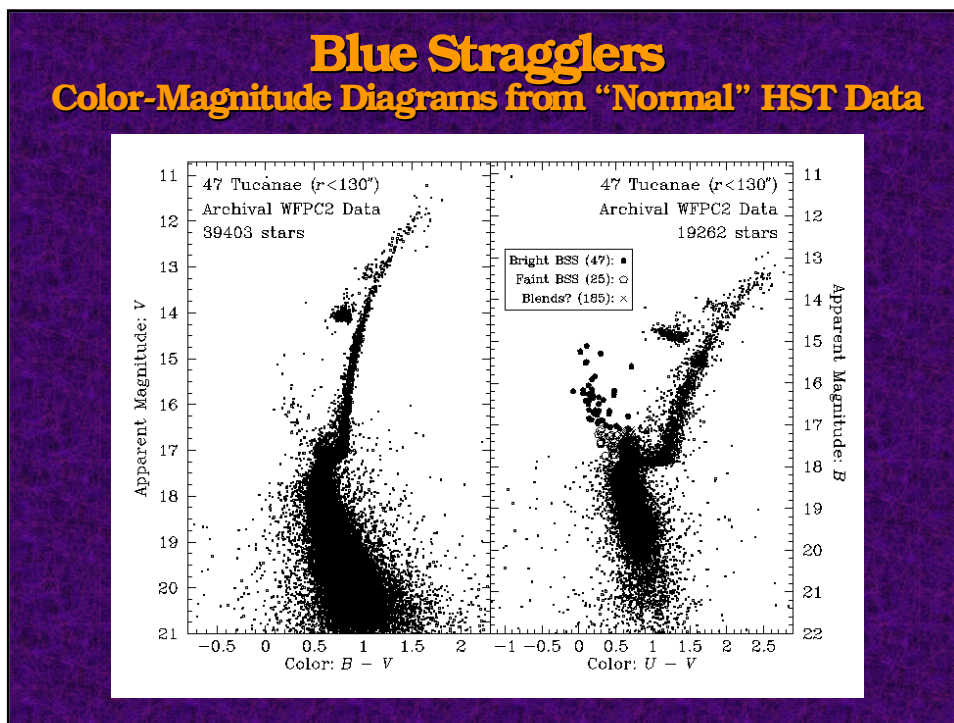
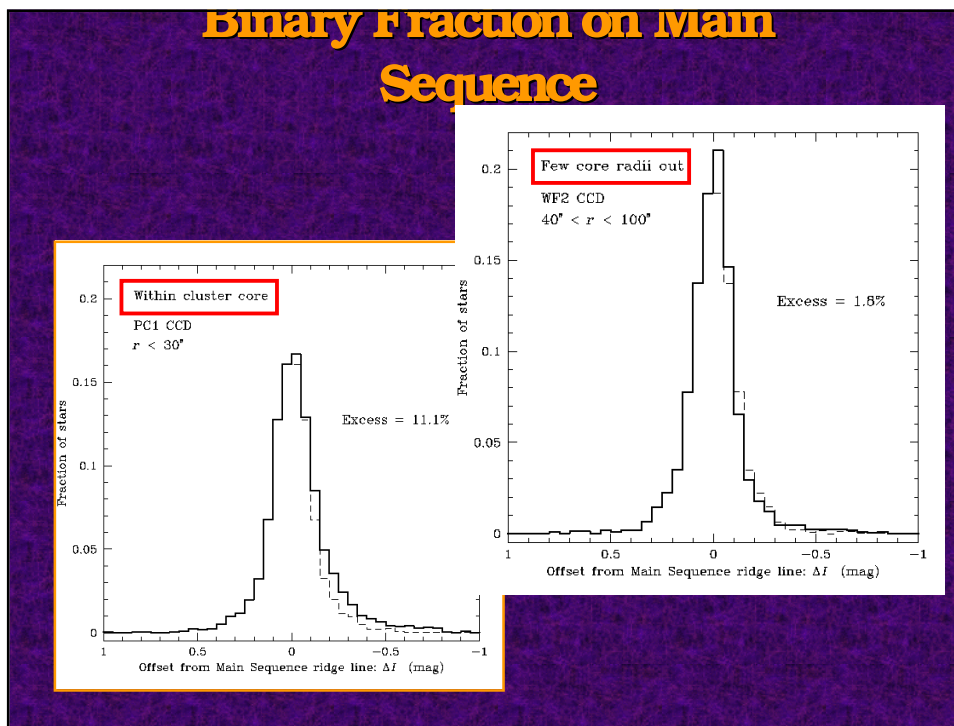


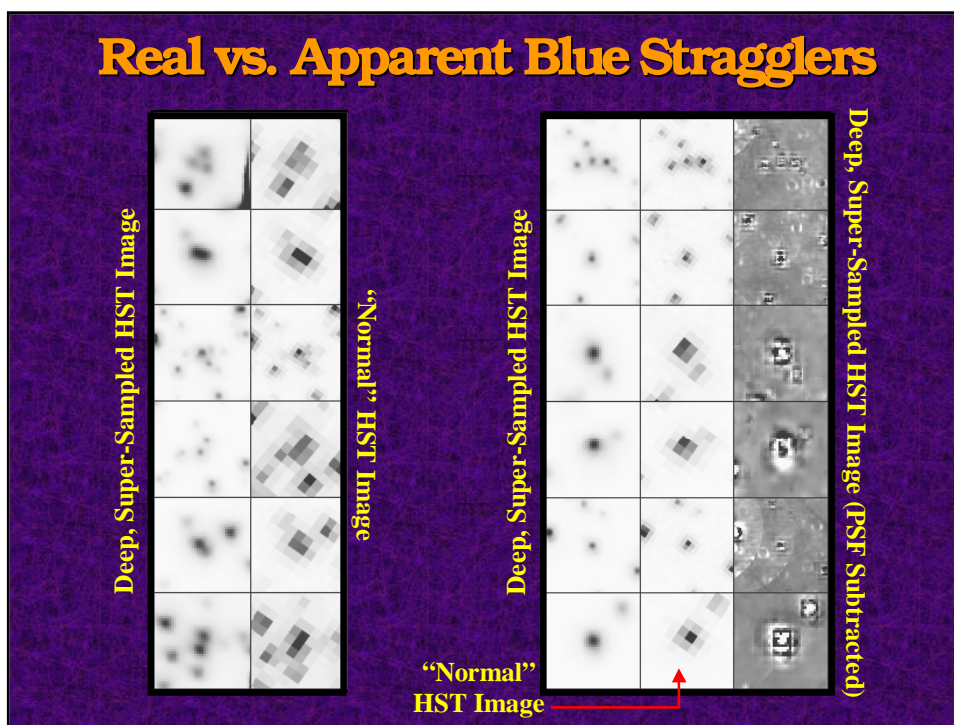
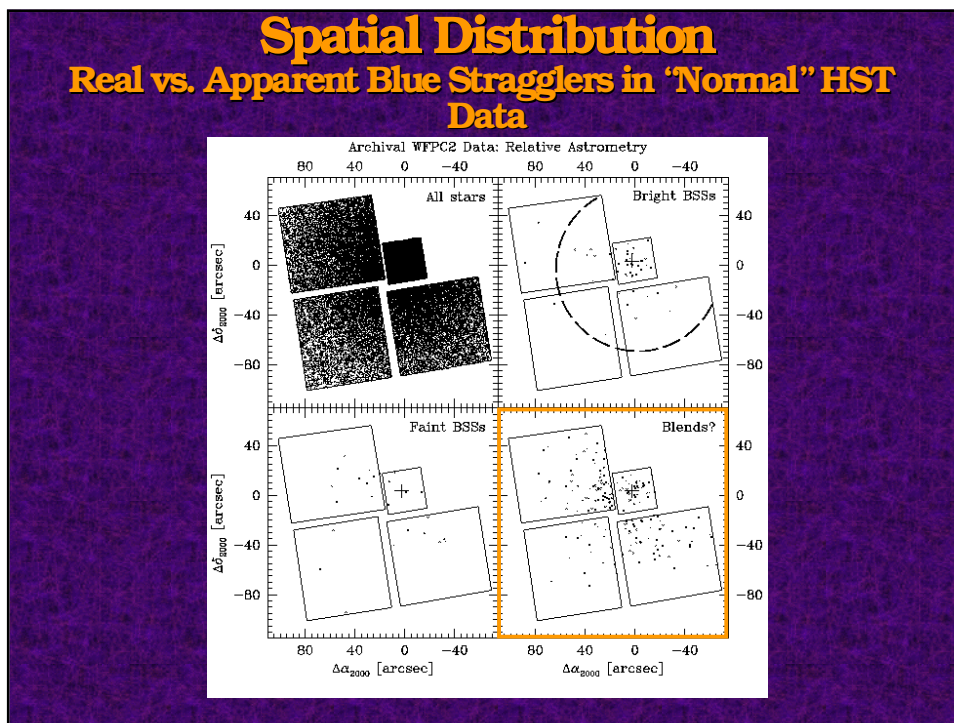
Smooth trend in mass function slope vs. radial distance from cluster center

Measured slope does NOT appear to depend on degree of stellar crowding

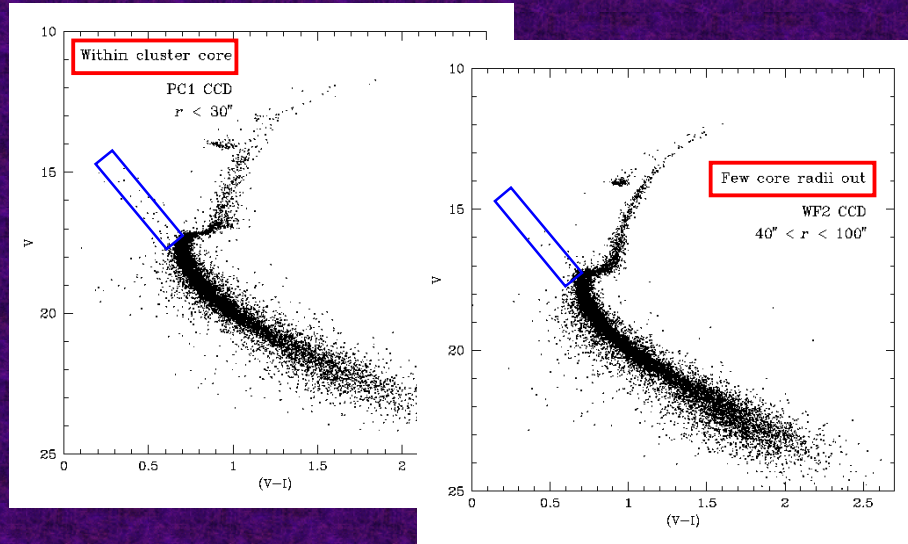
Binary Main Sequence



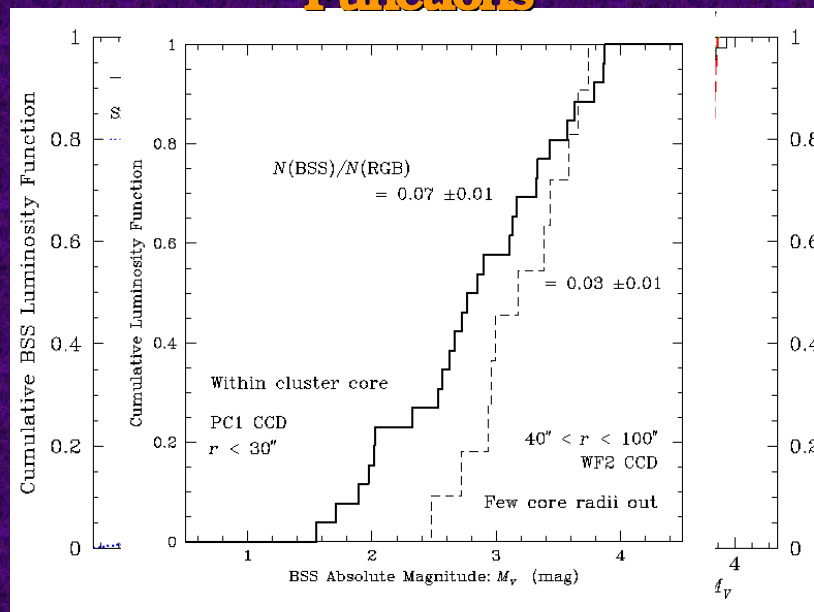


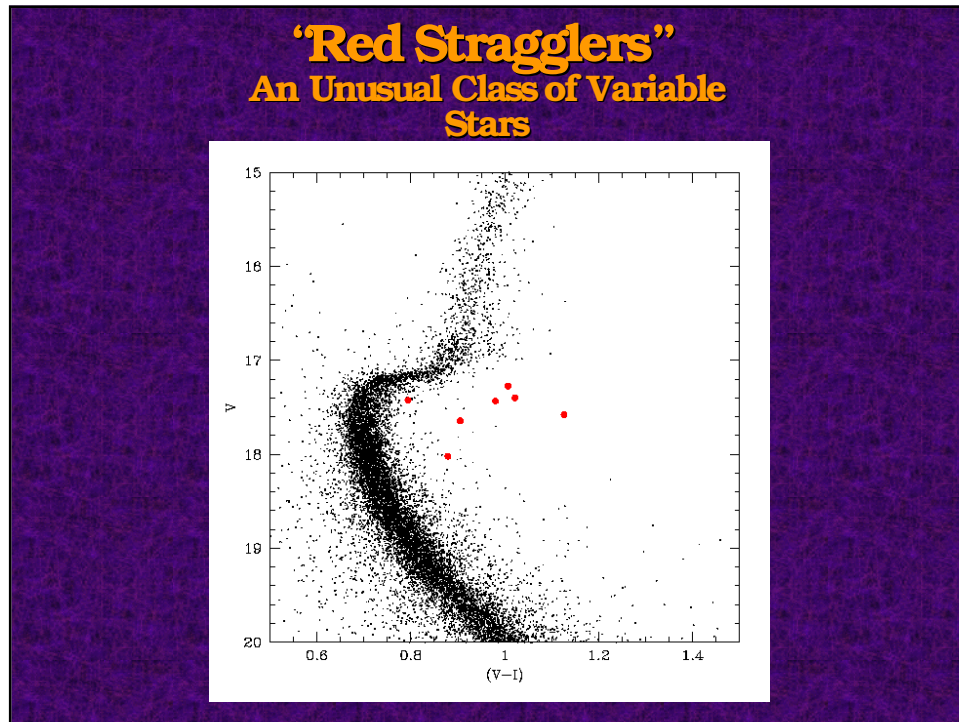


Blue Stragglers Color-Magnitude Diagrams from Deep, Super-Resolved HST Data



Blue Straggler Luminosity Functions





Summary

- Deep, high-resolution, 4x oversampled HST/WFPC2 image with large dynamic range centered on the core of 47 Tuc:
 - > FWHM of PSF $\sim 0.07 / 0.11$ arcsec in PC1 / WF CCDs
 - > Substantial improvement in photometric accuracy, completeness, and contamination over “normal” HST images
- Pronounced mass segregation:
 - > Mass function is well approximated by a power law in the stellar mass range, $m = (0.5 \text{ to } 1.0) m_{\text{turnoff}}$, with an index that varies from about -1 in the outer parts (few core radii out) to about -5 near the cluster center
 - > The mass function slope determination appears to be robust with respect to sample incompleteness at the faint end

Summary (continued)

- Binaries on the main sequence:
 - > Binary sequence visible in the core region up to 0.75 mag above the main sequence
 - > Estimated fraction of main sequence binaries: ~ 10%
 - > Contamination rate from chance superposition: ~ 1%
- Blue stragglers:
 - > Faint BSS region of the CMD derived from “normal” HST data is contaminated by blends
 - > BSS distribution in the core is skewed (w.r.t. region a few core radii out) towards higher luminosities and somewhat bluer colors
 - > Hints at truncation of BSS formation outside core a few Gyr ago