Globular Cluster Systems in Luminous Early-Type Galaxies

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NGCs 524, 4649 and 3115: *Photometry*

Faifer et al. 2009, in prep

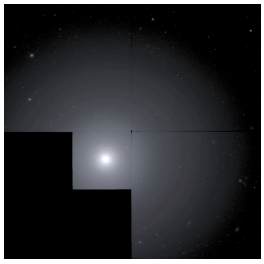


Figure 1. HST/WFPC2 image of NGC 524.

Figure 2: NGC 4649 (NGC 4647 to upper right)

Figure 3: GMOS image (two-element mosaic) of NGC 3115

Summary

- We have a sample of six early-type galaxies with Gemini/GMOS photometry (g,i) and multi-slit spectroscopy of their globular cluster (GC) systems
- All galaxies in our sample, except possibly NGC 524, have bimodal GC colour distributions
- The NGC 4649 GCs show a 'blue tilt', i.e. a mass-metallicity relation for the blue, metal-poor GCs, similar to that seen in other early-type galaxies
- We have pioneered a new technique to extract galaxy light from the background regions of the GC slits, allowing study of the galaxy stellar light to the same large radius as the GCs.
- We apply this technique to NGC 3923, and compare the kinematics, metallicities, ages, and [α/Fe] ratios for the GCs and stars. We find no significant rotation in either population, and good agreement in age, metallicity, and [α/Fe] between the red, metal-rich GCs and the stellar light.
- The GC and stellar velocity dispersions imply a significant dark matter halo in NGC 3923, with a M/L > 30 at 30 kpc radius. The NGC 3923 mass profile derived from GCs, stellar velocity dispersions, and X-ray emission all agree within the uncertainties.

NGC 524

- SA (rs) 0+ galaxy at 31 Mpc
- Chemically distinct stellar nucleus
- Inclined central disk

NGC 4649

- E2, with disturbed SAB companion
- Virgo cluster member
- 14 Mpc distance

NGC 3115

- Isolated S0- at 14 Mpc

NGC 3923: *Spectroscopy*

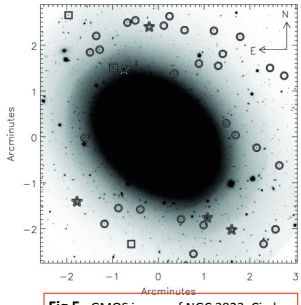


Fig 5. GMOS image of NGC 3923. Circles: confirmed GCs; Stars: MW stars; Squares: background galaxies/QSOs.

NGC 3923

- Shell elliptical at 21 Mpc
- Brightest member of average group
- 8 hour exposure on central field
- 3900-5500 Ang, ~6 Ang resolution
- 37 slits with 29 confirmed GCs

Figure 6 *Norris et al. 2008, MNRAS, 385, 40*

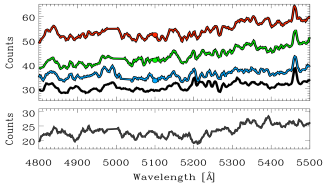
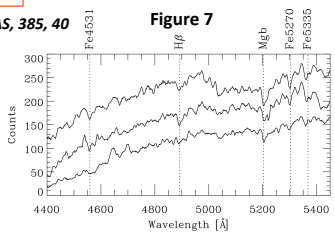


Figure 7

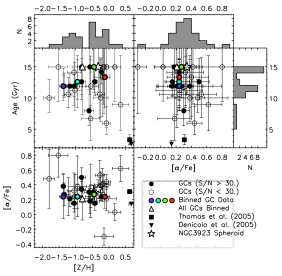


Extraction of Galaxy Light from GMOS Slits

Figure 6 (above left): **Upper panel:** three "sky + galaxy" spectra extracted from sky regions of GMOS slitlets. The bottom (black) spectrum is a "pure" background sky spectrum. **Lower panel:** subtraction of the sky spectrum from the top "sky + galaxy" spectrum. Redshifted (z=0.006) absorption lines from Hβ, Mgb, Fe5270 and Fe5335 are visible.

Figure 7 (above right): Representative galaxy light spectra for NGC 3923, from the co-addition of 16 individual exposures, and smoothed to Lick/IDS resolution. Redshifted absorption lines due to various features are marked on the plot.

Figure 8



Metallicities, Ages, and [α/Fe] for NGC 3923 GCs and Stellar Light

Figure 8 (left): Metallicities, ages, and [α/Fe] ratios for NGC 3923 GCs (filled circles: S/N > 30, open circles: S/N < 30), GC data binned by colour (coloured circles), NGC 3923 central regions (Thomas et al. 2005: filled square; Denicolo et al. 2005: filled triangle), and NGC 3923 spheroid (unfilled star)

Figure 9 *Norris et al. 2009, in preparation*

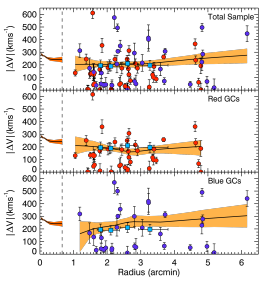
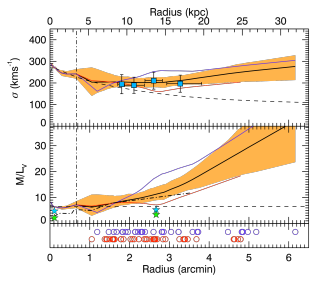


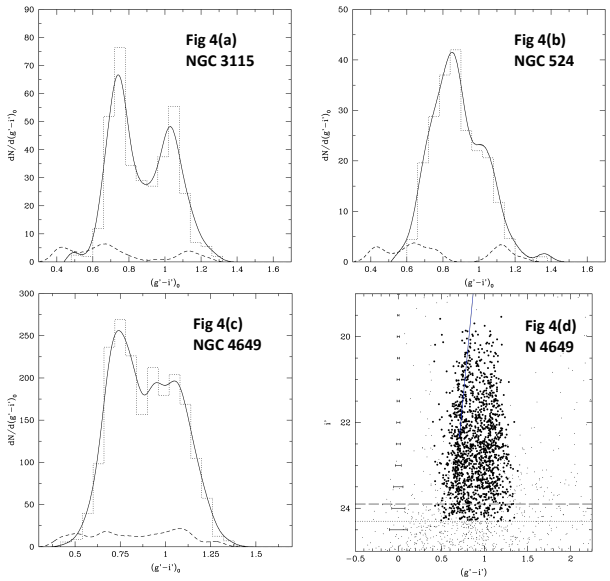
Figure 10



Dynamics of NGC 3923 GCs and Stars

Figure 9 (upper left): Velocity dispersion σ vs radius for total GC population (top panel), red GCs (middle panel), and blue GCs (bottom panel). Solid black lines: fits to the stellar light in the inner region and GCs in the outer region. Orange shaded regions: 68% confidence intervals. Orange region at left: σ for the stellar light from (ref). Light blue squares: σ for the stellar light measured from galaxy+sky regions in the GC slitlets. **There are no significant differences in the σ profiles for the 3 populations.**

Figure 10 (upper right): **Top panel**: σ vs radius for galaxy light (blue squares) and GCs (blue/red lines). Black line: same as Fig 5. Black dashed line: constant M/L model. **Bottom panel**: M/L_V vs radius. Blue/red/black solid lines, black dashed line: same as top panel. Dot-dashed line: X-ray M/L profile (Fukazawa et al 2006). **The mass profiles from GCs, X-ray emission, and the stellar light velocity dispersion agree within uncertainties.**



Photometric Behaviour of the Globular Cluster Systems

Histograms of the colour distributions of the globular clusters in these galaxies reveal a diversity of properties. **NGC 3115 (Fig 4a) shows a strong bimodal colour distribution, an effect which is much less apparent in NGC 524 (Fig 4b). In NGC 4649, the bimodality is again strong (Fig 4c) , and a 'blue tilt' in the blue sub-population is clearly present (Fig 4d).**