The Star Formation Histories of Cluster Red Sequence Galaxies

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with
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Outline

- Stellar ages and star formation histories
- Environmental dependence
- Ram-pressure stripping
- Star formation in BCGs
Ages, Metallicities & $\alpha$-Enhancements from Spectra

• Measure “Lick” spectral absorption indices (typically $H\beta$, $H\gamma$, $H\delta$, several Fe lines, Mgb) for cluster red-sequence galaxies

• Compare with $\alpha$-enhanced models e.g. Thomas/Maraston et al., Schiavon.

• Get (“luminosity-weighted”) ages, metallicity, $\alpha$-enhancement

Similar work: see posters by Sanchez-Blazquez, Ferre-Mateu
The “Driving Parameter” of Stellar Populations

Velocity dispersion, $\sigma$, is the driving scaling parameter, with little or no residual dependence on stellar mass.

Smith, Lucey, MH ‘09
Graves & Faber ‘09
The End of Downsizing?
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Shapley

(Smith et al 07, Allanson, MH et al 09)
Stellar M/L vs Dynamical M/L

At high $\sigma$, all stars are old.
~40% dark matter with $R_{\text{eff}}$

At low $\sigma$,
“frosting” and exponential models overpredict the dynamical M/L

Environmental dependence of bulges and disk colours

Bulges redder, but colours show no cluster-centric dependence
Disks bluer, show a strong effect

MH et al., MNRAS, submitted
Environmental Dependence

For giant ($\sim L^*$) galaxies, dependence of stellar populations on environment is significant but weak:

Smith et al. ‘06 found a 15% variation in age from the cluster core to the virial radius.
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For dwarfs the story is very different ...
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For dwarfs the story is very different …
Coma dwarfs: slope = $-0.21 \pm 0.04$  rms = 0.20
"Archaeology" vs. "Lookback"

We measure SSP-equivalent ages.

Translation to "time when galaxy arrived on red-sequence" depends on the real SFH.

For same $T_{\text{SSP}}$ (same linestrengths), "quenched" models turn red at lower $z$ than SSP models.

SSP and quenched models bracket the observed LF evolution!

Tight correlation between accretion and quenching
Using GALEX and deep CFHT we have identified 13 gaseous stripping events in Coma. Tails point away from cluster center.

12 of these are located within 1 Mpc, representing 30% of blue galaxies.

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Stripping in the core of Coma

30"

GALEX

H-alpha

Optical

Mpc, representing 30% of blue galaxies.

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Stripping in the core of Coma
Star Formation in BCGs from the NFP survey

Edwards, Hudson, Balogh & Smith ‘07
Star Formation in BCGs from the NFP survey

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Cluster Red Sequence Galaxies

**Giant red galaxies**

- have strong variation in age ("downsizing"), metallicity and $\alpha$-enhancements
- Younger ages are due to star formation quenching at intermediate epochs and not due to a small amount of very recent star formation.
- *Velocity dispersion* sequence suggests internal process: AGN?
- Star formation ongoing in all BCGs within 50 kpc of CC clusters

**For dwarfs,**

- the downsizing in stellar age stops at $\sigma \sim 70$ km/s and the scatter in age increases.
- Dwarf ages (and disk colours) are strongly dependent on cluster-centric radius indicate quenching by the cluster environment.
- Ram-pressure stripping common in Coma < 1 Mpc