THE STAR FORMATION HISTORIES OF FOSSIL GROUP GALAXIES

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INTRODUCTION:

In the extremely sparse regions of space, some 70 % of the galaxies are forming a significant number of stars. However, the remaining 30 %, bright and isolated galaxies with no sign of star formation defy an interpretation. Fossil groups are considered the 'final stage' of the merging of L* galaxies in low-density environments. Therefore, it is coherent to think they can originate those 'quiescent' isolated ellipticals.
In this case, their isolation may be a misleading representation of environment; in fact, they may represent the most dense environments, where all bright, surrounding galaxies have merged into one (Balogh et al. 2004). In the present work, we try to test this interpretation by studying the Star Formation Histories (SFH) of the first-ranked ellipticals in fossil groups and clusters compared to their quiescent counterparts in less crowded environments.

WHAT IS A FOSSIL GROUP ?

A group of galaxies dominated by a single giant elliptical galaxy (*) with an extended halo of X-ray emitting gas

(*) The second brightest galaxy is more than a factor five less luminous than the dominant one.

Fossil Group NGC 1132 (Chandra + HST / NASA)

OPEN QUESTIONS:

Are fossil groups the place of formation of the isolated ellipticals?

How do first-ranked galaxies in fossil groups compare with those in clusters?

THE SAMPLES

TARGETS

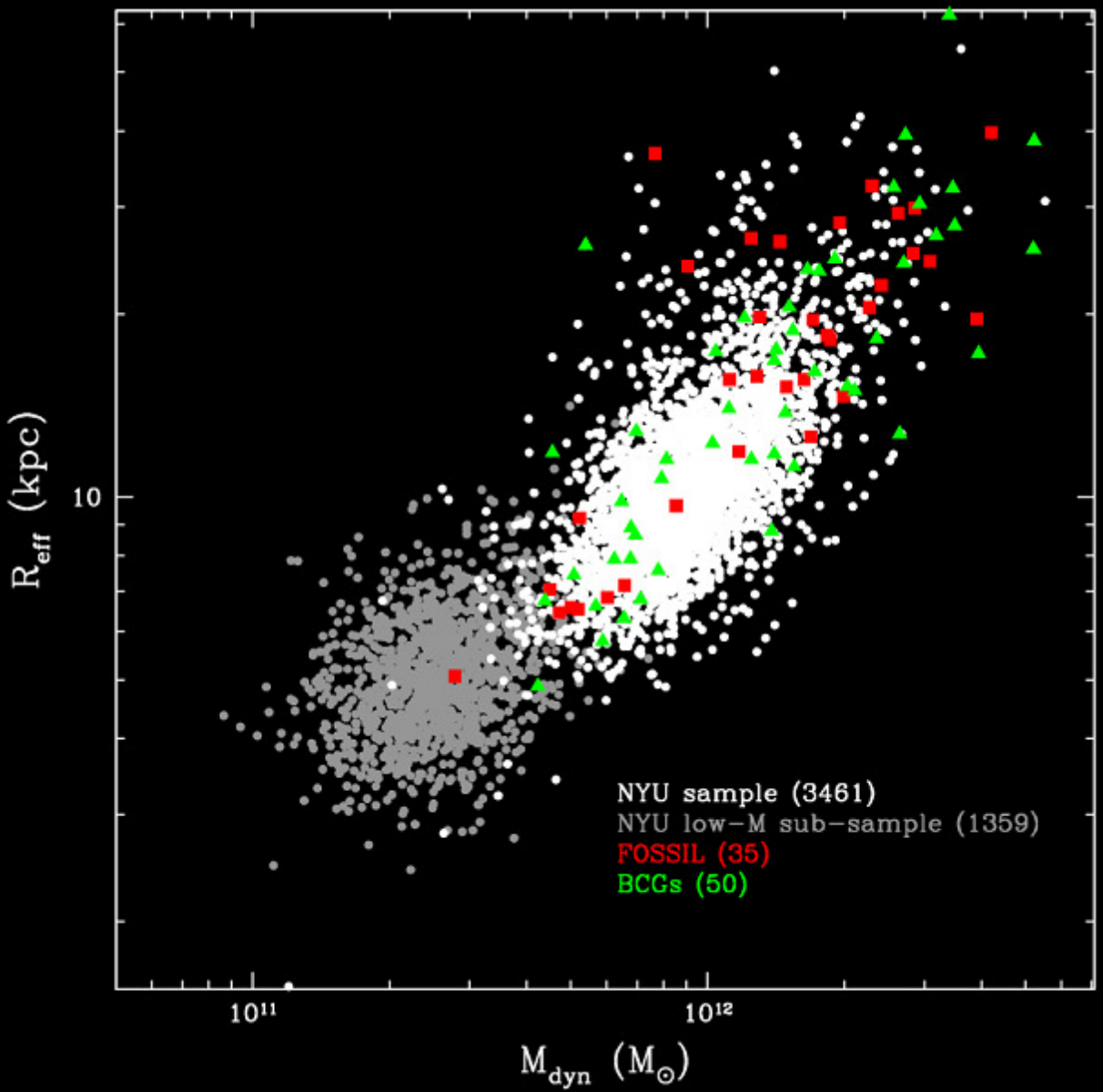
35 First-ranked galaxies of Fossil Groups (SDSS)
Santos et al. (2007)

50 BCGs from the MaxBCG Catalog (SDSS)
Koester et al. (2007)

COMPARISON

3461 ETGs from NYU-VAGC SDSS (Blanton et al. 2005)
Sérsic Index: $3.5 < n < 5.9$
$M_* > 3 \times 10^{11}\ M_\odot$

1359 ETGs from NYU-VAGC SDSS (Blanton et al. 2005)
Sérsic Index: $3.5 < n < 5.9$
$0.9 \times 10^{11}\ M_\odot < M_* < 1.1 \times 10^{11}\ M_\odot$



THE METHODS:

Three methods have been used to obtain either the SFH or the Luminosity-weighted age/metallicity:

(1) **Spectral index pair**, using $H\beta_0$ (Cervantes & Vazdekis, 2009) and [MgFe]', which provides L-weighted ages, metallicities and [Mg/Fe]

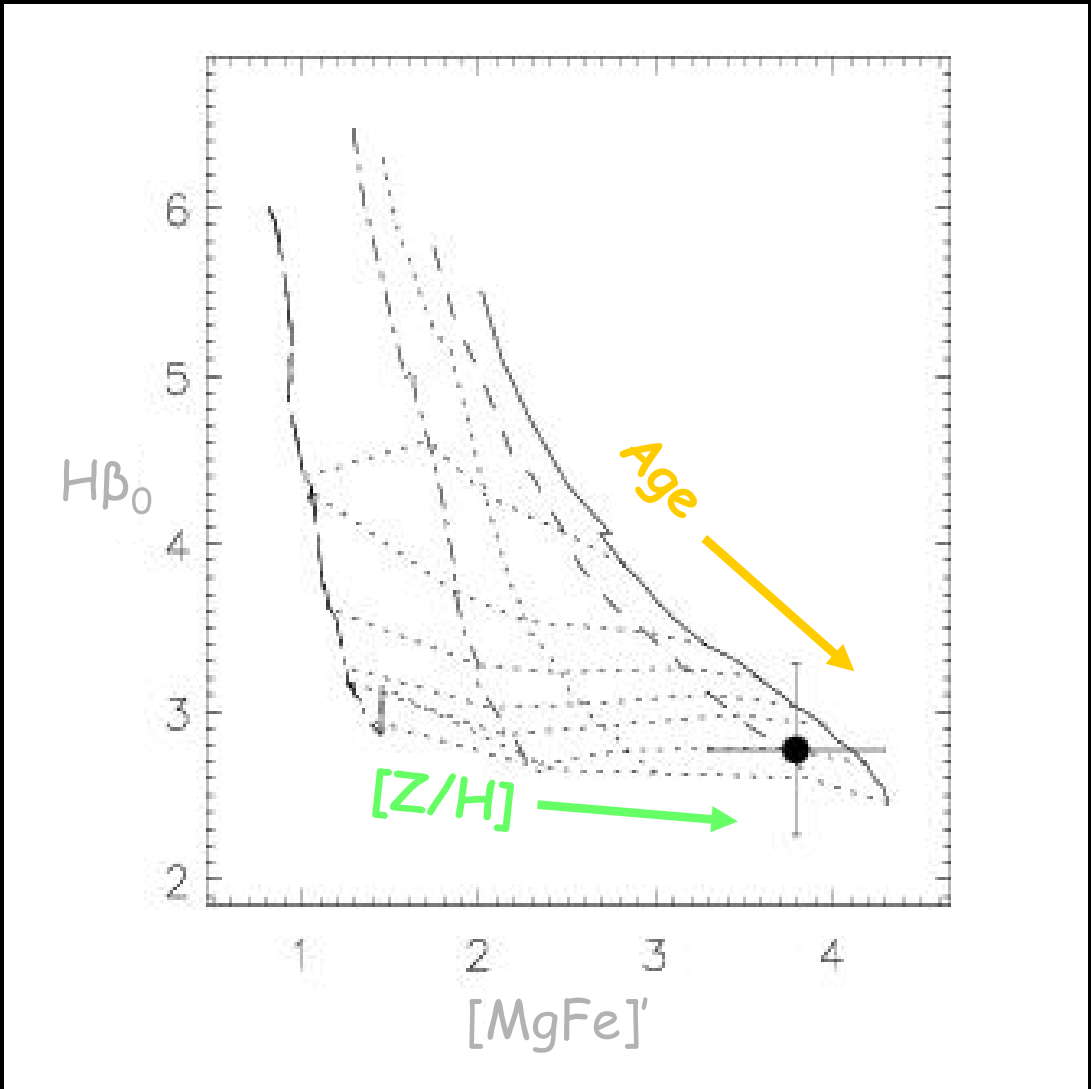
(2) **Full spectrum match** with **STARLIGHT**-code (Cid Fernandes et al. 2005), which provides SFH. A base of 88 MILES models has been used for the match.

(3) **Multi-spectral index** study (Proctor), which provides L-weighted ages, metallicities and [α/Fe]

The present study only uses the SFH provided by the second method, although a comparison on the performance between methods (1) & (2) is shown. The comparison is made by applying them to 3000 synthetic spectra of mixed populations (MILES) and extracting the L-weighted age/metallicity. Results are shown in the figure.

TWO METHODS FOR STELLAR POPULATION ANALYSIS

METHOD 1: Spectral Index Pairs



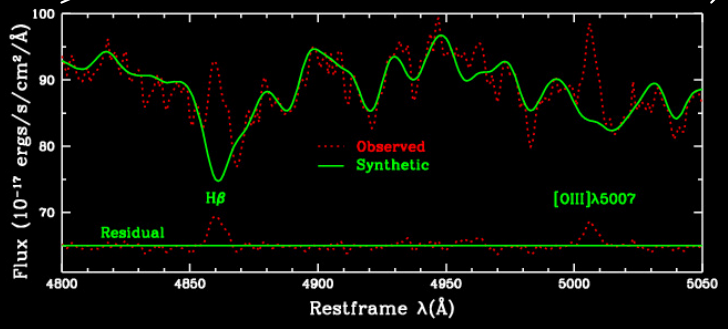
METHOD 2: STARLIGHT spectrum match (Cid Fernandes et al. 2005)

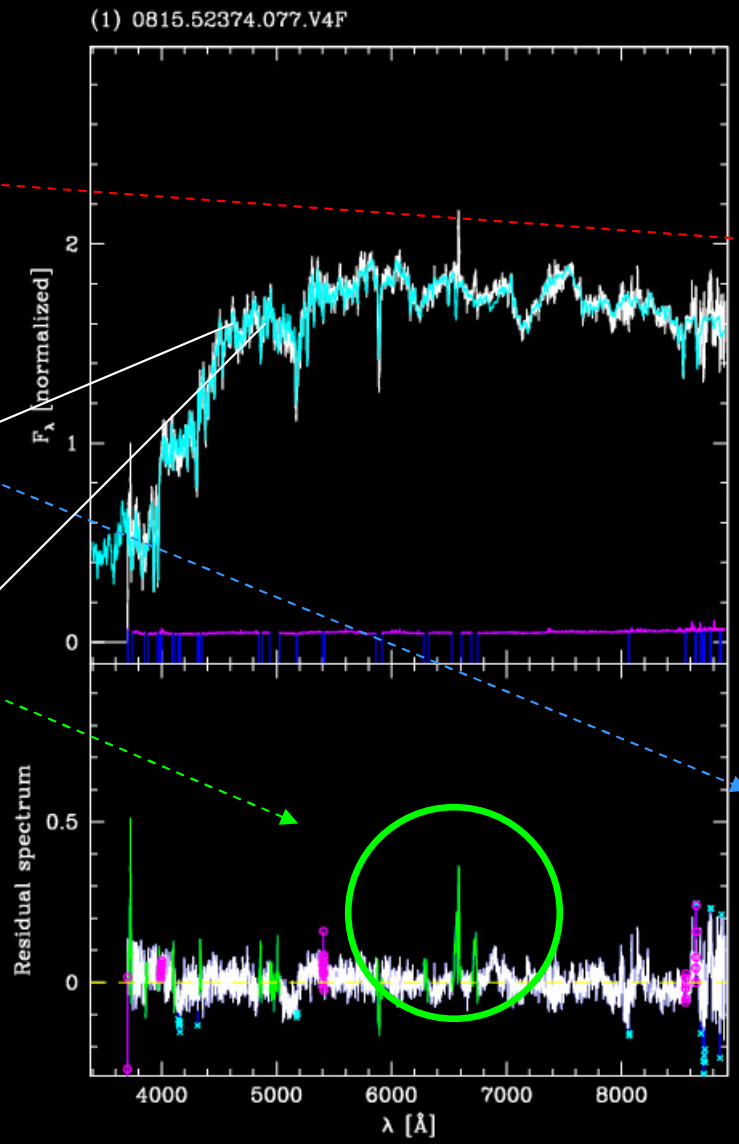
Velocity dispersion

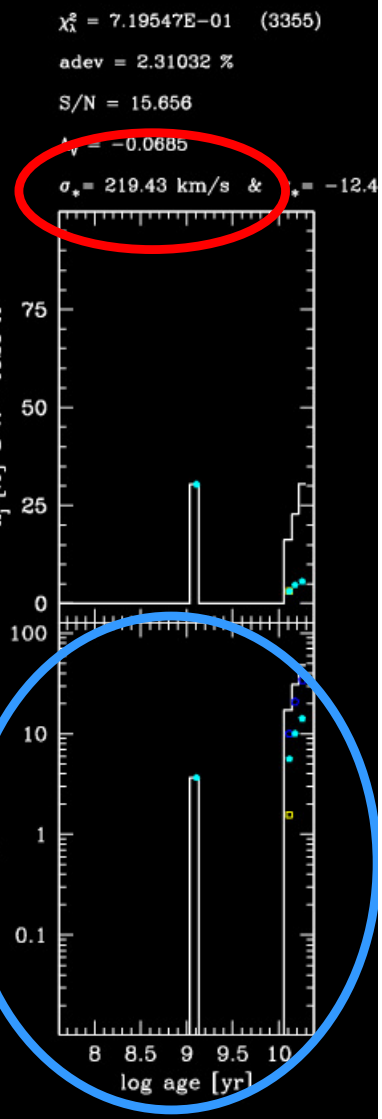
Star Formation History

Emission lines

Zoom







How well both methods extract age/met (solar)?

SIMULATION:

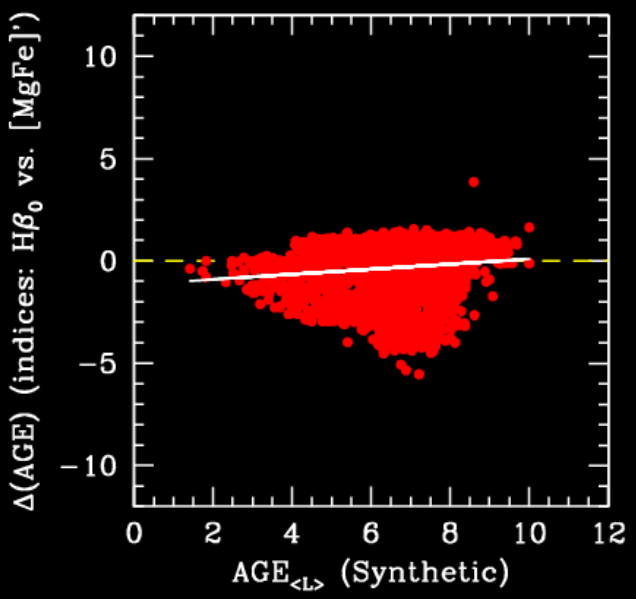
INPUT: 3000 synthetic mixed-population spectra

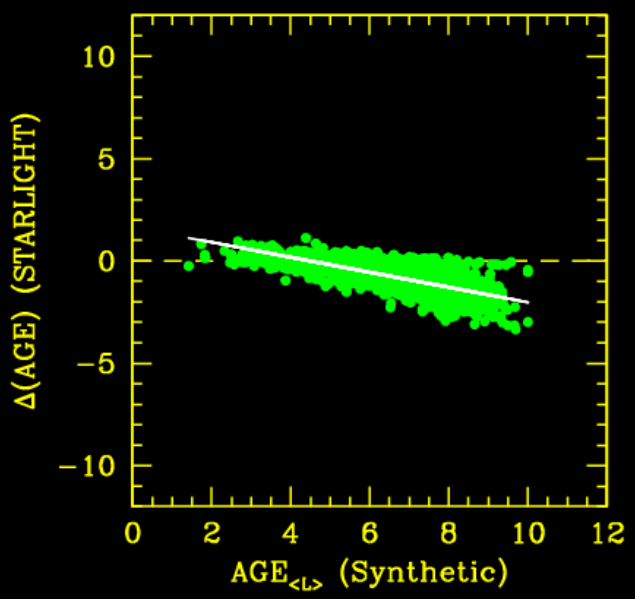
METHOD: Two alternative approaches to recover L-weighted age/met

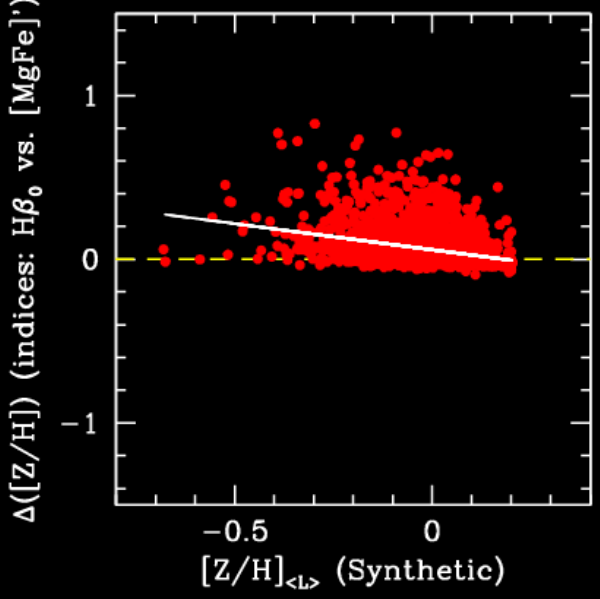
PLOTS: Δ(age/met) = age/met (output) – age/met (synthetic)

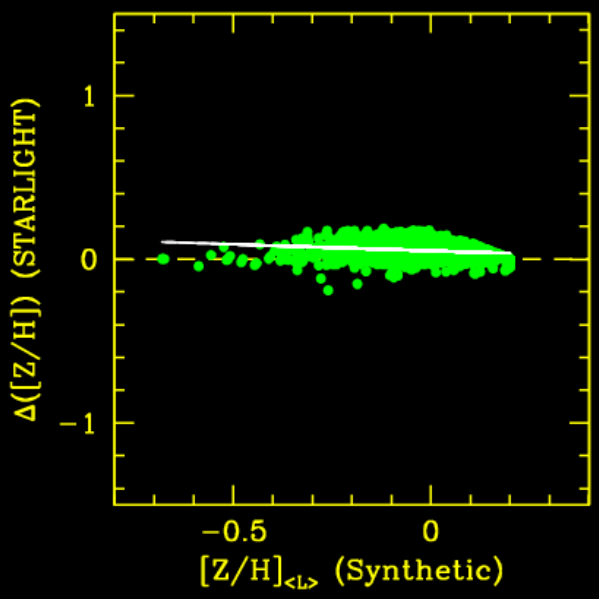
Spectral Indices

Spectrum match









RESULTS:

Galaxies have been segregated in bins of $\Delta(\log(M_{dyn})) = 0.193$, where $M_{dyn}=5*R_{eff}*\sigma^2/G$. Lookback-time has been added to each galaxy's age.

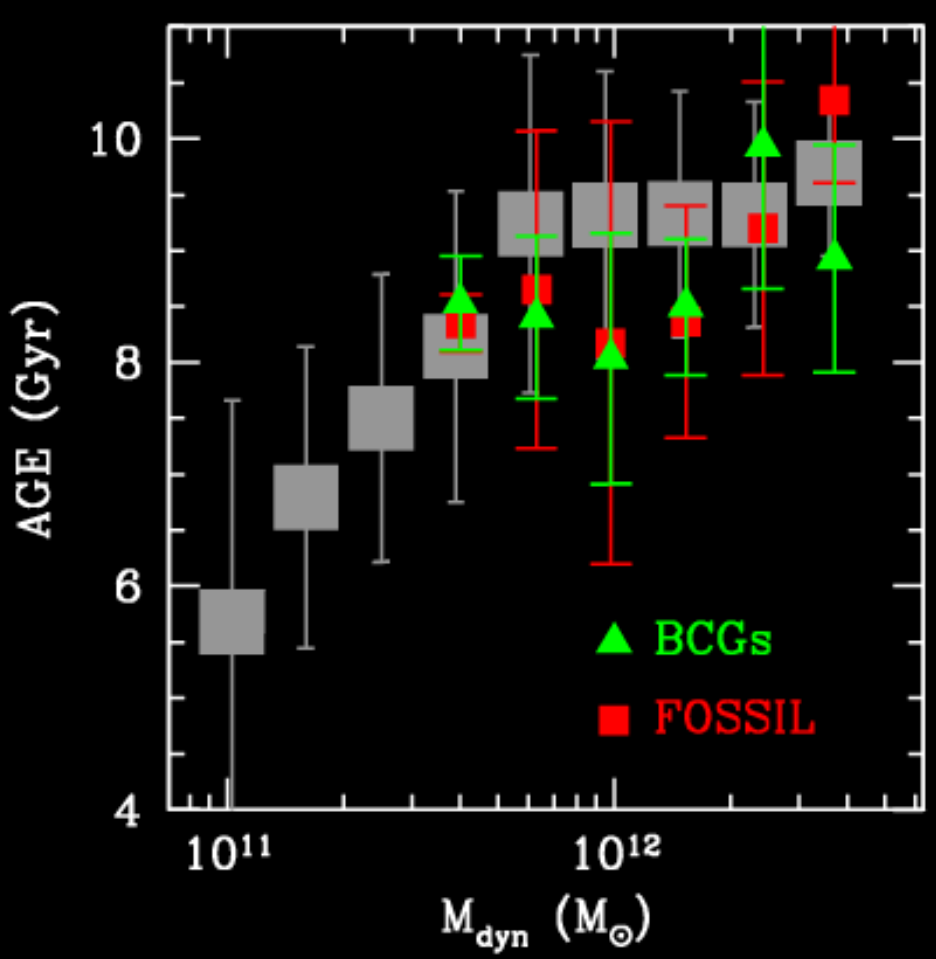
(1) *Normal* galaxies show that both their ages and [Z/H] increase with M_{dyn}, especially along the interval 1- 8 10^{11} $M_\odot$

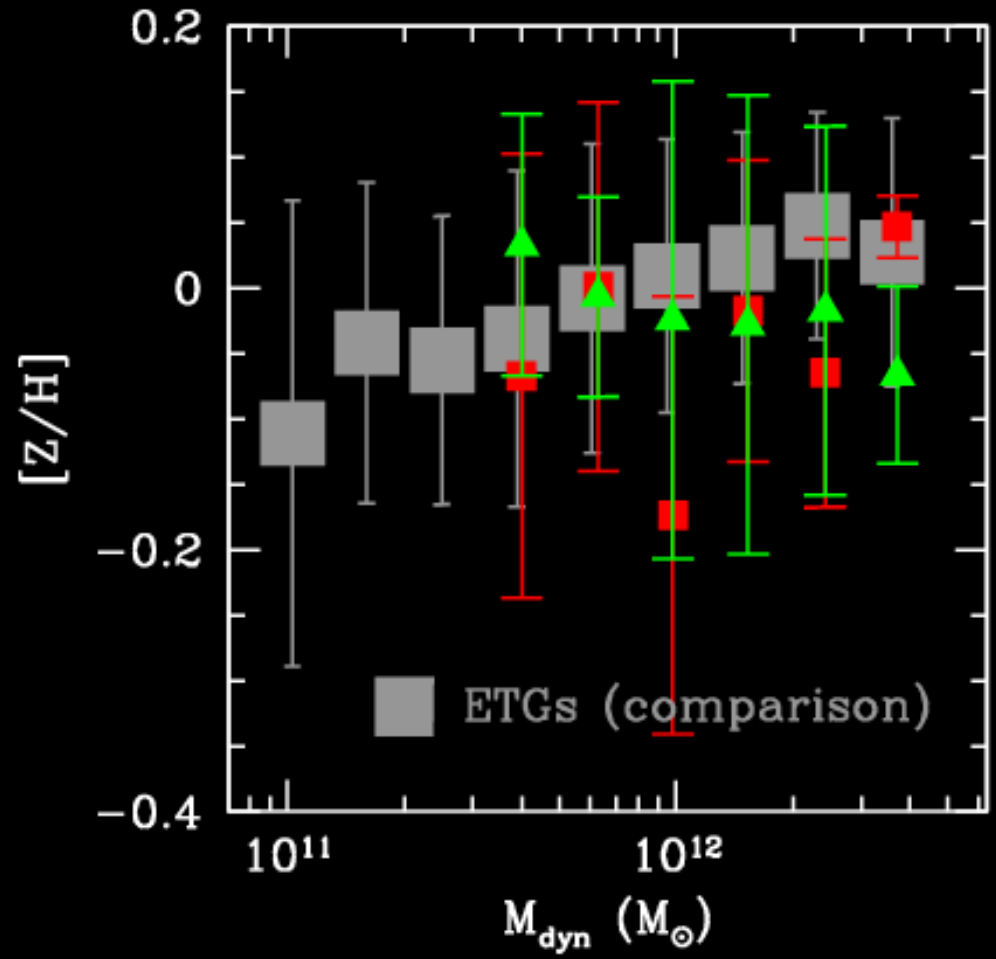
(2) Age/[Z/H] of first-ranked galaxies in fossil groups and clusters are statistically indistinguishable.

(3) First-ranked galaxies in fossil groups and clusters are similar to their *normal* counterparts. Younger ages are seen in the fossil/cluster galaxies for the mass interval: 4.9 - 19 10^{11} $M_\odot$. This discrepancy is relevant, because that interval includes 70% of the *normal* galaxies and respectively 54 % and 62 % of those in fossil and clusters.

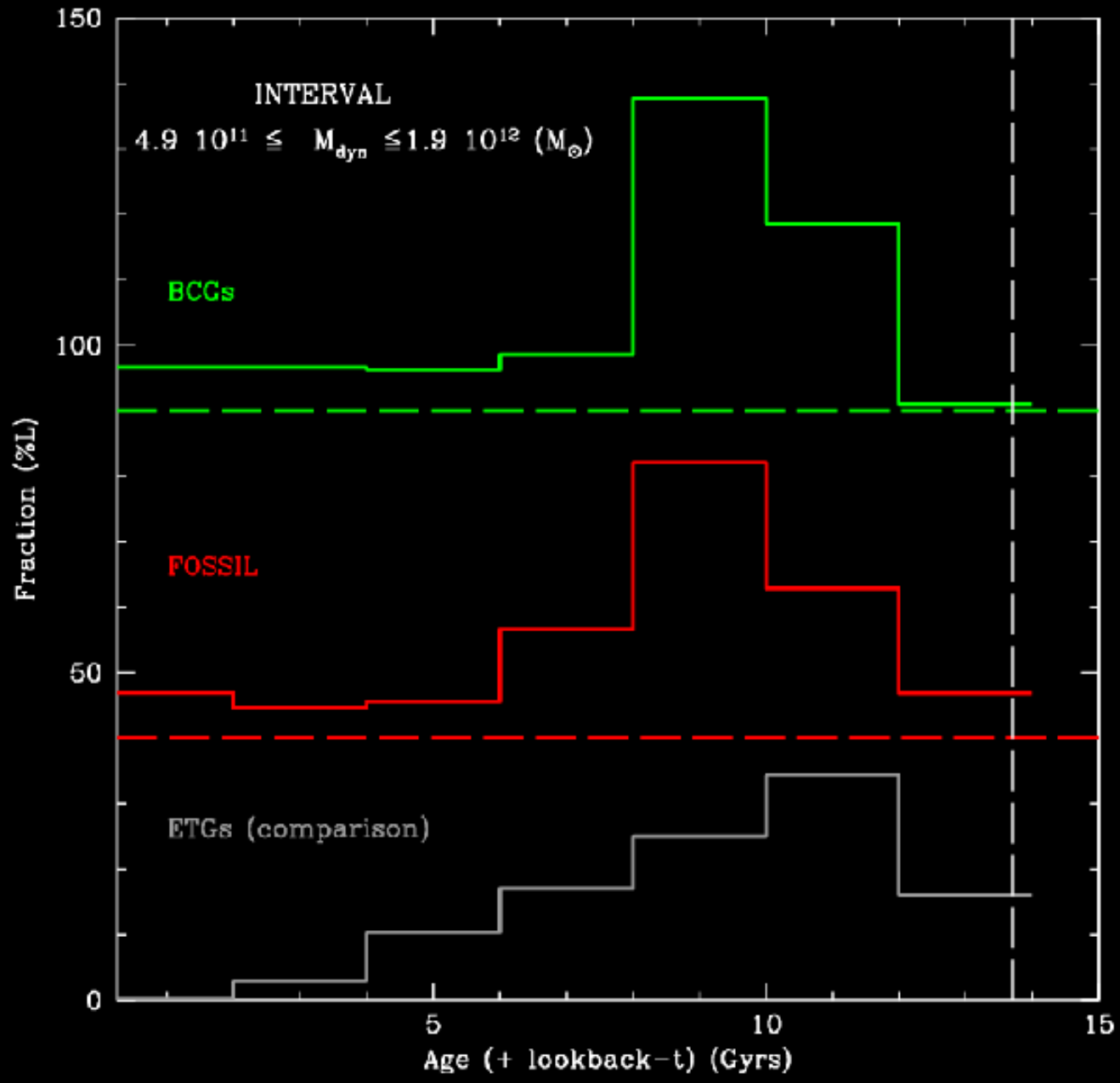
(4) The average Star Formation Histories (SFHs) of the three galaxy samples in the 4.9-19 10^{11} $M_\odot$ interval (see (3)) show a clear similarity between first-ranked galaxies in fossil and clusters. On the contrary, the *normal* counterparts show older SFH and lack of recent star formation episodes.

RESULTS
FORMAT 1: binned in M_{dyn}





STAR FORMATION HISTORIES (SFH)



DISCUSSION:

We do not find any trace of different SFH between fossil and clusters

The slightly younger SFH of fossil/cluster galaxies can indicate that their accretion process, including some gas rich satellites, is still active. In contrast, normal quiescent galaxies have finished their hierarchical growth some 2 Gyrs earlier.

Hierarchical formation of BCGs is difficult in the high velocity dispersion environment of the dense clusters, but easy in groups. It has been suggested that infalling groups can contribute their ready-made brightest galaxies to the BCGs. Equally, the unexplained existence of isolated quiescent ellipticals can be attributed to a final stage of fossils.

A recent study by La Barbera et al. (2009) also conluded that there is no difference between fossil group and field galaxies.

CONCLUSION:

According to their Star Formation Histories, fossil galaxies can be the source of both BCGs and isolated quiescent ellipticals.