Tracing the Formation of Massive Spheroids from High-z Galaxy Clustering

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Abstract. The high-z progenitors of local massive early-type galaxies should be characterized by a strong level of clustering, larger than that measured for $z = 3$ Lyman Break Galaxies and comparable to that of $z \sim 1$ EROs. First possible evidences for such strongly clustered objects at $z \gtrsim 2$ were found by the FIRES and K20 surveys, that have identified new classes of faint high-z K-selected galaxies. Some details are given here for the new population of massive star-forming galaxies at $z \sim 2$, found by the K20 survey in the GOODS-South area. Because of their much redder UV continuum, most of these galaxies would not be selected by the Lyman Break criterion. Such objects are good candidates for the precursors of local ellipticals caught in their formation phase. We have calibrated a two color criterion to allow the identification of these highest redshift galaxies in bright K-limited samples.

1 Introduction

Understanding the evolution, star-formation and assembly histories of early type galaxies up to their highest redshifts of formation is a crucial observational question that remains unsolved. Passively evolving, massive spheroidal galaxies appear to be common up to $z \approx 1$ with little evolution, if any, from present days [6,22,2]. It is not well constrained yet if and how many passive spheroids exist at higher redshifts, $z > 1.5$–2. Moreover, it is unclear up to what redshift most precursors of spheroids maintain the low-redshift signatures of morphological and stellar population properties. Approaching their formation epoch, spheroid progenitors will appear as star-forming and possibly morphologically irregular galaxies. Therefore, identifying the precursors of todays ellipticals close to their most interesting formation or assembly phases requires to rely on independent and alternative signatures than their morphologies or old stellar population properties.

2 Expected Clustering of Spheroid Precursors

Spheroids inhabit preferentially the densest environment in the local universe. They have the largest correlation lengths among galaxies in the present day universe and up to $z \sim 1$ [19,7]. *Searching for the most clustered population at any redshift is therefore a natural way to locate such progenitors and to investigate their properties.*

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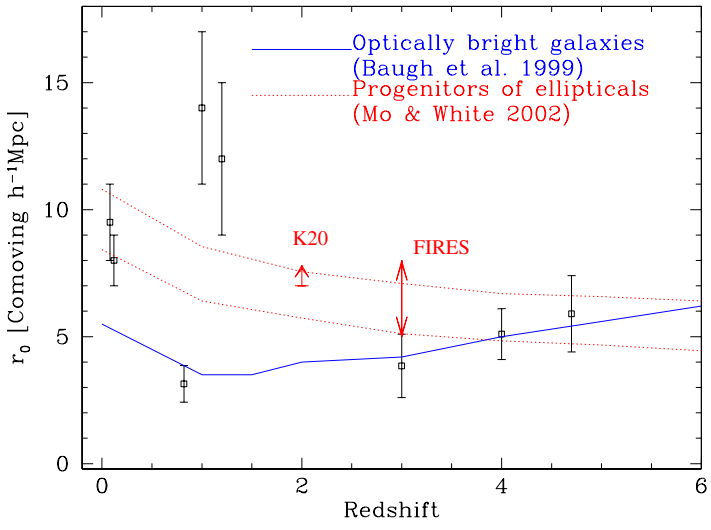

Fig. 1. Predicted evolution for the correlation length of halos that will evolve into local massive ellipticals (dotted lines, from [17]) and of optically selected galaxies (solid line, from [1]). Together with the new constraints coming from K-selected populations at $z \gtrsim 2$ (heavy symbols), we show relevant measurements taken from the literature: ellipticals at $z \sim 0$ from [19], optically selected galaxies at $z \sim 0.8$ from [5], EROs and radio galaxies at $z \sim 1$ from [7,21], $z = 3$ LBGs from [13] and $z = 4$–5 LBGs from [20]

This view is supported by model predictions for the redshift evolution of the correlation length of halos hosting today massive ellipticals (Fig. 1, based on [17]). Halos clustered with $r_0 \sim 8$–10 in the local universe, are predicted to have $r_0 \sim 5$–$8\ h^{-1}$ Mpc even at $2 < z < 4$. Being referred to halos, these predictions could represent only lower limits for galaxies that, at the relatively small scales probed by high-z measurements, can have enhanced correlations due to large halo occupation numbers (e.g. [18]).

In practice, it is impossible to observationally preselect a population by its clustering properties and one has to look at the clustering properties of the available classes of high-z galaxies to find putative progenitors.

Extremely red objects (EROs) and giant $z \sim 1$ radio galaxies, as well known, have an high clustering and therefore are good candidate progenitors of local ellipticals [6,16,7,21], in agreement with some significant fraction of these objects being passive spheroids (e.g. [4]).

Measurements for the highest redshifts ($z \sim 4$–5) star-forming galaxies [20] of $r_0 \sim 5$–6 may be consistent with the predictions for forming spheroids. This is also in qualitative agreement with the observation that the oldest stars (thus the ones formed at the highest redshifts) are nowadays in spheroids.

Typical $z = 3$ Lyman Break Galaxies (LBGs) appear instead to start falling short of the expected clustering level of ellipticals progenitors, with the best current estimates of $r_0 \lesssim 4\ h^{-1}$ Mpc [24] and with fainter LBGs having even