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# Lyman break galaxies at high redshifts (Z > 3) as probes of galaxy formation

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**Abstract.** We propose the study of star - forming galaxies at high redshifts with large 10-m class telescopes. Lyman break galaxies serve as the best candidates to probe galaxy formation and evolution. The faintness of these objects ($I_{814} > 24$) necessitates the use of large telescopes.

*Key words* : galaxy formation, galaxy evolution, lyman break galaxies

## 1. Motivation for studying star-forming galaxies at high redshifts

Star - forming galaxies seen at high redshifts are the progenitors of present day galaxies. A chemo-dynamical study of these systems is probably the only way to understand galaxy formation and evolution. By studying galaxies at $z > 3$, which corresponds to lookback times of ≈ 90% of the Hubble time (for $q_0 > 0.05$), one hopes to constrain the models of galaxy formation. There are a number of issues that need to be addressed like, when did the first galaxies form? did galaxies form at one epoch and then evolve passively? or did they form as sub-galactic fragments and then undergo merging to form the present day local galaxies? Do the blue field populations that we see in deep images like the Hubble Deep Field (HDF) correspond to such fragments? How do the blue population of galaxies seen in clusters differ from the field population? A complete picture of galaxy evolution require systematic studies covering the full redshift range from the epoch of galaxy formation to the present.

## 2. Why are Lyman Break Galaxies the right candidates?

In star forming galaxies the UV continuum from $Ly_\alpha$ 1215 Å to about 3000 Å is devoid of any strong features and is relatively flat. The spectra of cosmologically distant, actively star forming galaxies, show strong breaks at redshifted $Ly_\alpha$ line and Lyman continuum due to internal interstellar absorption, absorptions due to intervening HI clouds, the diffuse intergalactic medium and other galaxies (Madau, 1995). Such galaxies can be identified through multi-band imaging across the 912 Å discontinuity. For different redshifts, the lyman break shifts across the different broad band filters and this discontinuity feature is used to identify and estimate the redshifts of distant star-forming galaxies referred to as Lyman break galaxies.

## 3. Identification of Lyman Break Galaxies through photometry

Star-forming galaxies at high redshifts can be identified using the Lyman break technique based on a set of color criteria. (Adelberger & Steidel, 1997; Giavalisco et al., 1998). At $z > 2.5$, the Lyman limit is redshifted far into the U and B passbands. Broad band photometry by placing filters on either side of the redshifted break, enables the identification of $z > 3$ objects, by their faintness in the U band, but very blue spectral energy distributions in other bands. This occurs because the Lyman limit has shifted in between the U and B bands, while the strong Lyman continuum is now contributing in the B-band. These objects are referred to as U dropouts and have redshifts in the range $2 < z < 3.5$. Extending the Lyman break technique to longer wavelengths, a similar criteria using B dropouts would select galaxies in the range $3.5 < z < 4.5$ . This technique has been proved to be very successful through its application to the Hubble techniaue has been proved to be very successful through its application to the Hubble Deep field (HDF) where an excellent agreement was obtained between the photometric and spectroscopic redshifts (in cases where measurements were possible).

## The need for "BIG EYES"

From the study of Lyman break galaxies in the HDF, it appears that these are the assembly of the oldest populations in the Universe and are responsible for the spheroids and bulges of present day galaxies. Are these drop-out objects sub-galactic fragments observed in the starburst phase, and will subsequently merge to form massive galaxies? Or, do they correspond to the early evolutionary phase of a massive galaxy in formation ? From the observational point of view, these issues can be addressed through deep multiband imaging and medium resolution spectroscopy at optical and near -IR wavelengths. Due to the faintness of the Lyman break galaxy candidates ($I_{814} > 24$), it has been difficult to provide enough spectroscopic support to the existence of a population of galaxies at $z > 3$, and this requires the power of 10 m class telescopes. For example, a few Lyman break galaxies, selected from the HDF using the color criteria, has followup spectroscopy performed using the KECK 10-m telescope (Lowenthal et al., 1997). Spectra were obtained with exposure times of 6000s to 12000s and moderate spectral resolution of 4.5 Å. The signal-to-noise was only 15 even for the strongest Ly$\alpha$ emission line (flux of $\approx 1 \times 10^{-16}$ ergs s$^{-1}$ cm$^{-2}$). This clearly brings out the need for large telescopes to study star-forming galaxies at high redshifts.

## References

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