H-band dropouts in the deepest CANDELS fields

A new population of bright massive galaxies at z>3

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1. Motivation & objectives

The recent increase in depth, spatial and wavelength coverage of extragalactic surveys has improved dramatically our understanding of galaxies formation and evolution, and we are now revealing a new population of galaxies at high redshift. This is consistent with down-sizing (Cowie et al. 1996; Heavens et al. 2004; Juneau et al. 2005; Bauer et al. 2006; Pérez-González et al. 2008) scenario, which implies that the most massive galaxies formed early in the history of the universe and evolved quickly. Thus, we could expect to see a population of massive passively evolving galaxies at those redshifts.

A small number of those distant and red galaxies have already been spectroscopically or photometrically in recent works. Analysing IR data allows us to distinguish sources that are very faint in optical wavelengths but bright as the in the near-IR (Thompson et al. 1999; Cimatti et al. 2002; Wilson et al. 2004). Their extremely red colors can be caused by either evolved stellar populations or very extinct starbursts. The analysis of their number density and properties is key ingredients to achieve a better understanding of evolution of galaxies during the first billion years of cosmic time.

In this context, we present preliminary results of our search for H-band dropouts: extremely red sources that are not detected in the deep IRAC 3.6 and 4.5µm but clearly detected in the two IRAC blue bands in one of the most important cosmological fields: GOODS-N.

2. Image processing, selection process & photometry

Our H-band dropout sample, has been built searching for extremely red objects in the Spitzer 3.6 and 4.5µm IRAC images that are not detected in the F160W CANDELS band over ~100 arcsec of the GOODS-N field.

The mill images have very different and lower angular resolution (~2") than that obtained with the HST WFC3 band (~0.25`). A software package called TFIIT (Laidder et al. 2007) is specially design to perform photometry given a high resolution and a low resolution image by using the spatial positions and morphologies of objects in the high resolution image to construct object templates, which are then fitted to the low resolution image. When running TFIIT for IRAC images it produces an improved convolved image where the flux has been scaled and also, after subtracting all the H-band detected galaxies, a residual image containing the remaining flux.

Thus, the flux from the H-band dropouts sources will remain in the residual images. However, those images do not only contain the galaxy candidates we are searching for but also remaining flux coming from the wings of bright sources. In order to avoid spurious detections, we clean the image prior to run SExtractor applying several masks.

First, we create a mask for pixels above a threshold flux, then we create another mask around the brighter sources that appeared in the image during the convolution process.

All those masks are applied to the residual image and replaced by the median background with a gaussian noise. Next, we try to avoid detection of the remaining wings with mathematical morphology method.

source detection

As we followed the same procedure separately in 3.6 and 4.5µm we obtained two different catalogues using SExtractor in the two final images. To avoid spurious sources, we cross-correlate the catalogues and discard any source not detected in both.

Finally, we visually inspect the final images to remove any false source from our sample.

3. Preliminary characterization of the sample

We search for counterparts of the sources in all available wavelength bands from the UV to the IR. When the photometric data do not provide a constrained SED, we can derive any redshift estimation. For those sources, simple red color criteria are generally applied to photometry in the optical and IR bands to separate different types of galaxies and discriminate between those at high redshift and very dusty ones.

Color-selection criteria

Red color criteria and the analysis of deep mid-IR have been proved to be essential to constrain the presence of massive galaxies at z>3 as shown in (Caputi et al. 2011 and Huang et al. 2012). The red colors of our sources are unlikely to be due to Lyman break with as it would imply z>10. However, galaxies with a strong Balmer 4000Å break at z>10 can have very red H-[3.6] colors. It is very instructive to see the location of the sources in near-midIR color-color diagram especially for sources with unconstrained SED.

Being our candidates H-band dropouts we shouldn’t have photometry from blue bands. However, by forcing photometry we recover sources that weren’t detected as they are in the detection limit.

Multiwavelength photometry & SEDs

For some sources, the multiwavelength photometry provides us a constrained SED that allows to derive more reliable redshifts and parameters. We present examples of our SED-fitting results. Both galaxies have a zphot>6 and are detected in other bands. A, is characterized by a power-law spectrum while B is a very red color criteria.

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References


Multicolor postage stamps of B; clearly detected in IRAC 8.0µm and PACS 100µm. A new population of bright massive galaxies at z>3 is revealed in the deep IRAC 3.6µm residual image filtering the mIR images have very different and lower angular resolution (~2") than that obtained with the HST WFC3 band (~0.25`).

Color-color diagram H-[3.6] versus H-[4.5]: It presents a power-law spectrum. The mIR images have very different and lower angular resolution (~2") than that obtained with the HST WFC3 band (~0.25`).

Color-color diagram 60/80/100µm versus 3.6/4.5µm: It presents a power-law spectrum. The mIR images have very different and lower angular resolution (~2") than that obtained with the HST WFC3 band (~0.25`).

Color-color diagram 8/24µm versus 3.6/4.5µm: It presents a power-law spectrum. The mIR images have very different and lower angular resolution (~2") than that obtained with the HST WFC3 band (~0.25`).

H-band dropouts, a residual image containing the remaining flux which is a very instructive to see the location of the sources in near-midIR color-color diagrams especially for sources with unconstrained SED.

Bonafide H-band dropouts