Intermediate Redshift Low-Metallicity Dwarf Galaxies in the CDF-S

M. Langener[1)] & D.J. Bomans[1),2)]

mlange@astro.rub.de, bomans@astro.rub.de

1) Astronomisches Institut, Ruhr-Universität Bochum, Germany

2) RUB Research Department Plasmas with Complex Interactions

Introduction

Observations of the earliest phases of galaxy formation and evolution at high redshift can currently only reach the most luminous objects. Therefore direct imaging of galaxies in their early evolutionary phases is very limited. Fortunately, recent observations imply that metal-poor intermediate redshift dwarf galaxies resemble galaxies in the early universe. Usually, these galaxies are selected by their strong emission lines. However, this requires deep narrow-band imaging. Our approach is to select those galaxies from existing deep fields by their very blue colours, owing to their strong starformation, low metallicity, and largely missing old stellar component.

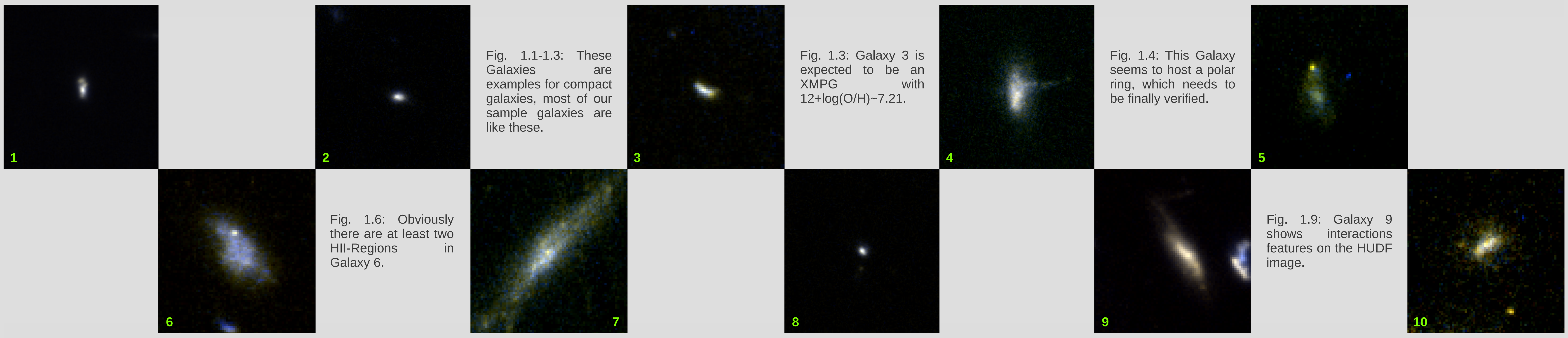

Fig. 1.1-1.3: These Galaxies are examples for compact galaxies, most of our sample galaxies are like these.

Fig. 1.3: Galaxy 3 is expected to be an XMPG with 12+log(O/H)~7.21.

Fig. 1.4: This Galaxy seems to host a polar ring, which needs to be finally verified.

Fig. 1.6: Obviously there are at least two HII-Regions in Galaxy 6.

Fig. 1.9: Galaxy 9 shows interactions features on the HUDF image.

Fig. 1: An example of the sample galaxies. Poststamps 5'' x 5'' produced from data retrieved from Hubble Legacy Archive.

1. Original Sample and Problems

We generated our first sample using the Chandra Deep Field-South COMBO-17 photometric data (Fig. 2), selecting dwarf galaxies by their very blue colours (*B-V*<0.26), resulting in ~100 candidate objects at $0.1 < z < 0.5$ according to the COMBO-17 photometry (Wolf et al. 2004). This selection criteria were motivated by Barazza et al. (2006), who found extremely blue objects by those selection criteria. Unfortunately, due to the missing IR data COMBO-17 redshifts for this kind of objects are not very reliable. Taking the publicly available spectroscopic data and comparing the redshifts of COMBO-17 with the MUSYC photometric redshift estimations (Cardamone et al. 2010, 32-band imaging including IRAC-bands), it turned out, that many of the original sample objects are at much higher redshifts (z>1). Therefore many galaxies in the original sample are definitely neither faint nor small. In the following we use a subsample of 29 galaxies, applying a magnitude cutoff at M_V=-19.

2. Morphology

As can be seen in the poststamps (Fig. 1), the morphology of our sample galaxies is quite heterogeneous. There are galaxies with a rather cometary structure or those with interaction features or maybe even one with a polar ring (which still has to be verified). However, most of the galaxies seem to be disky and relatively compact (Fig. 3). There is one galaxy (Fig. 1.1), which is relatively bright (M_V~-19) but has a very small half-light radius($r_{1/2}$=1.58 kpc), in fact, it seems to have a rather low oxygen abundance (*12+log(O/H)*~7.7) as well, which makes it a very interesting object.

All in all, our galaxies have small half-light radii (Rix et al. 2004) what had been expected selecting dwarfs (by their brightness in *V*).

4. Conclusions & Future Tasks

- Selection of extremely blue dwarf galaxies in the CDF-S yields 29 galaxies within 0.1<z<0.5
- Morphology varies but most galaxies are compact and disky
- Some of the galaxies have oxygen abundances that differ significantly from the local luminosity-metallicity-relation which only acts as some kind of upper limit for metal-poor galaxies, which indicates that there may be several other XMPG candidates in our sample
- SED-Fitting will help get a closer look on all candidates not only the ones with available spectra

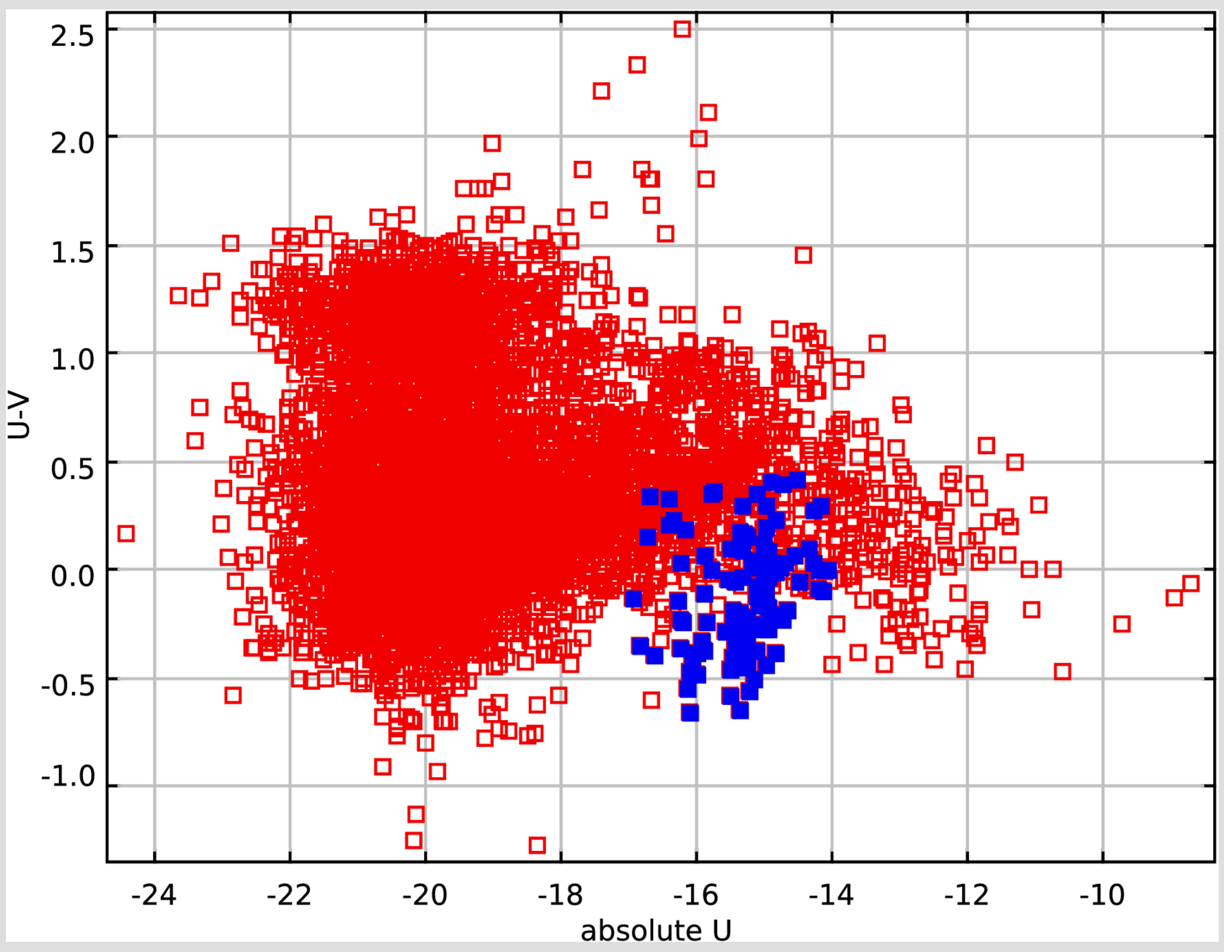

Fig. 2: CMD of the COMBO-17 data (red). Marked in blue are the sample galaxies. Our sample galaxies are extremely blue.

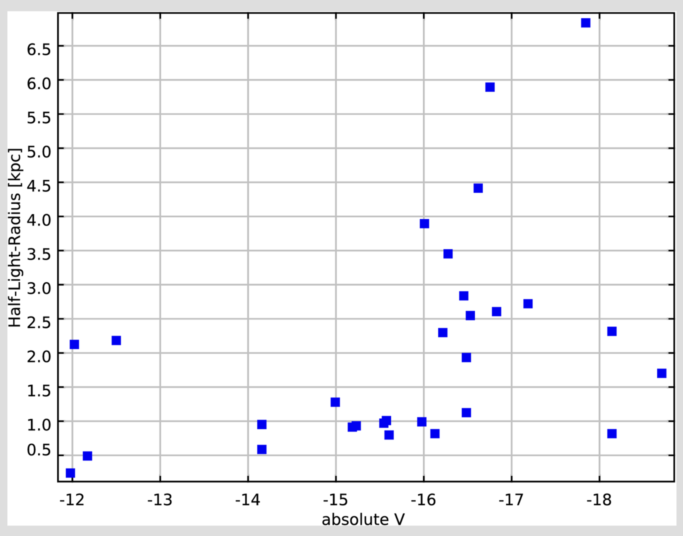

Fig. 3: Half-light radii of the 29 sample galaxies.

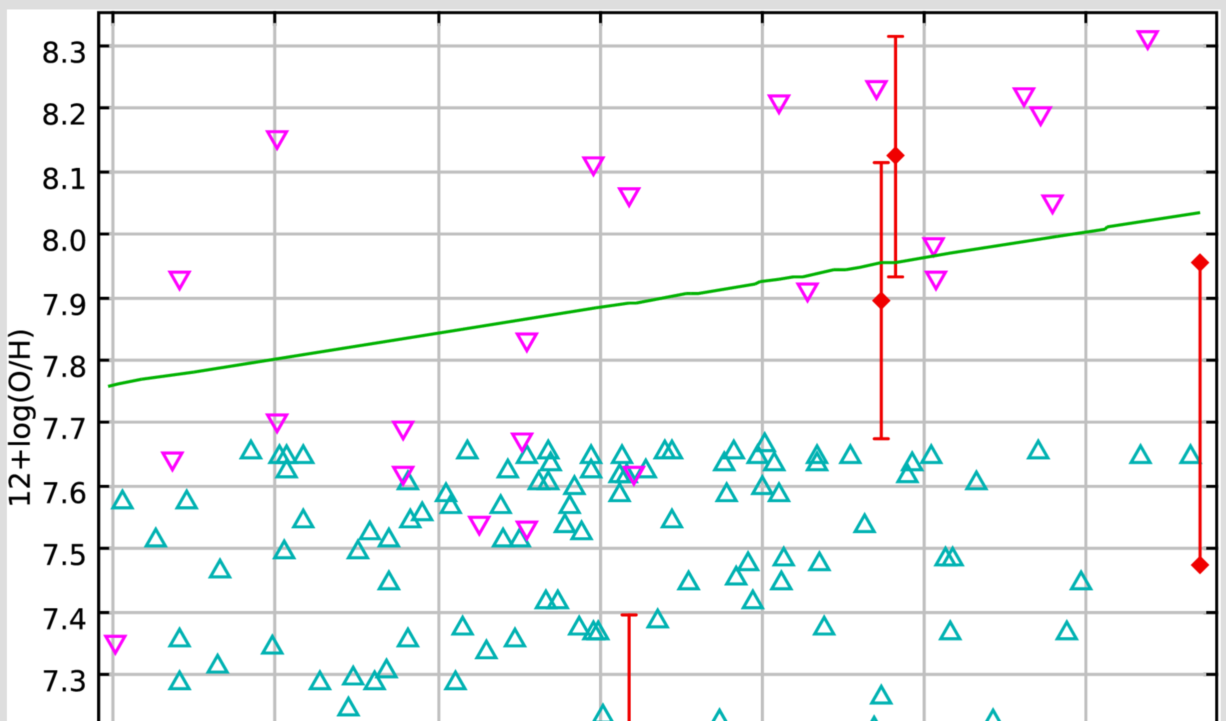

Fig. 4: Oxygen abundances derived by using the LZR (green line) for our sample galaxies and in comparison spectroscopically determined redshifts (red, using Kewley and Dopita 2002 and Pilyugin 2000). The cyan triangles represent a selection of local XMPGs and the pink triangles the Lee et al. (2006) sample in the luminosity range plotted here. One galaxy's (Fig. 1.1) oxygen abundance could only be estimated with a technique recommended by Kewley and Dopita (2002) (red line connecting two red diamonds), an average of both estimates should give a rough idea of the galaxy's metallicity. Obviously, the LZR seems to represent an upper limit for the oxygen abundances of our sample galaxies since even the spectroscopically determined abundances are close to this relation. Therefore we can expect not only the two spectroscopically analyzed galaxies to be XMPG candidates in our sample. We are confident to find galaxies in early stages of their formation in our sample.

3. Oxygen Abundances

Galaxies in the early universe should have low oxygen abundances, because their gas has not yet been processed multiple times. This astration could be suppressed by the meta-galactic radiation field out to z~0.5 (Babul and Ferguson 1996). To check, whether our galaxies are candidates for low metallicity galaxies, oxygen abundances were derived when possible via analysis of the galaxy's spectrum (calibrations), otherwise by applying a Luminosity-Metallicity-Relation as rough estimate. The spectra were obtained from Vanzella et al. (2005) and LeFèvre et al. (2004). One galaxy turned out to be an XMPG (Extremely Metal Poor Galaxy, *12+log(O/H)*<7.65, Fig. 1.3) and one has an oxygen abundance of ~7.7 (using Kewley and Dopita 2002, Fig. 1.1 and Fig. 5), which is extraordinary low for its luminosity (see Fig. 4). The others were low as well with a highest determined abundance of 8.12 (methods used: Kewley and Dopita 2002 and Pilyugin 2000). To get a hint on the oxygen abundances of the remaining galaxies a modified version of the Luminosity-Metallicity-Relation (Lee et al., 2006) was performed: the original Lee et al. (2006) sample has been used to determine a Luminosity-Metallicity-Relation (LZR) for the V-band. The scatter in V is significantly higher, because of the influence of star-formation on the V-band luminosity. Nonetheless the LZR is good tool to give a rough estimate of a galaxy's oxygen abundance. It results in oxygen abundances in the range of 7.7<*12+log(O/H)*<8.1. Fig. 4 clearly shows that the LZR (green line) is an upper limit for all XMPGs (cyan triangles) and that the Lee et al. (2006) sample (pink triangles) scatters (although rather broadly, for the reason given above) around the LZR for our sample. All spectroscopically derived oxygen abundances (red diamonds) lie near or even below the LZR, so that it can be supposed that there is a good chance to find more XMPGs or at least metal-poor galaxies in our sample. This would indicate that our sample might include several galaxies in their early stages of formation.

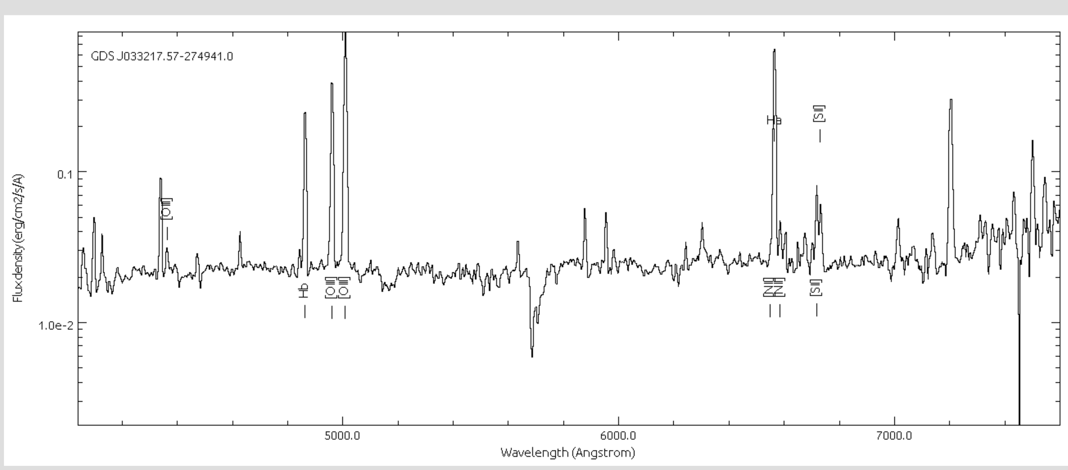

Fig. 5: Spectrum of the galaxy in Fig. 1.1. Its oxygen abundance is 12+log(O/H)~7.7 (derived using Kewley and Dopita 2002). This is an example of the best spectra available for our sample.