The FORS Deep Field Spectroscopic Survey of High-Redshift Galaxies

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1 The Project

The evolution of the properties of galaxy populations with redshift provides important constraints on current models of galaxy formation and evolution. In order to investigate this evolution we used the FORS instruments at the VLT to obtain high-S/N galaxy spectra at redshifts up to 5.0 in the FORS Deep Field (FDF). A detailed discussion of the project can be found in [4].

2 The Sample

Our targets were selected on the basis of photometric redshifts [1], which were derived using the deep photometric data in seven filter bands from U to K, presented in the FDF photometric catalogue [2]. The high-redshift candidates were usually brighter than 24.5 mag in I.

The multi-object spectroscopy (MOS) observations were carried out using the FORS instruments at the VLT. All spectra were obtained with the low-resolution grism 150 I and a slit width of $1''$ corresponding to a resolution element of 18 – 23 Å (FWHM). Typical total integration times for the high-redshift objects were 10 h, leading to $\langle S/N \rangle \approx 13$ for $z > 2$.

Including objects which coincided with the slits by chance, reliable redshifts could be derived for 341 FDF objects. 98 objects are starburst galaxies and QSOs at $z > 2$. The spectroscopic redshift distribution indicates significant redshift clustering in the whole redshift range, which can be attributed to the large-scale structure in direction to the FDF.

3 Results

We analysed the spectral properties of the high-redshift FDF galaxies using the individual as well as composite spectra for different redshift ranges, luminosities, Lyα emission strengths, and continuum slopes. Significant evolutionary effects were found comparing the redshift ranges $2 < z < 3$ and $3 < z < 4$ (Fig. 1). Most conspicuous are the decrease of the frequency and strength of Lyα emission, the increase of the C IV absorption [3], the enhanced dust reddening of the UV continuum, and the increase of the intrinsic UV luminosity (and consequently the star-formation rate) of the most luminous galaxies with decreasing redshift.

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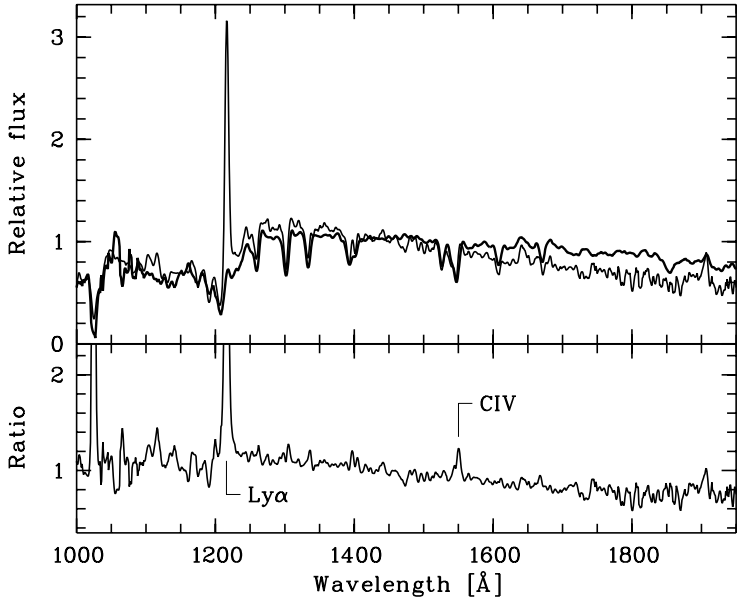

Fig. 1. Comparison of FDF composite spectra covering the redshift intervals $2 < z < 3$ (42 galaxies; *thick line*) and $3 < z < 4$ (22 galaxies; *thin line*), respectively. The lower panel gives the ratio of the $3 < z < 4$ and the $2 < z < 3$ composite spectrum

The majority of the mutual relations between Lyα, C IV, the low-ionisation interstellar absorption lines, and the continuum slope β turned out to be independent of redshift and in accordance with the results of [5], based on composite spectra covering the redshift range $2.5 < z < 3.5$. In contrast, the relation between β and the Lyα emission shows an increase of the average reddening for fixed Lyα emission strengths with decreasing redshift, which implies an evolution of the average properties of the galaxies' interstellar medium.

We interpret the evolutionary effects between $z \sim 3.3$ and 2.3 in terms of an increase of the metallicity, which is traced by C IV. Moreover, we find with increasing cosmic age a predominance of more massive starbursts, characterised by higher star-formation rates and stronger obscuration of the starburst cores by dusty gas clouds.

References

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