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# STAR FORMATION IN THE HUBBLE DEEP FIELD NORTH

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RESUMEN

Estoy analizando los espectros de emisión de línea de ∼600 galaxias de la muestra de Cohen et al. (2000) y Cohen (2001) en la región norte del HDF con $z < 1.5$. Se presenta un reporte sobre los resultados obtenidos en este proyecto del Caltech Faint Galaxy Redshift Survey.

ABSTRACT

I am currently analyzing the emission line spectra of the ∼600 galaxies from the sample of Cohen et al. (2000) and Cohen (2001) in the region of the HDF-North with $z < 1.5$. A progress report on this effort of the Caltech Faint Galaxy Redshift Survey is presented.

*Key Words:* **GALAXIES: STAR FORMATION — GALAXIES:FUNDAMENTAL PROPERTIES**

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I am measuring the equivalent widths of emission lines in the ∼600 galaxies from the sample of Cohen et al. (2000) and Cohen (2001) in the region of the HDF-North with $z < 1.5$. This redshift survey, based on spectra from LRIS at the Keck Observatory, is more than 93% complete for $R < 24$ in the HDF itself and for $R < 23.5$ in the Flanking Fields, comprising a circle 8 arcmin in diameter centered on the HDF. While all the measurements are carried out automatically with a script, they must be checked by hand. So far I've completed checking the results for 254 galaxies, all with spectra taken by me.

The analysis of these emission line strengths is in progress. Equivalent widths have been measured both using a feature and blue and red continua bandpasses defined in the rest frame as well as using Gaussian fitting.

We adopt the emitted luminosity in the 3727 Å line of [OII] as our primary indicator of the star formation rate because of the wider redshift range over which it can be detected, given that at present we are restricted only to optical spectra for galaxies in our sample.

All luminosities are given in the rest frame, unless otherwise specified. The SED formalism of Cohen (2001) is used to derive all continuum luminosities. Emission line luminosities are calculated using the measured equivalent width and the inferred continuum luminosity deduced from broad band large aperture photometry. We are thus assuming that the 1 arc-sec wide slit passes a reasonable sample of the total galaxy light, i.e. that emission is not concentrated just in the region of the galactic nucleus.

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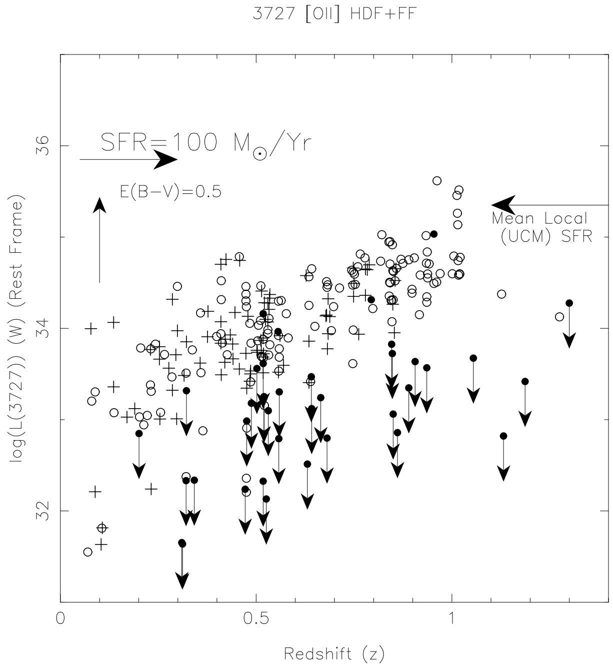


Fig. 1. The emitted flux in the rest frame in the 3727 [OII] line is shown as a function of redshift. Open circles are galaxies whose spectra are dominated by emission lines, filled circles are galaxies lacking emission lines (with the 3727 Å [OII] emission line flux shown as upper limits), while crosses denote intermediate cases.

As an example of the analyses that can be carried out with this data, Figure 1 shows $L(3727)$ (luminosity of the [OII] emission line in the rest frame) as a function of redshift. An arrow indicates the luminosity in this emission line corresponding to a SFR of 100 $M_\odot$/yr. The mean local star formation rate for emission line galaxies from the Universidad Complutense de Madrid Survey (Gil de Paz et al. 2000) is indicated as well. These local SFR measures include reddening corrections, while our data do not. The effect of a reddening correction corresponding to the mean adopted $E(B-V)$ of 0.5 mag is indicated on the figure. Adopting this value as a typical reddening, we find SFR rates among the galaxies in this distant sample which cover approximately the same range as in local samples of emission line galaxies.

In Figure 2 we show the star formation rate per unit mass (SFR/$M$) for these 254 galaxies. This parameter is an indicator of the current SFR divided by the mean SFR over the lifetime of the galaxy. We use the rest frame luminosity emitted in the 3727 Å [OII] emission line divided by the rest frame luminosity at $K$ as a measure of the specific SFR. The former is dominated by emission from the youngest stars in a galaxy, with high luminosity per unit mass, while the latter is dominated by the light from any older population that may be present, and is much less affected by the possible presence of luminous young stars.

The specific star formation rate parameter is plotted as a function of redshift. As suggested by Guzman et al. (1997) based on a much smaller sample of galaxies, the upper bound of the specific SFR is independent of redshift.

However, the luminosity of those galaxies with the highest specific SFR increases with redshift. At the present epoch, high specific SFR is associated primarily with low luminosity (presumably low mass) galaxies, but at $z \sim 1$, the most luminous galaxies show this high specific SFR.

To summarize the results we have found thus far, our data in the HDF demonstrate that star formation in distant galaxies is quite similar to that in the local Universe. The range of equivalent widths of the most common diagnostic lines is similar over the full range of redshift probed here, $z < 1.3$. We define the specific SFR as the star formation rate per unit luminosity (equivalent to SFR per unit mass for a constant $M/L$ ratio, a reasonable approximation for luminosity at rest frame $K$). This ratio is effectively the current SFR divided by the mean SFR over the lifetime of the galaxy. The maximum specific SFR over the full range of redshift probed here is similar to that of local star forming galaxies.

However, the most massive galaxies seen at $z \sim 1$ are forming stars at this rate while locally, high

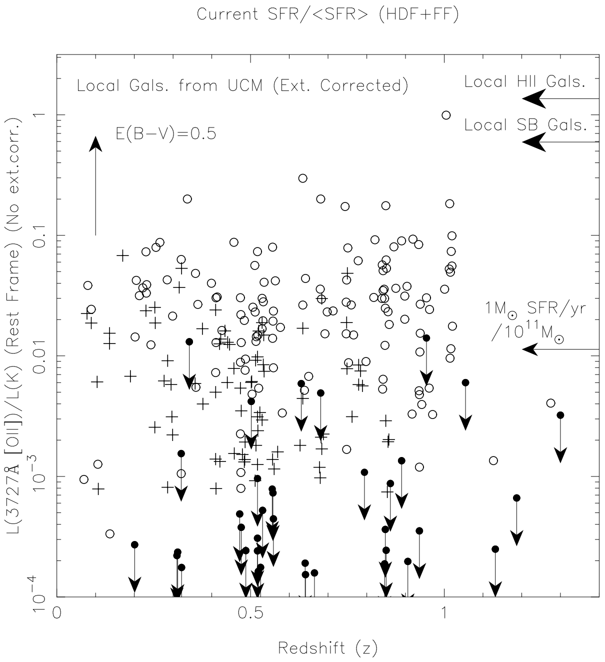


Fig. 2. The star formation rate per unit stellar mass for ∼250 galaxies in the HDF-N is shown as a function of redshift. The symbols are as in Figure 1.

specific star formation rates are seen mostly in low mass galaxies. It appears that the high specific SFR seen in galaxies at $z \sim 1$ is associated with a mode of star formation in which the whole galaxy, not just the nucleus or a few isolated HII regions, participates.

The fraction of narrow-lined AGNs is small ($\leq$ 15% of the sample), out to $z < 0.4$. There is no evidence from the present sample to support a larger fraction for $z > 0.4$.

I hope to complete the check of emission line strengths for the full set of spectra within a few months.

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