XSHOOTER follow-up spectroscopy for VISTA NB118 selected [OII] emitters at z = 2.2

Dark Cosmology Centre

Preliminary results

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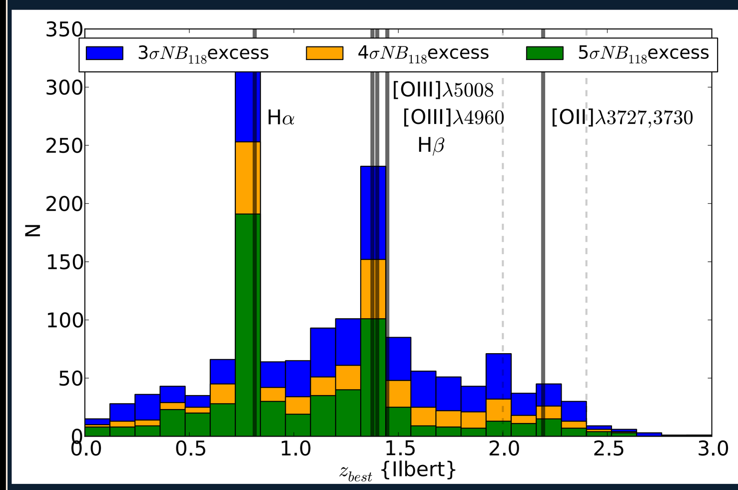
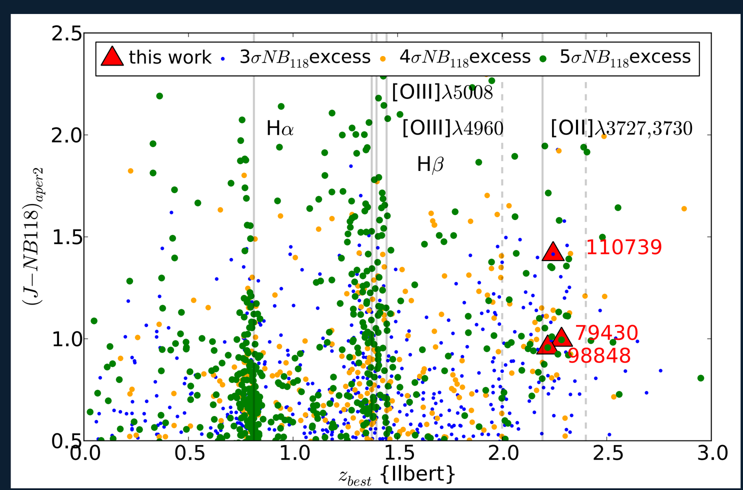
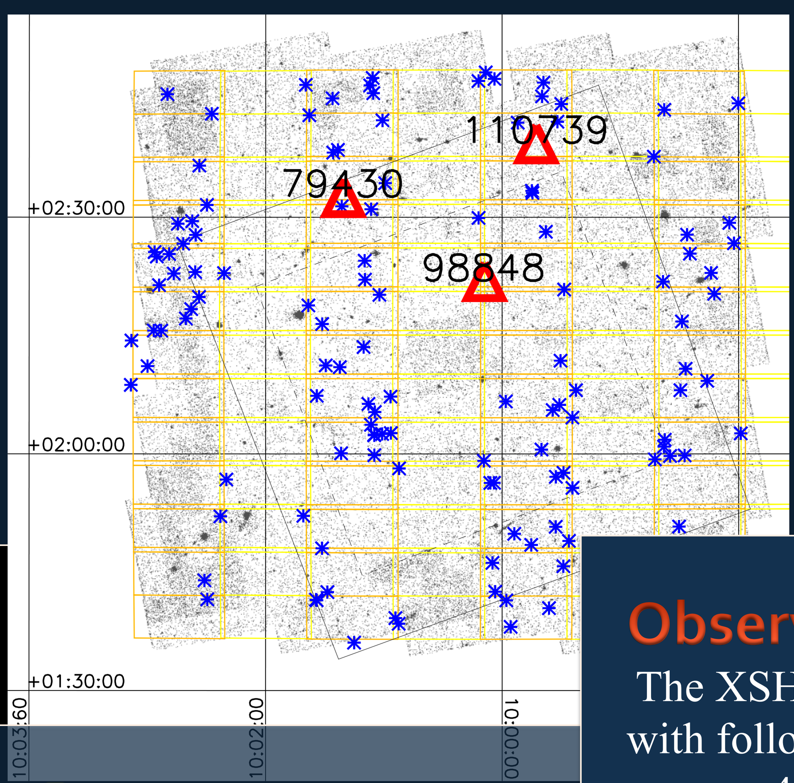
NB118 selection of [OII] emitters at z~2.2



Emission Line Galaxies at well defined redshifts can be found by the excess flux-density in a narrowband filter compared to that in the matching broadband filter. In the case of the VISTA NB118 filter (cf. talk by B. Milvang-Jensen), the excess is mainly due to Hα, [OIII], Hβ, and [OII] at redshifts of 0.8, 1.4, 1.45, and 2.2, respectively. In order to discern between the different possibilities, we have used photometric redshifts (Ilbert; priv. comm.).

The objects included in the figures are based on VISTA NB118 GTO observations (PI: J. Fynbo; B. Milvang-Jensen+ (in prep)). In order to select [OII] λ3727,3730 emitters, we include currently those objects, which have a photo-z with 2.0 < z < 2.4. The spatial distribution of all selected [OII] emitters (3σ excess; blue stars) is shown below. (Background: ACS; orange NB118 GTO; yellow NB118 UltraVISTA; black Chandra)





We have confirmed the robustness of our selection by means of the spectroscopic redshifts obtained from the spectra presented on this poster:

- **98848**: 2.197 (upper) 2.196 (lower)
- **79430:** 2.194 (both components)
- **110739:** 2.208

Motivation for the follow-up spectroscopy

A redshift of two corresponds to the very important cosmological time, at which the cosmic star-formation activity peaks. The NB118 observations provide us with a large and independent sample of galaxies at a very well defined redshift of z~2.2.

In order to characterize the selected population of galaxies in detail, especially for comparison with samples selected by other methods, it is necessary to combine spectroscopy both in the rest-frame UV and the rest-frame VIS with the available multi-wavelength data in the COSMOS field. Among the primary scientific drivers are:

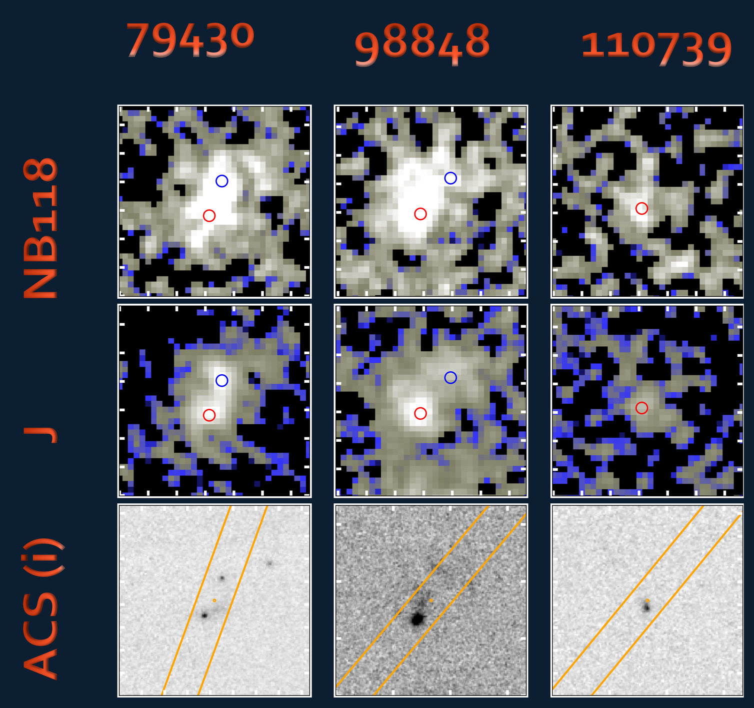
- Do the fundamental relations between mass, metallicity, and SFR hold in the same way as for samples selected with other methods?
- Importance of out- and inflows for the chemical enrichment based on ISM kinematics (both metal absorption lines and Lyα in the rest-frame far UV spectra).

As a first important step, we have obtained **XSHOOTER spectra for three of the objects**.

Even so the number of objects is relatively small, we tried to encompass a spread in properties. For example:

- Different morphologies (mergers & non-mergers)
- Different [OII] EW, different J-magnitudes.

However, we did not select based one the multiband SEDs (except a bias towards objects with good photo-z). Here we present the data and preliminary results.



Marked in the NB118 and J cutouts are the positions at which traces are found in the spectra. In the ACS F814W cutous, the orientation and width of the used slit is shown instead. All cutouts have a side length of 5". 1" corresponds to 8.3kpc at redshift z~2.2 (default cosmology).

	79430	98848	110739
NB118 (2")	22.32	22.16	23.32
J (2")	22.98	22.89	24.39
J-NB118 (Y-J correction)	0.99	0.96	1.42
EW (based on color) [nm]; observed frame	17.8	17.0	32.4

Observations:

The XSHOOTER (UT2) spectra were taken in the first half of the night on 21 April 2012 (Prog. ID: 089.B-0710(A)) with following observation times:

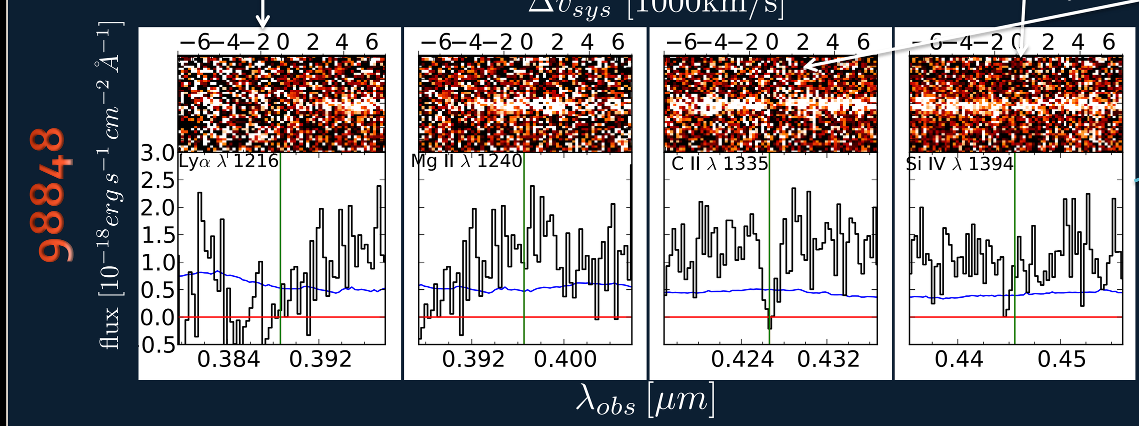
79430: 4x1200s (NIR 4x2x600s); ABBA nod
98848: 2x1800s (NIR 2x2x900s); AB nod
110739: 4x1800s (NIR 4x2x900s); ABBA nod

The spectra

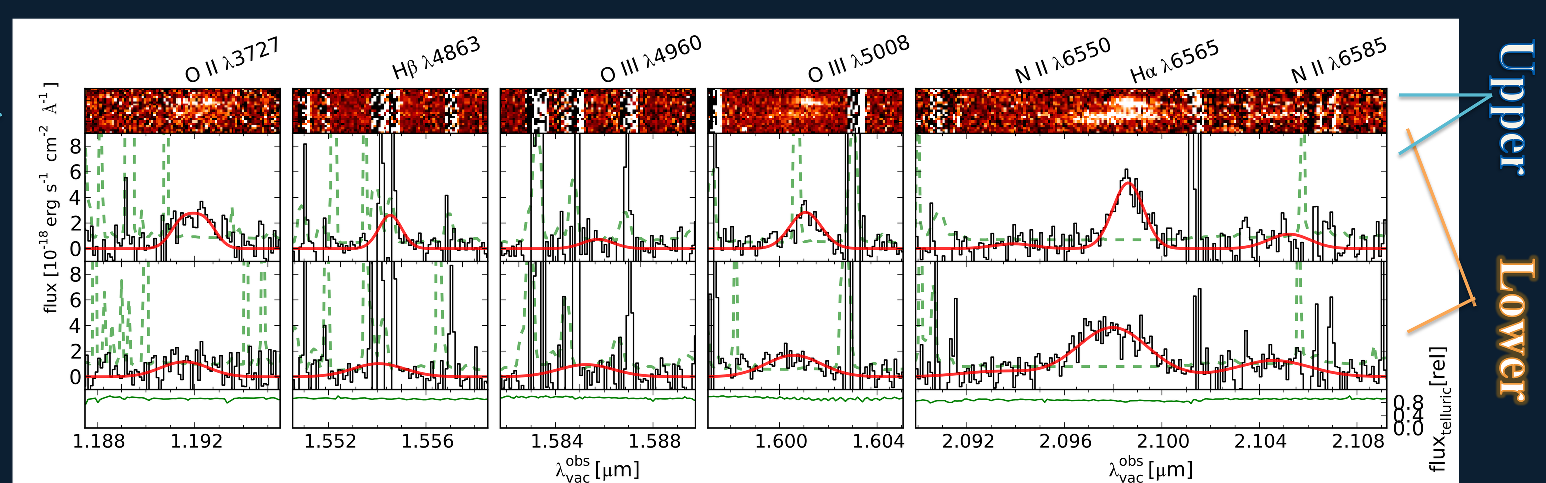
Lyα is in absorption

UVB arm: rest-frame far UV

The high ionization SiIV line has a large, but typical outflow velocity, while CII is at the systemic redshift,



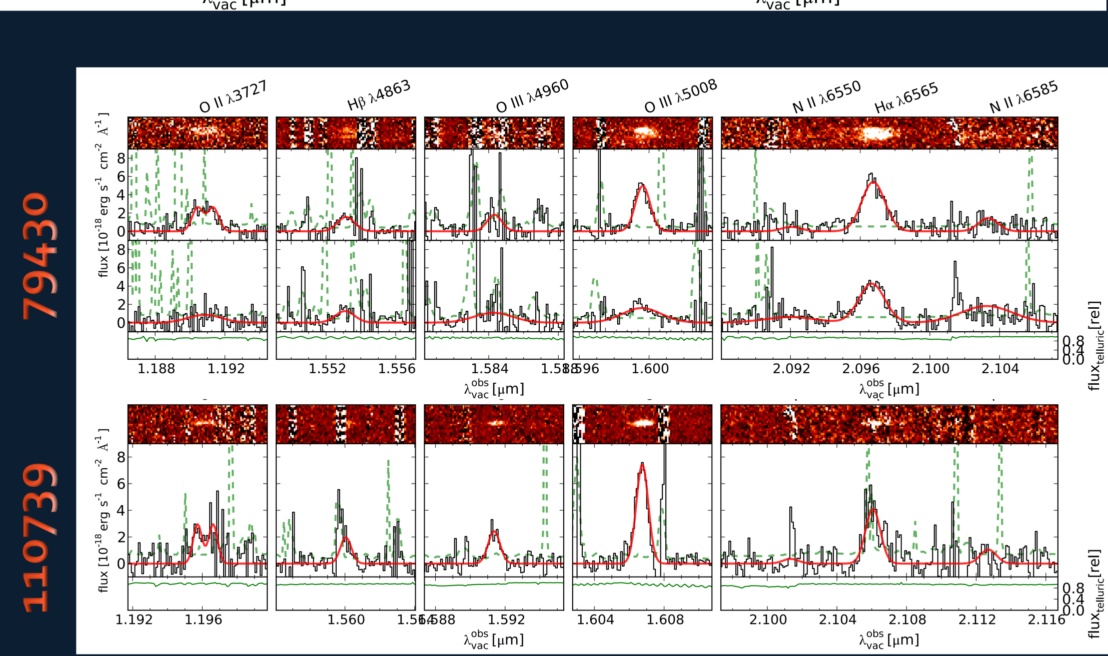
NIR arm: rest-frame NIR



The shown UVB arm spectrum was taken with the 100k/1pt/hg/1x2 read out, meaning that the spectrum is already instrumentally binned in wavelength direction. In addition, we rebinned it in the reduction by a factor of 7. This allowed us to detect with only one hour of integration time in a 24 B-mag object clear absorption lines. Vertical lines in the panels give the systemic redshift as determined from the rest-frame optical emission lines.

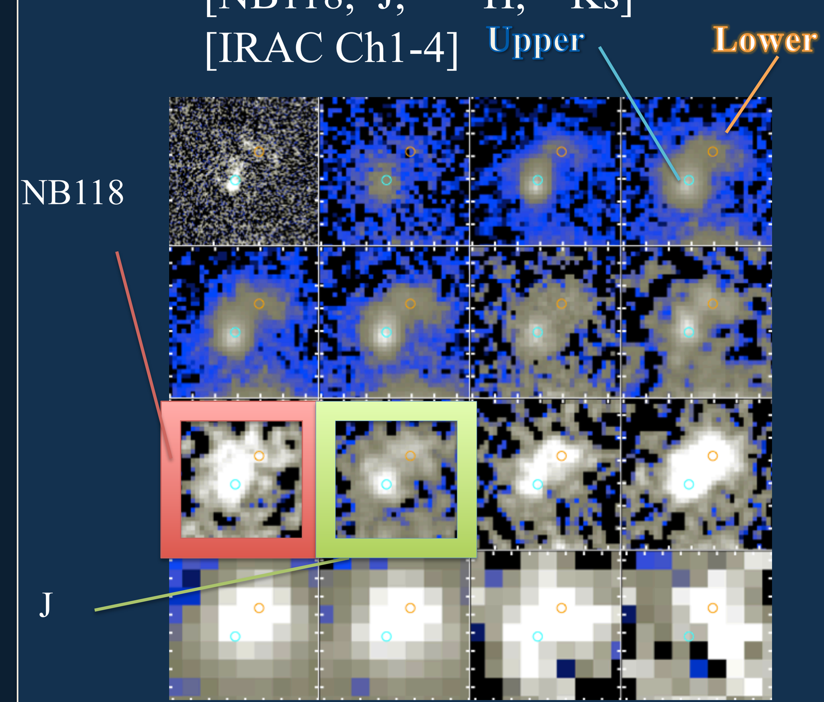
We fitted the strong optical emission lines simultaneously. While the fit assumed that there is no velocity offset between the lines, different widths for Balmer- and forbidden-lines were possible. The joined fitting allows to get reasonable estimates of the line fluxes, even when the major part falls on sky lines.

Errors were determined based on putting fake sources at exactly the same wavelengths as the measured lines.

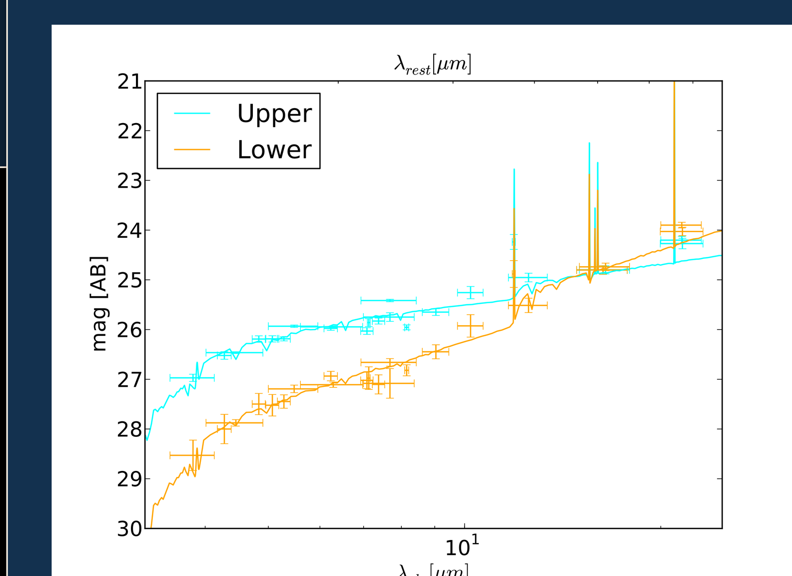


Resolved multi-band SED fitting:

Shown are cutouts in following bands:
[ACS(I), U, B, V]
[r+, i+, z+, Y],
[NB118, J, H, Ks]
[IRAC Ch1-4]

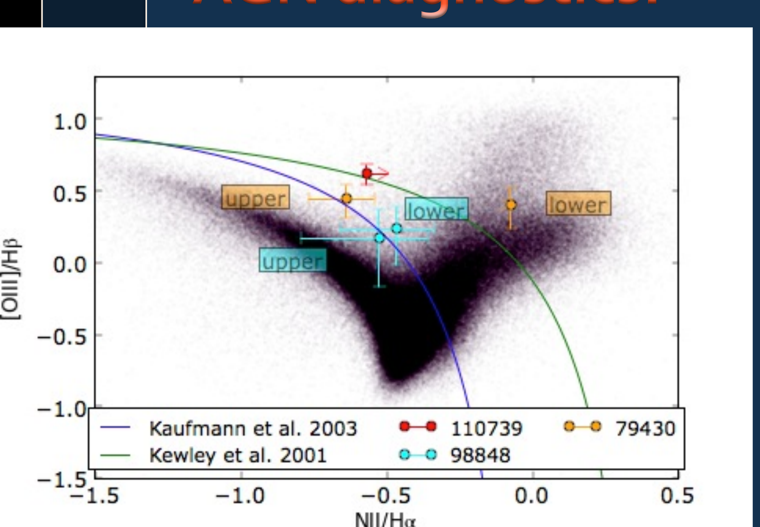


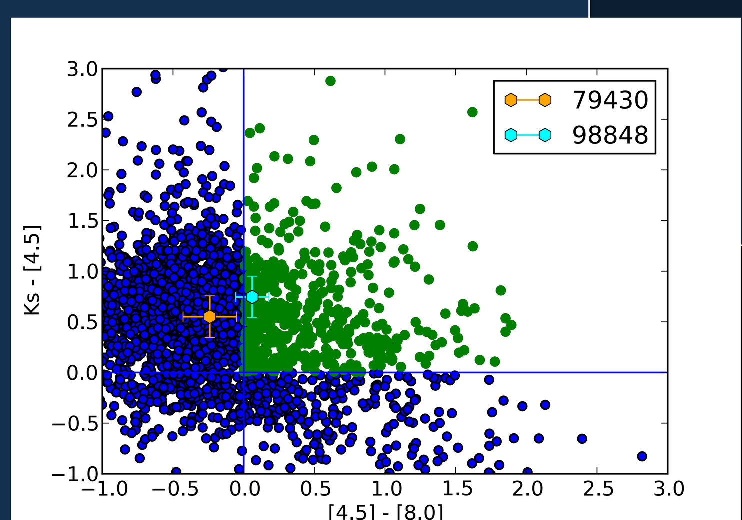
Both in the spectra of 79430 and 98848 two spatially distinct components can be clearly identified. While available multi-band catalogues usually include objects like 98848 (shown above) as a single source, the images still contain information about the individual SEDs. Therefore, we have locally PSF-homogenized all available optical and NIR bands (from the u-band to the VISTA Ks band) with a seeing better than in the VISTA NB118 filter.



Then, magnitudes were determined in small 0.6" apertures. The SEDs above show fits with the LePhare (Arnouts+ 1999, MNRAS,310,540) photometric redshift code using BC03 templates.

AGN diagnostics:



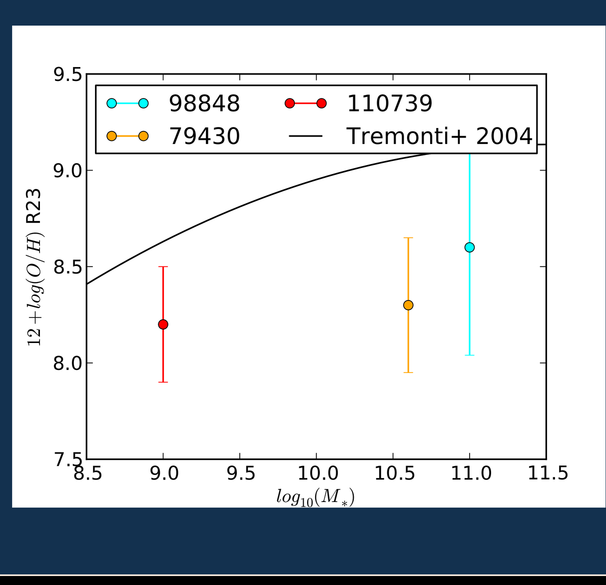


- BPT diagram: The objects seem to be slightly offset w.r.t. to the star-forming galaxy sequence of the local SDSS sample. This is consistent with what has been observed for other galaxies at redshifts similar to that of our objects (For 79430 (lower), NII/Hα is an upper limit)
- According to the Ks+IRAC criterion (Messias+ 2012, ApJ, 754,120), 98848 might be in the region of possible AGN contribution, however not conclusively.
- No X-ray counterparts in Chandra and XMM catalogues

Line measurements:

	110739	79430 (upper)	79430 (lower)	98848 (upper)	98848 (lower)
$f_{[OII]\lambda3727}$ $[10^{-17} erg/s/cm^2]$	1.9 ± 0.3	2.1 ± 0.5	1.0 ± 0.9	2.6 ± 0.7	1.4 ± 0.8
$f_{[OII]\lambda3730}$ $[10^{-17} erg/s/cm^2]$	1.9 ± 0.3	2.1 ± 0.5	1.0 ± 0.9	2.6 ± 0.7	1.4 ± 0.8
$f_{H\beta}$ $[10^{-17} erg/s/cm^2]$	1.6 ± 0.3	1.9 ± 0.5	1.8 ± 0.5	3.1 ± 1.6	2.7 ± 1.2
$f_{[OIII]\lambda4960}$ $[10^{-17} erg/s/cm^2]$	2.1 ± 0.1	1.9 ± 1.2	3.0 ± 1.5	1.2 ± 0.6	2.7 ± 1.5
$f_{[OIII]\lambda5008}$ $[10^{-17} erg/s/cm^2]$	6.5 ± 0.6	5.3 ± 0.6	4.5 ± 0.9	4.6 ± 0.8	4.7 ± 0.6
$f_{H\alpha}$ $[10^{-17} erg/s/cm^2]$	4.4 ± 0.8	9.0 ± 1.1	8.0 ± 1.0	8 ± 2	14 ± 3
$f_{[NII]\lambda6585}$ $[10^{-17} erg/s/cm^2]$	1.2 ± 0.9	2.0 ± 0.5	6.7 ± 3.4	2.4 ± 0.9	4.7 ± 1.3
$E(B-V)$Cardelli	< 0.3	$0.49^{-0.33}_{0.38}$	$0.47^{-0.37}_{0.42}$	< 1.0	$0.58^{0.76}_{-0.58}$
SFR ($H\alpha$) [$M_\odot$/yr {red. corr.}]	12 ± 2	26 ± 3{$1.2 \cdot 10^2$}	23 ± 3	23 ± 6	40 ± 8{$2.3 \cdot 10^2$}
FWHM (Balmer) [km/s]	$(2.1 \pm 0.1)10^2$	$(2.2 \pm 0.1)10^2$	$(2.5 \pm 0.1)10^2$	$(2.1 \pm 0.1)10^2$	$(4.8 \pm 0.2)10^2$
preliminary 12+log[O/H] (KK04)	8.2 ± 0.3	8.2 ± 0.5	8.4 ± 0.5	8.7 ± 0.8	8.5 ± 0.8

The mass-metallicity plot shown to the right must be understood as very preliminary. Nevertheless, it shows as expected the offset w.r.t. to the local SDSS relation by Tremonti+ 2004 (ApJ, 613,898)



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