Matching the Local and Cosmic Star Formation Histories

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A collaboration with:

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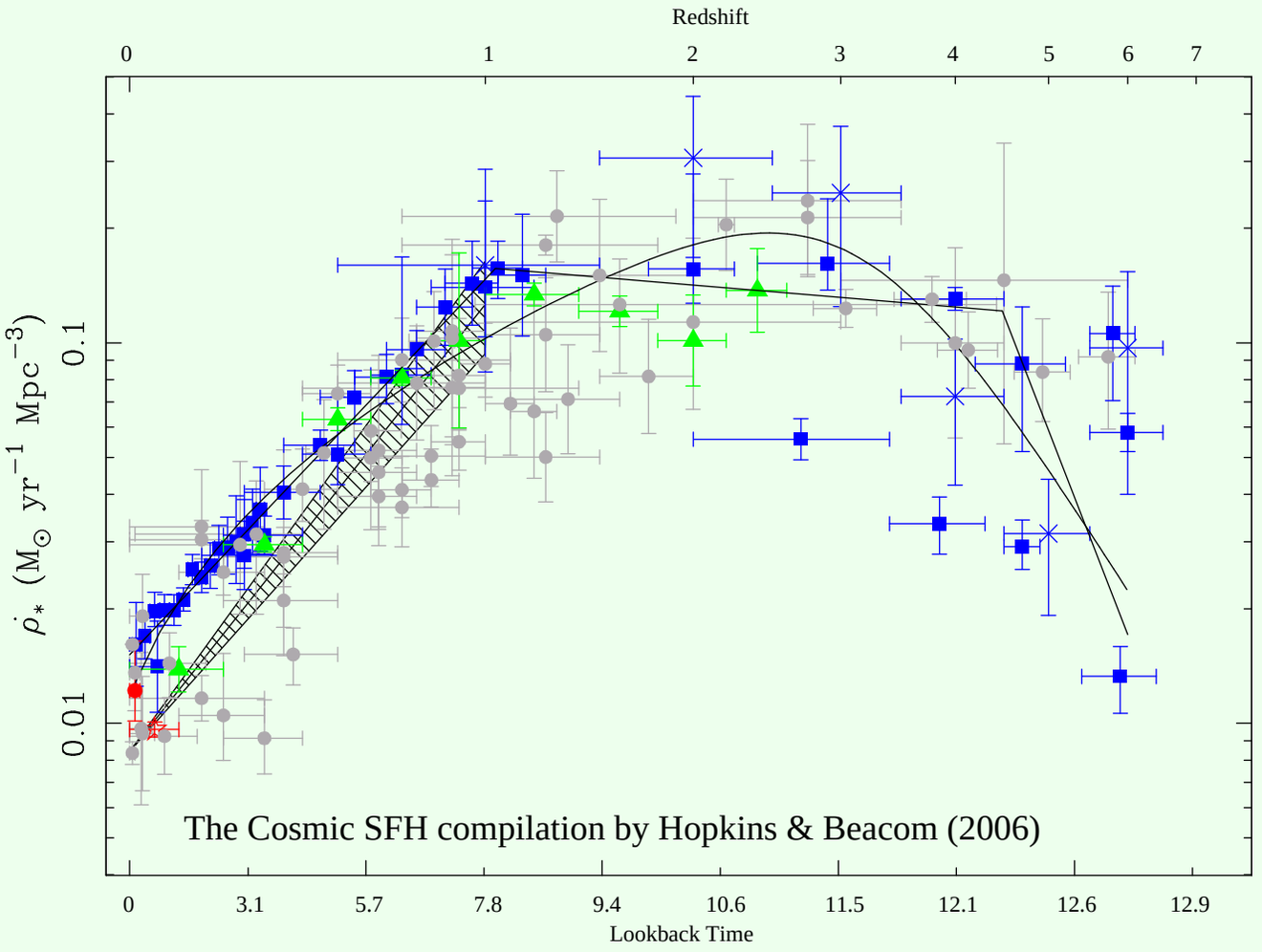
The Cosmic Star Formation Rate Evolution

In the last decade measurement of the Cosmic SFH has tremendously progressed:

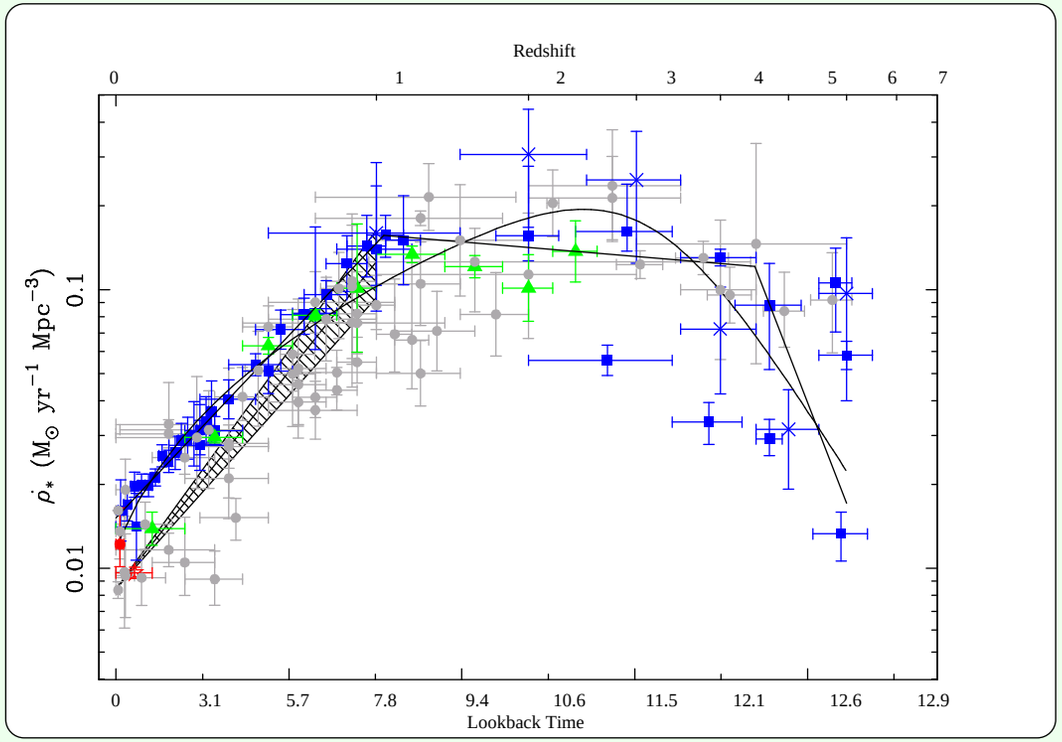
- a consistent picture of the SFH out to z~6, with especially tight constraints for z<1.
- growing evidence that the evolution is essentially flat beyond z=1
- for z>3 it is still unclear whether the evolution flattens, declines, or continues to increase.

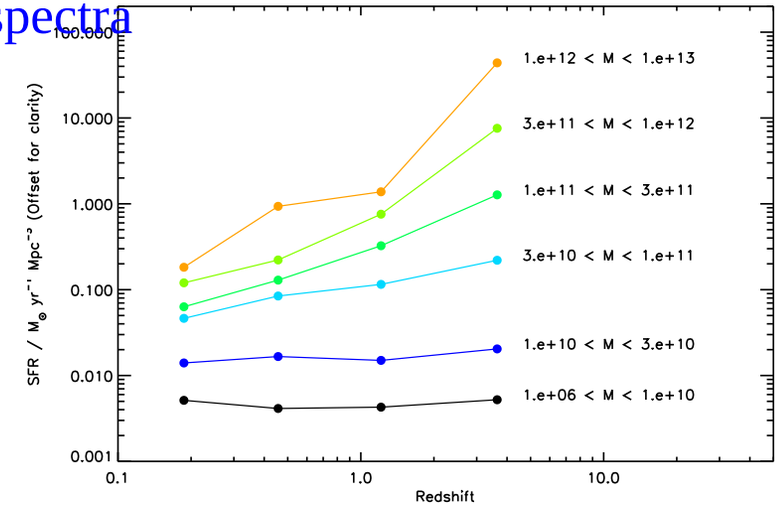


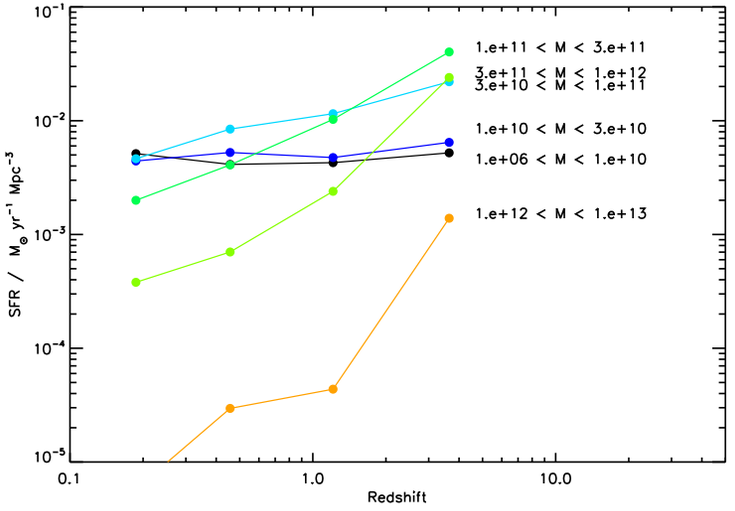
The Cosmic SFH compilation by Hopkins & Beacom (2006)

Cosmic SFH from Population Synthesis

(Panter+06) MOPED analysis of ~300000 galaxy spectra
No conclusive peak in the SFR out to z<2,
but continue to show evidense for 'downsizing'
Main factors affecting results:
the IMF and theoretical models





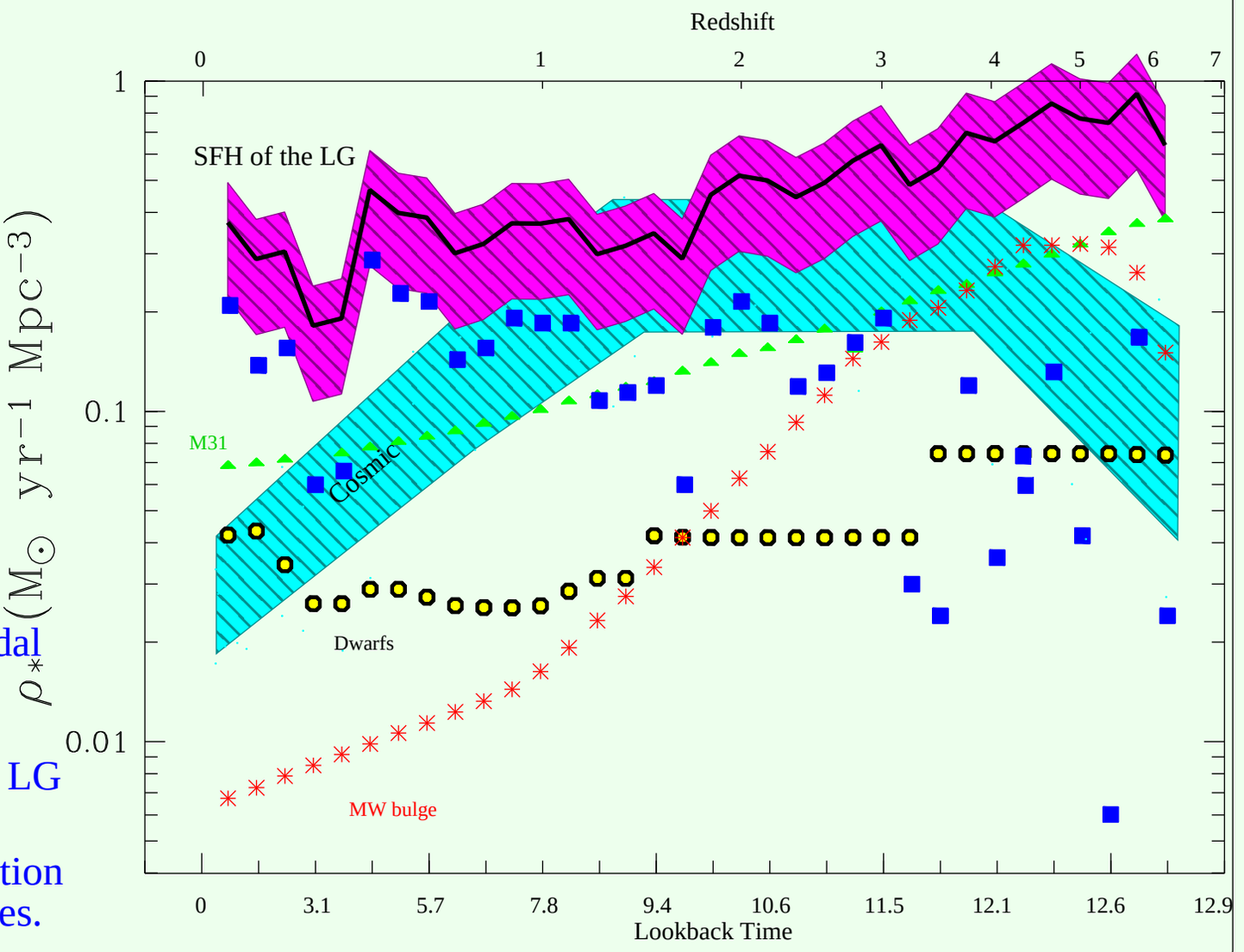


Comparing the Local and Cosmic SFHs

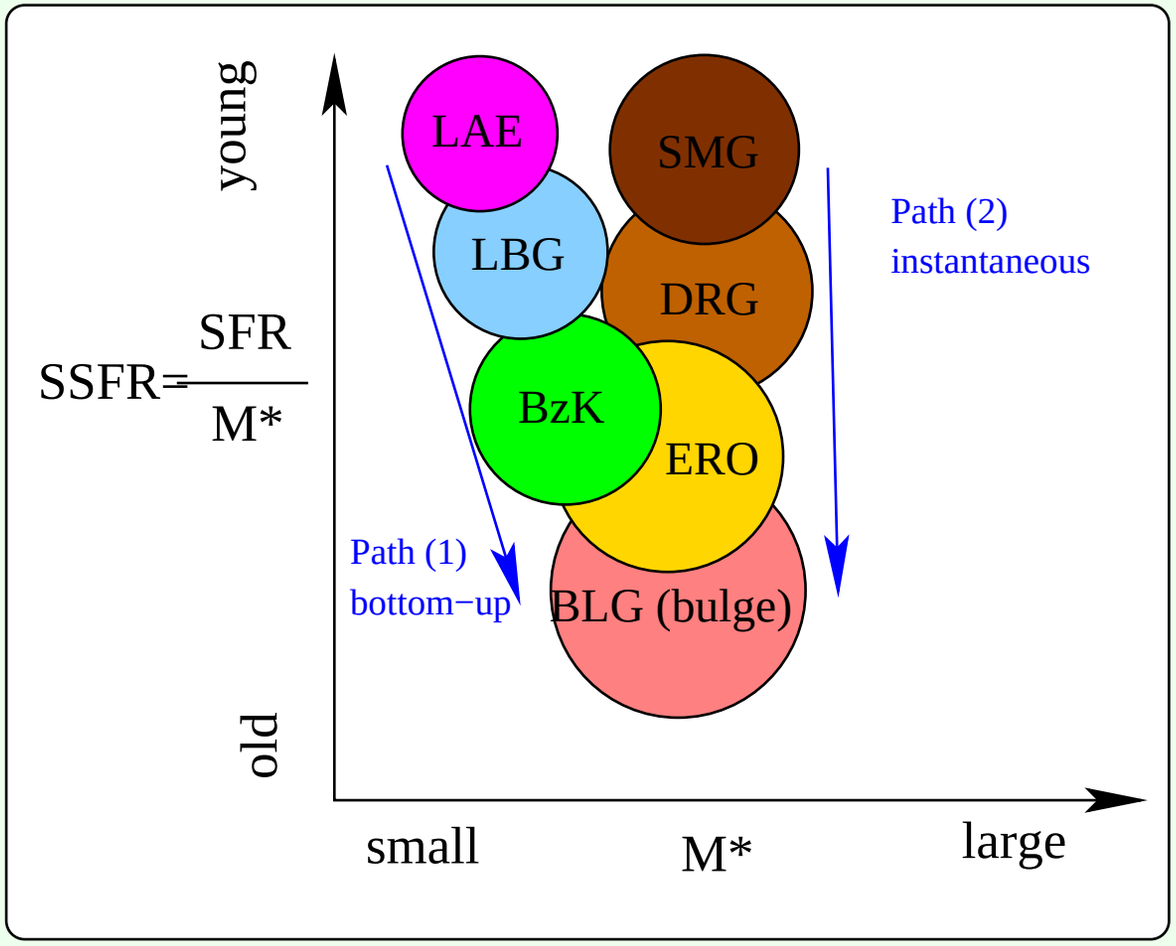
Drozdovsky+ 2008:

- An excess of the local star formation density in the recent ~5 Gyr mainly due to the fluctuations of star formation of the MW disk.
- Between ~8 and ~12 Gyr, the SFH of the LG is rather consistent with the Cosmic one.
- The early/initial evolution of the LG was dominated by spheroidal component of the MW and M31.
- The overall trend of ρ_* from the LG supports a fairly flat evolution.

=>factors of ~10 extinction correction to high−Z UV−based SFR measures.



High−redshift Zoo



Neither an evolutionary connection nor inter−relationships are understood well.

Two arrows indicate two posible paths to form a bulge dominated massive galaxies (e.g., Kodama+06)

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Only 10% of the LBGs at z<4 emit Lyman lines, while nearly all LBGs at z>5 are LAEs. Does the 4<z<5 marks the epoch when a change occurs in the physical properties of the high−z galaxies?

Ly-alpha Emission-Line Galaxies in the Virgo Cluster field

- **Based on a deep imaging survey around the Virgo Cluster field in a 5000 Å, Hα narrow-band and various broad-band filters (Arnaboldi + 2002; Aguerri + 2005; Castro-Rodriguez + 2009), we have selected a sample of 120 candidate Ly-α emission line galaxies (LAE) at z=3.1.**
- **We are carrying out a follow-up imaging and spectroscopic program with the GTC and VLT to confirm these candidates and complement them with a representative sub-sample of LAEs and Lyman-break Galaxies (LBG) at 3<z<5.**
- **By comparing the Ly-α and rest-frame UV continuum features of these galaxies, we will be able to shed light on the connection between the LAEs and LBGs, study their redshift evolution, look for the presence of outflows, discuss feedback mechanisms, constrain their dust content, and test whether these objects are truly primordial galaxies.**

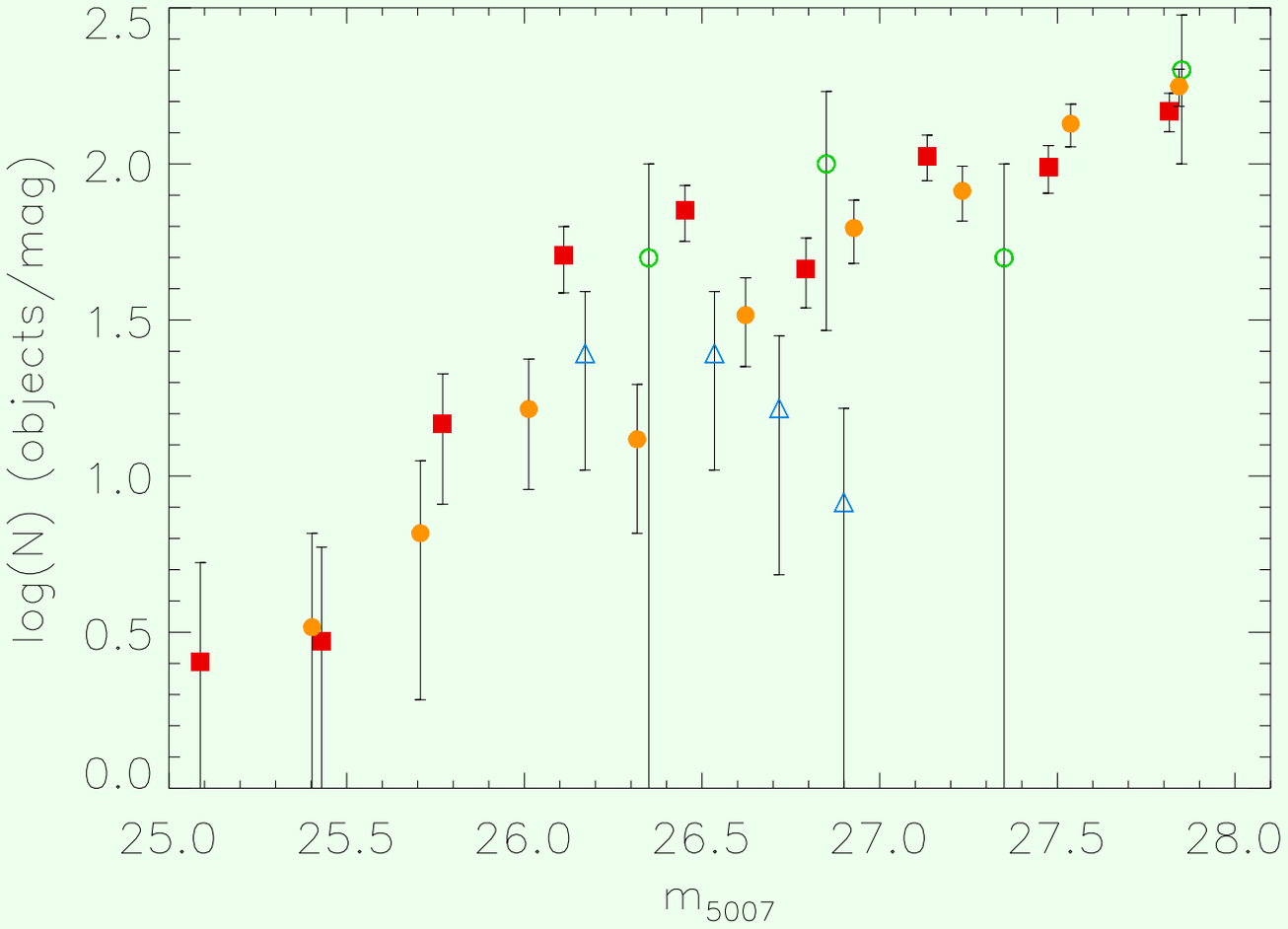
The Luminosity Function of Ly−alpha candidates

■ − Virgo z=3.1 LAEs candidates from our survey

△ − Ciardullo+ 2002

○ − Kudritski+ 2000

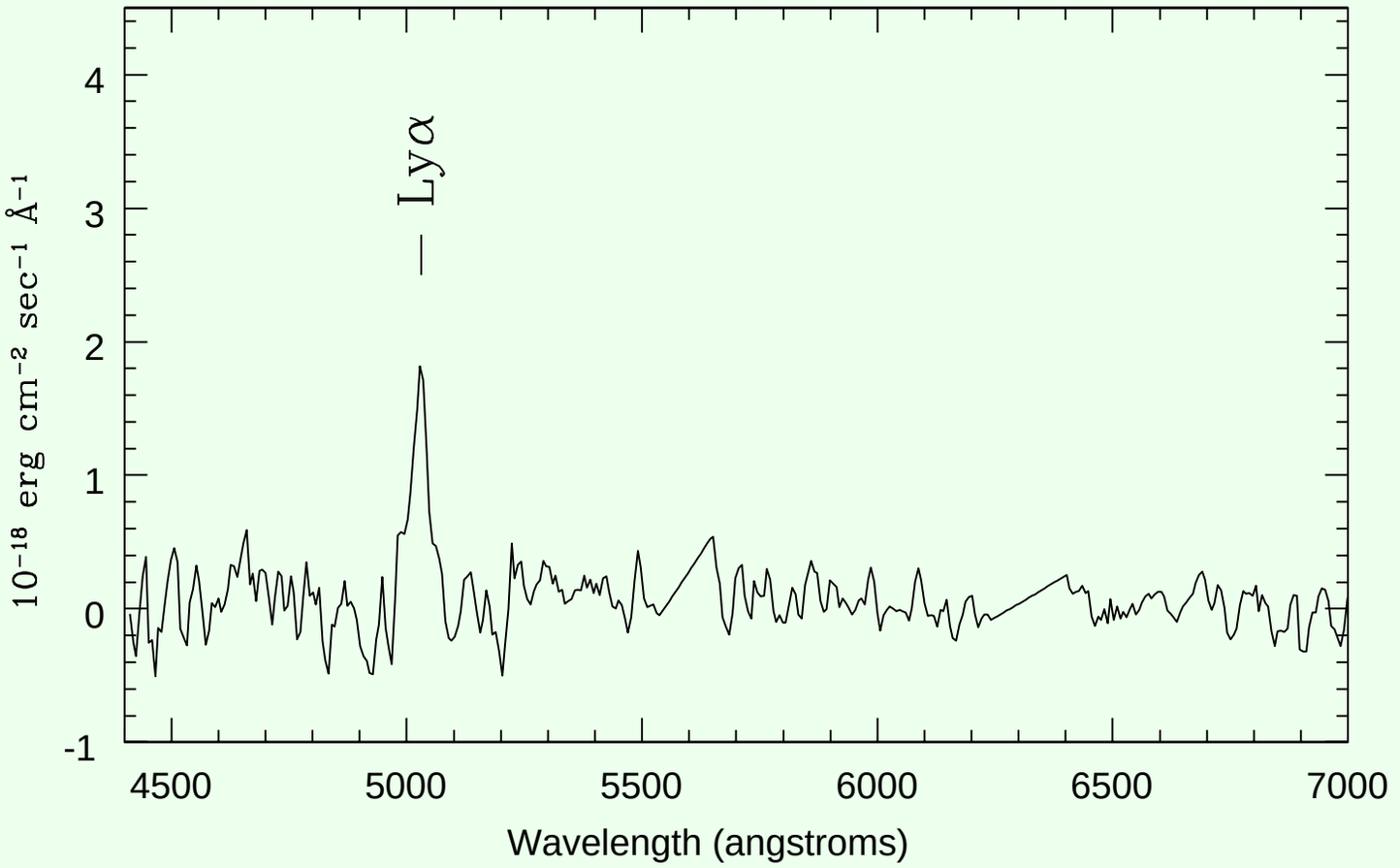
● − Gronwall+ 2007



The spectroscopic observations with OSIRIS will allow us to confirm their nature and adjust our LF of LAEs.

This will provide an estimate of the star formation density contributed by LAEs at the cosmologically critical look−back time of ~11.5 Gyr ago.

An example of Spectroscopic confirmation of LAEs



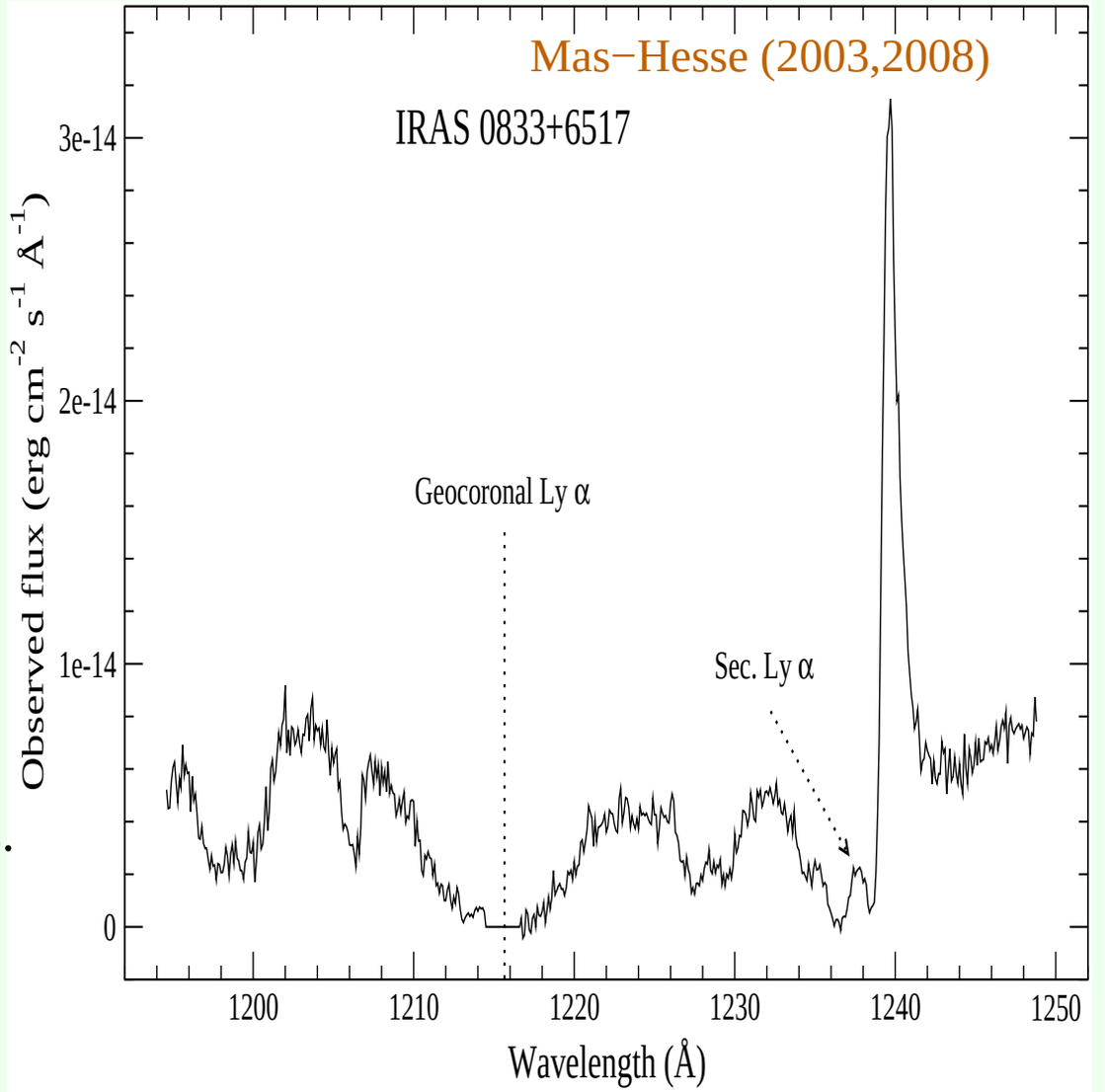
The z=3.13 LAEs spectrum obtained during the VLT/FORS2 spectroscopic follow−up of the [OIII]−band emitters in the Virgo intracluster field (Arnaboldi+ 2003).
Our proposed observations are designed to identify such Ly−alpha emitters.

The Lyman−alpha & the effect of kinematics

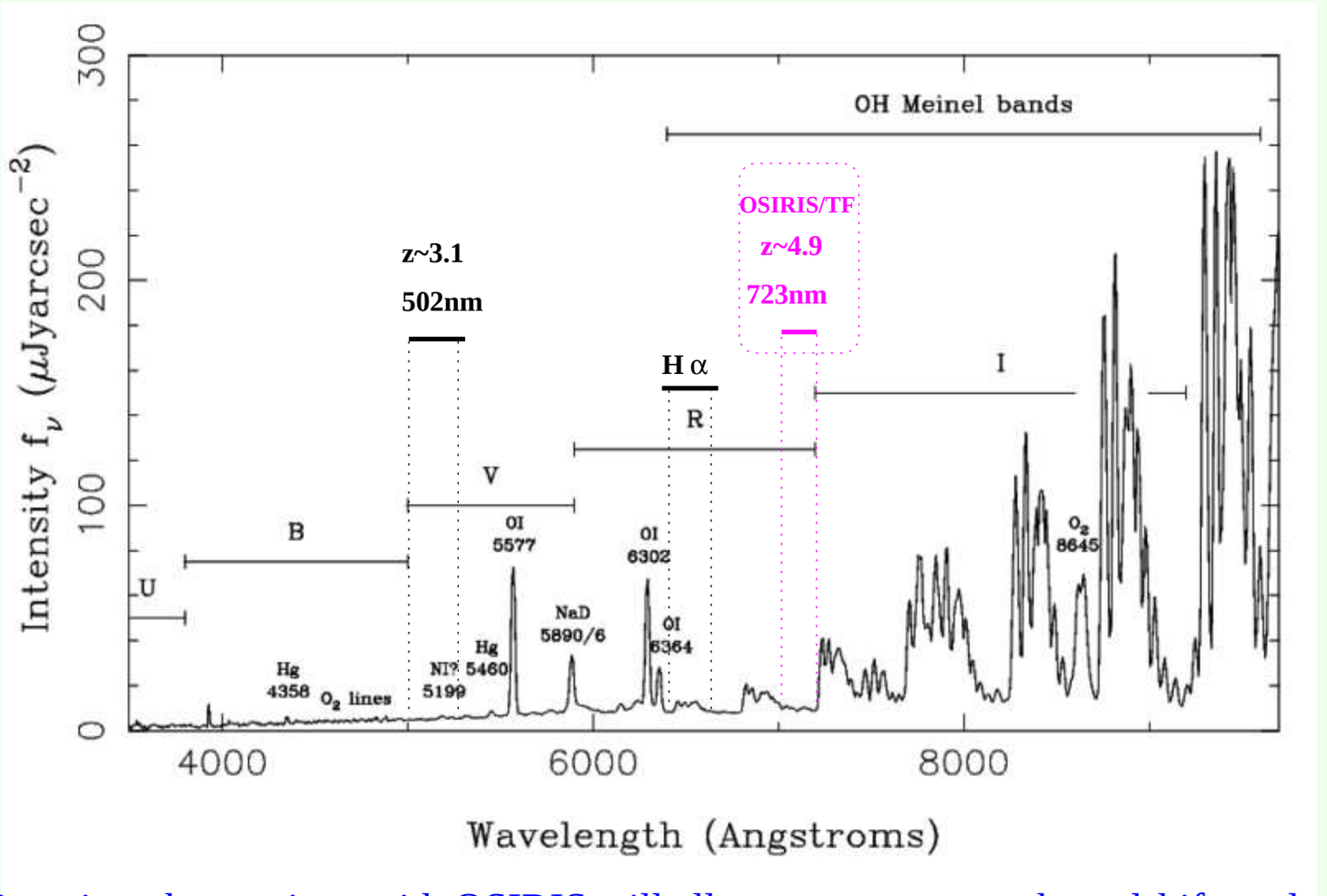
* Kinematics of the neutral gas surrounding a starburst might be a key factor driving the visbility of the Ly−alpha line.
* Even small amounts of dust might destroy the photons affected by resonant scaterring.
* Distribution of the surrounding neutral and ionized gas is therefore critical:
−− Porosity (low column density) or complete ionization of the gas along the line of sight can lead to strong ELs.

The emission of Ly−alpha photons is therefore a complex multiparametric process.

Since kinematics plays an important role high spectral resolution is needed to understand the properties of the line.



Search for the LAEs at z~4.9 with the GTC/OSIRIS−TF



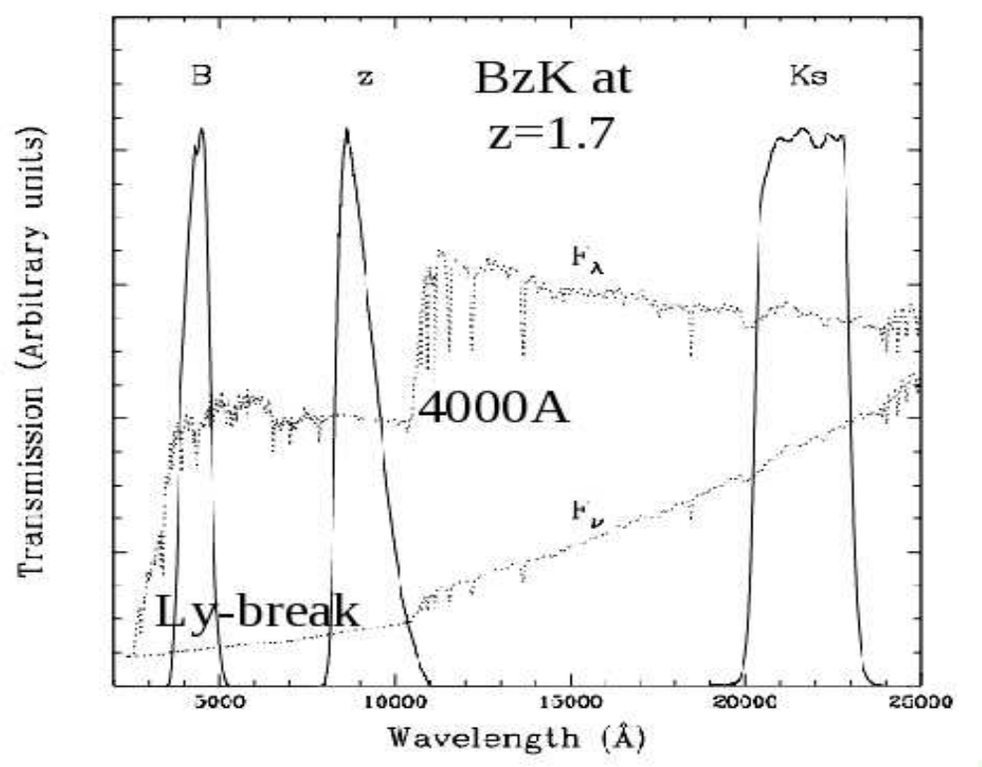
The TF−imaging observations with OSIRIS will allow us to compare the redshift evolution of the LF of LAEs testing alleged changes in their properties that is supposed to occur between 4<z<5

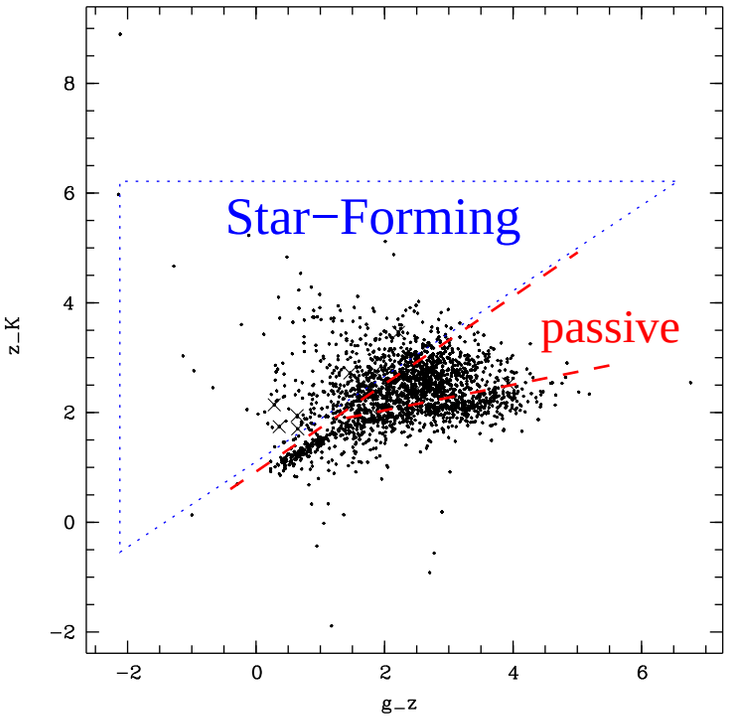
The Decline of Cosmic Star Formation Rate Density between $z \sim 1$ and the present epoch

The parallel spectroscopic survey to:

- **Provide a definitive sample of Emission-Line Galaxies (ELGs) at $z \simeq 1$ in order to obtain accurate measurements of volume averaged star formation rate versus redshift. A particular interest is on the faint compact galaxies with strong star formation missing in general cosmological surveys (see Drozdovsky+ 2005). This would allow us to explore the specific star formation rates (per unit galaxy mass) and test the downsizing effect.**
- **Obtain a comparable sample of evolved galaxies with strong 4000 Åbreak at the same redshift range. Compare their rest-frame UV continuum properties and the luminosity function with ones of the ELGs.**

Selection of high−Z Star−Forming LBGs





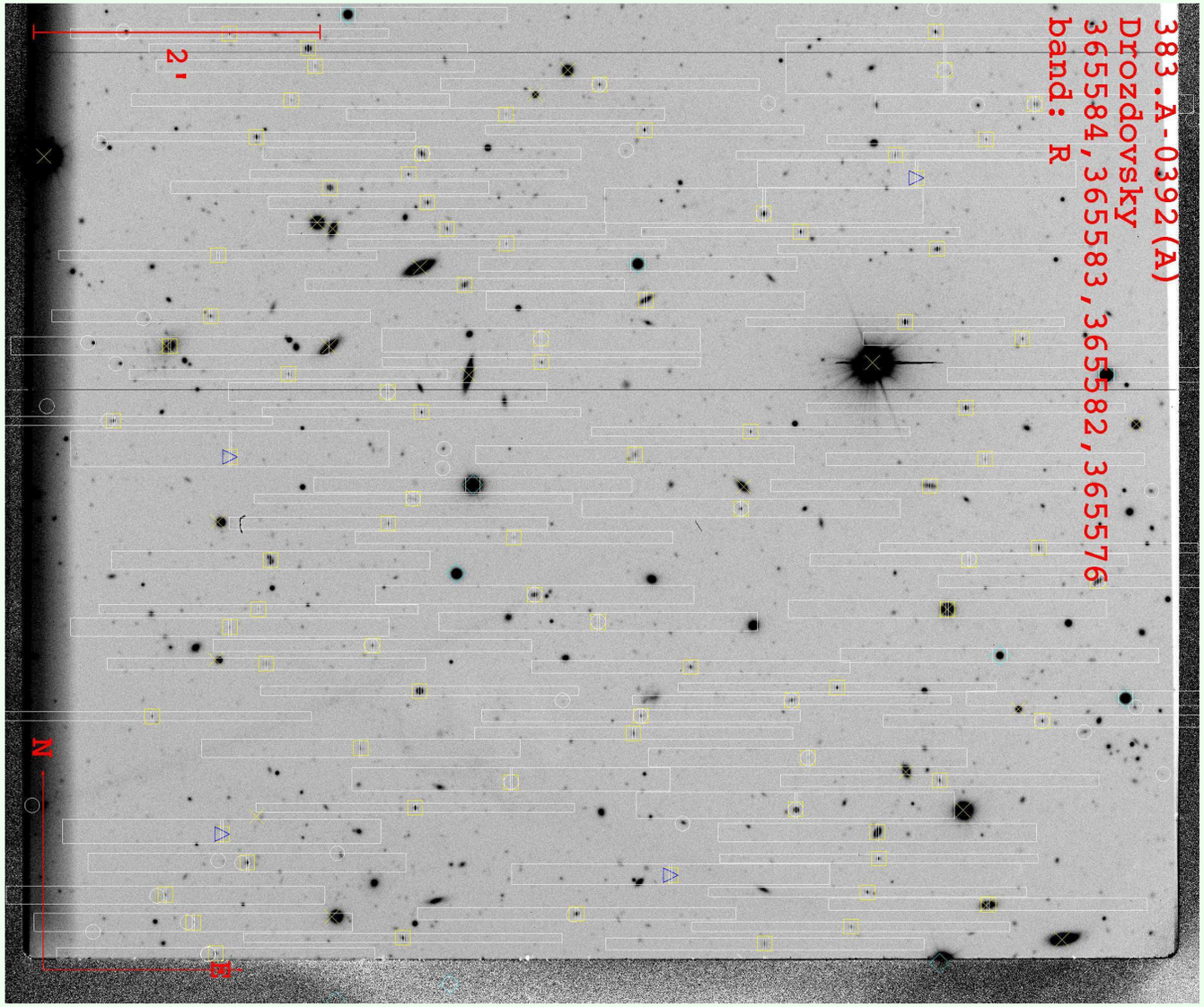
BzK=(z−K) vs. (B−z) selection

SloanDSS u,g,r,z and UKIDSS K−mag

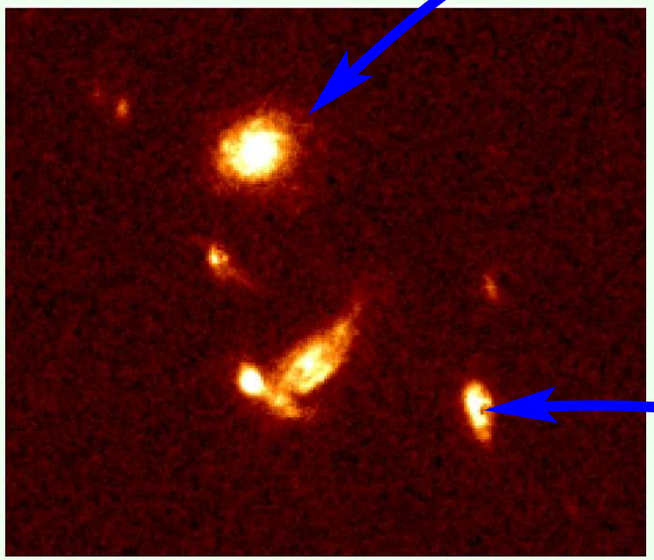
Selected candidates for VLT/VIMOS and (confirmed ELGs)

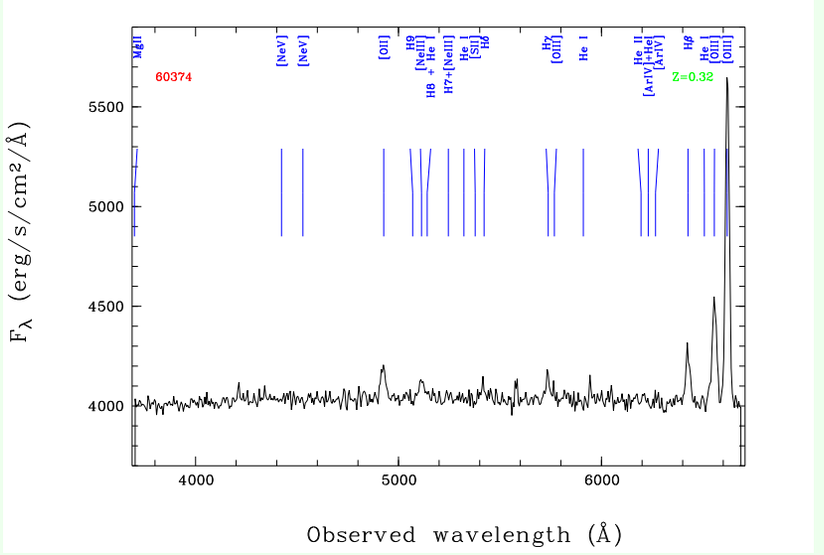
Field	LAEs	Zph(Sloan)	Galex	BzK	Hα	Total
LSF1	2	23	9	52	0	86
LSF2	6	24	10	31	0	71
LSF3	0	20	19	49	0	88
LSF4	1	13	18	51	0	83
SUB1	1	14(5)	0	37(10)	19(3)	73(18)
SUB2	4	16(4)	0	53(14)	14(4)	82(22)
SUB3	1	17(4)	0	56(11)	17(3)	90(18)
SUB4	1	17(3)	0	68(5)	10(5)	86(13)

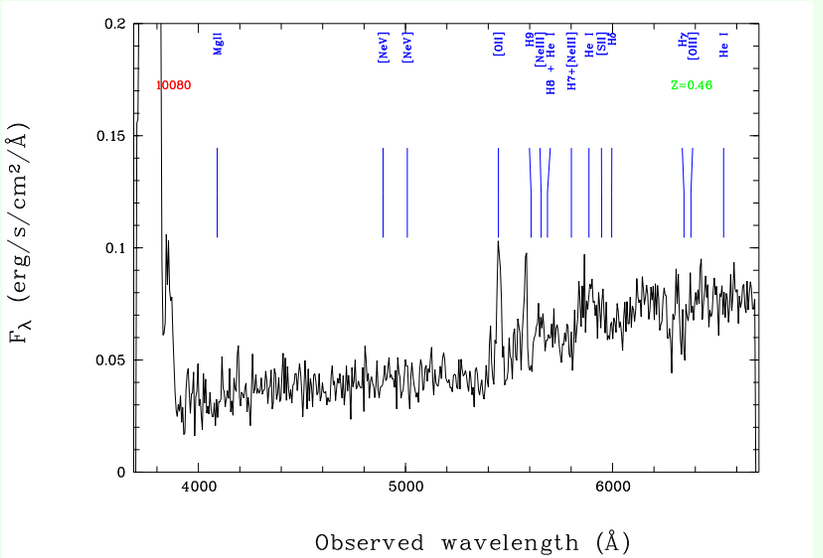
VLT / VIMOS SUB2−field



VLT/VIMOS follow−up spectroscopy: An Example of the ELGs

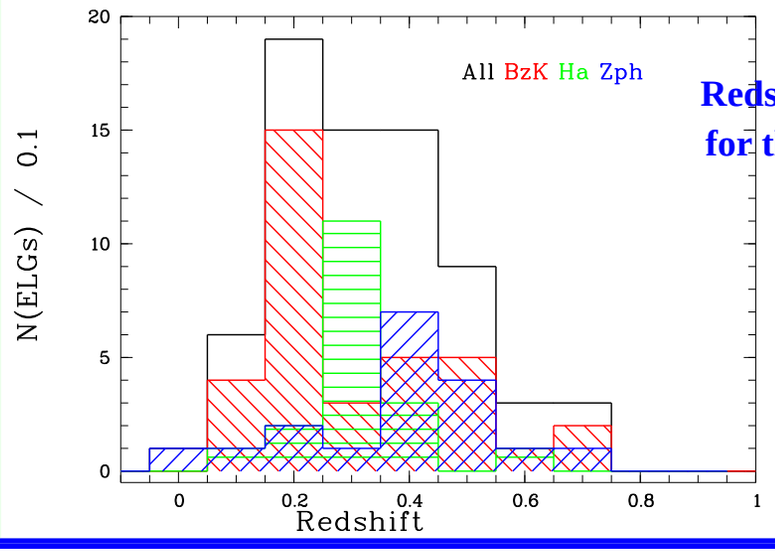




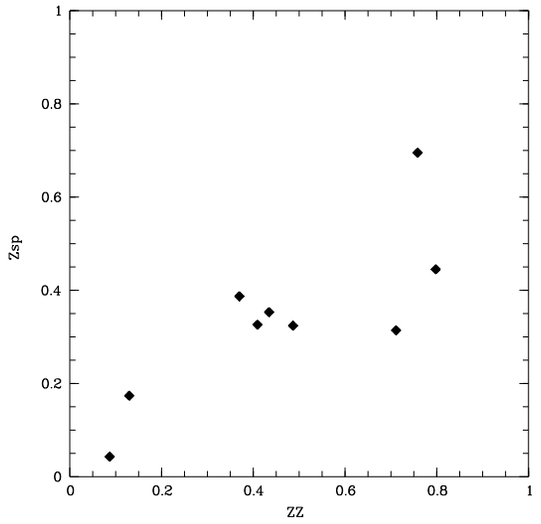


Direct image and VIMOS spectra of two z<1 ELGs

Emission Line Galaxies with VLT/VIMOS



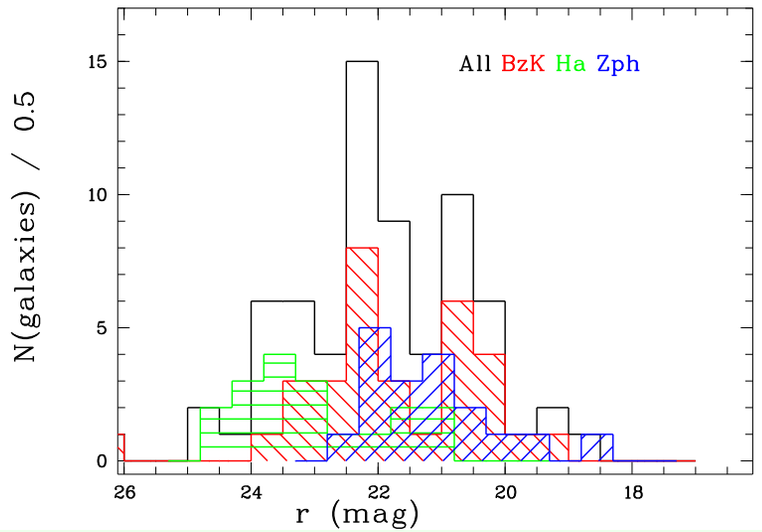
Redshifts distribution for the detected ELGs



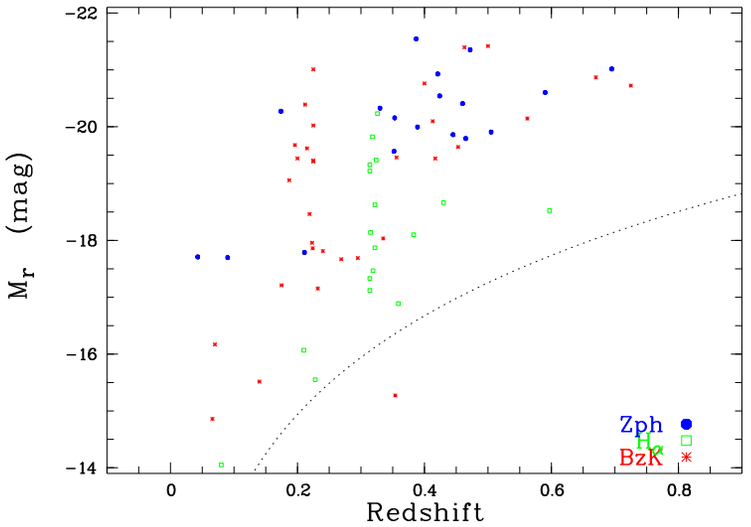
Spectroscopic vs. photometric (Sloan u,g,r,i,z + UKIDS K−band) redshifts

We were able to cull out some of z~0.3 [OII] interlopers among the candidate z~3.1 LAEs using the low−resolution VLT/VIMOS spectra, confirming the low fraction of those interlopers among the [OIII]−band sources (e.g., Rauch 2008), This data also allow us to start a complimentary parallel project aimed at the investigation of the decline in the star formation rate of the Universe at z<1.5. We are particularly interested in this project in exploring the SFR per unit galaxy mass ('Specific SFR') and downsizing.

Emission Line Galaxies with VLT/VIMOS



r−band distribution for the detected ELGs



The different selection criteria ensure the broader sample of high−redshift galaxy populations