SIGNALS: I. Survey Description

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ABSTRACT

SIGNALS, the **S**tar formation, **I**onized **G**as, and **N**ebular **A**bundances **L**egacy **S**urvey, is a large observing program designed to investigate massive star formation and H II regions in a sample of local extended galaxies. The program will use the imaging Fourier transform spectrograph SITELLE at the Canada-France-Hawaii Telescope. Over 355 hours (54.7 nights) have been allocated beginning in fall 2018 for eight consecutive semesters. Once completed, SIGNALS will provide a statistically reliable laboratory to investigate massive star formation, including over 50 000 resolved H II regions : the largest, most complete, and homogeneous database of spectroscopically and spatially resolved extragalactic H II regions ever assembled. For each field observed, three datacubes covering the spectral bands of the filters SN1 (363 - 386 nm), SN2 (482 - 513 nm), and SN3 (647 - 685 nm) are gathered. The spectral resolution selected for each spectral band is 1000, 1000, and 5000, respectively. As defined, the project sample will facilitate the study of small-scale nebular physics and many other phenomena linked to star formation at a mean spatial resolution of ~20 pc. This survey also has considerable legacy value for additional topics including planetary nebulae, diffuse ionized gas, and supernova remnants. The purpose of this paper is to present a general outlook of the survey, notably the observing strategy, galaxy sample, and science requirements.

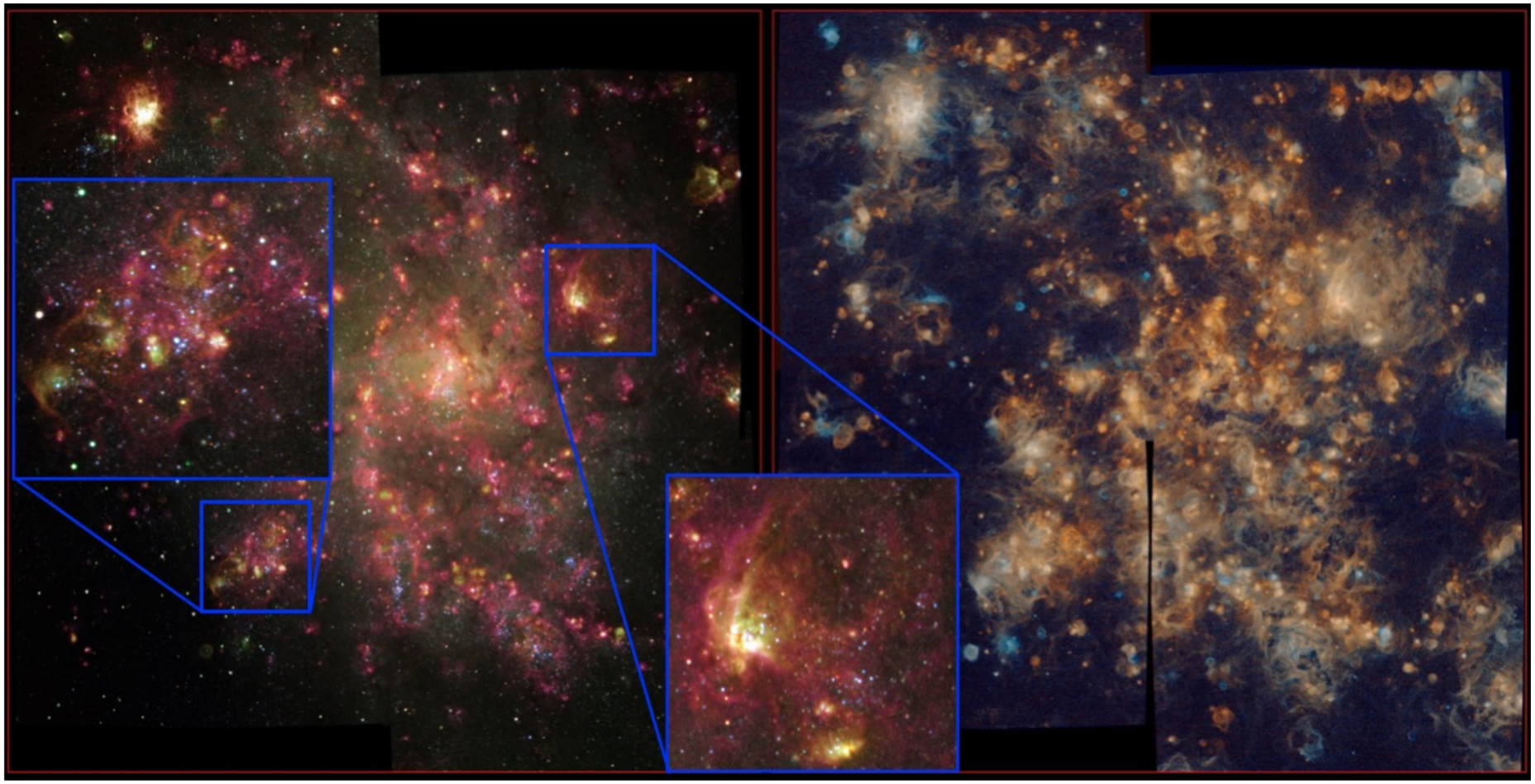
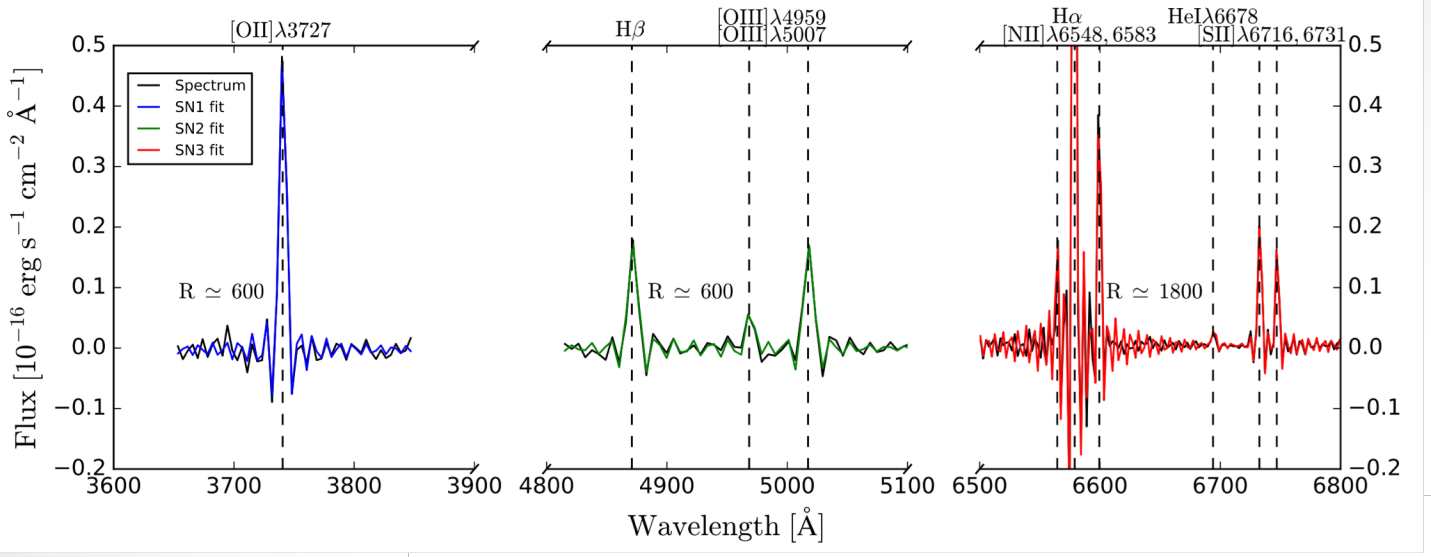


Figure 1. M33 : SIGNALS' science verification data (a mosaic of four fields). On the left, a composite image using the three filters . It combines the three continua over the wavelength range of the filters plus one emission line for each: SN3+Hα (red), SN2+[O III]λ5007 (green), and SN1+[O II]λ3727 (blue). The blue squares are zooms in two areas to show additional details. On the right, to emphasize the ionized gas component, we used the emission line map of Hα, [O III]λ5007, and [O II]λ3727 with different shades of orange, green, and blue, respectively.



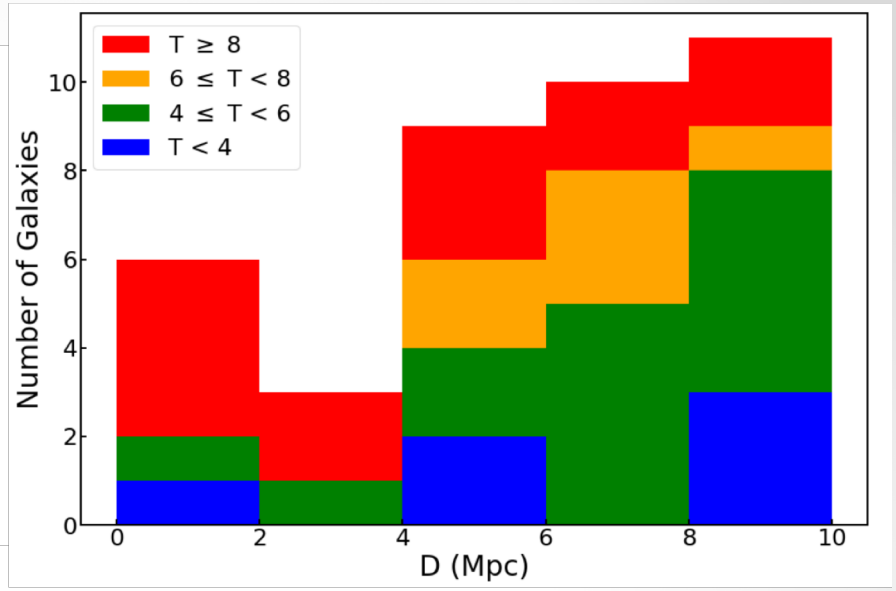
Filter	Band [nm]	Spectral Res.	Exposure time [sec step^{-1}]	# of steps	Integration time [hours]
SN1	363-386	1000	59.0	172	3
SN2	482-513	1000	45.5	219	3
SN3	647-685	5000	13.3	842	4

Пороговая поверхностная яркость (S/N>3)
SB(Hα) ~ 3.6×10^{-17},
SB(Hβ) ~ 4.2×10^{-17}
SB([O II]) ~ 3.0×10^{-17} erg s^{-1} cm^{-2} arcsec^{-2}

The current average seeing of the fields that have already been observed is 1.0″. The seeing of the observations is limited to a mean value of 1.2″ over a scan in order to maintain the global spatial sampling of the H II regions. Data

instrument) were rejected. The maximum galaxy distance was set to 10 Mpc in order to optimize the spatial resolution while still sampling a large number of H II regions. This ensures a spatial resolution of 40 pc per resolution element or less for a seeing of 0.8″. Our selection criteria can be summarized as:

1) star-forming galaxies;
2) $-22° < \mathrm{DEC} < +62°$;
3) $\mathrm{D} \leq 10$ Mpc;
4) limited amount of dust on the line-of-sight; and
5) limited crowding of the H II regions (inclination $\leq 71°$).



Исключали объекты, если они содержат менее 10 HII-областей на кадре. В частности – периферии крупных галактик

1) global metallicity: $7.5 \lesssim 12+\log[\mathrm{O/H}] \lesssim 9.0$;
2) magnitude: $-21.3 \lesssim \mathrm{M_{absolute}} \lesssim -13.5$ mag;
3) surface brightness: $18 \lesssim \mu_V \lesssim 30$ mag arcsec^{-2}; and
4) galactic environments: 1/3 isolated objects, 2/3 in groups, with no strongly interacting systems.

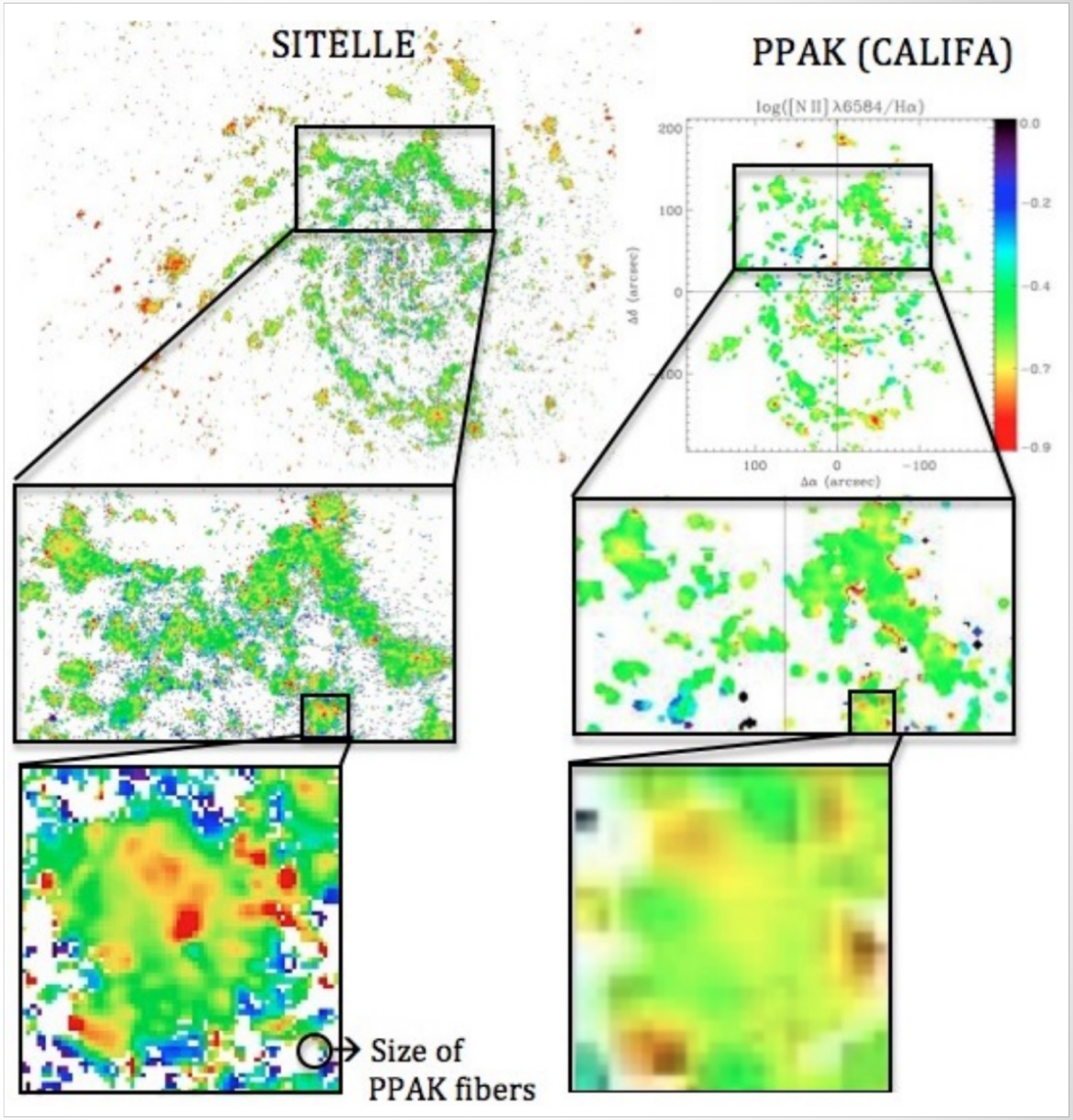
На данный момент запланированы наблюдения 54 объектов

Цели проекта:

- Ионизационная структура HII-областей
- DIG
- Локальная кинематика в областях звездообразования

Пространственное разрешение – порядка 10 пк

Пока данных практически нет, но осенью-зимой собираются активно наблюдать…



A New Technique for Finding Galaxies Leaking Lyman-Continuum Radiation: [SII]-Deficiency

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ABSTRACT

The source responsible for the reionization of the Universe is believed to be the population of star-forming galaxies at $z \sim 6$ to 12. The biggest uncertainty concerns the fraction of Lyman-continuum photons that actually escape from the galaxies. In recent years, several relatively small samples of "leaky" galaxies have been uncovered, and clues have begun to emerge as to both the indirect signposts of leakiness and of the conditions/processes that enable the escape of ionizing radiation. In this paper we present the results of a pilot program aimed to test a new technique for finding leaky galaxies—using the weakness of the [SII] nebular emission-lines relative to typical star-forming galaxies as evidence that the interstellar medium is optically-thin to the Lyman continuum. We use the Cosmic Origins Spectrograph on the Hubble Space Telescope to detect significant emerging flux below the Lyman edge in two out of three [SII]-weak star-forming galaxies at $z \sim 0.3$. We show that these galaxies differ markedly in their properties from the class of leaky "Green-Pea" galaxies at similar redshifts: our sample galaxies are more massive, more metal-rich, and less extreme in terms of their stellar population and the ionization state of the interstellar medium. Like the Green Peas, they have exceptionally high star-formation rates per unit area. They also share some properties with the known leaky galaxies at $z \sim 3$, but are significantly dustier. Our results validate a new way to identify local laboratories for exploring the processes that made it possible for galaxies to reionize the Universe.

Keywords: extragalactic astronomy – galaxy formation – star formation – interstellar medium – intergalactic medium

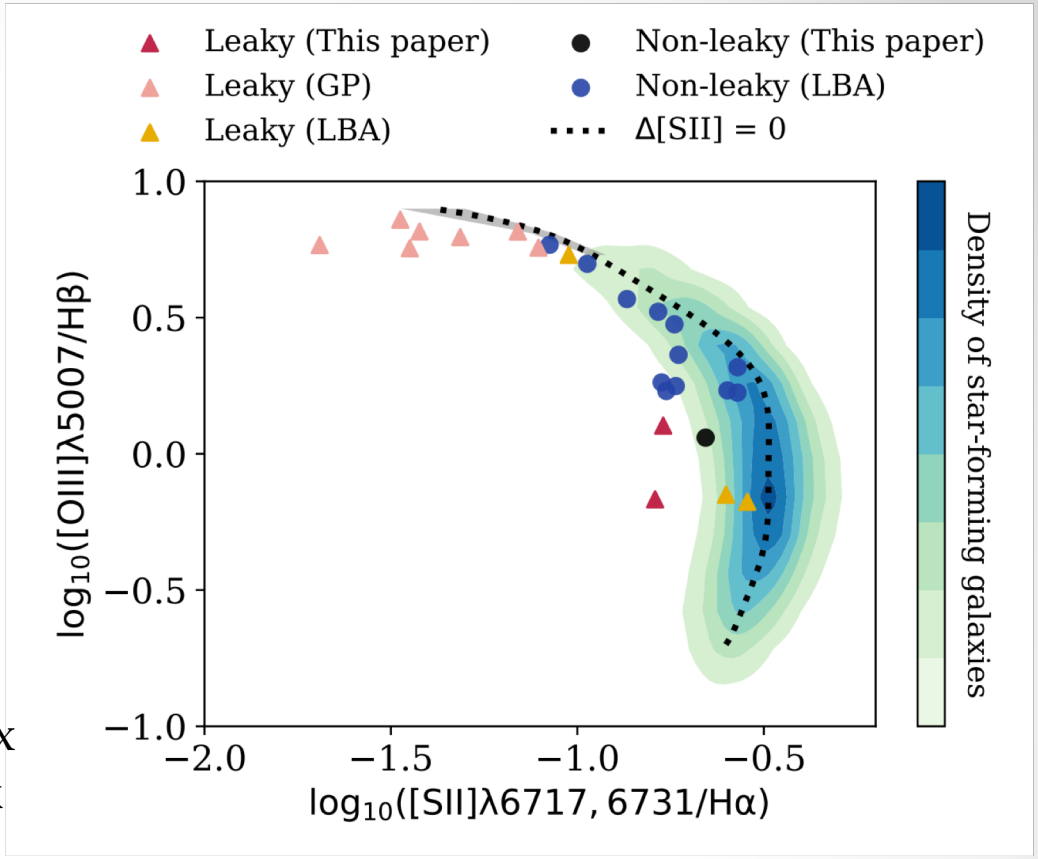
1. INTRODUCTION

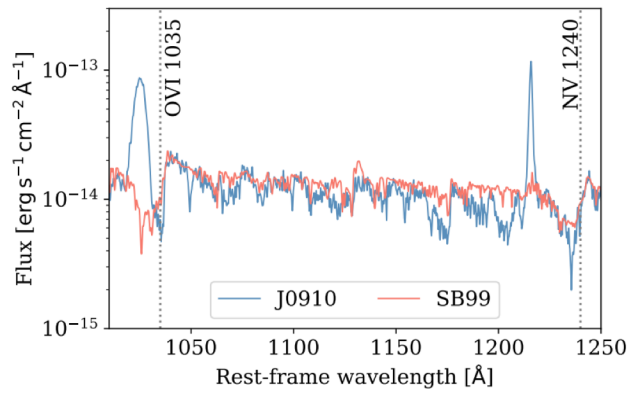
ΛCDM model (e.g. Bennett et al. (2013); Planck Collab-

Наблюдения на HST со спектрографом COS 5 галактик, выбранных из SDSS+GALEX по следующим критериям:

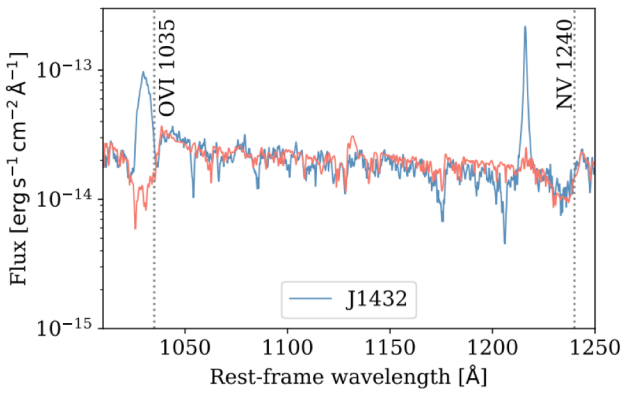
1) Недостаток [SII] по крайней мере на 0.2 dex
2) Reff~0.5” в фильтре u-sdss
3) Достаточно яркие в FUV
4) z>0.26
5) Не AGN

Несмотря на это, в двух галакткиках спектр в FUV связан с квазаром, так что оставили для анализа только три галактики

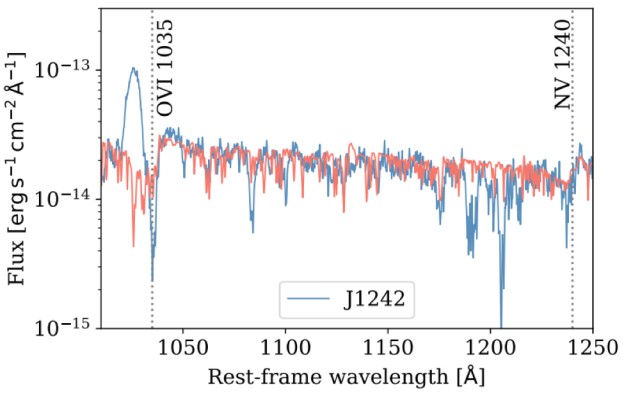




(a)



(b)



(c)

Table 2. Measured ancillary parameters.

	SFR_{UV} ($M_\odot yr^{-1}$)	$SFR_{H\alpha}$ ($M_\odot yr^{-1}$)	SFR_{IR} ($M_\odot yr^{-1}$)	$A(H\alpha)$	r_{50} (kpc)	SFR_{IR}/A ($M_\odot\,yr^{-1}\,kpc^{-2}$)	$M_\star$ ($\log_{10}M_\odot$)
J0910	128	35	125 ± 11	1.24	0.22	394	10.44
J1432	209	19	134 ± 10	0.75	0.17	705	10.54
J1242	100	21	55 ± 10	0.96	0.50	34	10.38
	$EW_{H\alpha}$ (Å)	$EW_{Ly\alpha}$ (Å)	$R_{Ly\alpha}$	Δ[SII] (dex)	[OIII]/[OII]	$12 + \log_{10}(O/H)$	
J0910	138	21.84	0.75	-0.30	1.29	8.66	
J1432	113	24.55	0.44	-0.28	1.57	8.60	
J1242	125	N/A	N/A	-0.17	1.42	8.52	

Сравнивают с Green Peas:
Отобранные по [SII] галактики существенно более массивные, более богатые тяжелыми металлами, ионизационный параметр существенно ниже

В целом, предлагают использовать метод для поиска галактик с утечкой LyC на больших z как дополнение к остальным критериям (например, высокое [OIII]/[OII])