Outflowing Winds in DEEP2 Galaxies at $z = 1$

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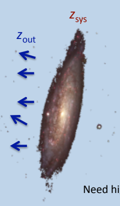
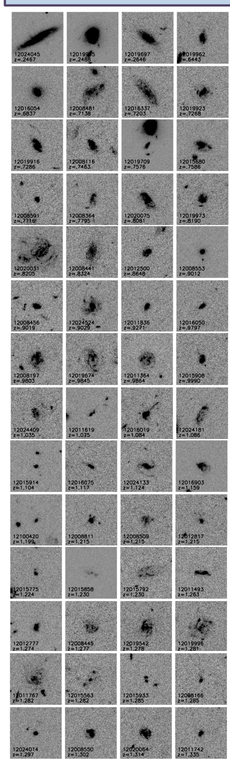
A Physical Picture:



Superwinds from the combined effect of supernovae explosions and stellar winds are thought to strongly affect both their host galaxy and the surrounding intergalactic medium:

1) Quench star formation by expelling cold gas
2) Enrich the intergalactic medium (IGM) in metals
3) Limit black hole growth

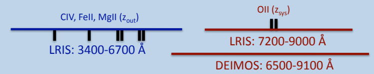
Need high-resolution spectra inclusive of both outflow features (z_{out}) and systemic lines (z_{sys})



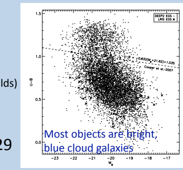
(left) *V*-band (F606W) *HST* thumbnails of the sample, ordered by redshift. Each image is 6″ on a side and North is up and East is to the left.

Data:

72 galaxies at 0.7 < z < 1.3 in the Extended Groth Strip



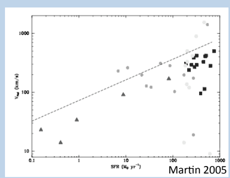
DEEP2 spectroscopy:
DEIMOS on Keck II
R = 5000 (60 km s^{-1})
R_{AB} < 24.1
LRIS spectroscopy (follow-up to probe blue wind features):
Low Resolution Imaging Spectrometer on Keck I
DEEP2/LRIS sample includes 212 galaxies (in 4 DEEP2 fields)
R = 600, 1000 (500, 300 km s^{-1})

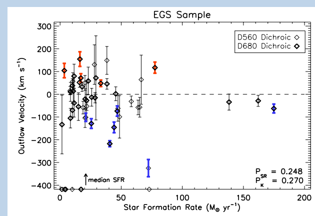


Systemic redshifts estimated from [OII] λλ3727/3729
HST imaging (F606W, F814W)
UV to radio coverage from the All-Wavelength Extended Groth Strip International Survey

Star Formation Rates:

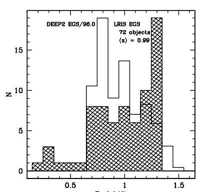
A galaxy's star formation rate is an important parameter which has been linked to outflows: higher velocity winds are associated with more rapidly star-forming galaxies.



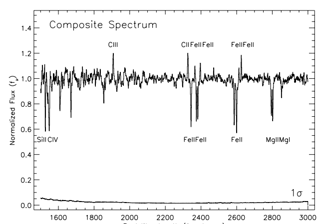


We estimate star formation rates using UV *GALEX* measurements. These SFRs have been checked against 24 μm observations (inferring L_{IR} using Chary & Elbaz (2001) SED templates).

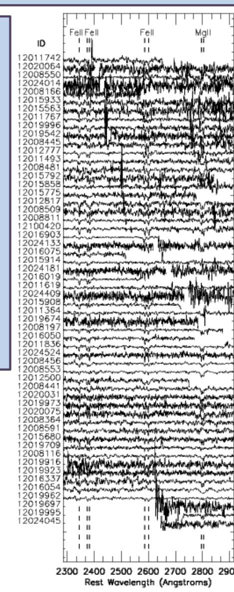
Interestingly, we do not observe a trend between star formation rate and outflow velocity in the data.



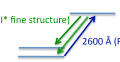
(above) Redshift distribution of the sample, compared with the EGS objects from the parent DEEP2 sample.

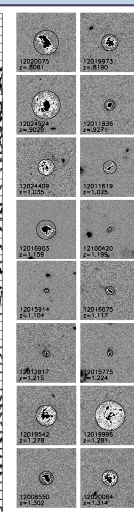


(above) Composite spectrum assembled from 209 LRIS rest-frame, continuum-normalized spectra, with associated error spectrum. Both emission and absorption features are clearly detected, where the latter are used to trace outflows.



(above) Keck Low Resolution Imaging Spectrometer (LRIS) rest-frame, continuum-normalized spectra. Prominent absorption features tracing outflows are indicated.

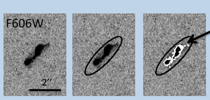




(above) White contours show galaxy area selected using the 74% technique; black circles indicate the Petrosian radius.

Galaxy Areas and SFR Surface Densities:

Determining the physical extent of star formation in galaxies allows a calculation of the star formation rate surface density (Σ).

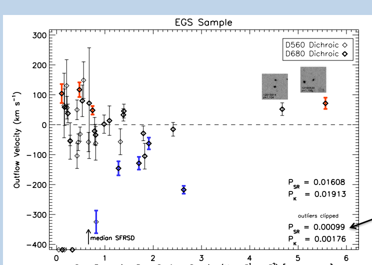


The combined area of luminous clumps (white contours) may be the most representative area for Σ

$$\frac{\text{counts}}{\text{pixel}} \xrightarrow{\text{via zpt}} \frac{f_\nu}{\text{pixel}} \xrightarrow{\text{via } z} \frac{L_\nu}{\text{kpc}^2} \xrightarrow{\text{via K98}} \frac{\text{SFR}}{\text{kpc}^2}$$

Select pixels on the basis of surface brightness [SFR/kpc^2]

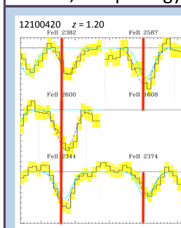
We found that the area selected by imposing Σ = 0.1 M_{sun} yr^{-1} kpc^{-2} was inclusive of approximately 74% of the flux within the Petrosian radius. We flagged this area as the "clump area".



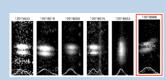
We find a strong trend between outflow velocity and Σ.

3σ trend

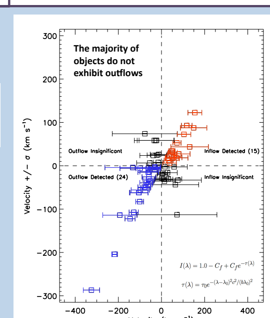
Inflows, Morphology and FeII* Emission:

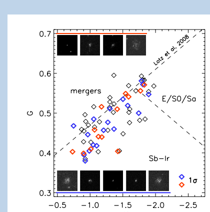


A small subset of objects show apparent *inflows*.



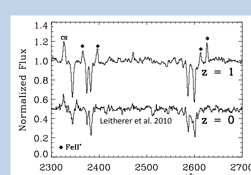
It is important to check for galactic rotation.





← Mergers are not required to drive winds; objects hosting outflows and those with apparent inflows span the same parameter space.

Fine-structure FeII* emission features are present in the spectra, including lines at 2365, 2396, 2612, and 2626 Å. These features are rarely seen in local starbursts; what is their origin?



We acknowledge Jennifer Lotz and Kai Noeske for kindly providing morphological information and star formation rates, respectively.