The BlueMUSE Deep Fields: science with deep redshift catalog and lessons learned from MUSE

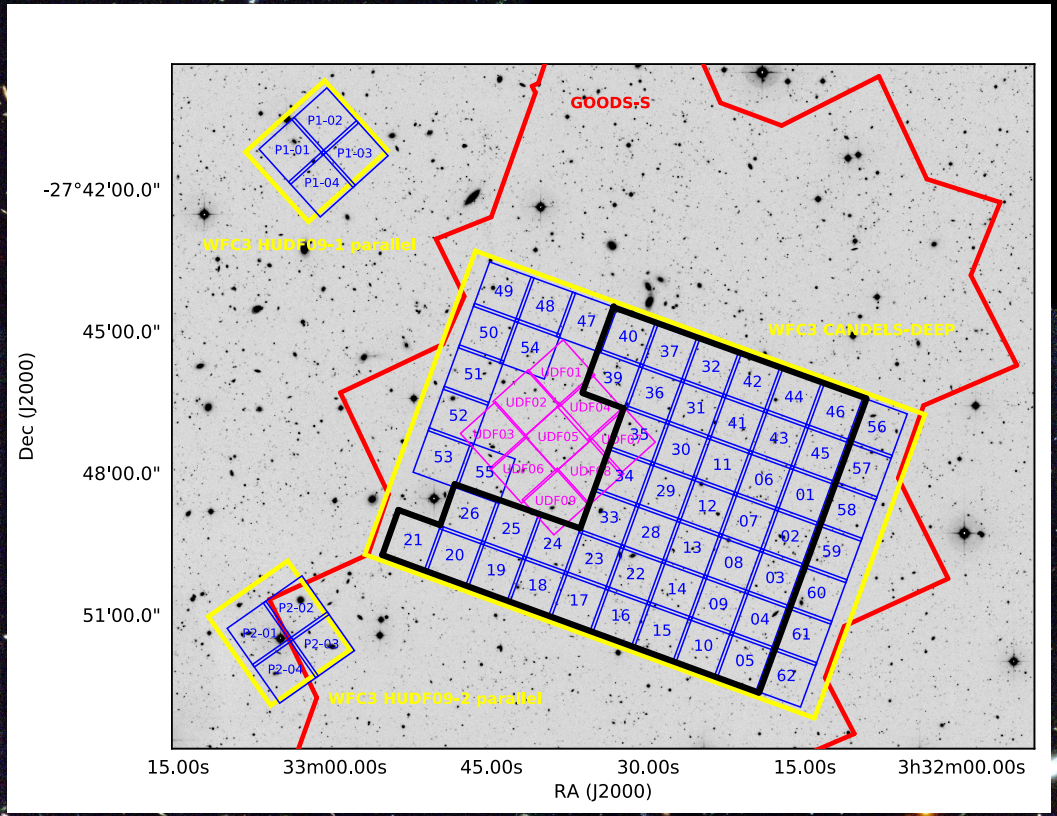
Tanya Urrutia

& the MUSE Consortium

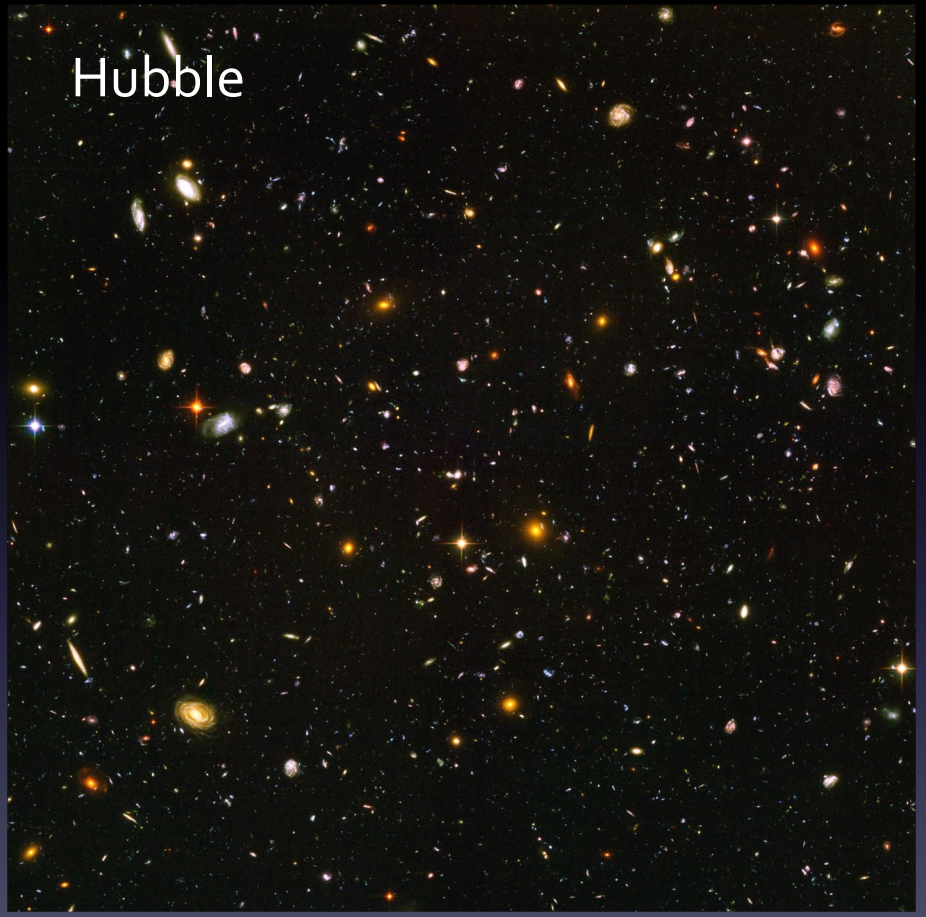
Especially: Roland Bacon & Lutz Wisotzki

@astrobellatrix

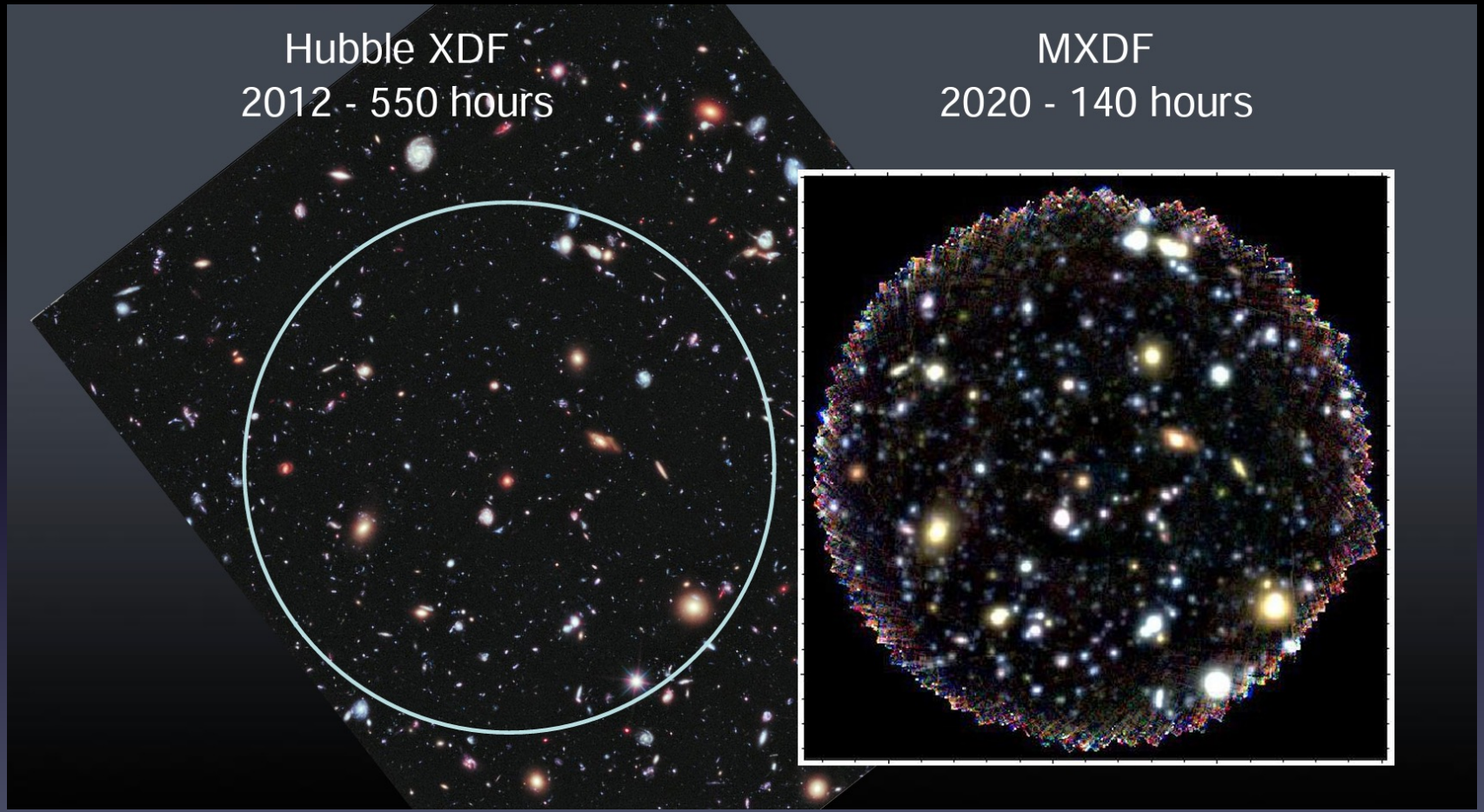
MUSE blind follow-up of deep HST surveys



- Motivation for Deep Fields is the same as the original HDF:
  - unbiased census allows us for statistical inferences / relations about galaxies
  - fainter fluxes = either lower masses or higher redshift
- Wedding-cake approach

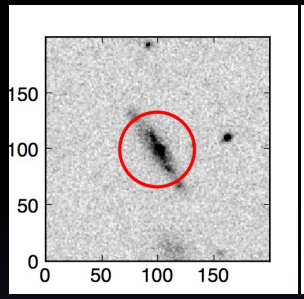


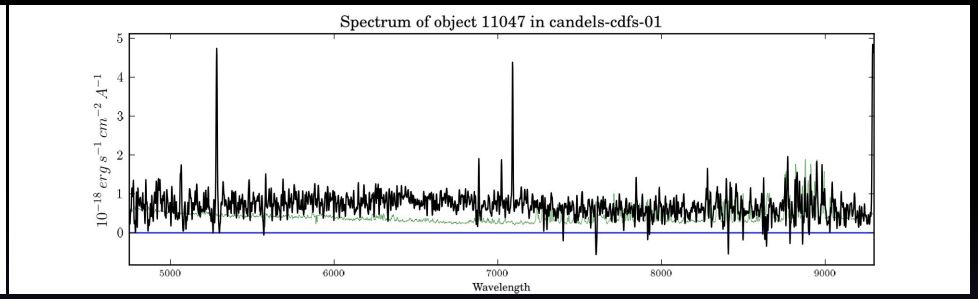
Bacon et al. 2023

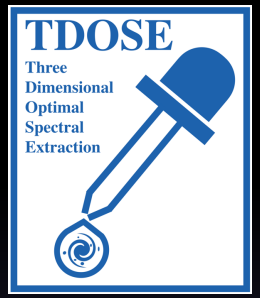


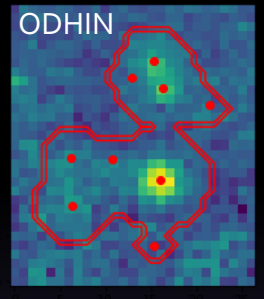
Bacon et al. 2023

MUSE spectra on deep field objects









- These are highly studied fields with several thousand spectra on continuum selected sources. Nevertheless, MUSE can enhance the picture due to:
  - Incompleteness in slit placement
  - Slit losses
- Optimally weighted spectra for **all** sources based on photometric catalogs.
  - TDOSE – Schmidt et al. 2019, using insights from stellar crowded field 3D spectroscopy (PampelMUSE, Kamann et al. 2013).
  - ODHIN – Same as above, but galaxy shape is based on segmentation maps – much faster!
- 98% redshift identification for objects with $mag_i<24$ in just 1 hour, >80% for $mag_i<26.5$ in 140 hours.

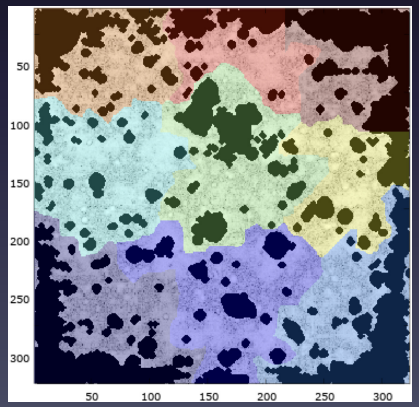
Emission always easier…

Emission line sources are easy to identify in a 3D cube.

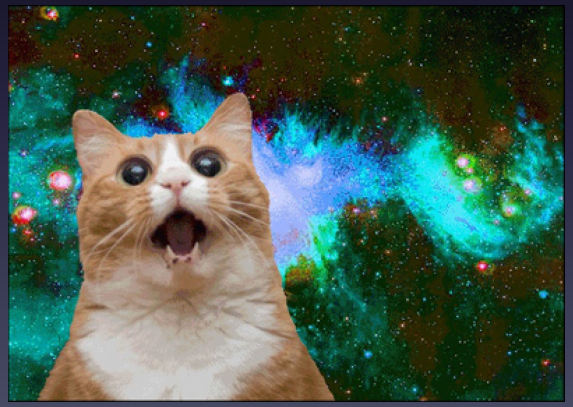
Movie: going in wavelength space. Note the emission appearing even where there was no previous continuum source.

Emission line search

- Several methods to find these emission-line sources in empty fields. We have converged on 3: ORIGIN, LSDCat and MUSELET.
- MUSE has proven to be very sensitive to emission line fluxes, comfortably reaching $5x10^{-18}$ erg/cm^2/s in 1 hour for σ~100 km/s, PS



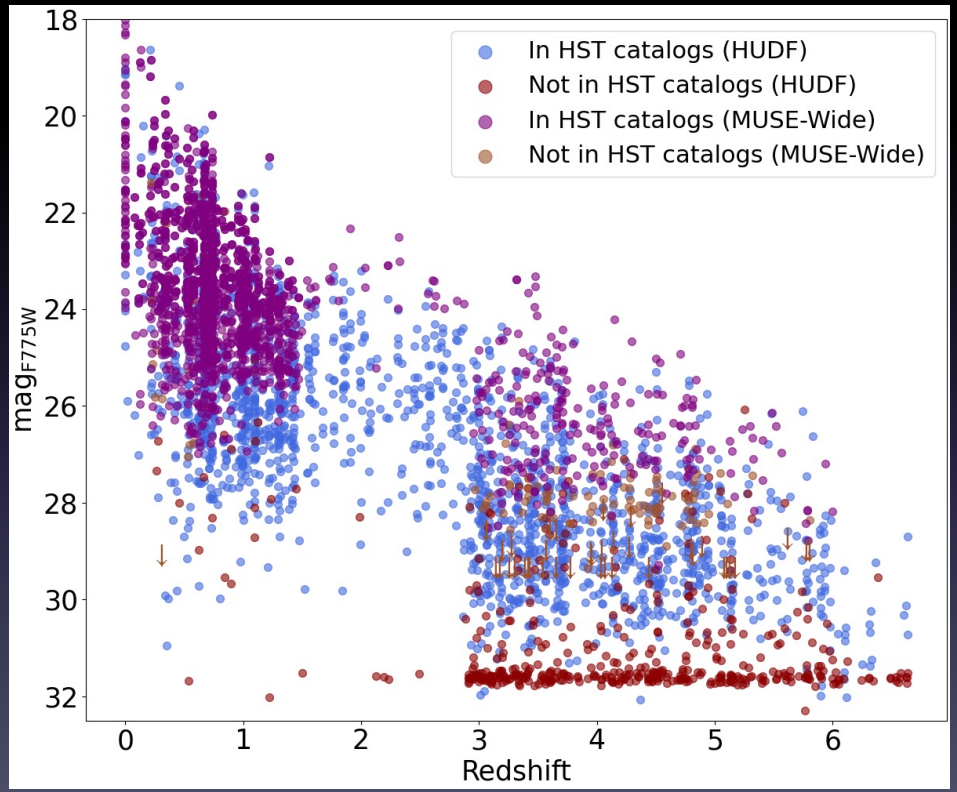
ORIGIN, Mary et al. 2020


LSDCat, Herenz & Wisotzki 2017

Part of MPDAF, Piqueras et al. 2017

How much does "spectroscopy of everything" yield?

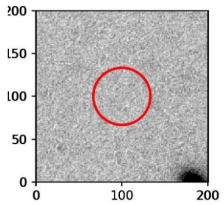
- More than 2200 sources redshift identified in HUDF, almost 4000 in CANDELS fields.
- In particular the MXDF yielded ~200 high confidence sources without an HST counterpart.



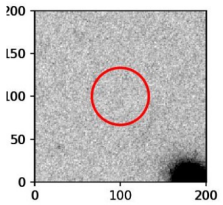
Individual sources

HST ACS images

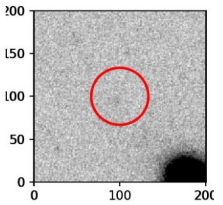
F435W

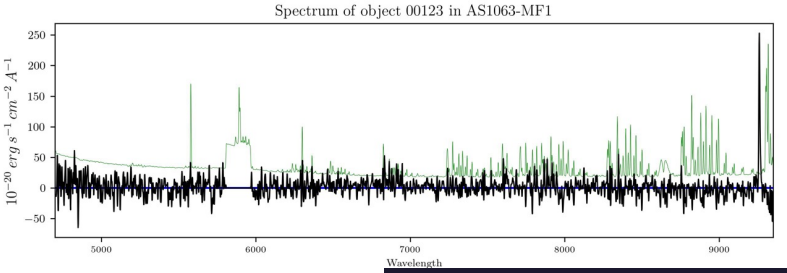


F606W



F814W

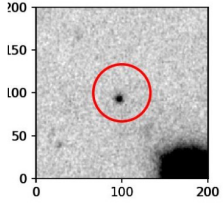




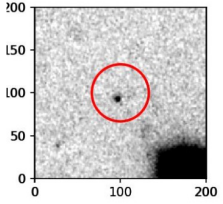
z=6.625

HST WFC3 images

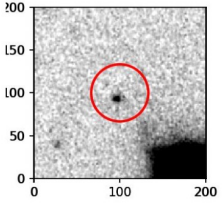
F105W



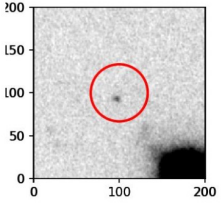
F125W



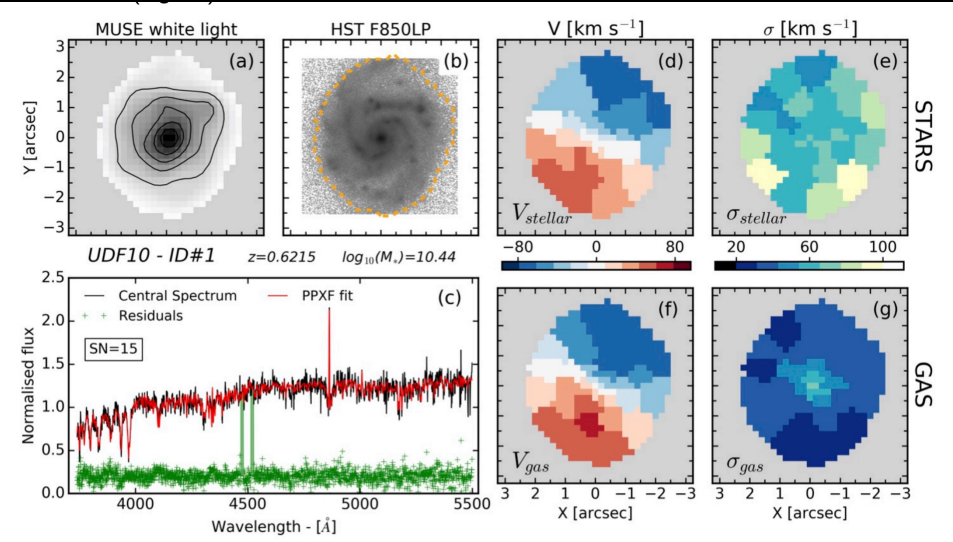
F140W



F160W

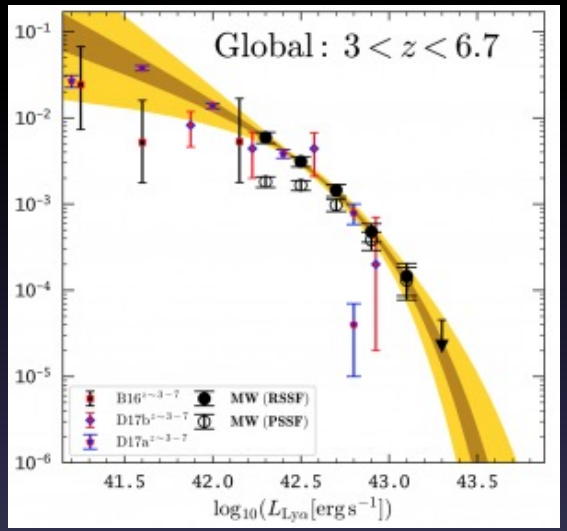


Science Topics – 1. Resolved studies

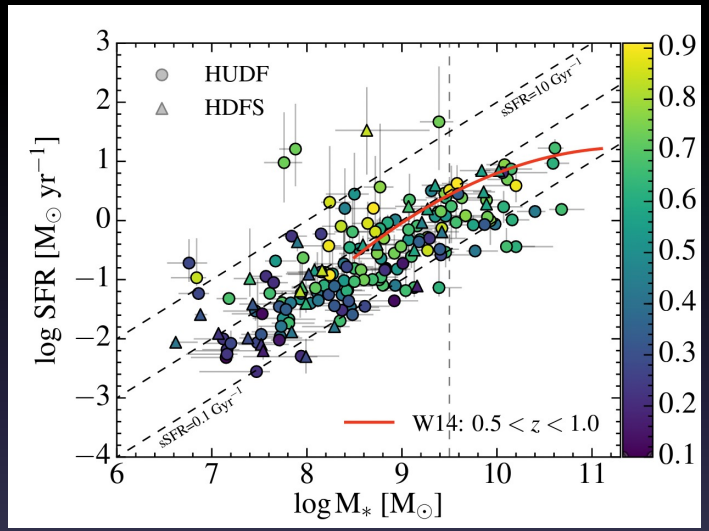


- While the number of bins is not very large, it is enough for:
  - Velocity and dispersion maps (especially for gas), e.g. Tully-Fisher relation, Fall relation out to z~1.
  - Metallicity, SFR, age, etc. gradients

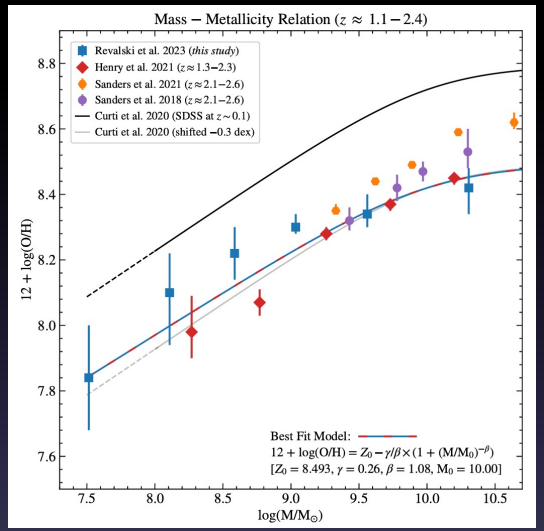
Science Topics – 2. Scaling relations



Herenz et al. 2019



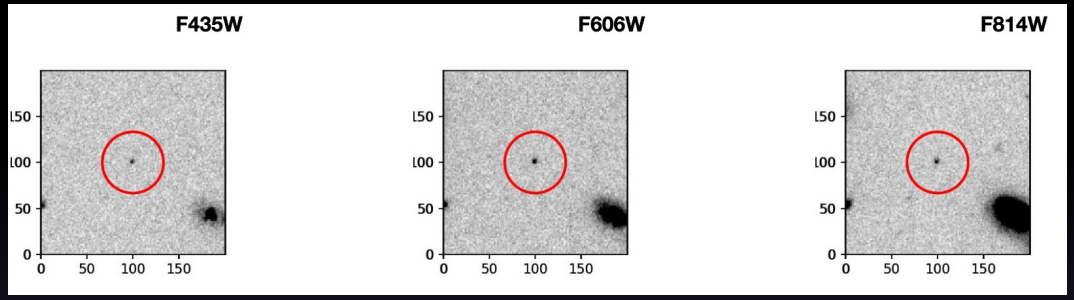
Boogaard et al. 2018

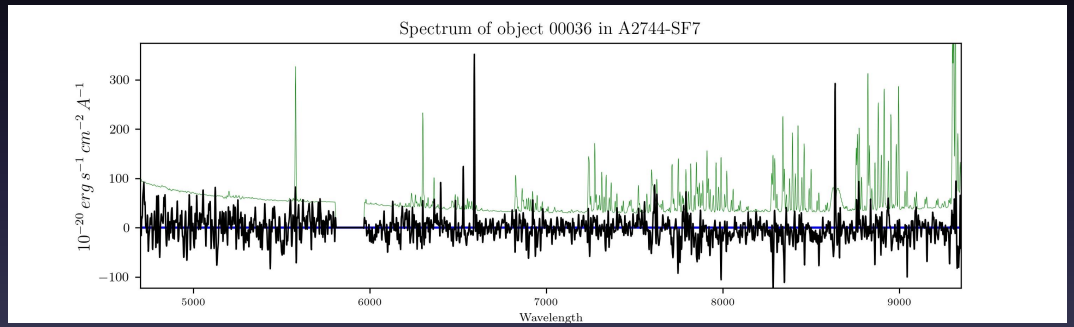


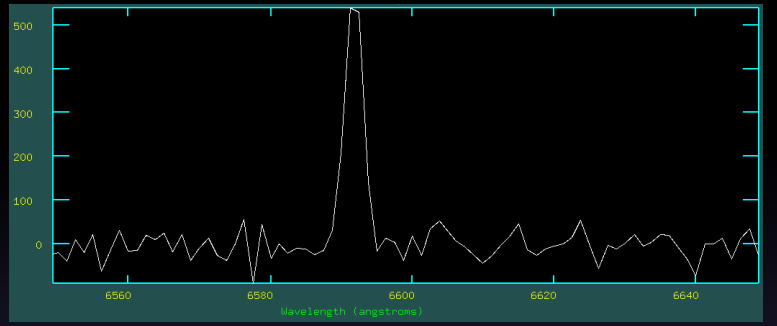
Revalski et al. 2024

- Luminosity functions (unbiased towards lower fluxes)
- Star Formation Main Sequence, Mass-Metallicity Relation (finally able to reach low stellar masses)

And just how far down…





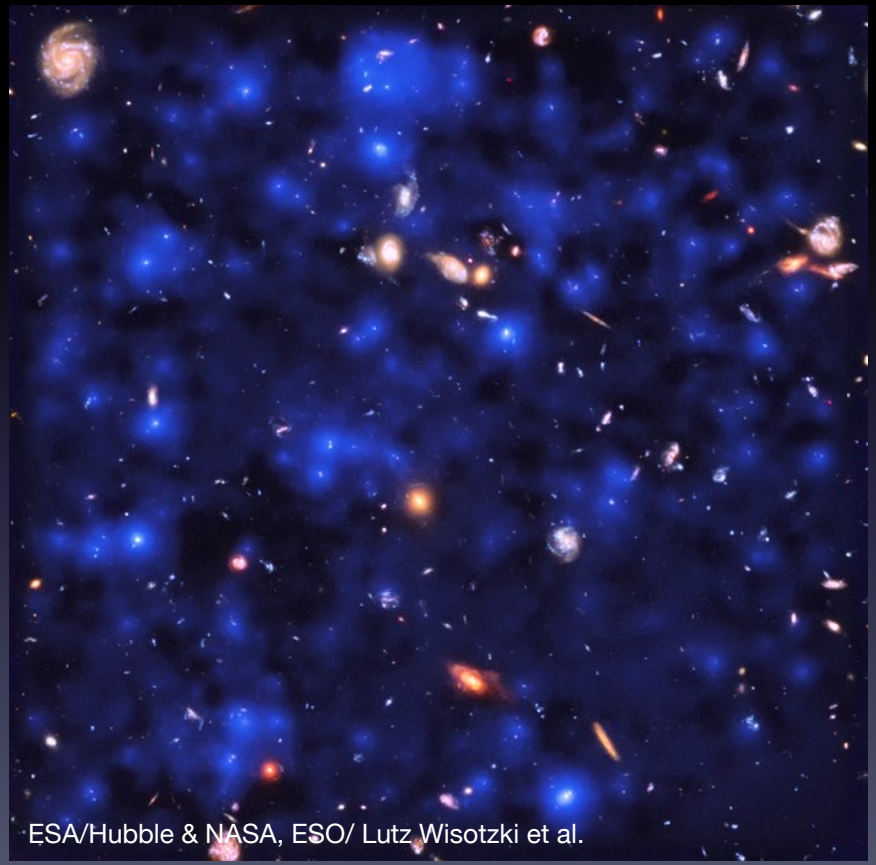


m_435 = 28.1
m_606 = 27.8
m_814 = 28.0

FAST $M^* \sim 10^{5.2}$ (?), $O_{32} >> 8$

We are entering the regime of Compact Blue Dwarfs, but Ultra Faint!

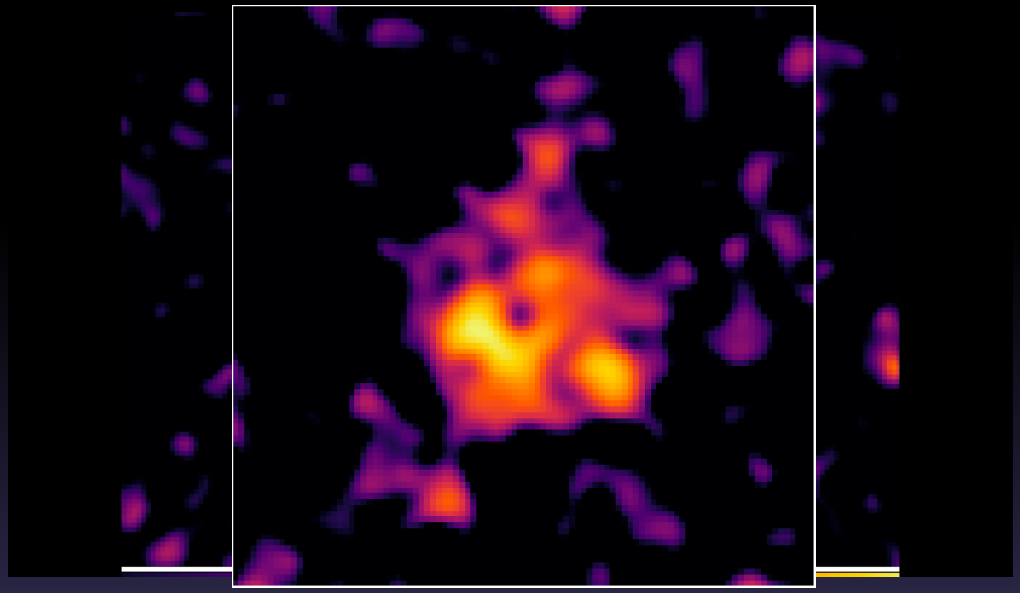
Science Topics – 3. Diffuse emission



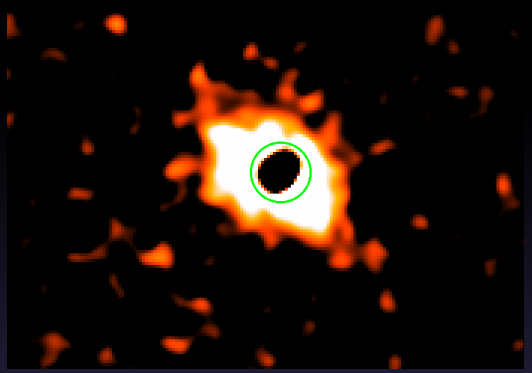
It is only based on the large number of unbiased LAE catalogs, that we saw the large LAE halos that were systematically around most of them.

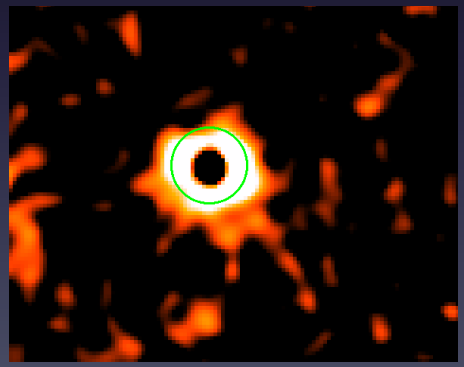
KEY BlueMUSE driver!

Lya



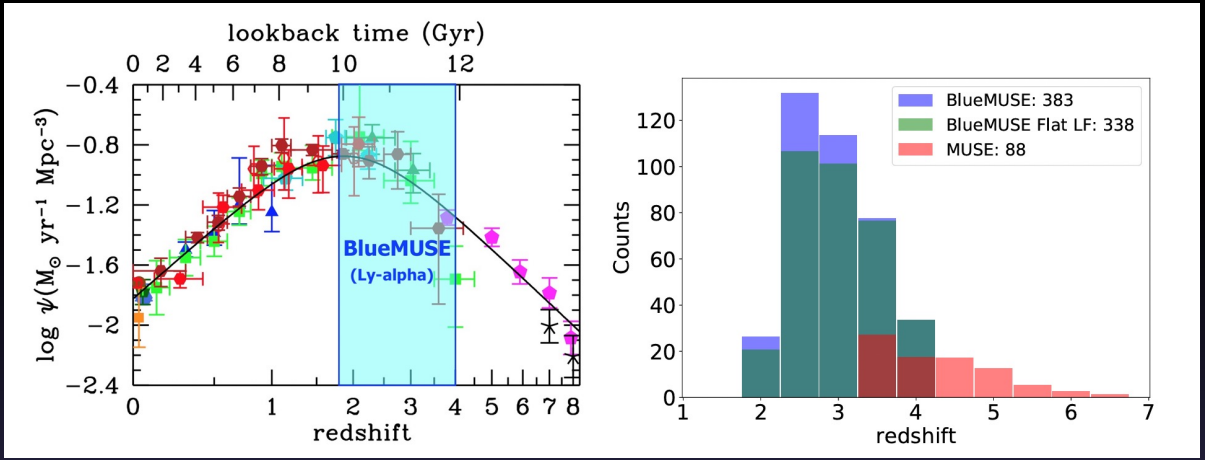
MgII





- Surface brightness dimming goes with $(1+z)^4$.
  - BlueMUSE will be more sensitive to these features!
    - Especially for non-resonant lines!

The promise of BlueMUSE



From BlueMUSE white paper Richard et al. 2019

- The main power with BlueMUSE surveys will go with the much higher reachable surface brightness luminosities, because we will probe lower redshifts.
- Lower spatial resolution is not a problem for resolved studies, also because we will be a lower redshift and because we can reach further out. But confusion may be an issue…