

## The KLEVER survey



Spatially resolved excitation properties and chemical abundances in high redshift galaxies

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**Emission Line Galaxies with MOS** 

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### The KLEVER Survey

- ESO Large Programme to observe ~150 galaxies at 1.2 < z < 2.5</li>
- Multi Integral Field Spectroscopy with KMOS (24 IFU) : spatially resolved spectral information
- full NIR wavelength coverage (J, H, K band) : map the entire set of rest-frame optical nebular diagnostics





physical conditions of the ionized gas

spatially resolved excitation properties and chemical abundances

#### The KLEVER Survey



• Sample :

**lensed galaxies** from HST CLASH & FRONTIER FIELDS clusters + unlensed from GOODS-S and COSMOS

+ few strongly lensed galaxies (SINFONI - Pilot)





#### probe wider regions of the star forming Main Sequence (logM < 10 M☉)



### Modeling and Analysis



- emission line fitting on image plane
- surface brightness maps delensed back into the Source Plane (typical resolution ~ 2 Kpc)







#### courtesy of Matt Auger





### BPT Diagrams at high redshift

Steidel+14

1.5

1

0.5

-0.5

-1

•  $[OIII]/H\beta + [NII]/H\alpha$ •  $[OIII]/H\beta, [NII]/H\alpha \lim$ • Spec AGN (Opt)• Spec AGN (UV)

- K01
- z~2.3 fit
- z~0 fit (KE08)
- z~0 fit (M08)

-1

-0.5

0

0.5

-1.5

log ([0III]  $\lambda 5008/H\beta$ )

higher density harder radiation field ionization conditions metallicity nitrogen enrichment

Newman+14, Masters+14,16, Steidel+14, Shapley+15, Hayashi+15, Zahid+14, Kashino+16, Strom+17...

#### **KLEVER**



### BPTs - Electron Density (Ne)



### BPTs - Ionization Parameter (U)

Fraction





 $Log([SII]/H\alpha)$ 

#### N/O abundance



-1.0

ن N/O)

R2248\_LRb\_p3\_M4\_Q3\_93\_

#### Williams, M.C. et al, in prep.

- N/O correlates well with the most deviating spaxels in the [NII]-BPT
- no clear trend in [S II] BPT



 $(\theta H/[00]) H\beta$ 

### N/O abundance

Deviation

- N/O correlates locally with O/H • above ~1/4 Z\_sun
- BPT offset as a function of • deviations from local O/H vs N/O relation

 $Log([NII]/H\alpha)$ 

0.5





#### Gas-phase metallicity





#### Te based calibrations : MC+17(R3+N2), Pilyugin+10

### Metallicity Maps & Gradients



- metallicity maps sometimes irregular
- gradients from average metallicity in elliptical apertures (Source Plane PSF)
- Resolved if sampled at least 2 linear PSFs
- radial metallicity gradients generally flat
- a few examples of **inverted** gradients





#### Metallicity Gradients





#### Summary



<ul> <li>first observations from KLEVER ~30 lensed galaxies analasyed so far</li> </ul>
<ul> <li>spatially resolved BPT diagrams at 1.2 &lt; z &lt; 2.5</li> </ul>
<ul> <li>high-z galaxies with higher electron densities but no strong correlation with offsets in BPTs</li> </ul>
• increase in ionization parameter drives the evolution in line ratios for some, but not all, galaxies
<ul> <li>N/O : nitrogen enriched regions deviates towards high [NII]/Ha</li> </ul>
(in particular the most deviating from local N/O vs O/H relation)
<ul> <li>BPT offsets arise from the combination of different effects whose relative</li> </ul>
contribution can change from galaxy to galaxy
<ul> <li>metallicity maps : often chaotic and irregular</li> </ul>
<ul> <li>radial metallicity gradients consistent with being flat between 1.2 &lt; z &lt; 2.5</li> </ul>



# stay tuned for more results soon !