AGC: Active Galactic Clump?

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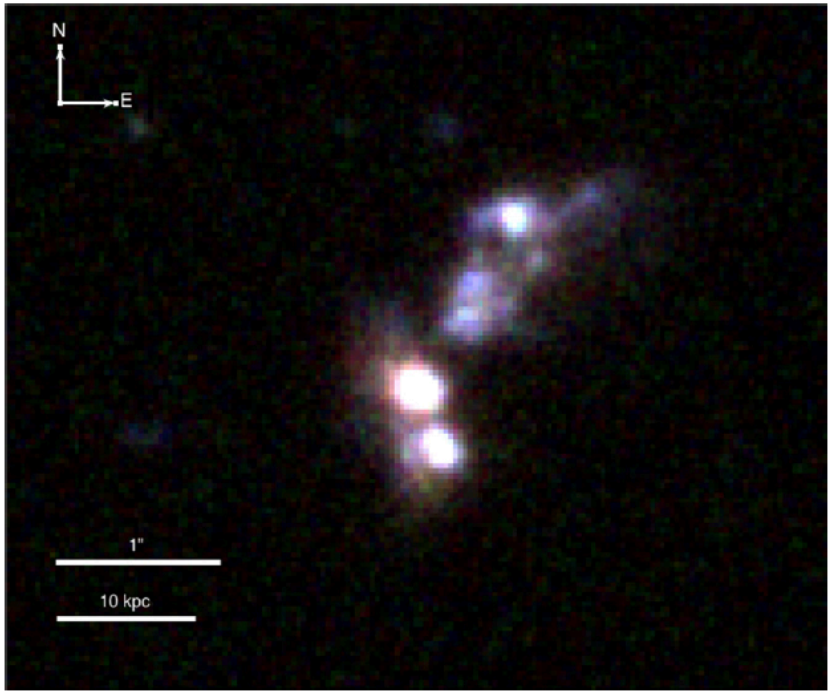
Introduction

How do SMBHs and AGNs form and grow?

galaxy mergers (Di Matteo+ 05, Hopkins+ 06)

disk instability-driven accretion (Kocevski+ 12, Bournaud+ 14)

Schawinski+ 11



Where do they form?

central nuclei

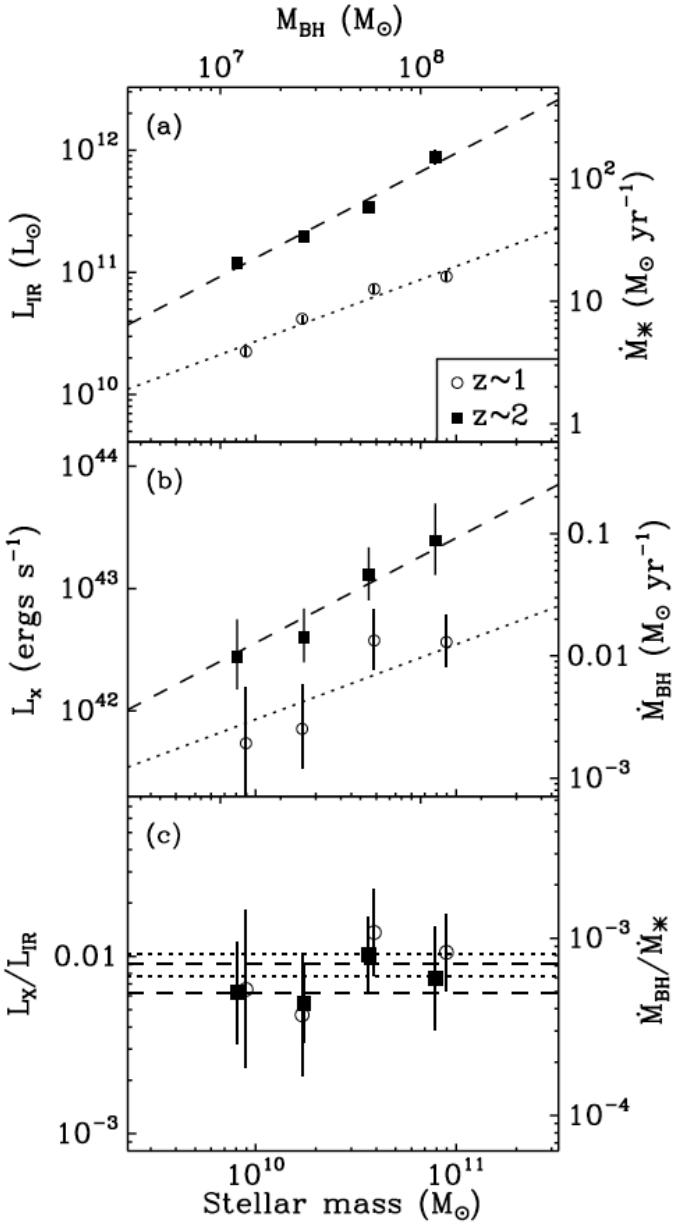
off-centered (e.g., in giant gas-rich clumps, Schawinski+ 11, Bournaud+ 11)

Introduction

Black hole activity at high z mainly takes place in **star forming** galaxies (Mullaney+ 11a)

Star forming galaxies at z>1 often have

- rotating disks (Genzel+ 11)
- high gas fractions (~50%, Daddi+ 10)
- clumpy morphologies (Genzel+ 11)

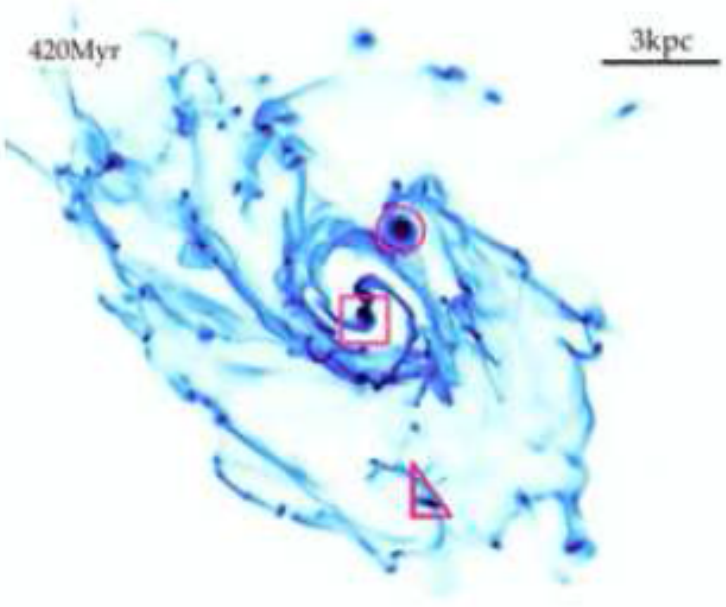


Mullaney+ 12

Introduction

Scenario (Dekel+ 11, Bournaud+ 14)

- Violent disk instability fragments high z disks into clumps
- Seeds of SMBHs form inside dense giant clumps
- Clumps migrate into the center of the galaxy



Bournaud+ 14

Ingredients

1) spatial resolution **AGN** probe: emission line diagnostics

2) spatial resolution probe of **stellar mass distribution**

3) spatial resolution probe of **star formation distribution**

Sample

68 **[OIII] emitting** galaxies at $1 \leq z \leq 2$

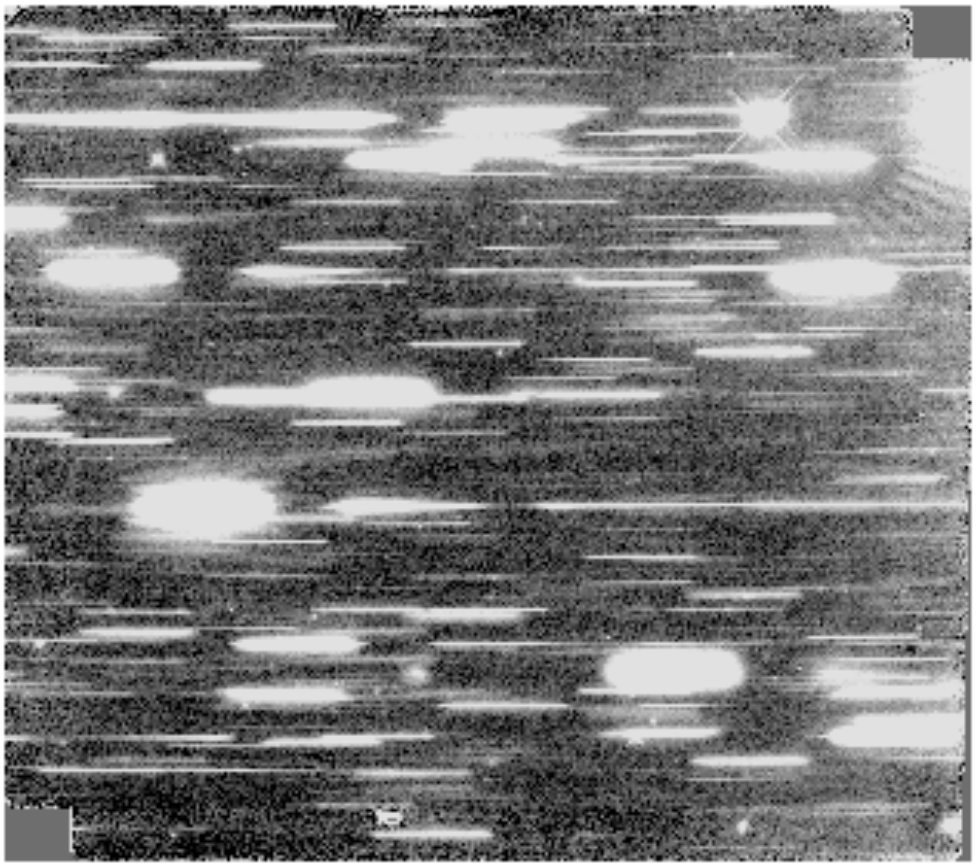
[OIII] = AGN indicator

Observations: WFC3 on board HST

Slitless spectroscopy: G_{141} ($\lambda = 0.8 – 1.2$ μm)

Imaging: near-IR (F140W, F105W)
UVIS (F606W)

Pointed at CL J1449+0856 cluster (Gobat+ 13)

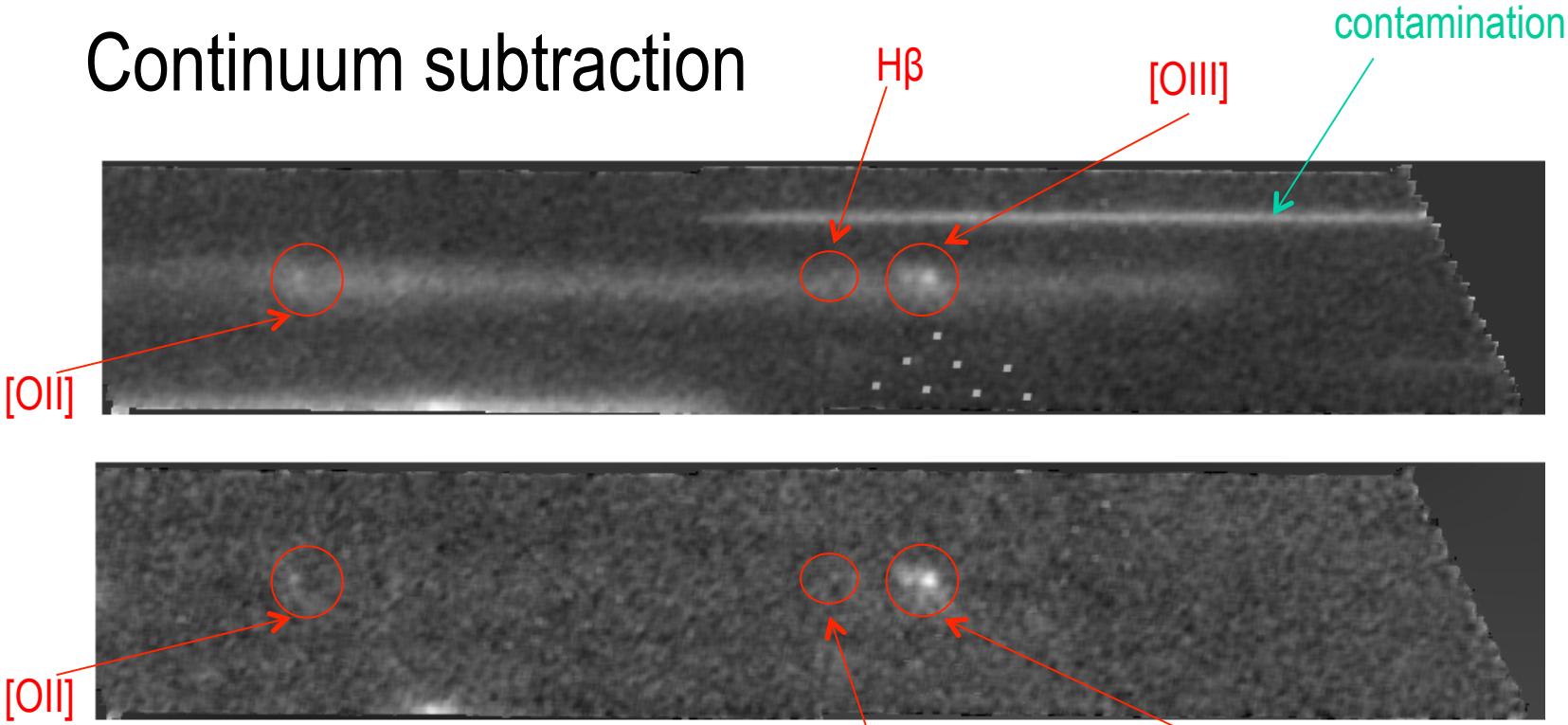


Slitless spectroscopy: 6.4 arcmin^2

Emission line maps

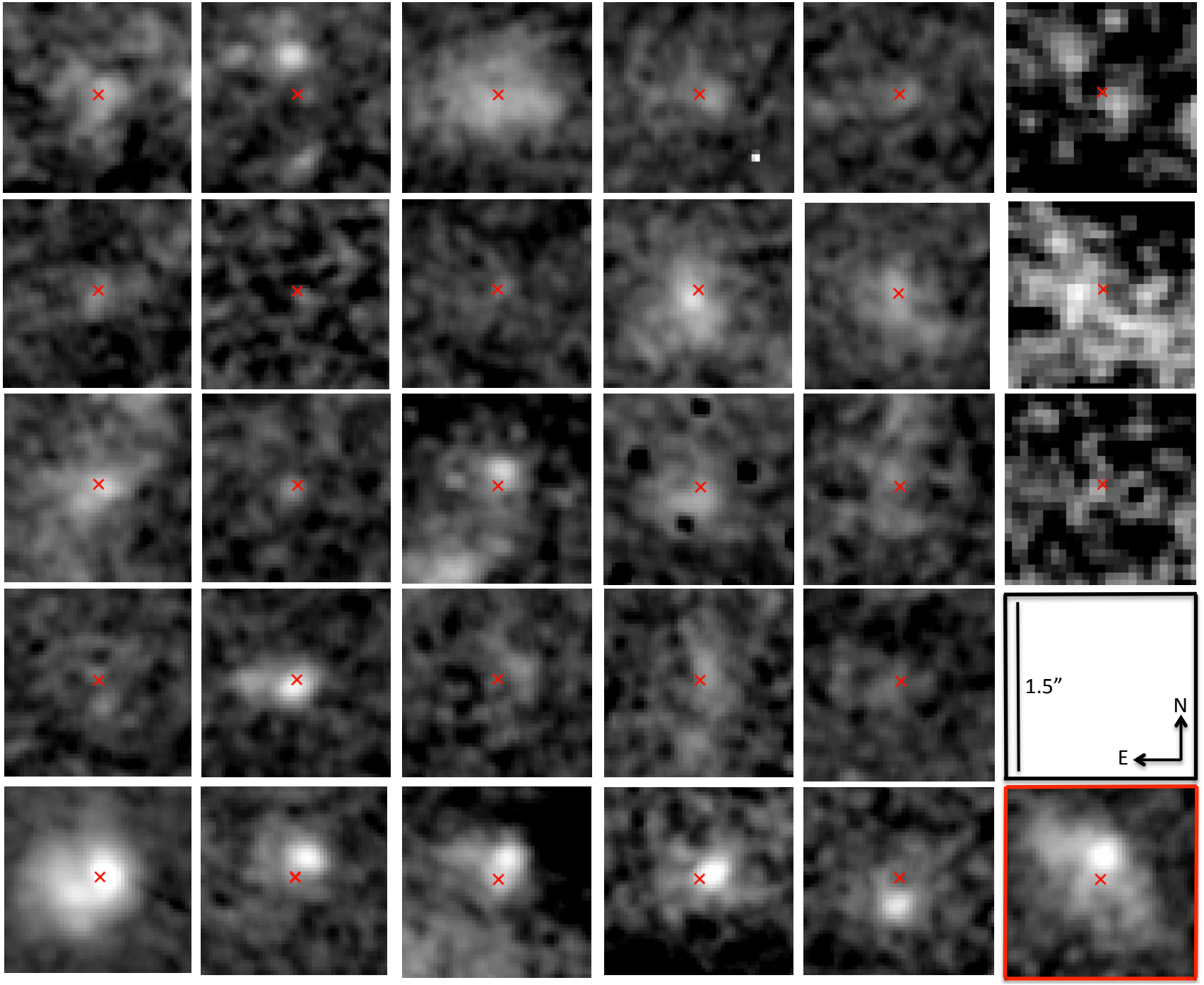
Contamination correction

Continuum subtraction

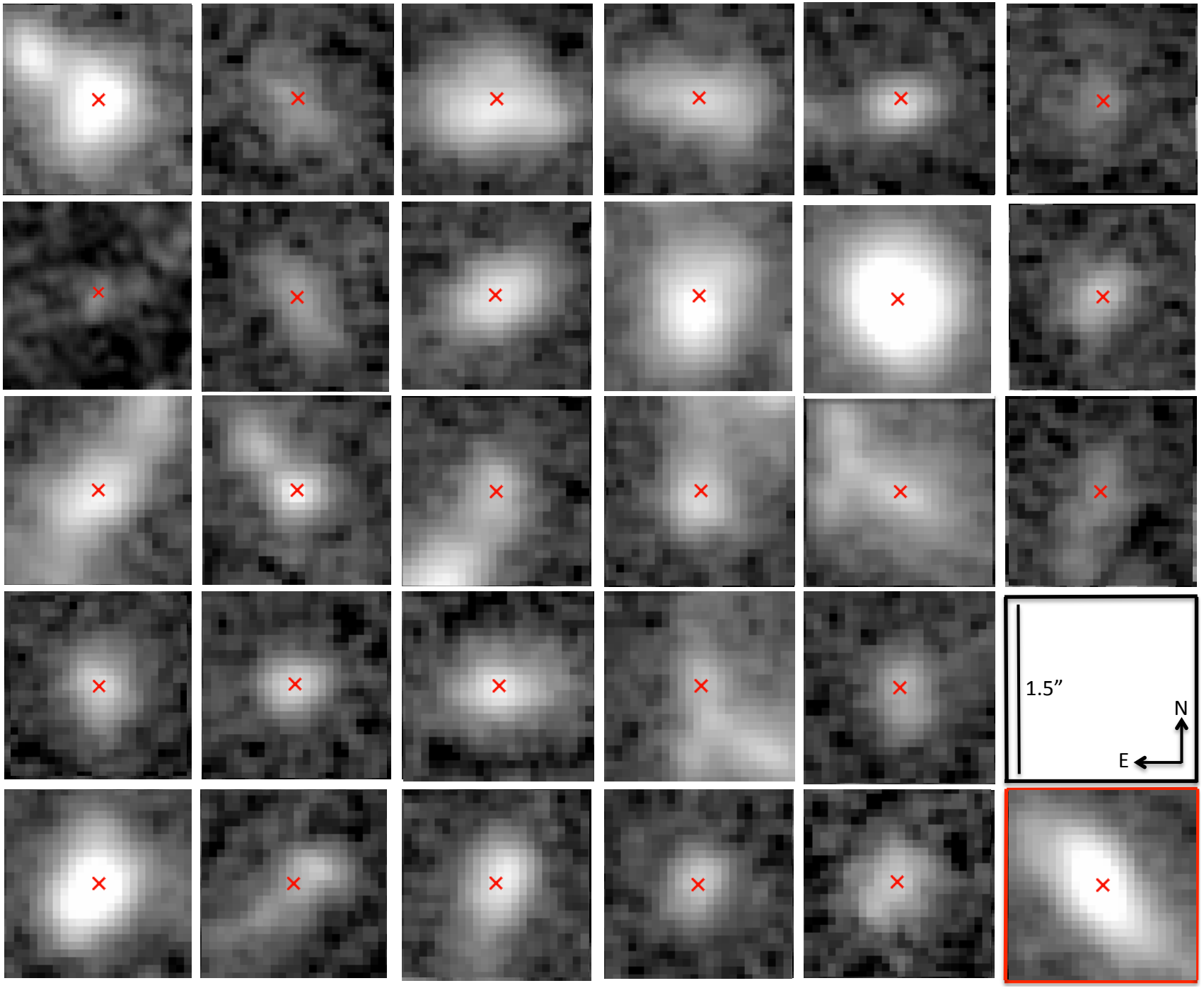


Cross correlation

[OIII] emission line maps

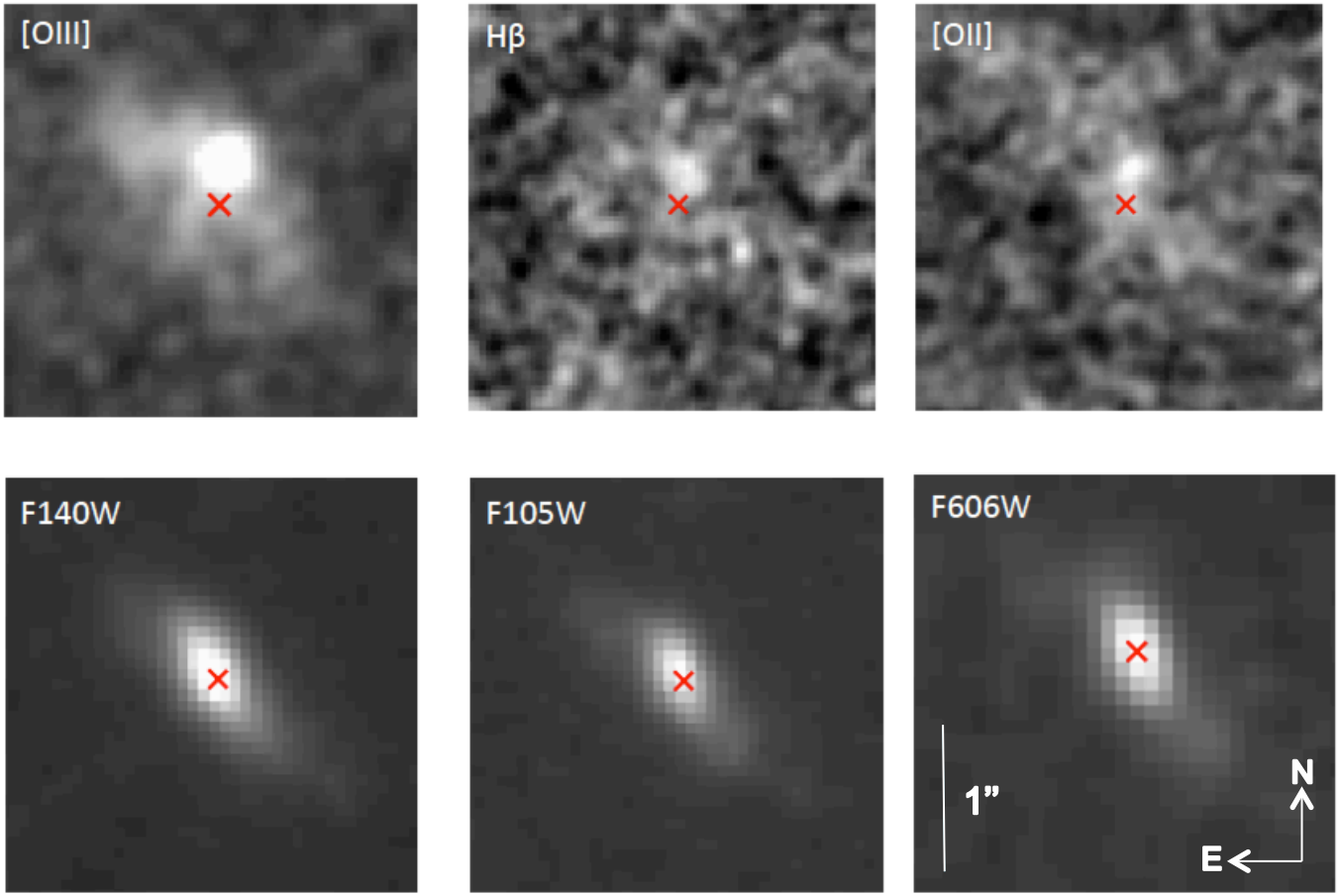


F140W
direct
images



Emission line maps

The case of ID568: **off-nuclear** [OIII], Hβ and [OII] emissions



GALFIT decomposition: diffused **disk** + off-nuclear **clump**

Offset **significance ~ 8σ**

AGN hypothesis

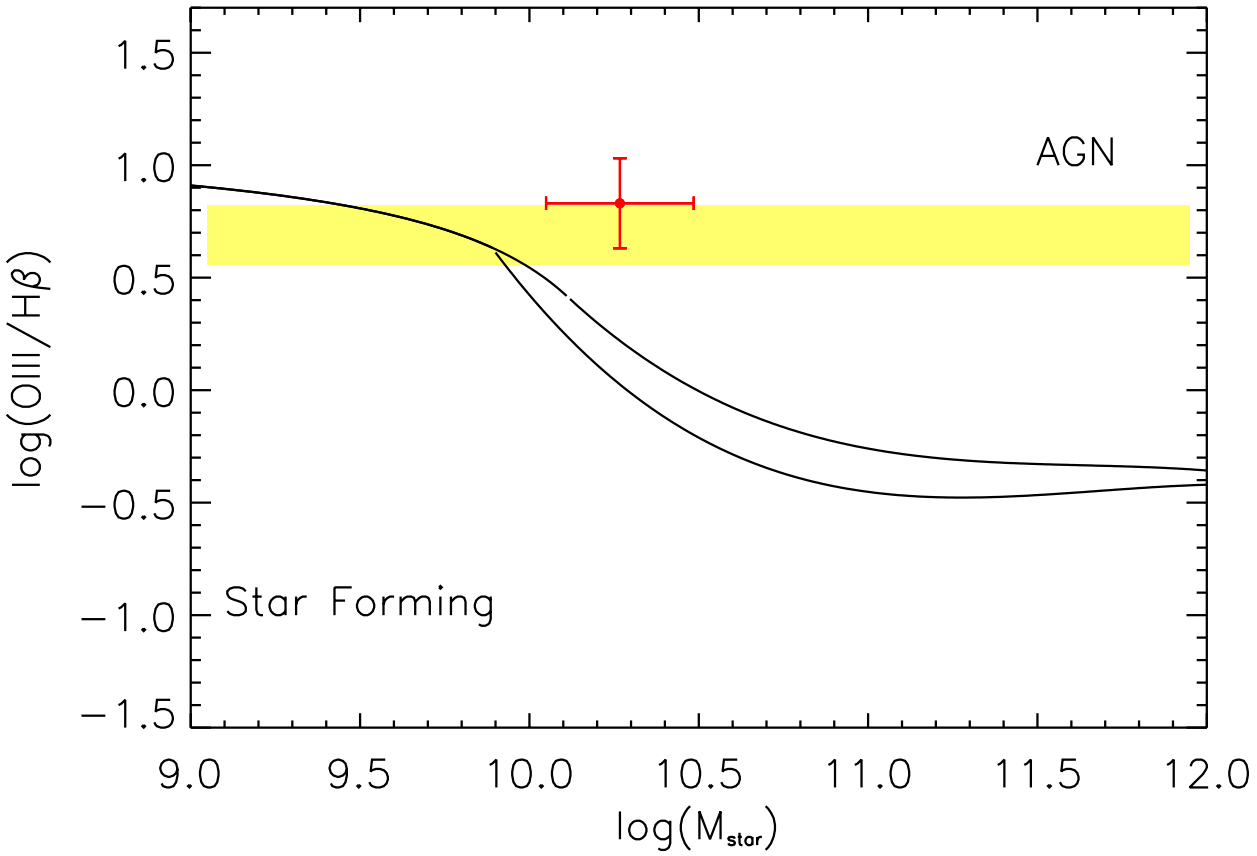
MEX DIAGRAM (Juneau+ 14):
in the AGN region

AGN off-nuclear?

Check also with new data

Subaru/MOIRCS
(spectroscopic follow up)

Chandra
(150ks)



AGN hypothesis

X RAYS:
no XMM and Chandra detection

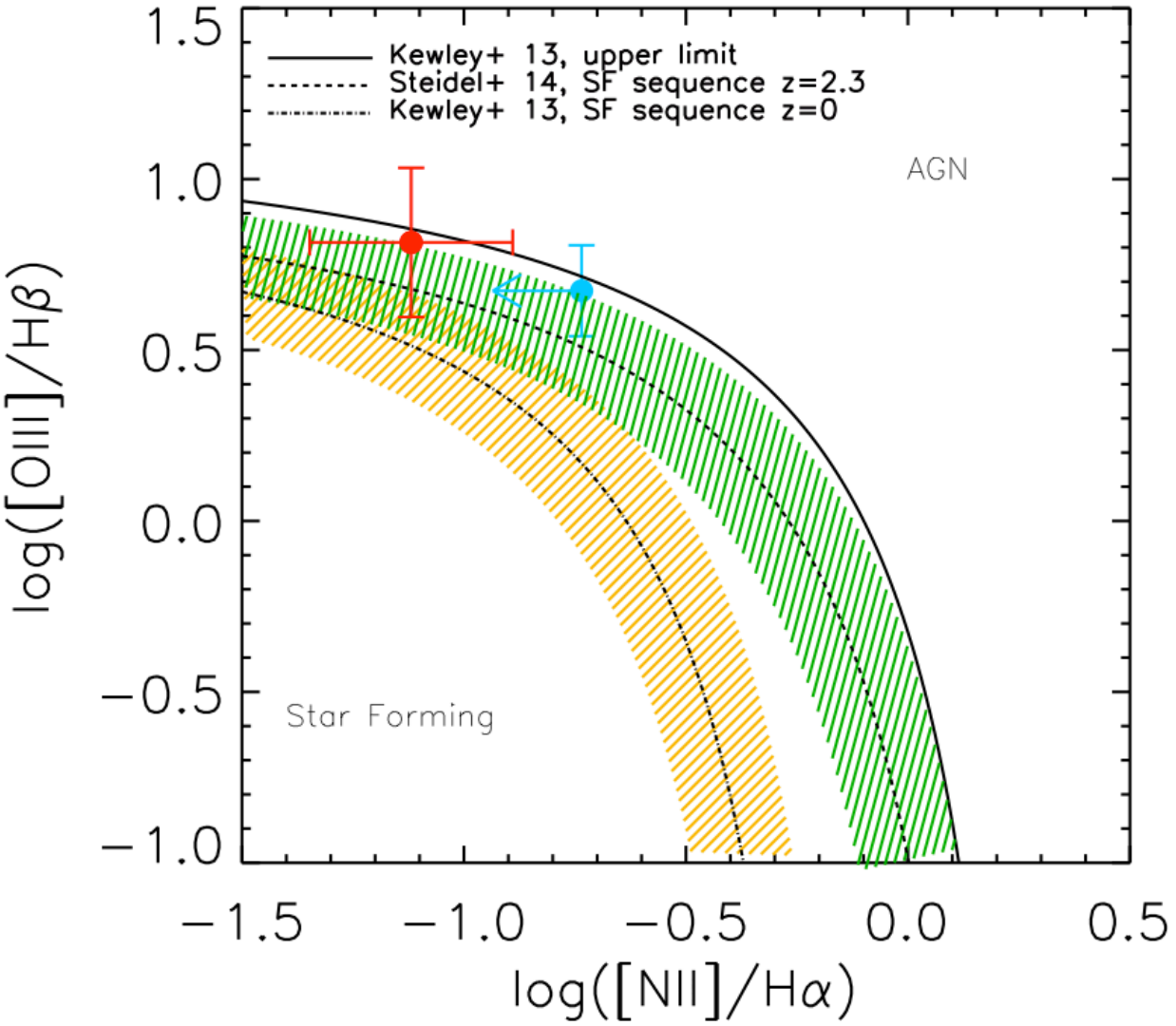
BPT (Baldwin+ 81):
in the SF region
(Subaru/MOIRCS follow up)

TOY MODEL:

$$\left(\frac{[\mathrm{OIII}]}{[\mathrm{NII}]}\right)_{\mathrm{AGN}} \cdot [\mathrm{OIII}]_{\mathrm{clump}} =$$

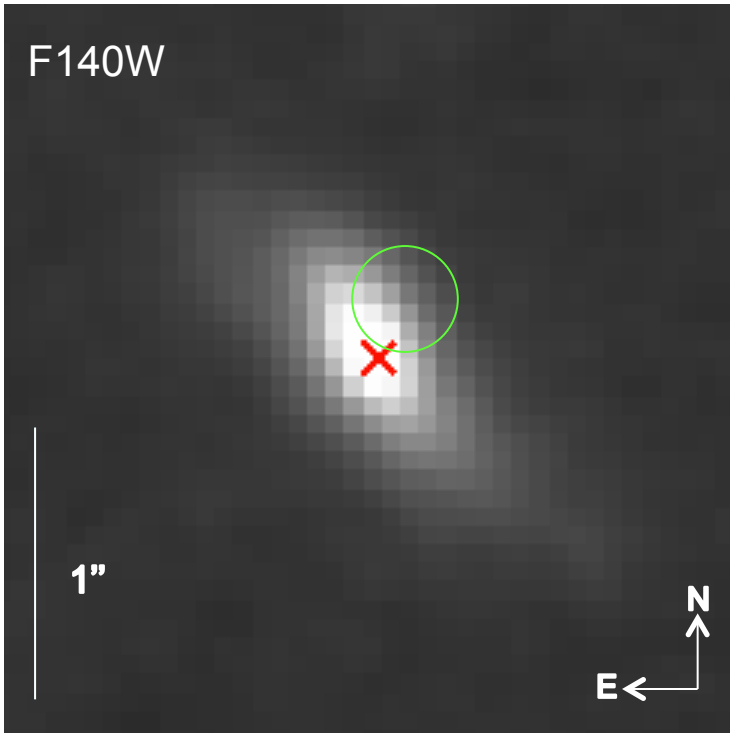
$$[\mathrm{NII}]_{\mathrm{clump}} > [\mathrm{NII}]_{\mathrm{galaxy}}$$

HIGH IONIZATION LINES
(e.g. NeV): no detection



Continuum emission

No detection of the clump in the continuum



Upper limits on the continuum flux:
simulations with GALFIT (Peng+ 08)

$$EW = \frac{F_{line}}{F_{continuum}}$$

Lower limit

$EW_{[OIII]} \geq 1700$ Å >> typical $EW_{[OIII]}$ of AGNs (~50-100Å template values)

SF clump hypothesis

Extremely young clump

$Z \sim 0.4\ Z_o$

Age < 10 Myr

$SFR \sim 25\ M_o/yr$

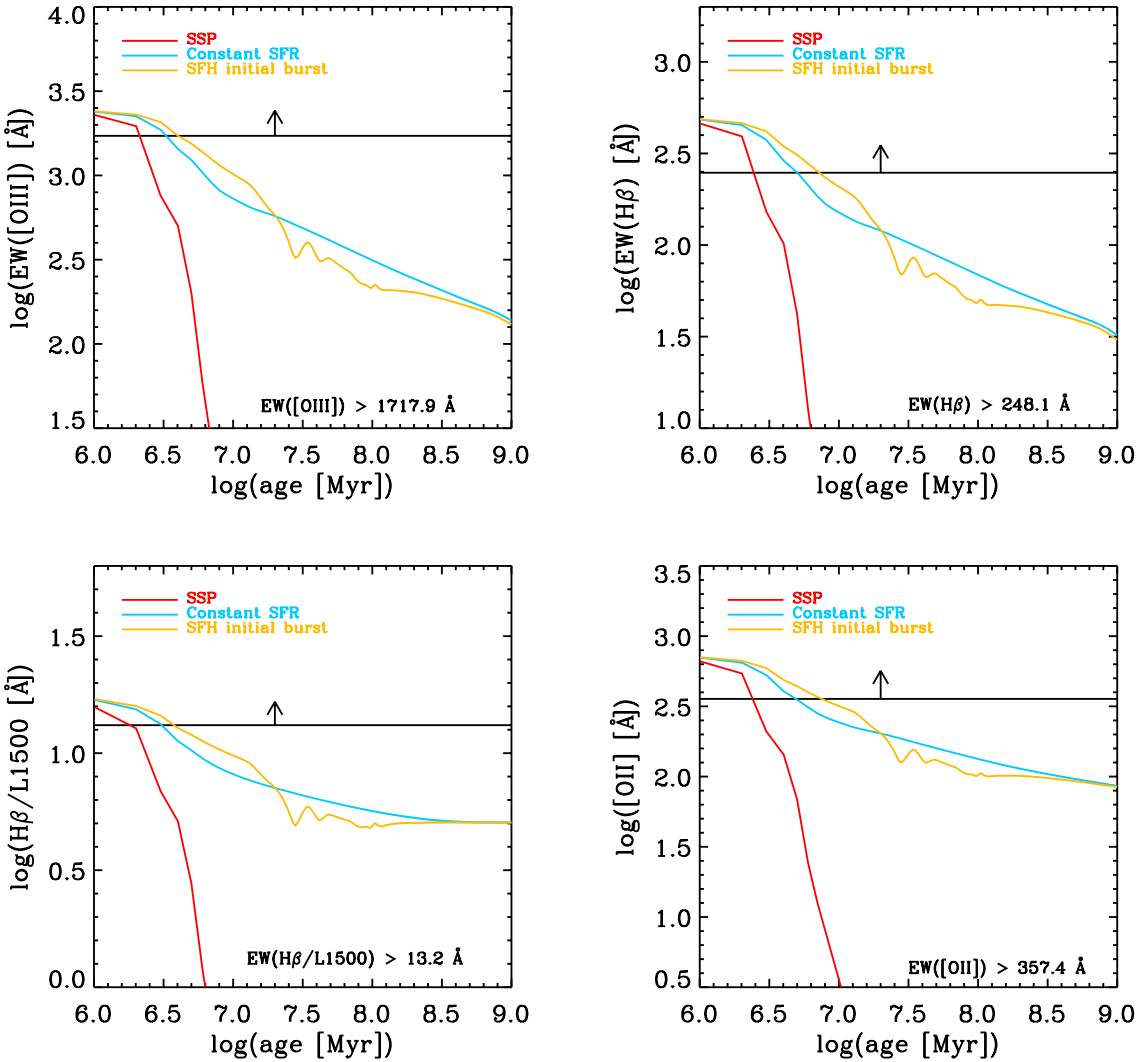
$M_\star \leq 10^8\ M_o$

$M_{gas} \sim 3 \cdot 10^9\ M_o$

$sSFR \geq 2.5 \cdot 10^{-8}\ yr^{-1}$

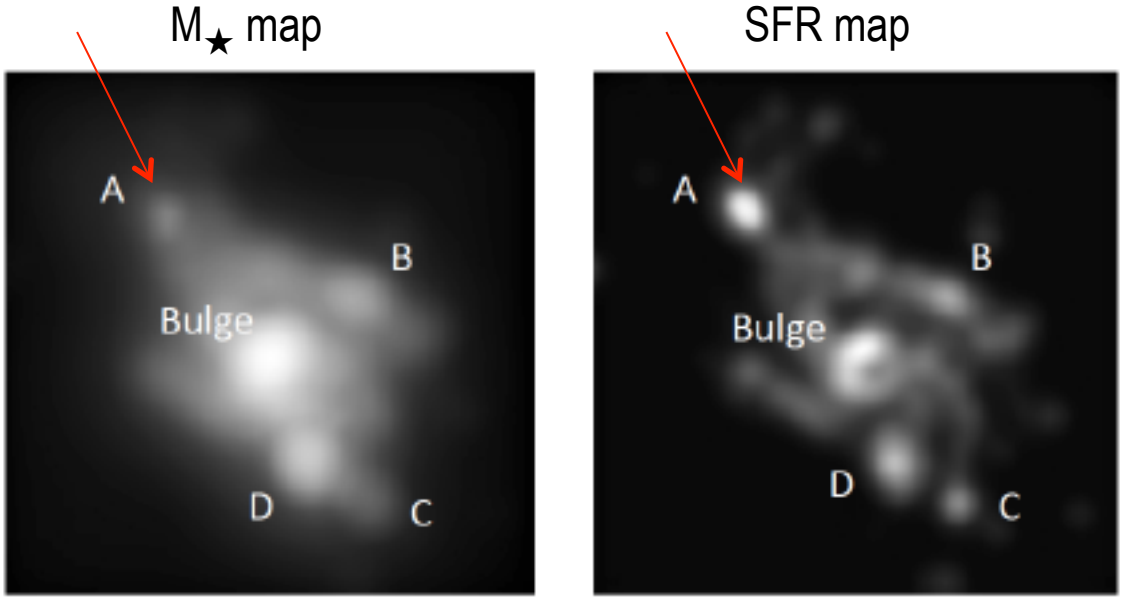
Re ≤ 0.5 kpc (unresolved)

Starburst99 models



Simulations

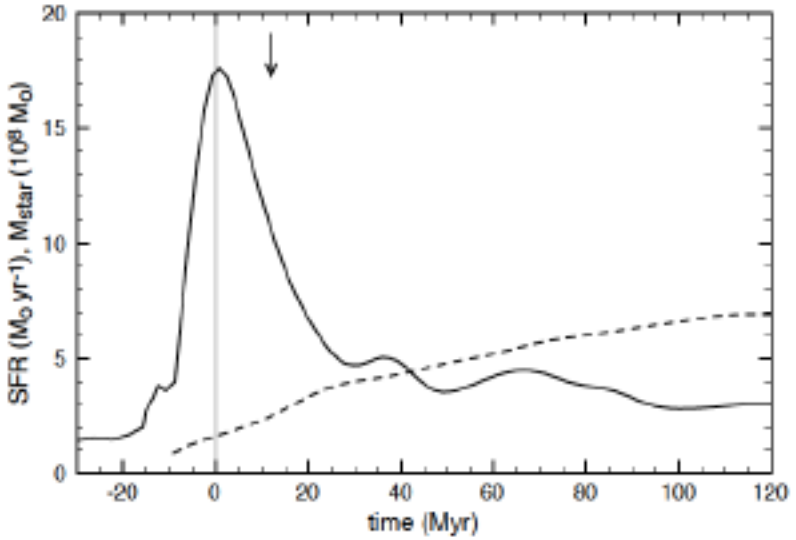
sSFR clump A = 10x sSFR other clumps



t = 0 birthtime clump A

t = 12 Myr observed time for the $M_\star$ and SFR map

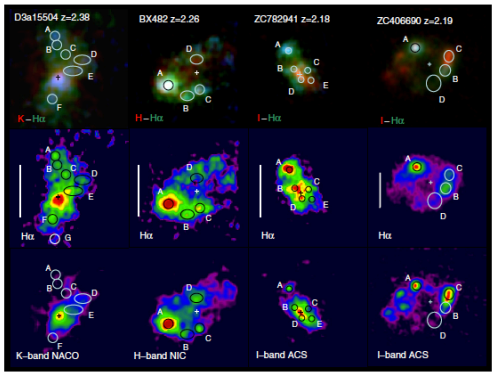
clumps B, C, D are older (100 – 300 Myr)



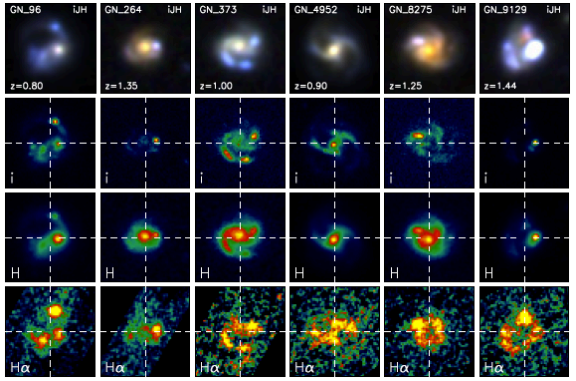
Credit: F. Bournaud

First insights on the collapse phase

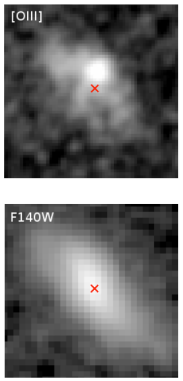
1. Direct evidence of clumps' **formation phase**



Genzel+ 11



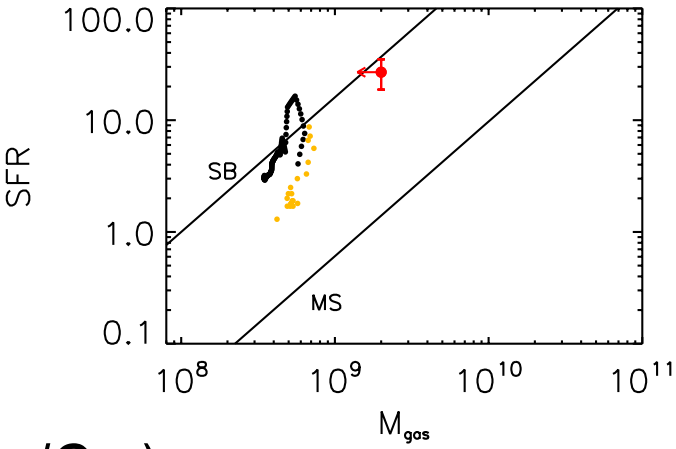
Wuyts+ 13



ID568

2. Newly born clumps behave like **mini-starbursts**

sSFR ~ 50x $sSFR_{gal,MS}$
SFE ~ 10x $SFE_{gal,MS}$



3. Constraints on **clumps formation rate** (~2 clumps/Gyr)
and **lifetimes** (~500Myr)
→ clumps do survive stellar feedback

Future developments

Kinematics constraints with Sinfoni IFS (DDT accepted proposal)

Detailed analysis of the rest of the sample

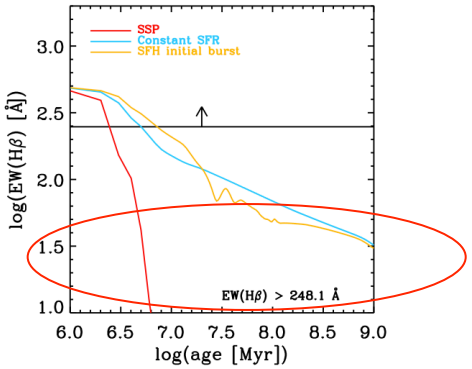
- **sSFR** changes between initial collapse and longer term evolution?
  → constraints on stellar feedback role
- clumps **formation rate**? → constraints on the clumps' lifetime
- **age** gradient? → constraints on clump migration

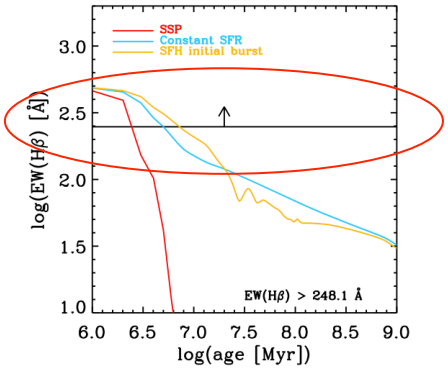
Increase of the statistics analyzing other fields

Looking for off-nuclear AGNs…..

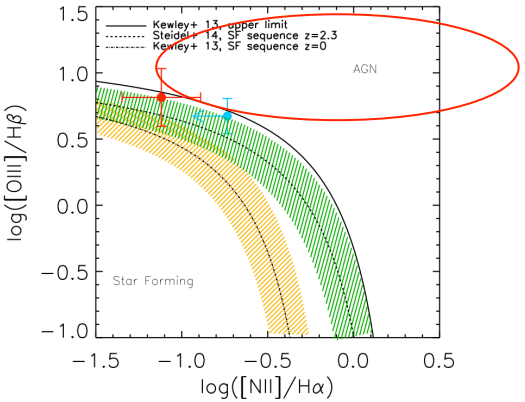
Off-nuclear AGN vs Star forming clump

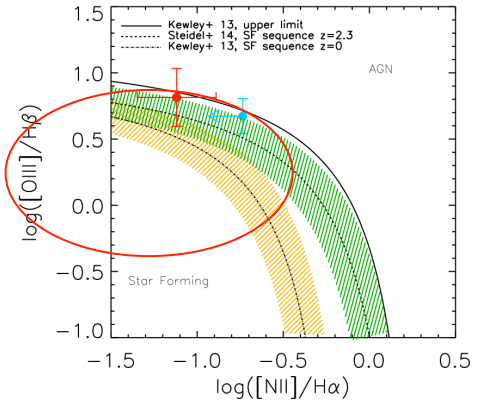
- X-rays detection
- No X-rays detection





- $EW_{[OIII]}$< 500 Å
- $EW_{[OIII]}$>> 500 Å (if young)

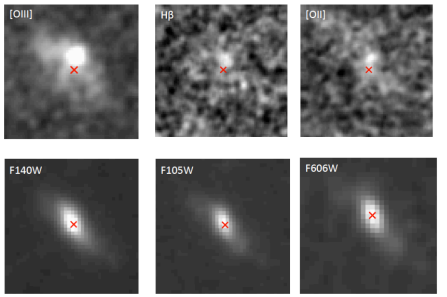




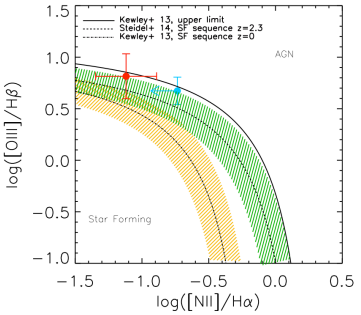
- BPT AGN
- BPT SF
- IFS: unresolved broad emission lines ($FWHM_{H\alpha}$> 1000 km s^{-1})
- IFS: unresolved narrow emission lines ($FWHM_{H\alpha}$< 500 km s^{-1})
- Continuum detection
- No continuum detection (if young)

Summary

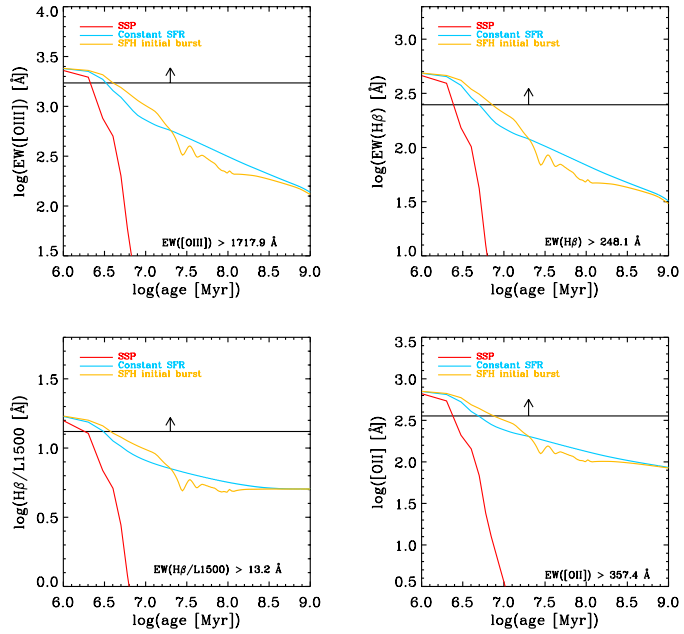
Do AGCs exist?



- We considered a sample of 68 [OIII] emitters at $1 \leq z \leq 2$
- We created spatially resolved emission line maps
- The case of ID568: bright off-nuclear [OIII] without a continuum counterpart
- It seems not to be a off-nuclear AGN



- It likely is an extremely young star forming clump



- It is the first direct observation of the clumps' formation phase
- Young clumps behave like mini-starbursts
- Clumps do survive stellar feedback