

Chemical properties of Blue Compact Dwarf galaxies: Local Analogues of High Redshift Galaxies

Nimisha Kumari

Schlumberger Fellow

University of Cambridge, UK

[Kumari+2017, 2018, 2019a](#)

Bethan James, Mike Irwin,
Alessandra Aloisi, Ricardo
Amorín, Enrique Pérez-Montero



Why BCDs?

Nearby Universe
High Star Formation Rate
Low Metallicity



Local Analogs of
high redshift
galaxies

Various Studies for Various properties

- 1. chemical enrichment** (e.g. Lanfranchi & Matteucci 2003)
- 2. star-formation history** (e.g. McQuinn 2010)
- 3. dust properties** (e.g. Hunt 2005)
- 4. WR features** (e.g. James 2010)
- 5. stellar nucleosynthesis** (e.g. Izotov & Thuan 1999)
- 6. black holes** (e.g. Izotov 2007)
- 7. Pop III stars** (e.g. Thuan & Izotov 2005)

... and many more across EM spectrum!!

Gemini Observatory - Hawaii

GMOS-IFU

One-slit mode:

FOV: 3.5" x 5"

500 lenslets(object)

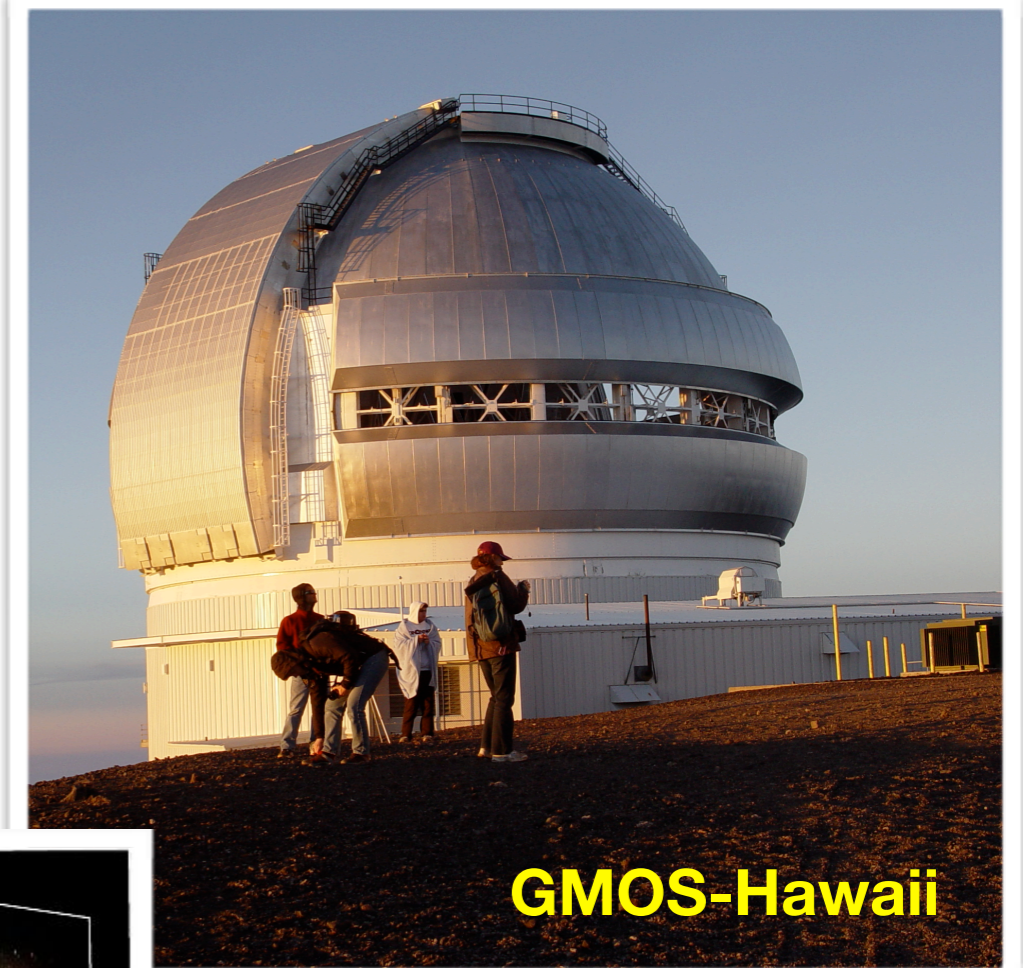
250 lenslets(sky)

0.4-1.1 μm

~1000 spectra !!

Two-slit mode

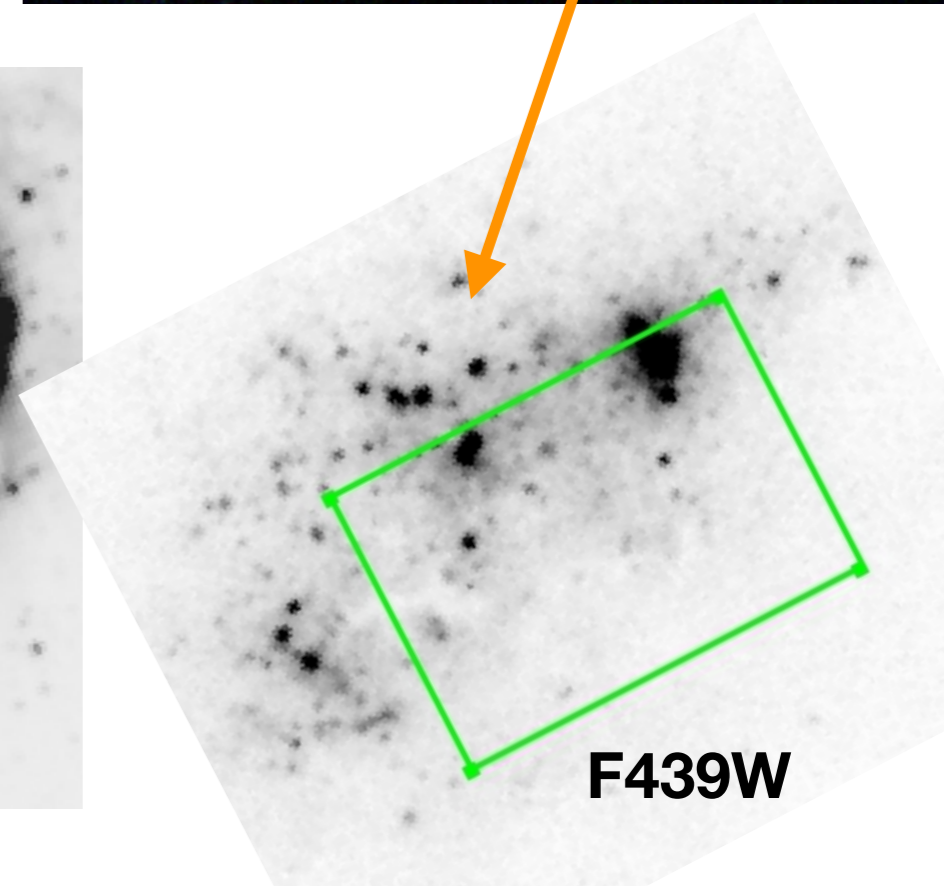
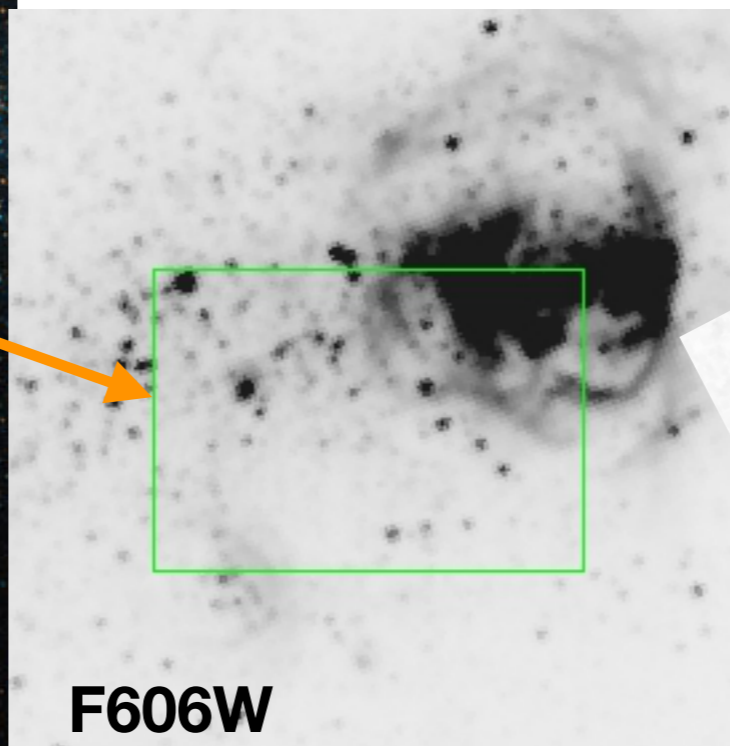
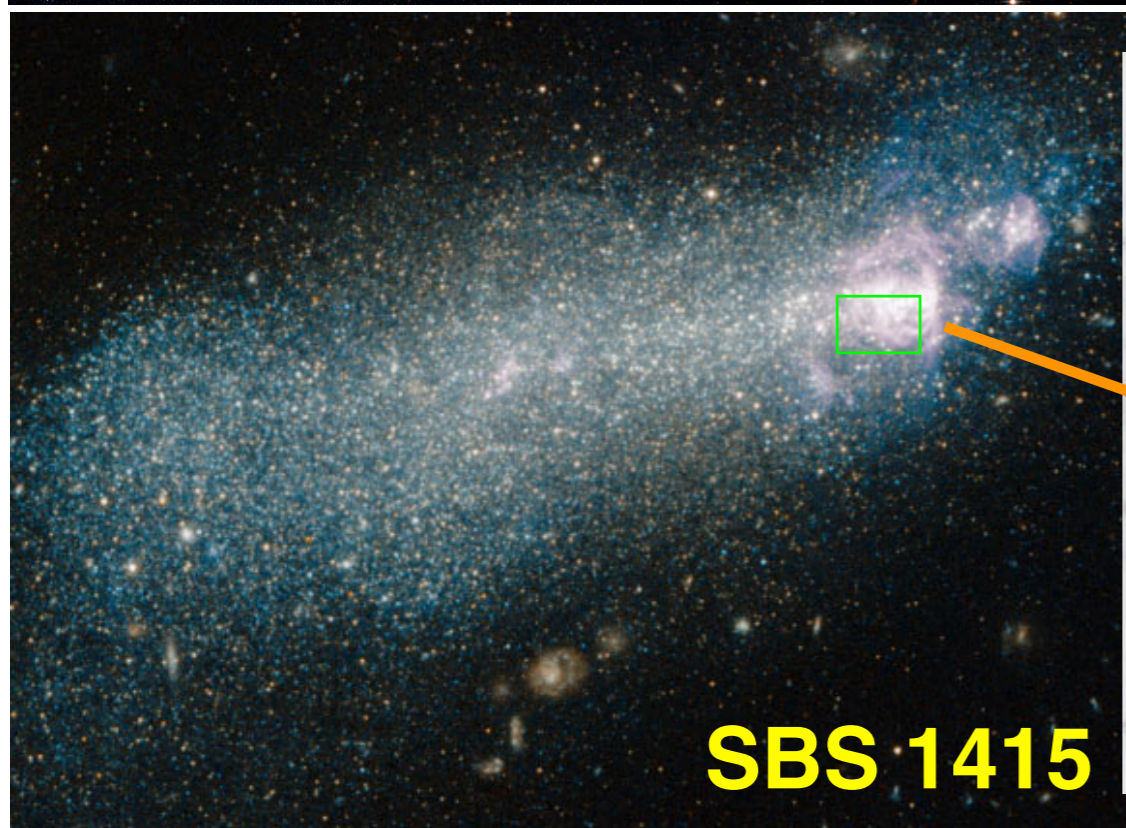
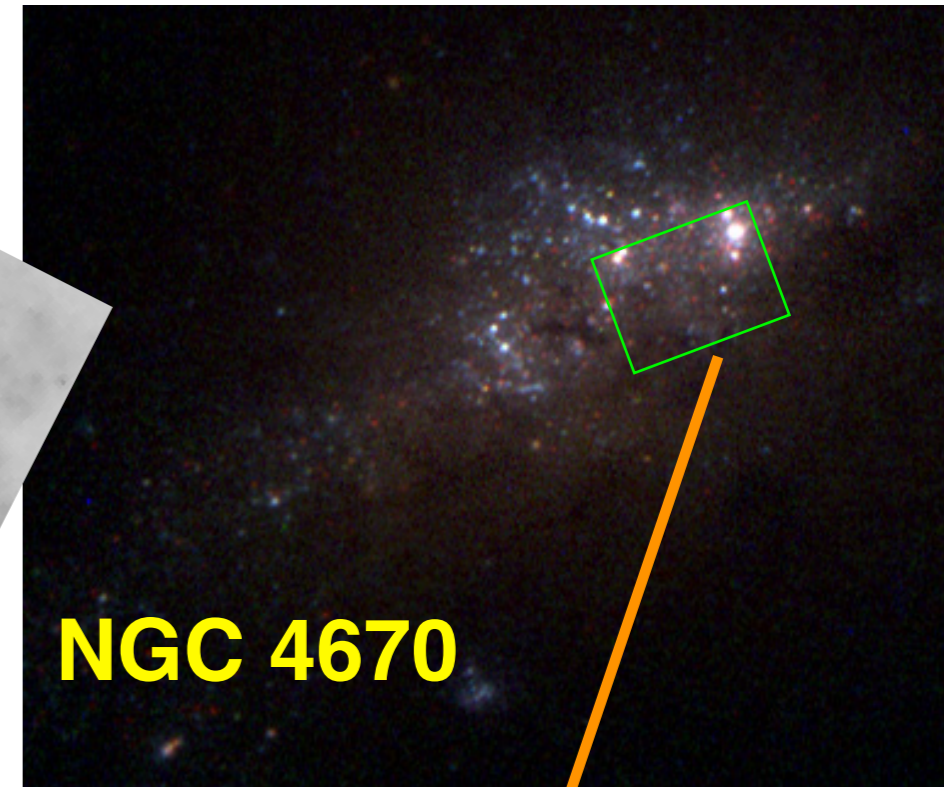
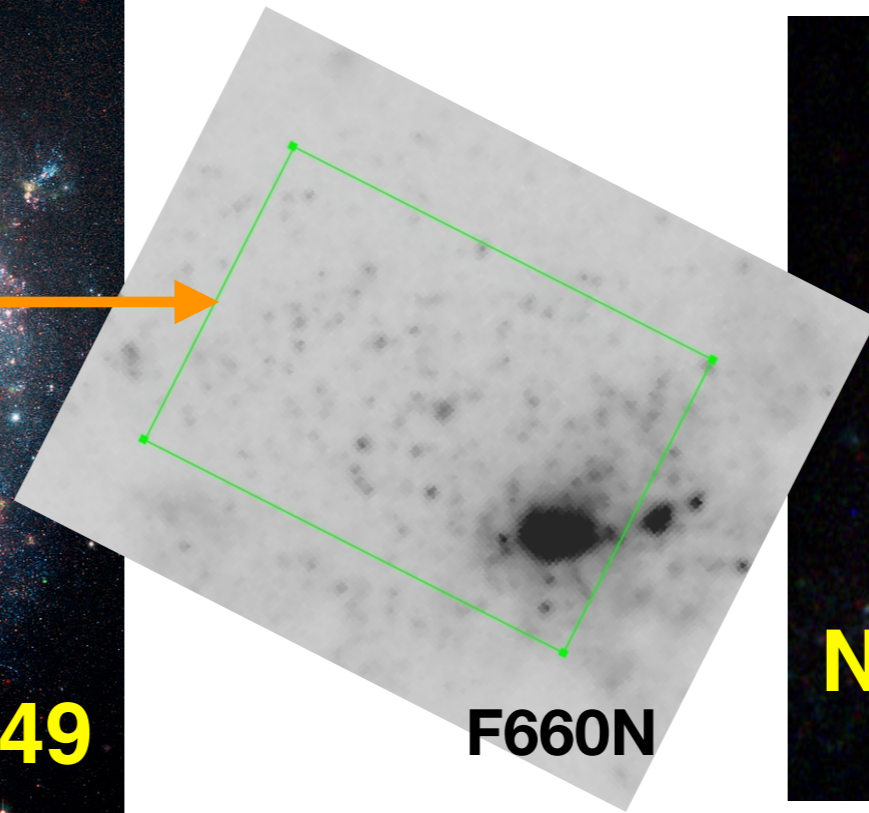
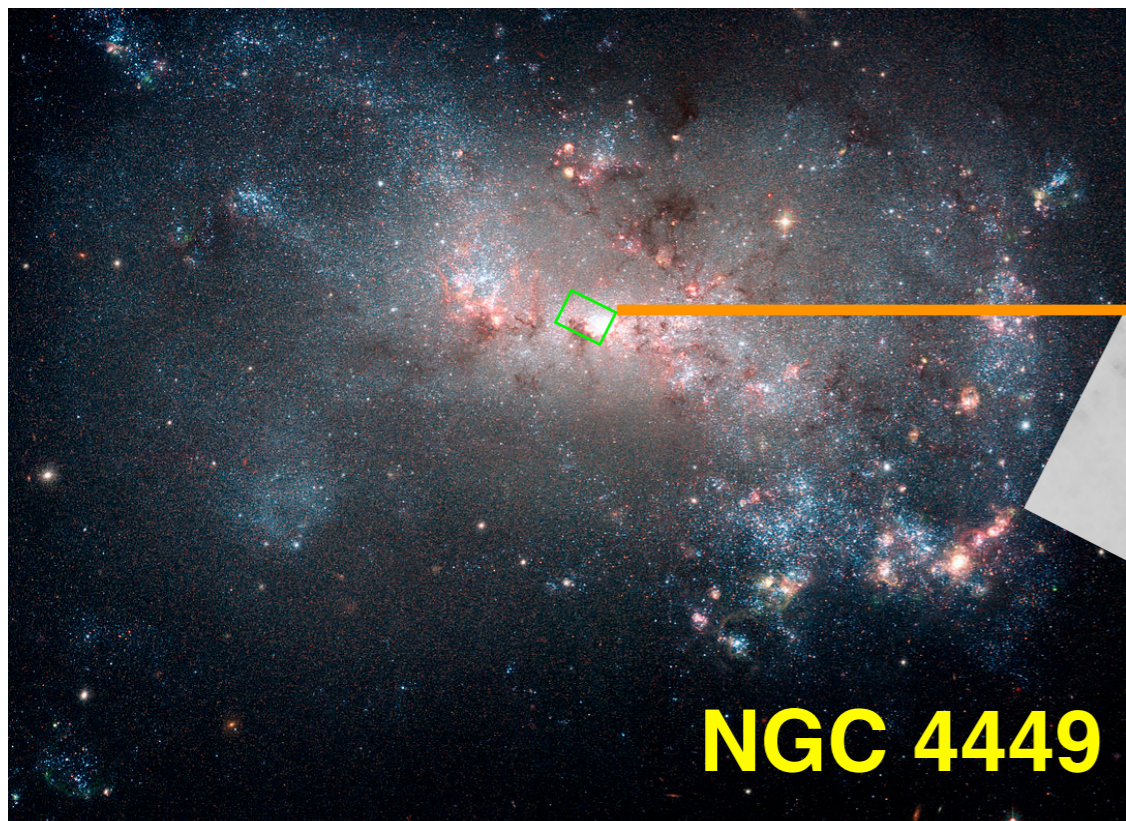
available too !!



GMOS-Hawaii



Primary Sample of BCDs

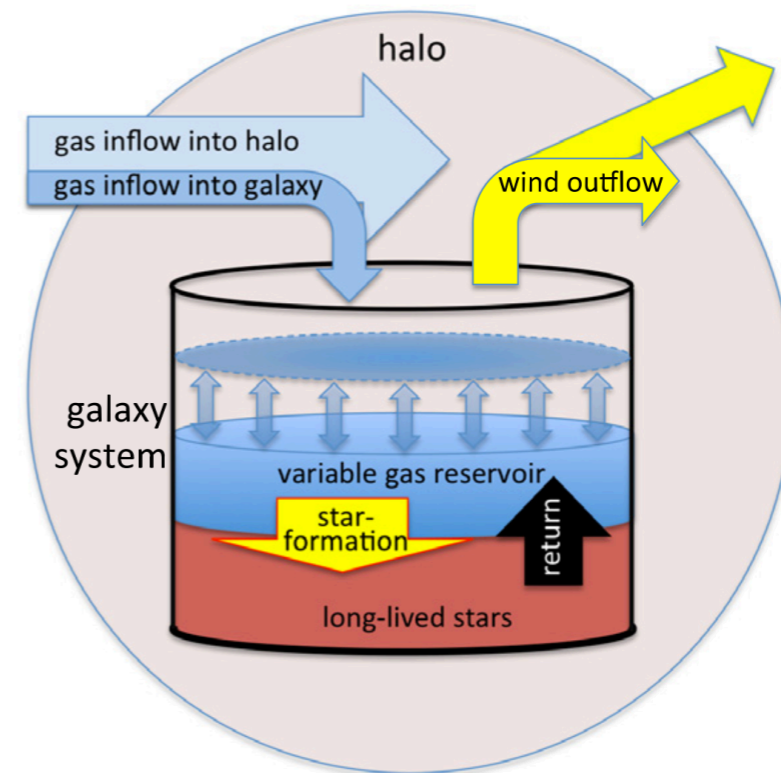


Research goals: Galaxy formation & Evolution

chemical abundance – star-formation – gas dynamics

Questions

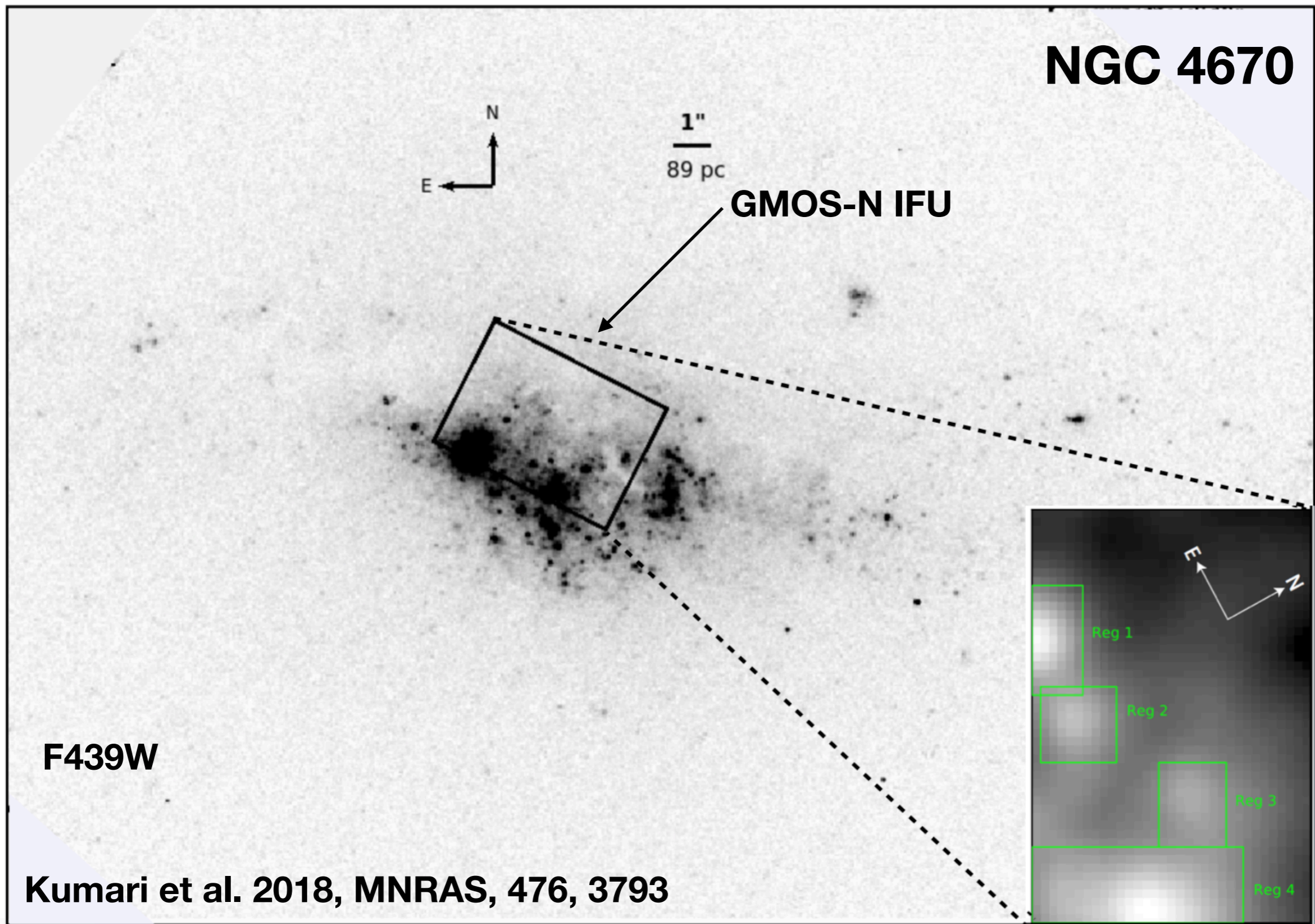
- Do **chemical inhomogeneities** exist at parsec scale in BCDs?
- What are the possible **ionisation mechanisms** at play in the gas surrounding the star-forming regions in BCDs?
- What are the **stellar properties** (e.g. age, star-formation rate) of the stellar population currently ionising the gas in BCDs?



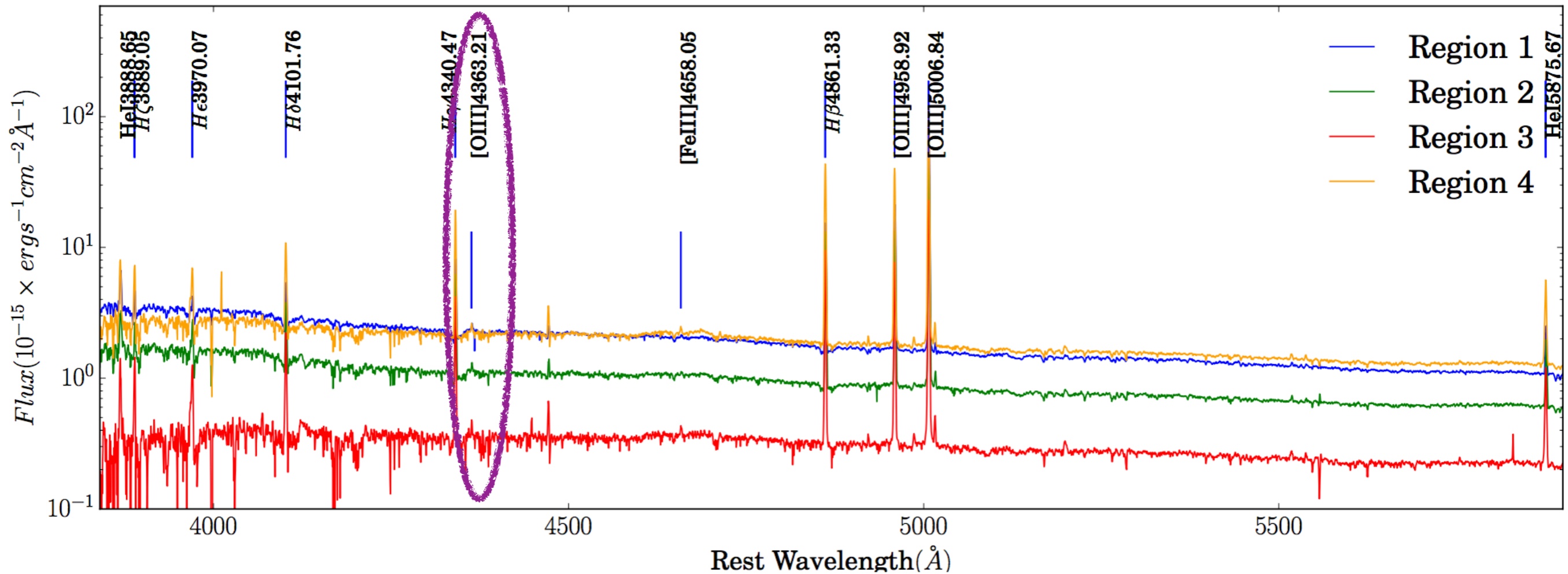
Bathtub Model
Lilly 2013

More profound questions
for each BCD

#1: O/H-N/O: the curious case of NGC 4670



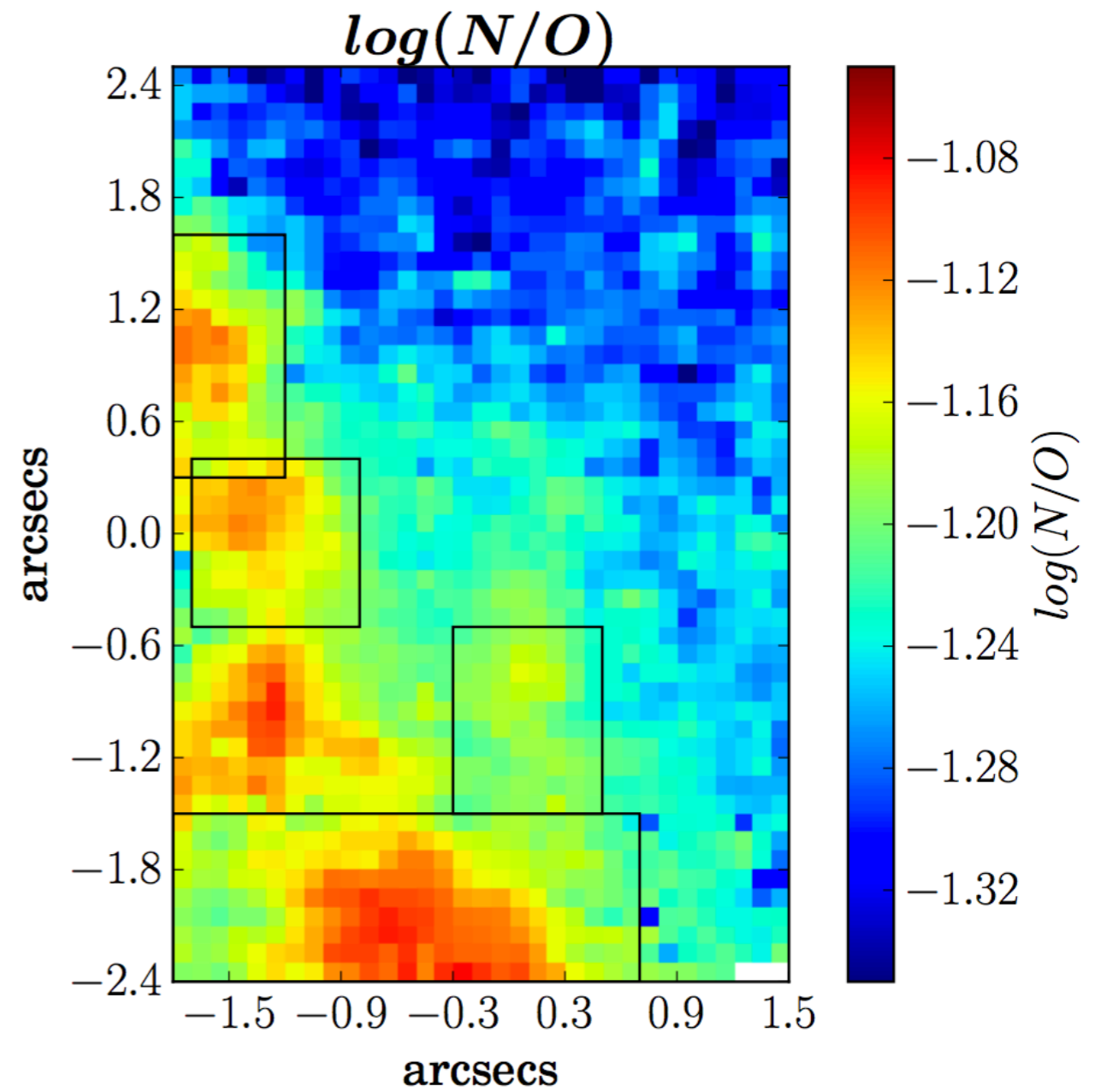
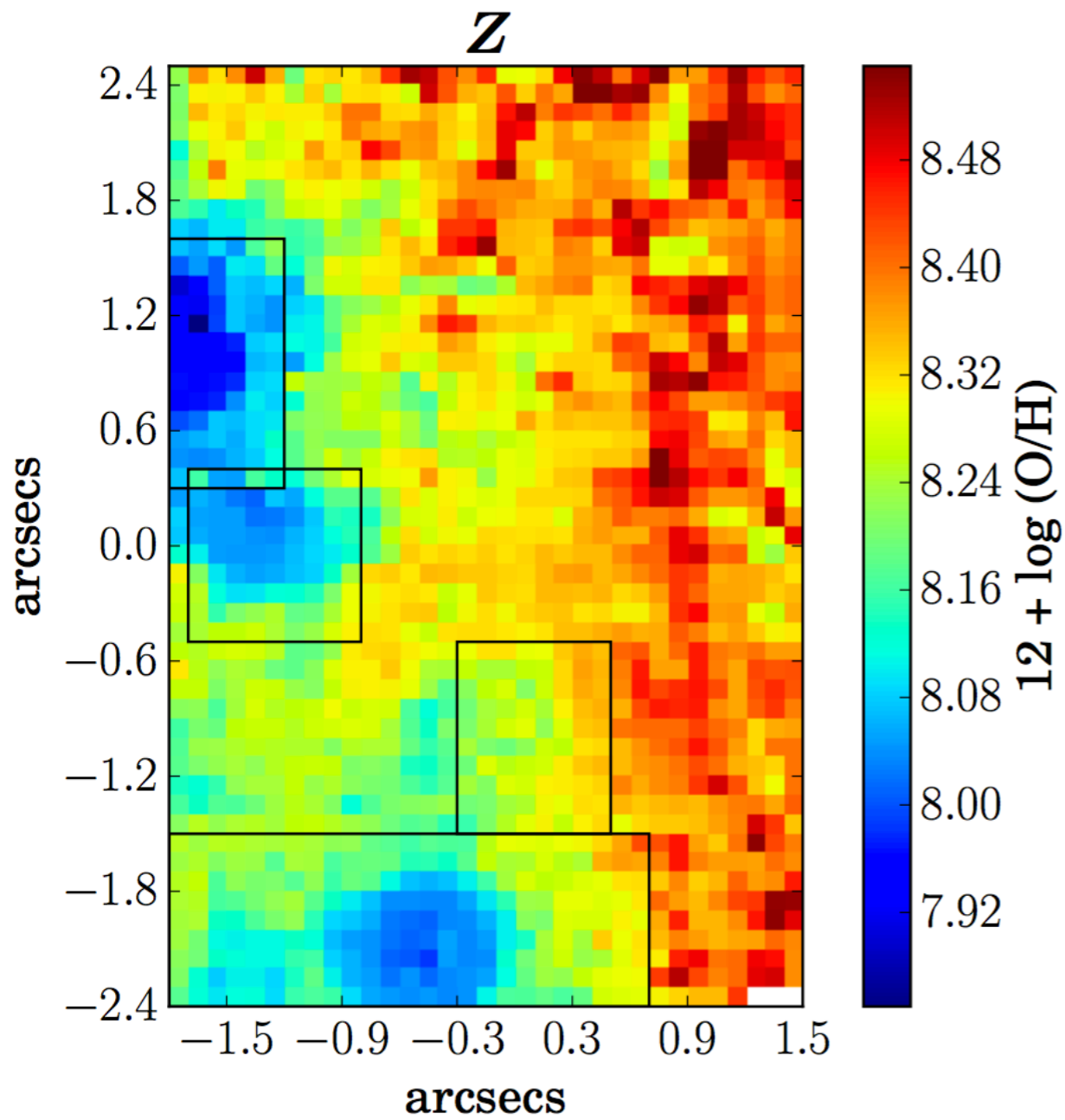
Abundance Estimates



[O III] 4363 -> abundances from robust direct Te-method

Not spatially-resolved !!

Abundance Estimates



**HII-Chi-mistry
(Perez-Montero 2009)**



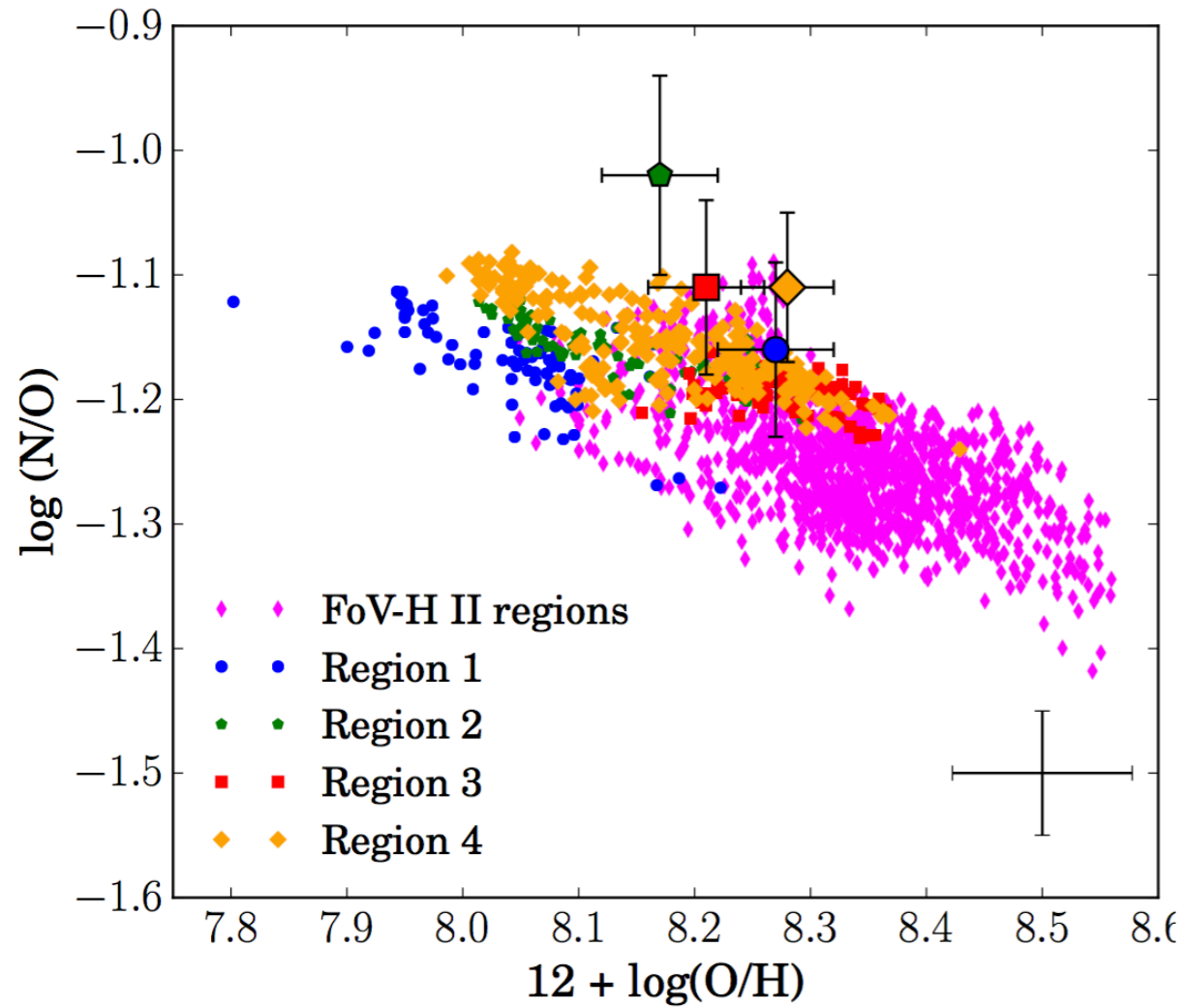
Maps

Direct Method



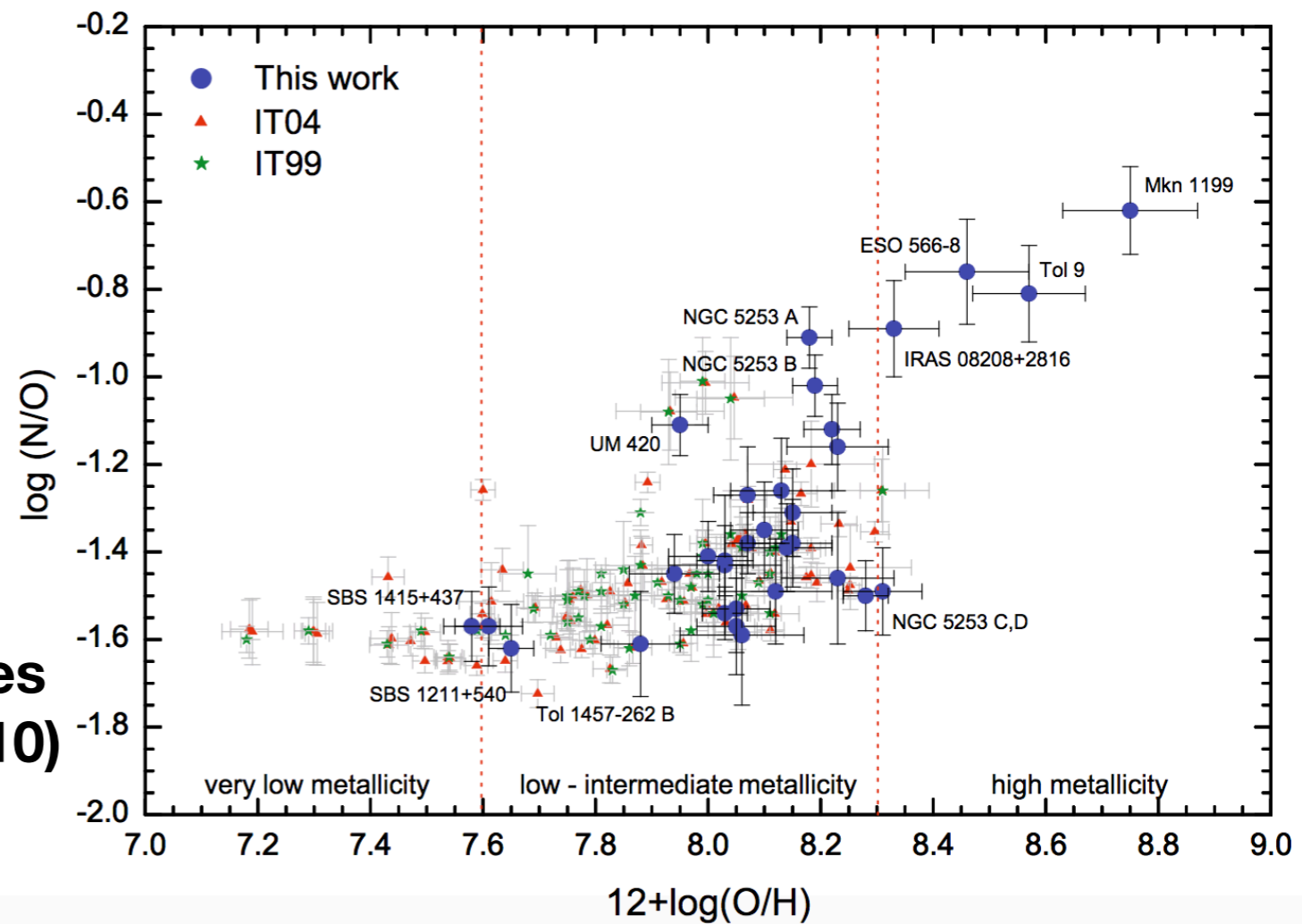
Integrated spectra

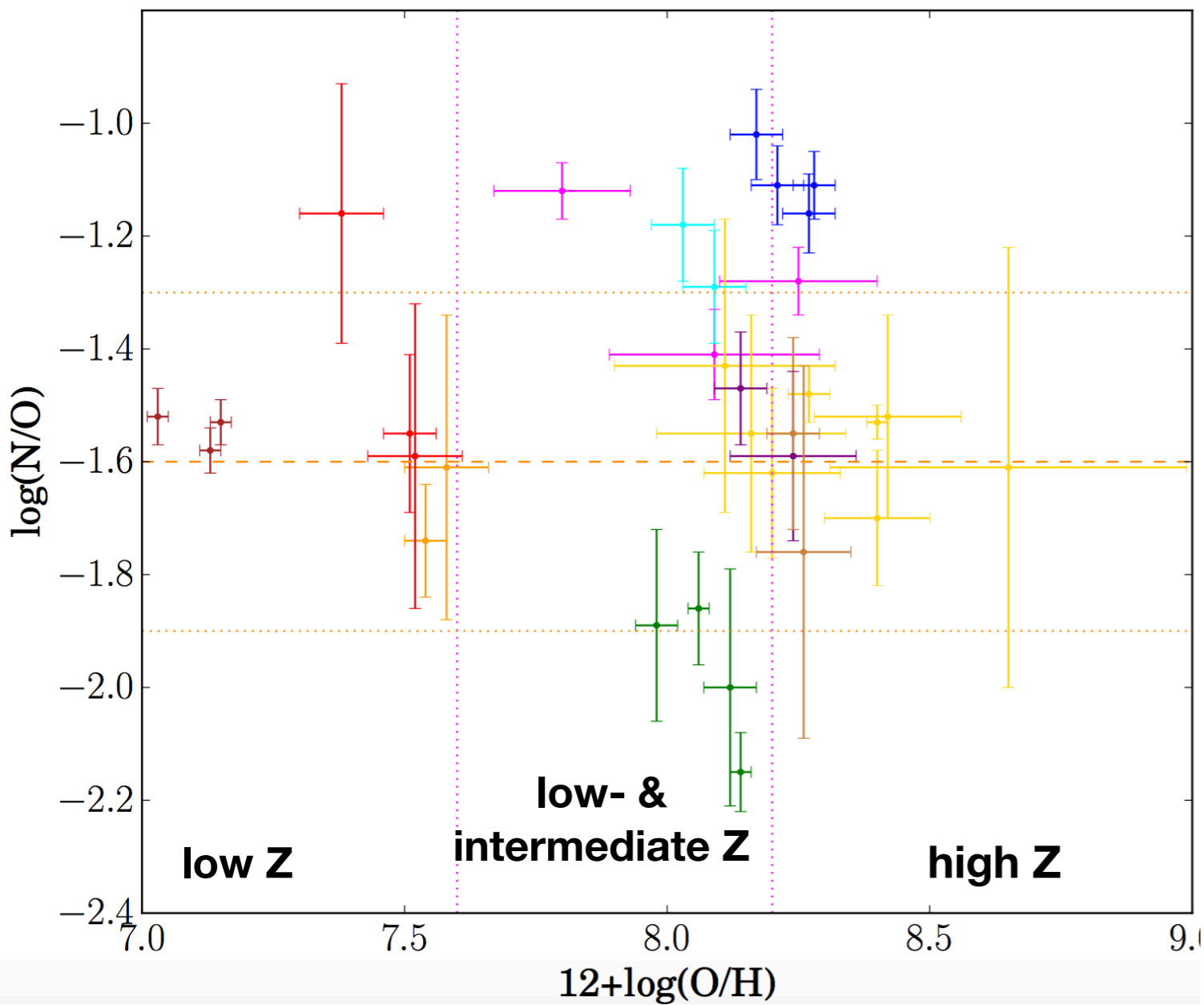
An unusual negative relation within NGC 4670



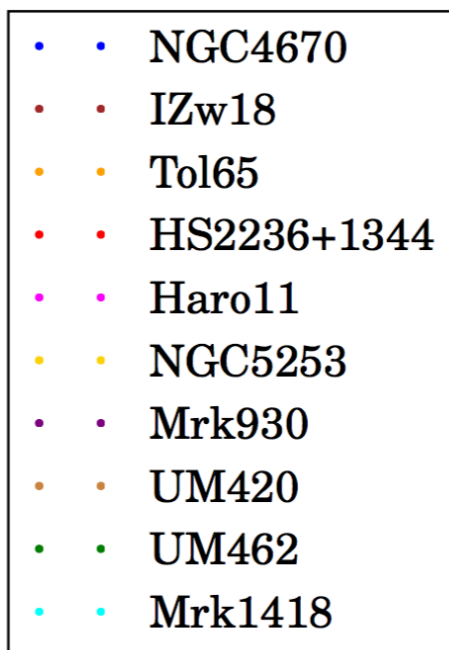
**20 starburst galaxies
(Lopez-Sanchez 2010)**

What is expected?

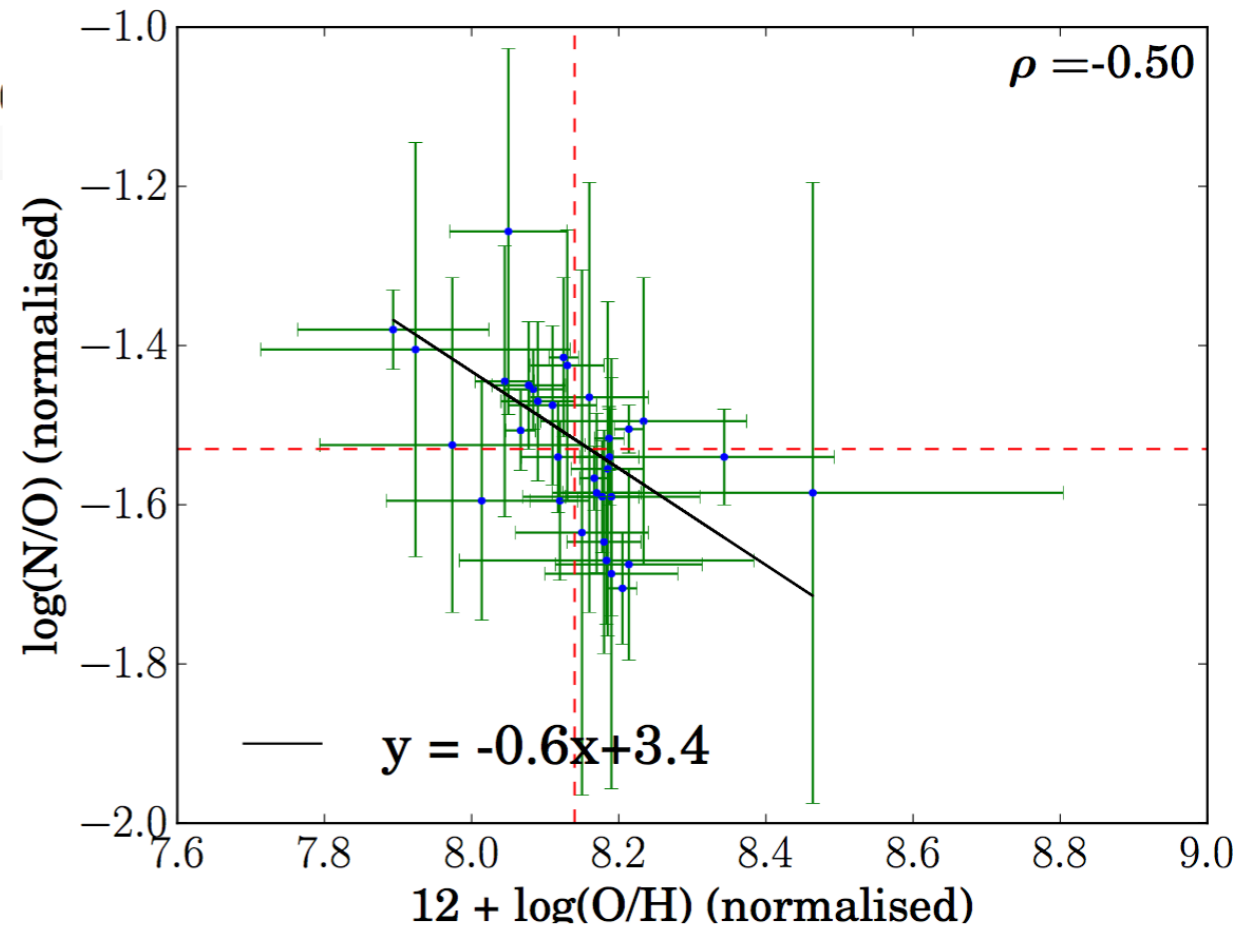




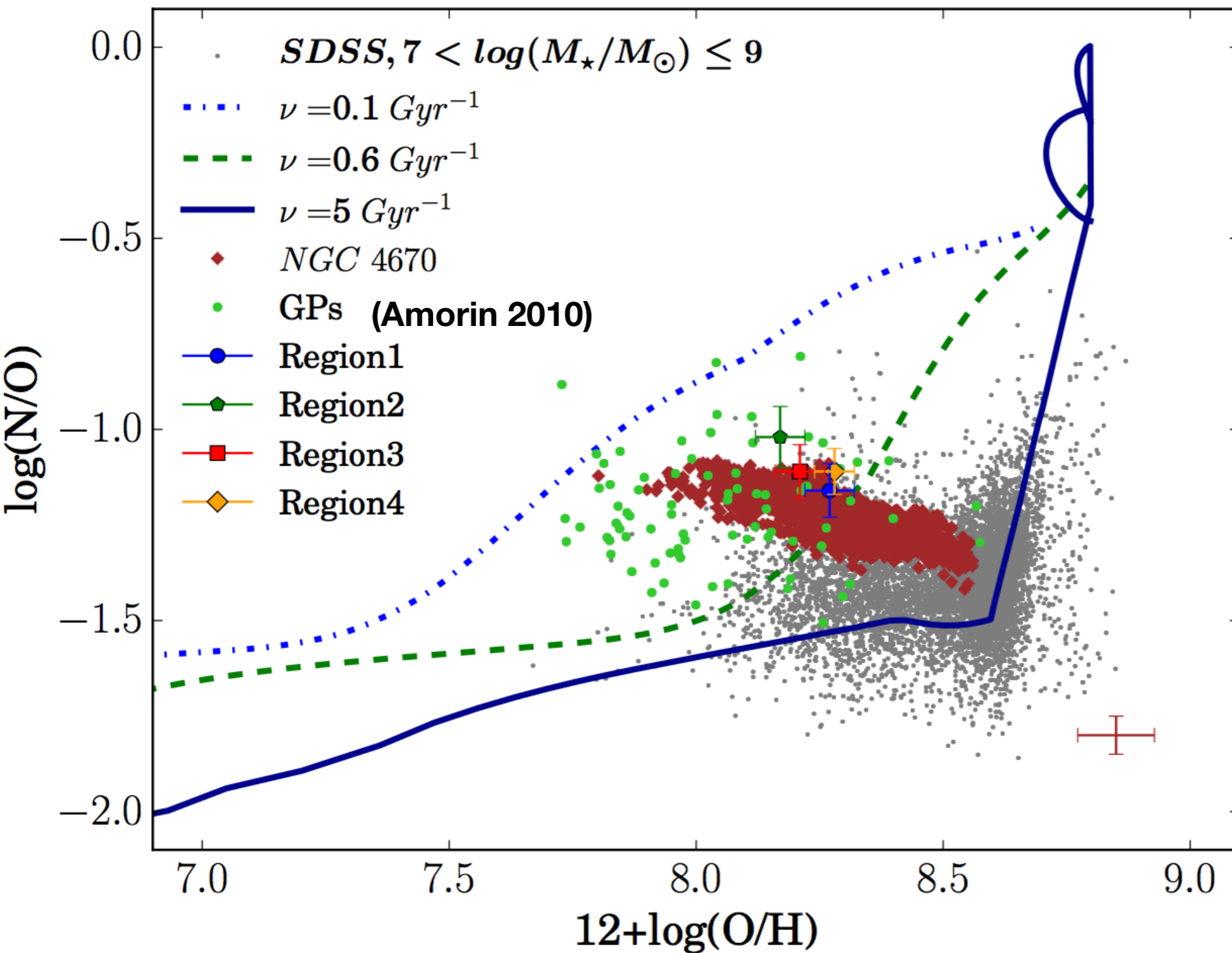
HII regions within 10 BCDs



Negative slope agrees with Kobulnicky+1996



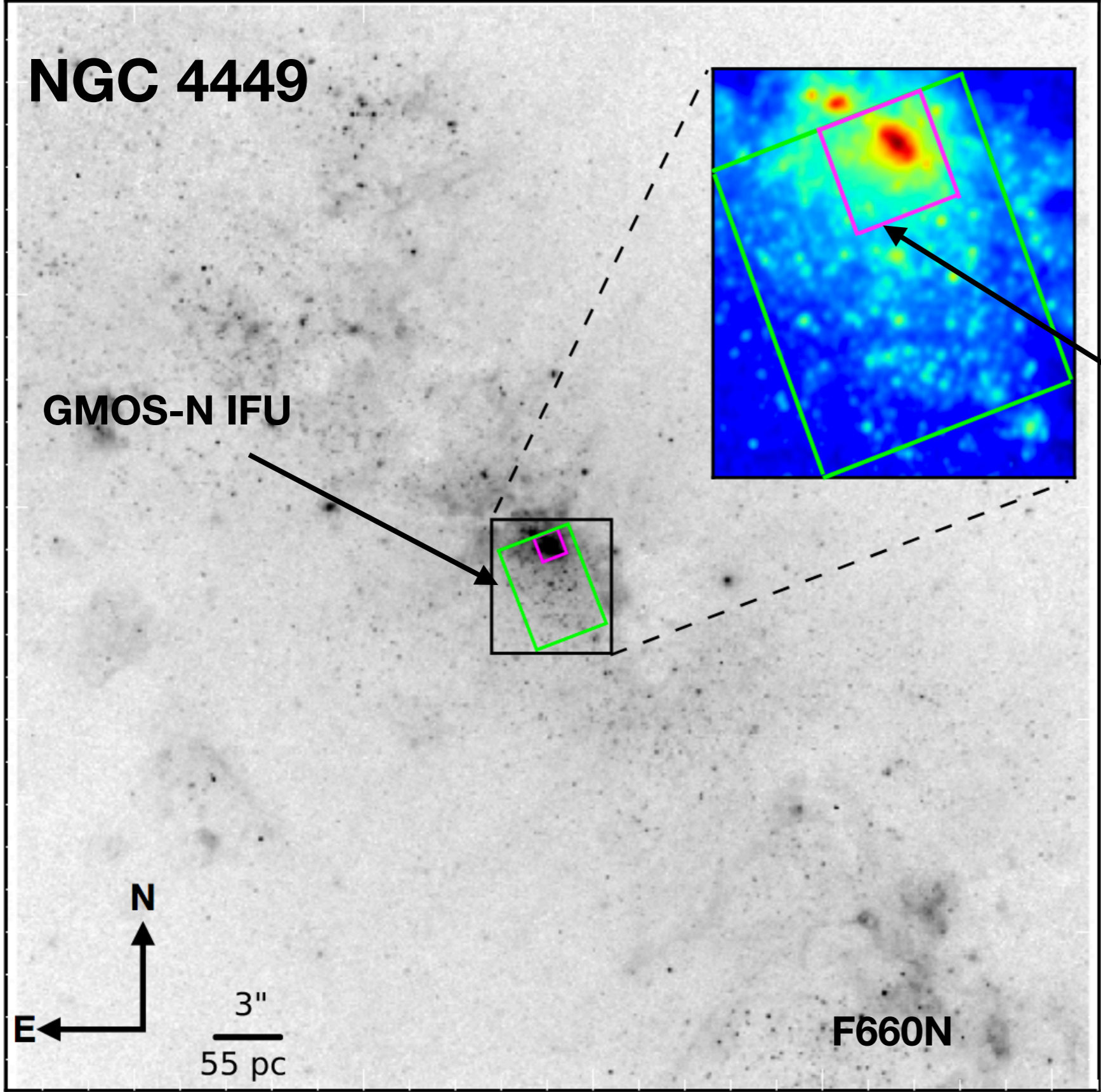
How to explain the negative trend?



**Alternative/
Complementary
hypotheses:**
Nitrogen enrichment/
pollution,
Star-formation
efficiency,
simultaneous inflow &
outflow,
Supernovae triggering
winds

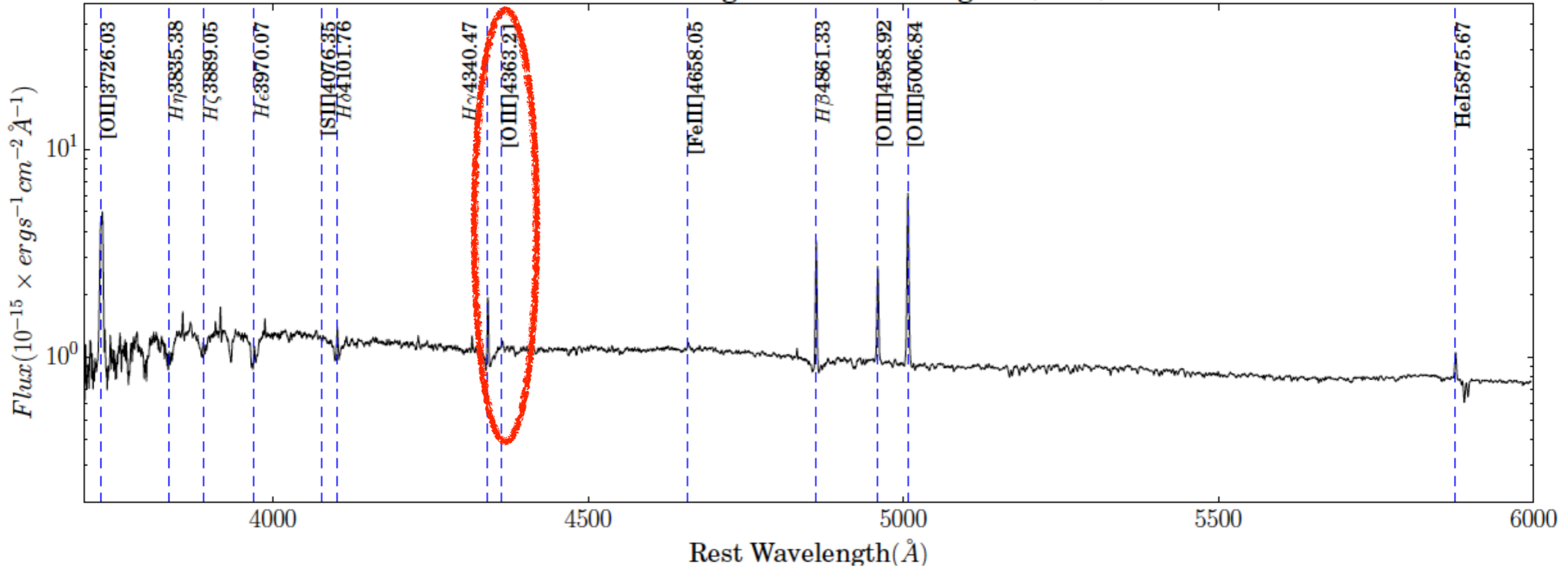
Kumari et al. 2018, MNRAS, 476, 3793

#2: NGC 4449: inverse metallicity gradient

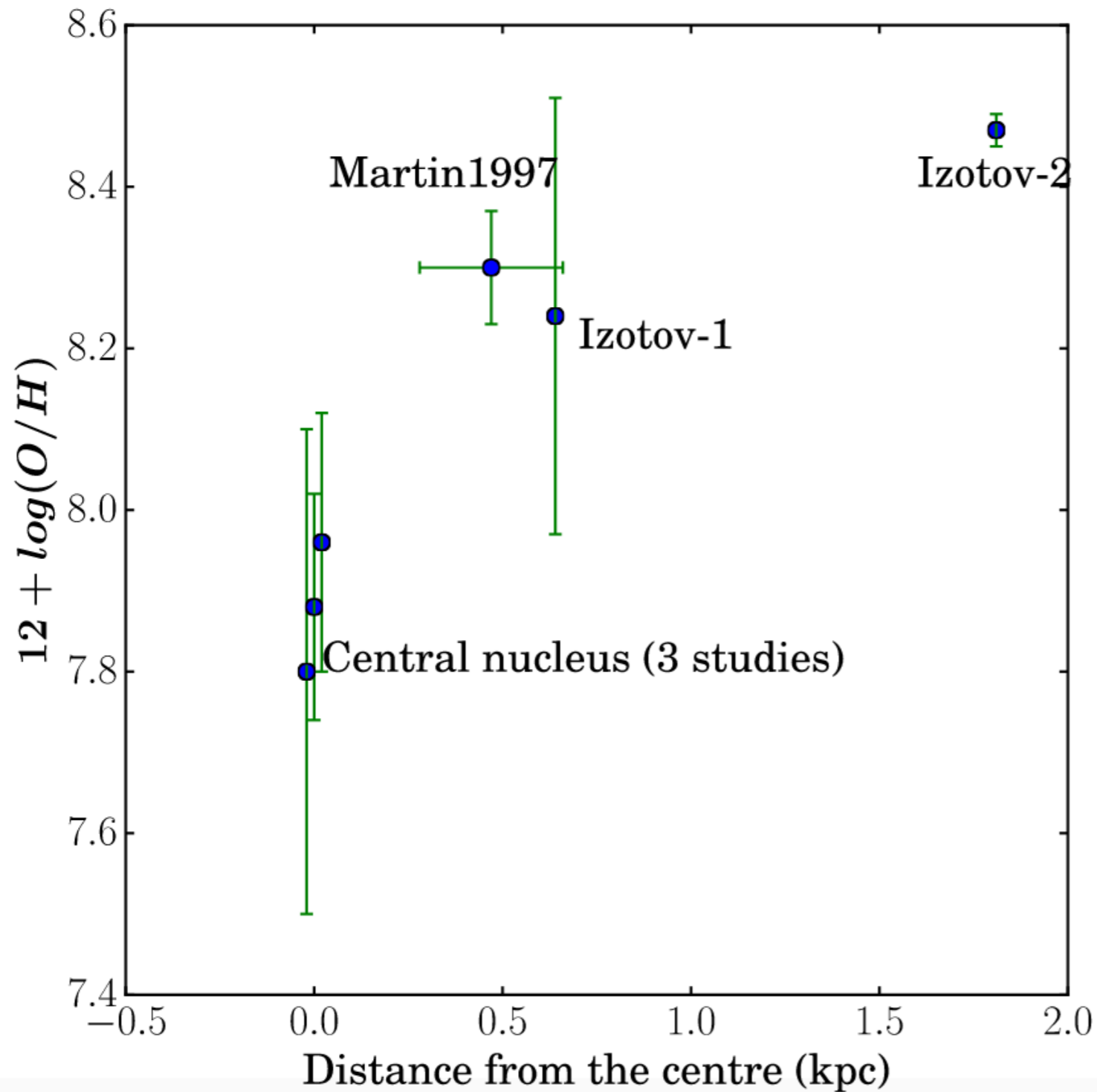


Kumari et al. 2017,
MNRAS, 470, 4618

NGC 4449: Bright Emission Region (blue)



[OIII] 4363 -> metallicity from robust direct Te-method



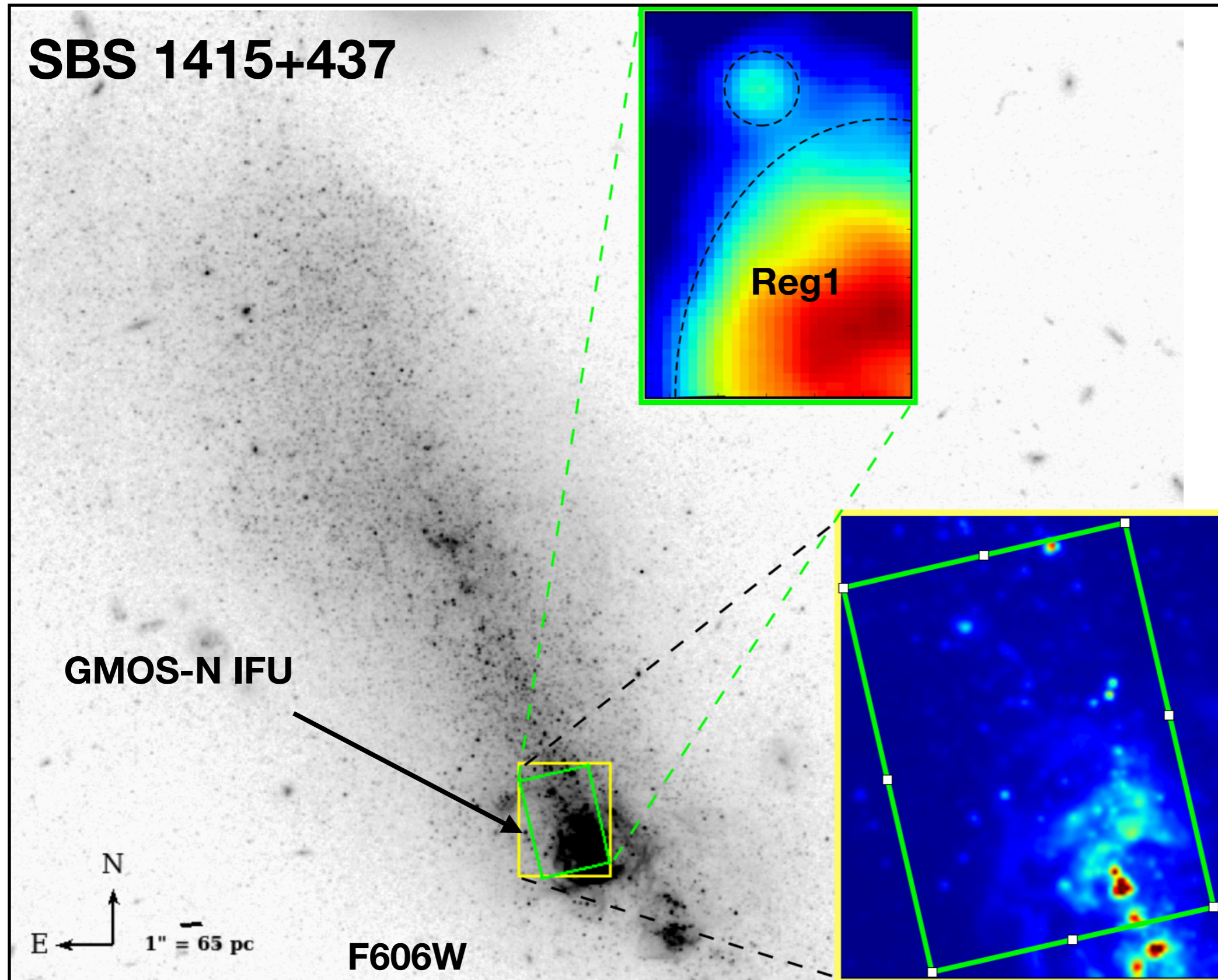
Similar observations
at low and high-z
 in Cresci+2010, Werk2010,
 Elmegreen+2012,
 Sanchez-Almedia+2014,2015

**Alternative/
 Complementary
 hypotheses:**
**Inflow of Metal-
 poor gas,
 Outflow of metal-
 rich gas,
 Supernovae winds,
 Merger events**

Kumari et al. 2017, MNRAS, 470, 4618

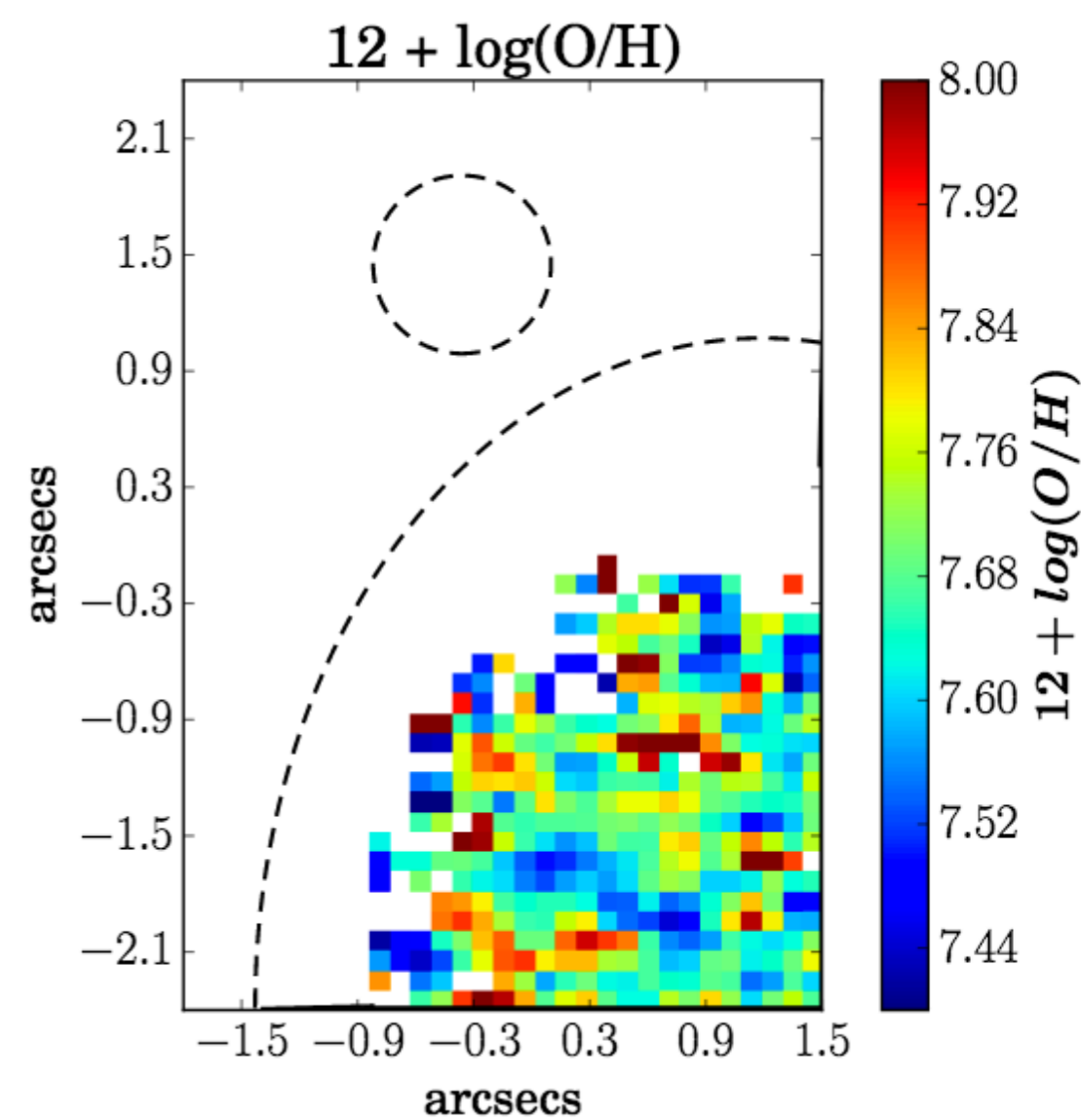
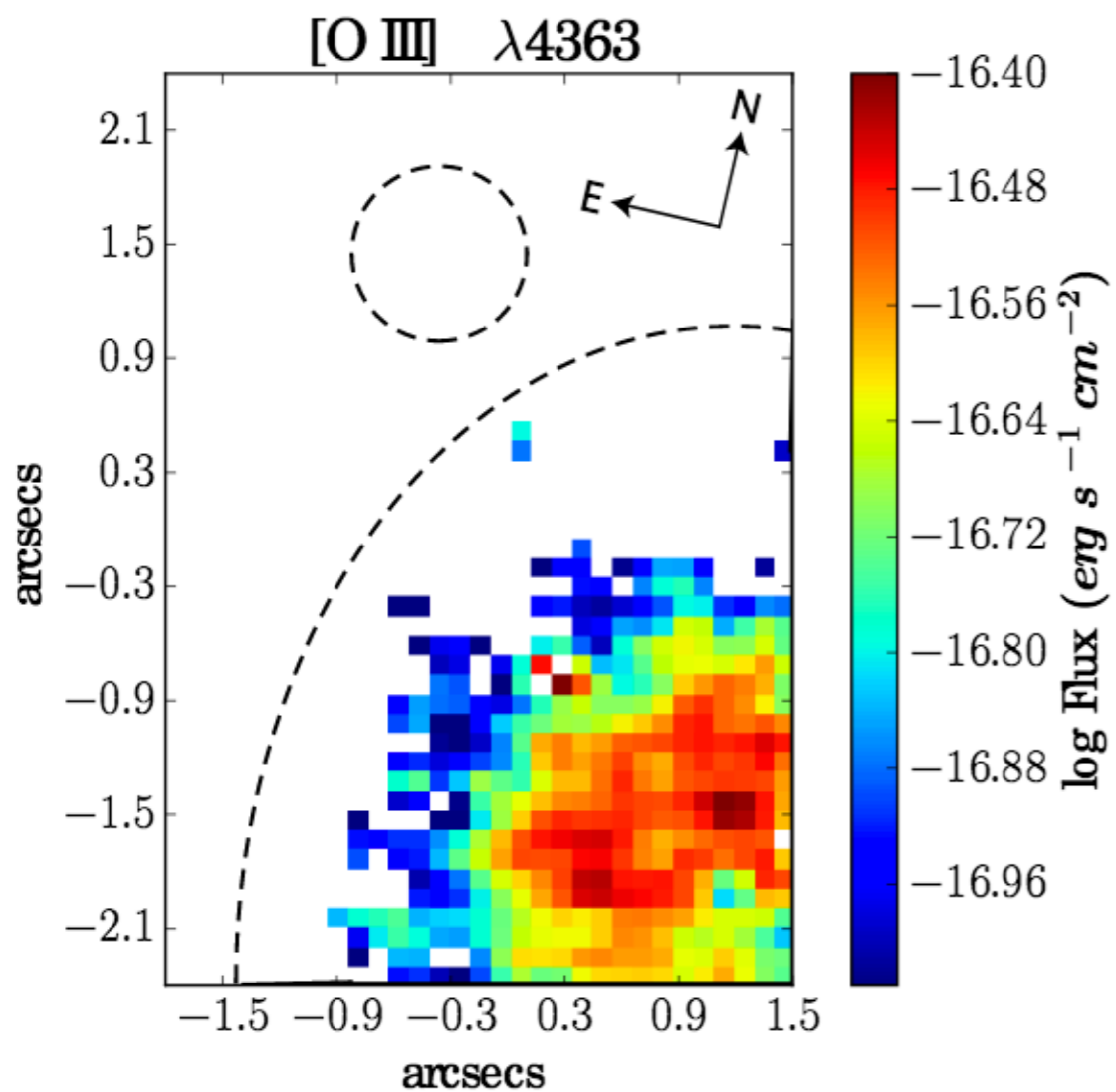
Metal-poor Star-forming region: Accretion of metal-poor gas

#3:SBS 1415+437: integrated vs spatially-resolved abundances



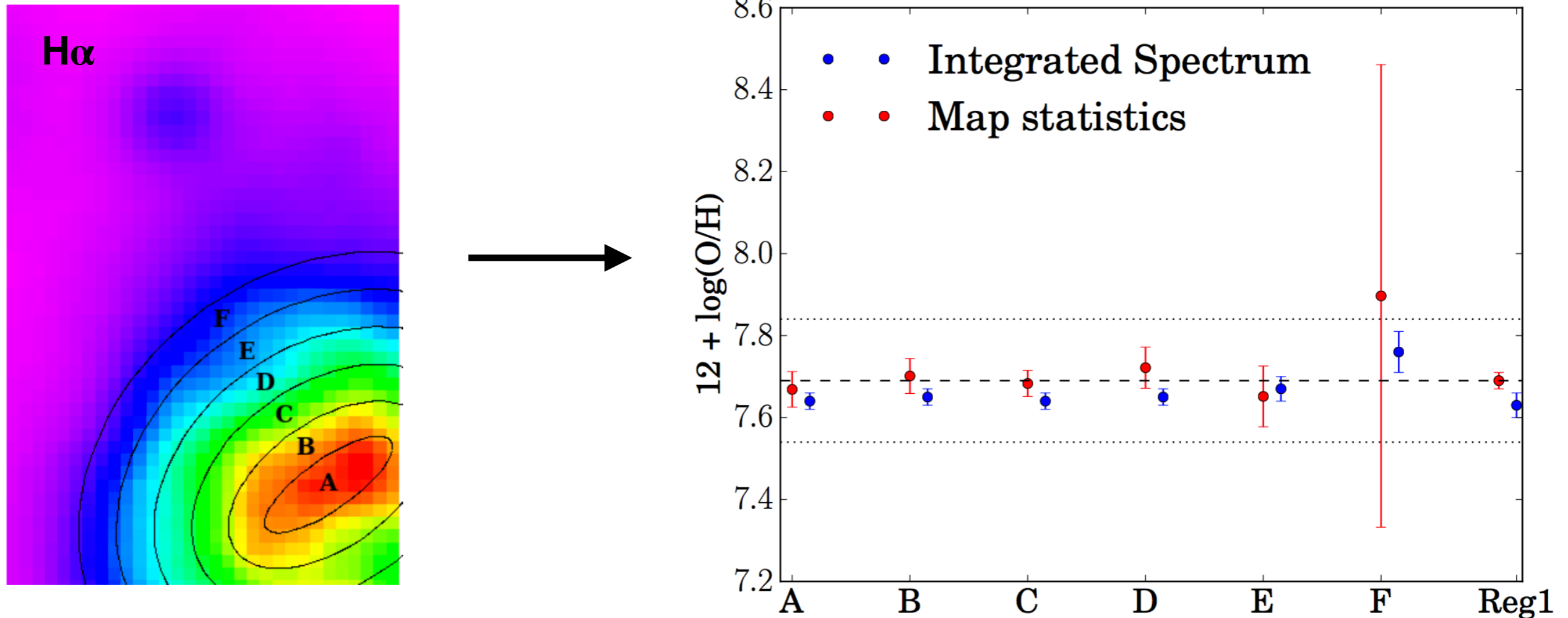
**Kumari+2019,
MNRAS, 485,
1103**

**Nimisha Kumari,
Cambridge**



[OIII] 4363 spatially-resolved -> Metallicity map from the robust direct Te-method

Segmentation Analysis



Agreement b/w spatially-resolved and integrated abundances

=> confidence to high-z abundance measurements (e.g. JWST)

What Next:

Keck Cosmic Web Imager

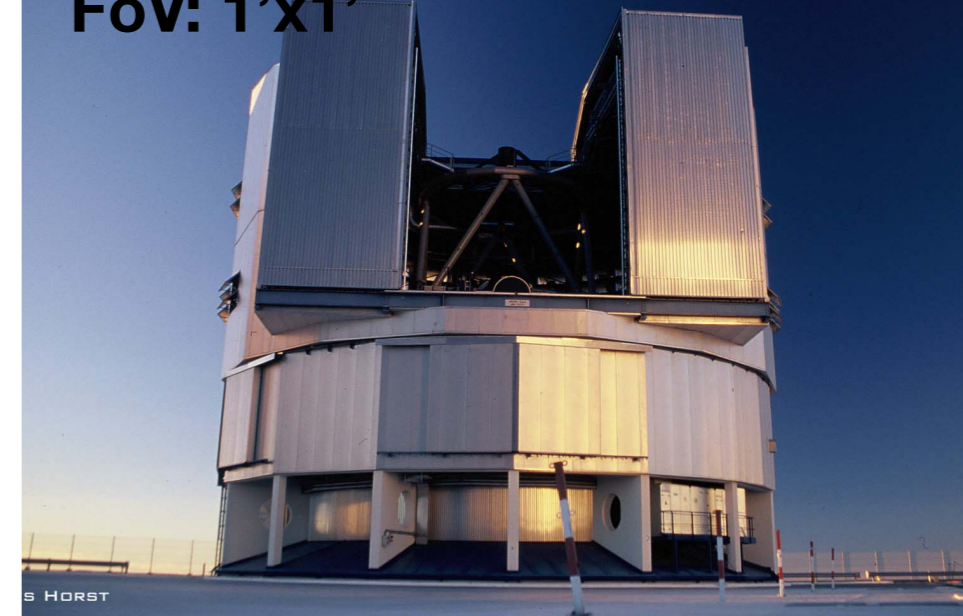
FoV: 20" x 33"



MANGA-SDSS

MUSE on VLT

FoV: 1'x1'

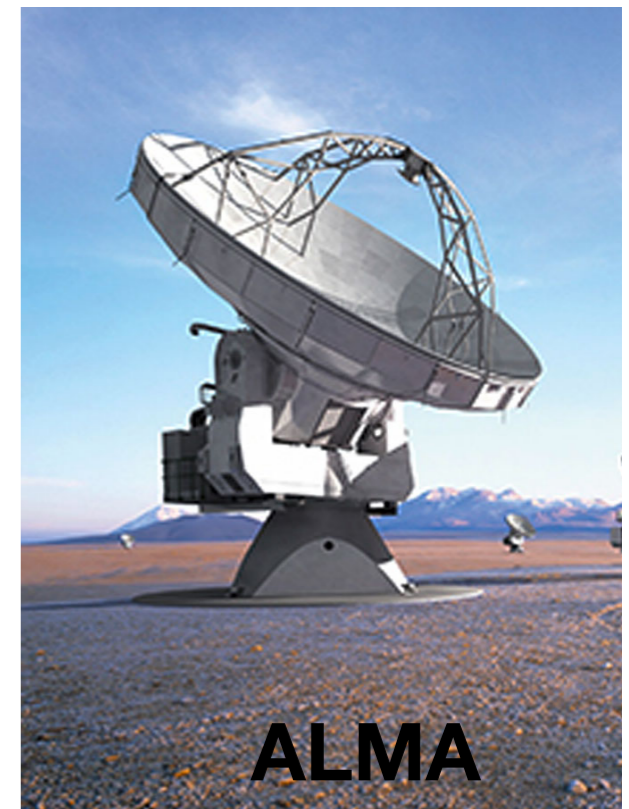


WEAVE (WHT)

FoV: 1' x 1'



JWST



ALMA

Summary

- NGC 4670: negative N/O vs O/H relation ([Kumari+2018, MNRAS, 476, 3793](#))
=> may be a negative N/O vs O/H exists **within other** galaxies
- NGC 4449: inverse metallicity gradient ([Kumari+2017, MNRAS, 470, 4618](#))
=> accretion of metal-poor gas to the centre
- SBS 1415+437: spatially-resolved abundance agrees with integrated abundance ([Kumari+2019, MNRAS, 485, 1103](#))
=> confidence to high-z results (e.g. JWST)
- Analysis of entire BCDs with IFU data => Useful for high-z studies

Thanks!!