

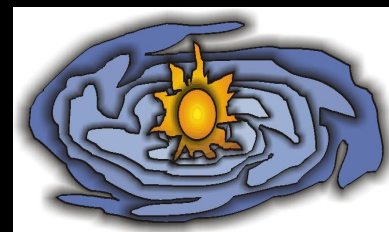
# NITROGEN-TO-OXYGEN RATIO

As a solid tool to ascertain the chemical evolution of star-forming galaxies

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Proyecto ESTALLIDOS DE FORMACIÓN ESTELAR

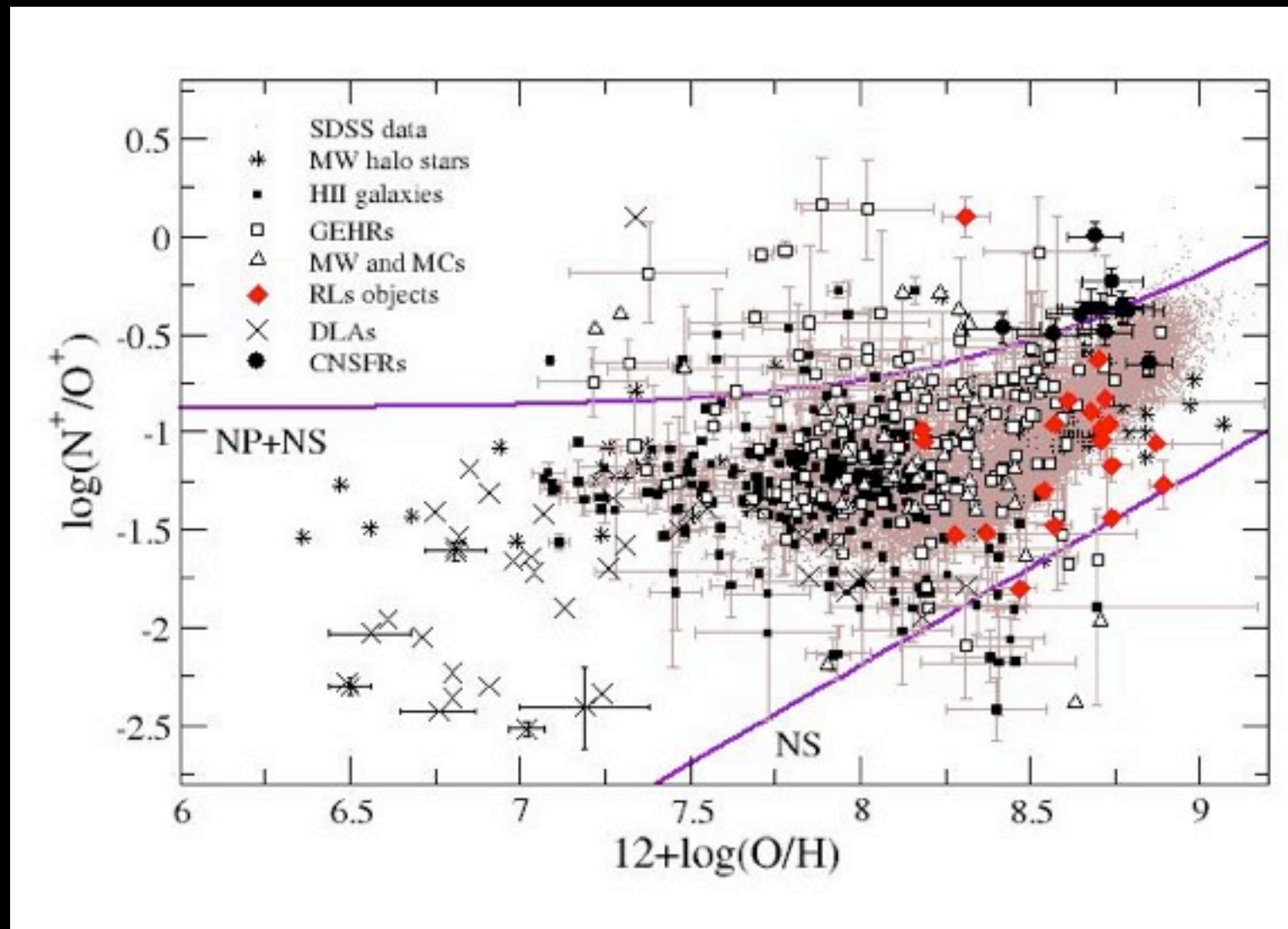


Mapping the oxygen in the Universe. El Puerto de la Cruz. May, 14th - 18th 2012

# WHY NITROGEN IS SO IMPORTANT?

- ✱ Nitrogen (N) is one of the most abundant metals in the Universe and has a non-negligible role in the cooling of the interstellar medium.
- ✱ It is mostly produced and ejected to the ISM by low and intermediate-mass stars, via the CNO cycle (e.g. Henry, Edmunds & Köppen, 2000).
- ✱ Therefore the study of the nitrogen-to-oxygen ratio gives important clues about the star formation history and the chemical evolution of galaxies (e.g. Pagel & Edmunds, 1979).

# WHY NITROGEN IS SO IMPORTANT?

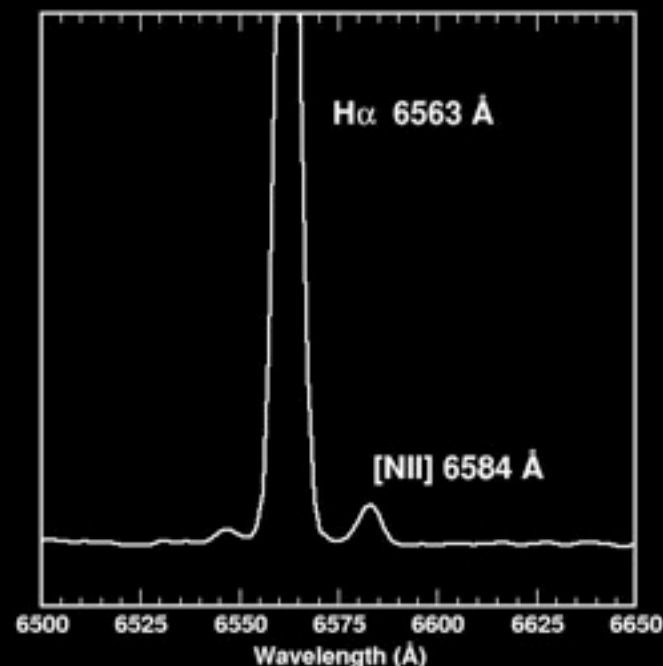


- The O/H vs. N/O relation is based on the relative production of primary and secondary N, but ...
- It has a great dispersion due to the delay of the N production and to other deviations from the Single closed-box model.

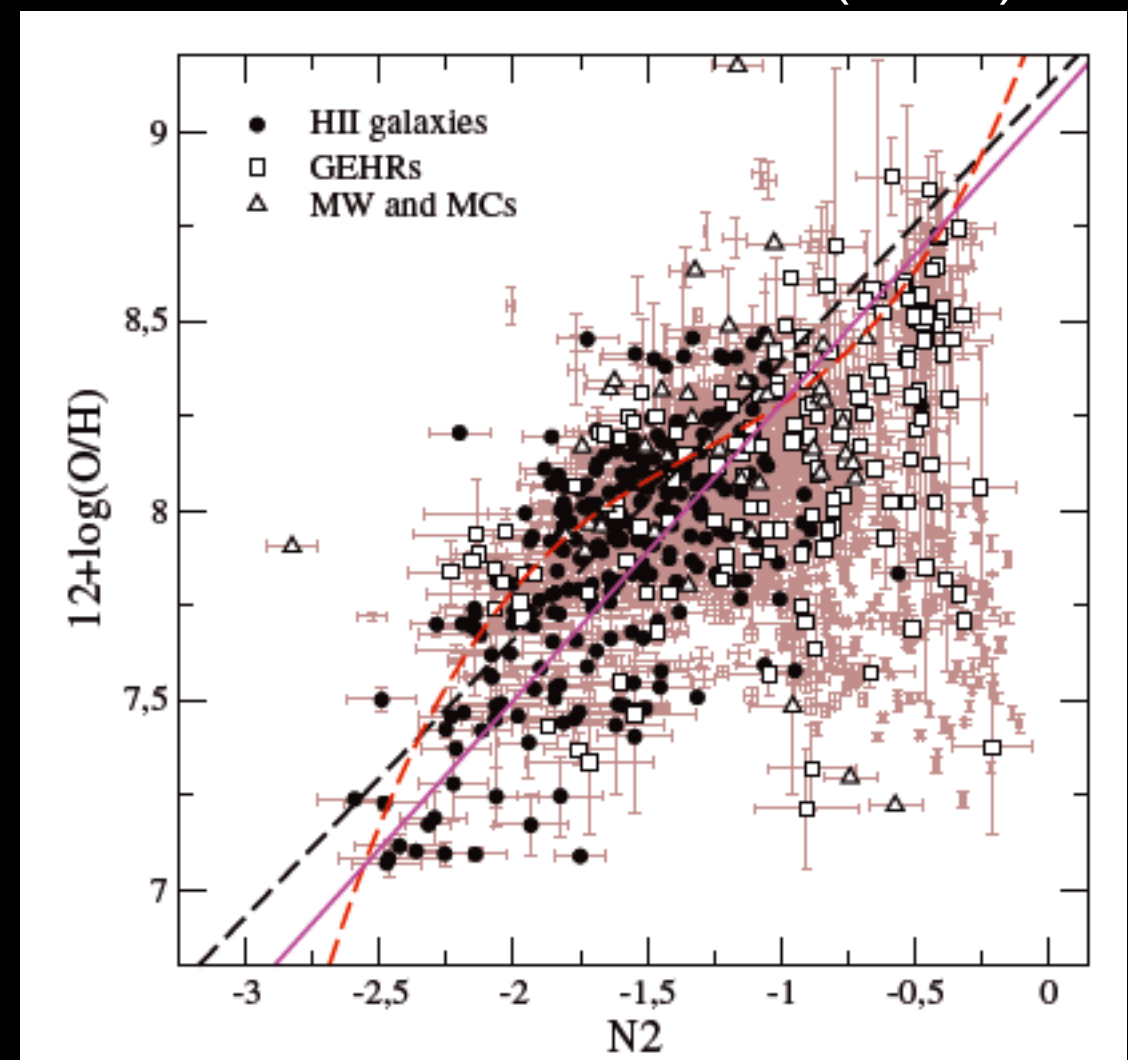
# [NII] BASED METALLICITY INDICATORS

- One of the brightest optical emission-lines of N has been widely used in the last years for the determination of metallicities in star-forming regions.

$$N2 = \log \left[ \frac{I([N II] 6584 \text{ \AA})}{I(H\alpha)} \right],$$

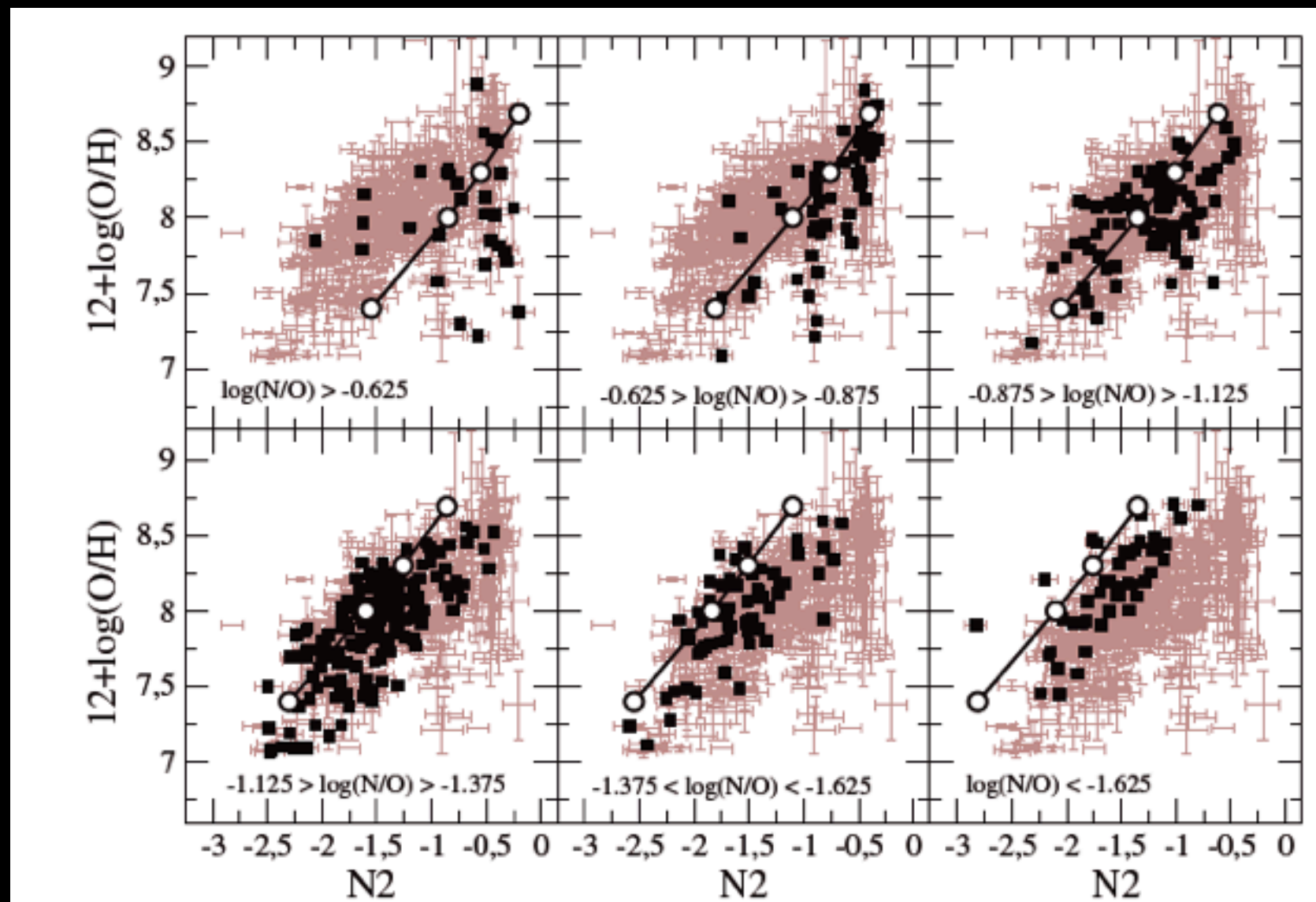


Pérez-Montero & Contini (2009)



# [NII] BASED METALLICITY INDICATORS

But ... when deriving O/H from [NII] we must take into account N/O



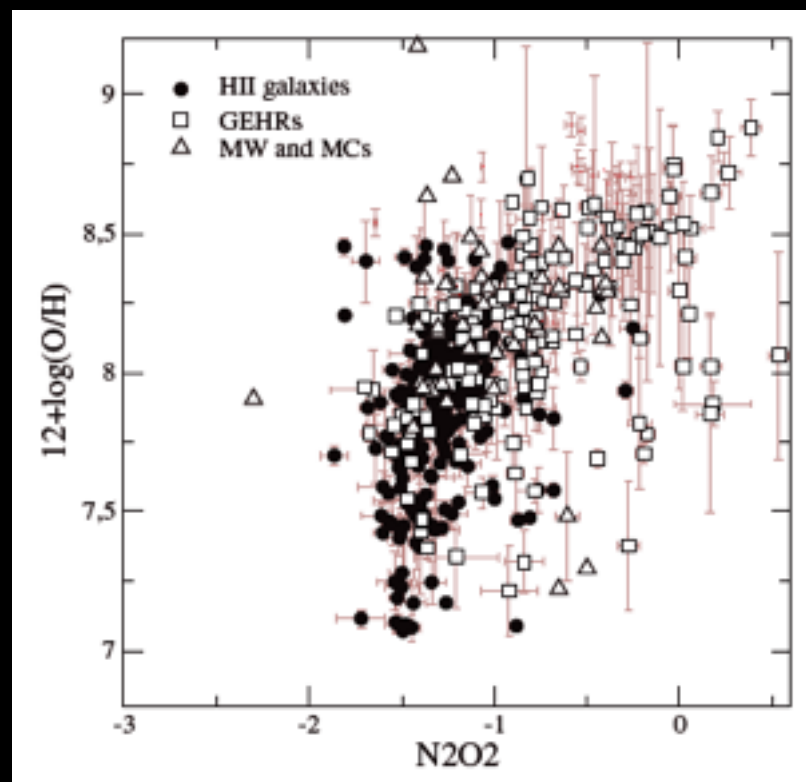
Pérez-Montero & Contini (2009)



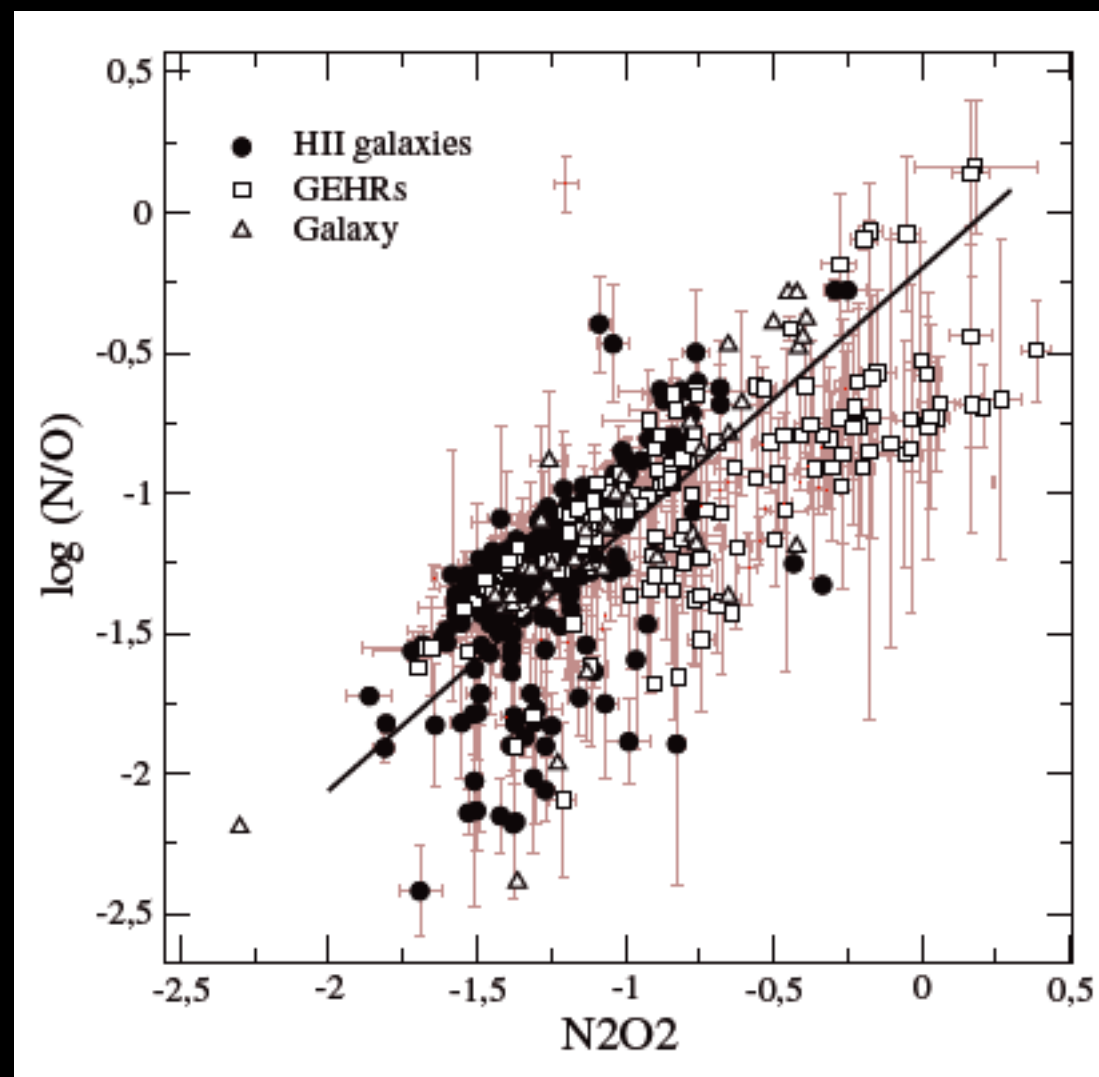
# [NII] BASED METALLICITY INDICATORS

Other strong-line methods as N2O2 or N2S2 are not good indicators of O/H because they totally depend on N/O, even if they are log U independent.

$$\text{N2O2} = \log \left[ \frac{I([\text{N II}]6584 \text{ \AA})}{I([\text{O II}]3727 \text{ \AA})} \right]$$

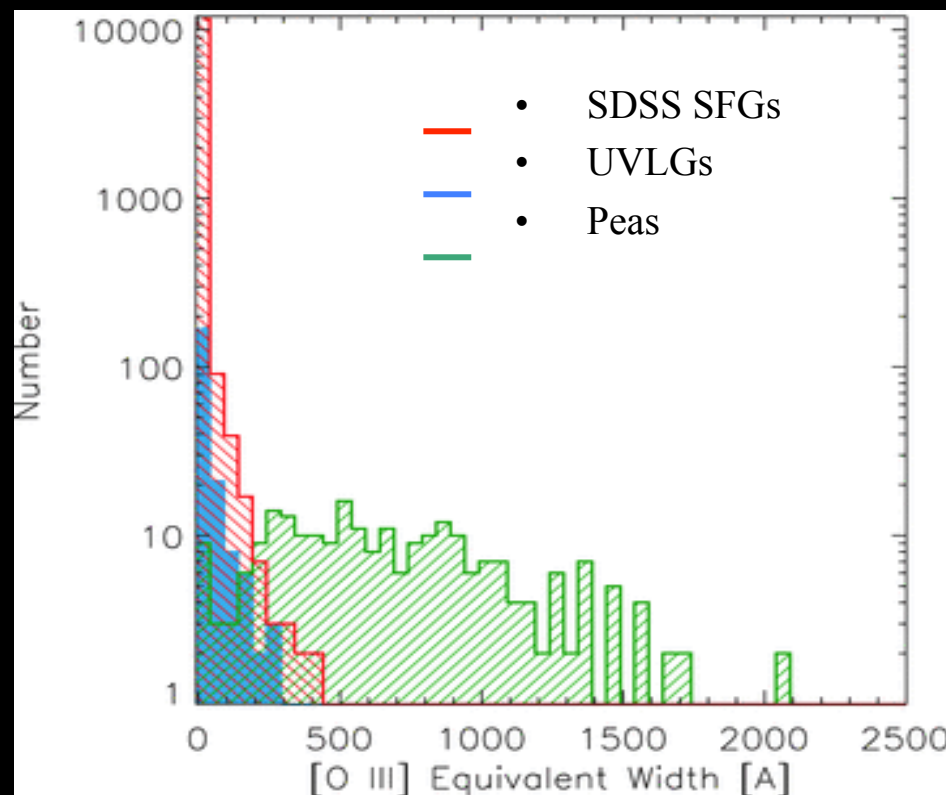
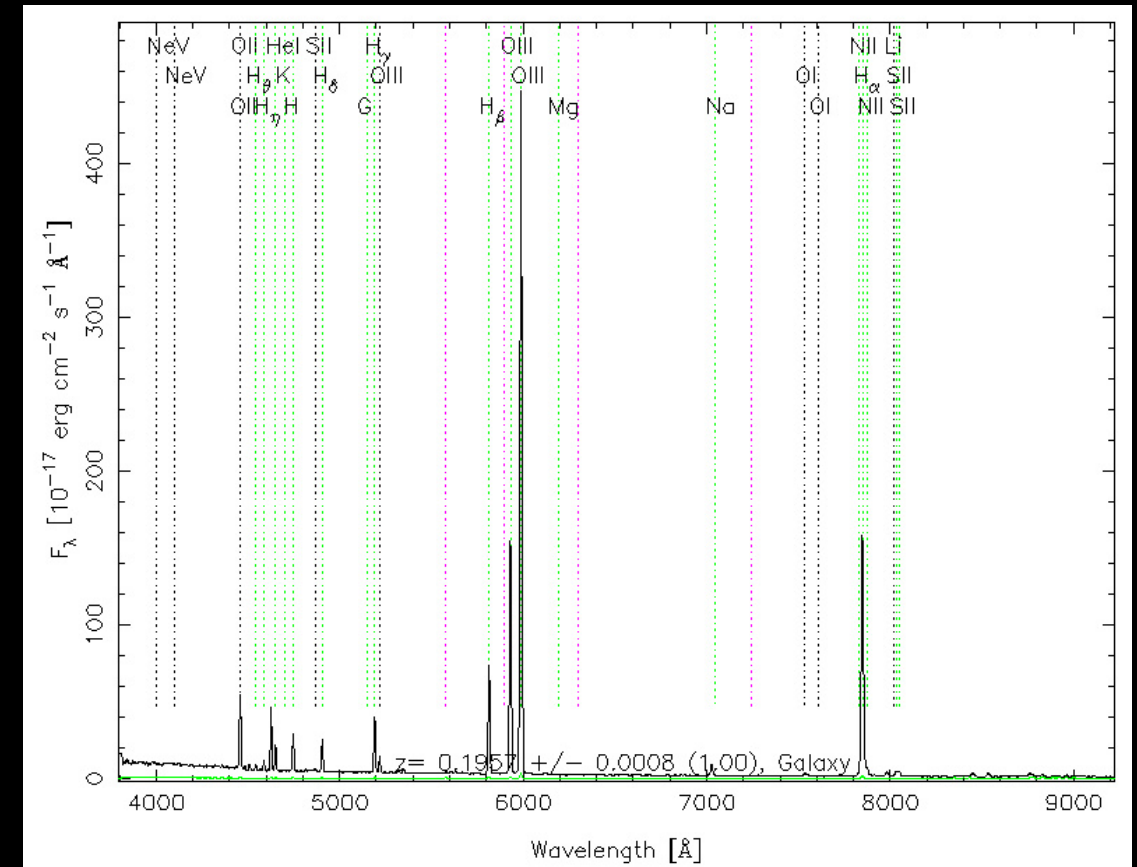
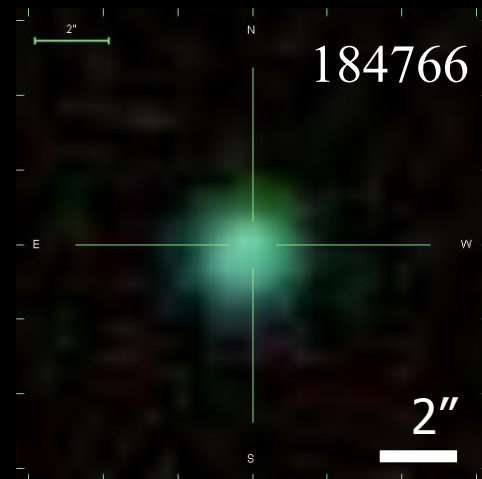


Pérez-Montero & Contini (2009)



# THE “GREEN PEA” GALAXIES:

## *An example of bad usage of [NII] indicators*



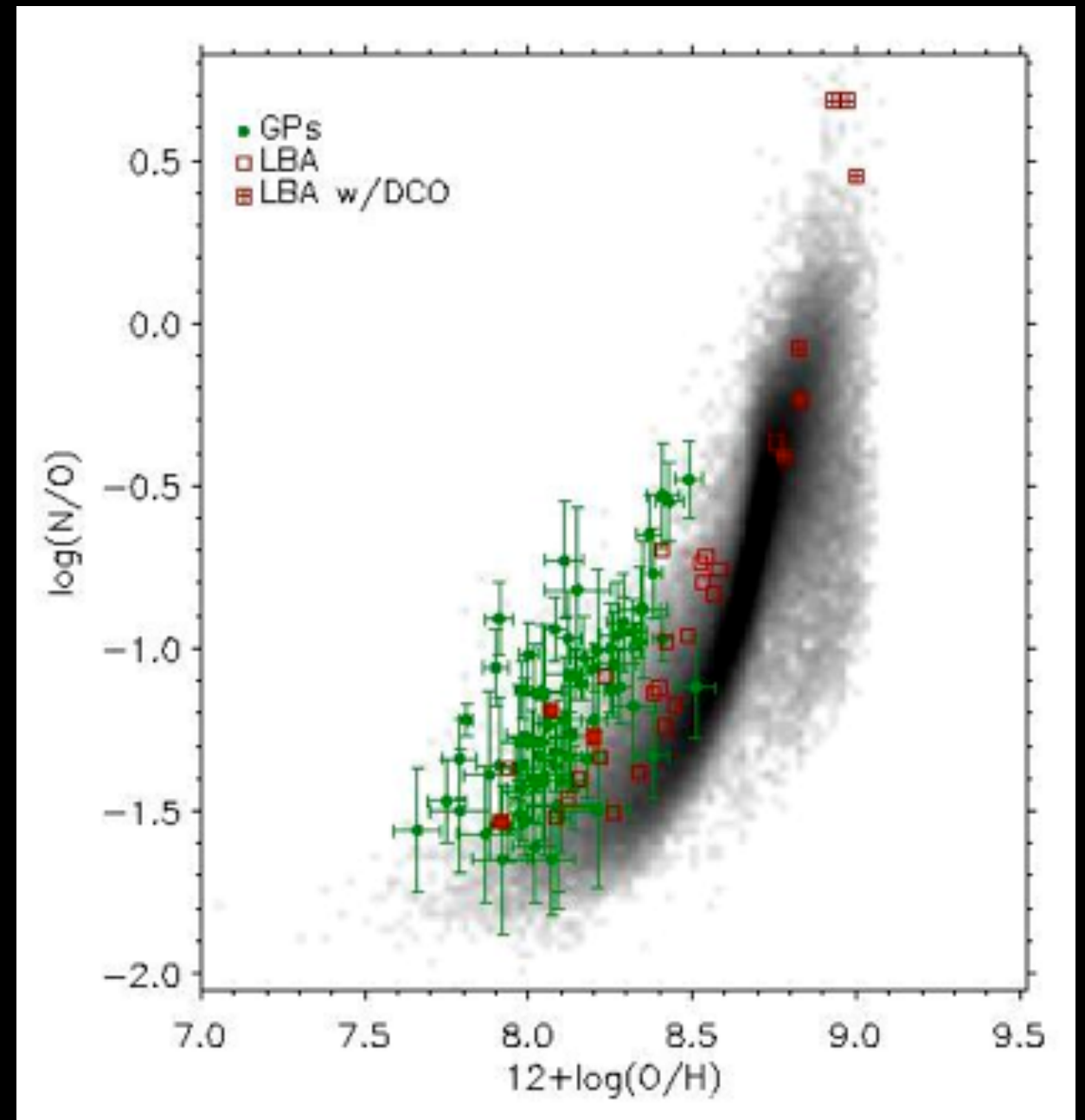
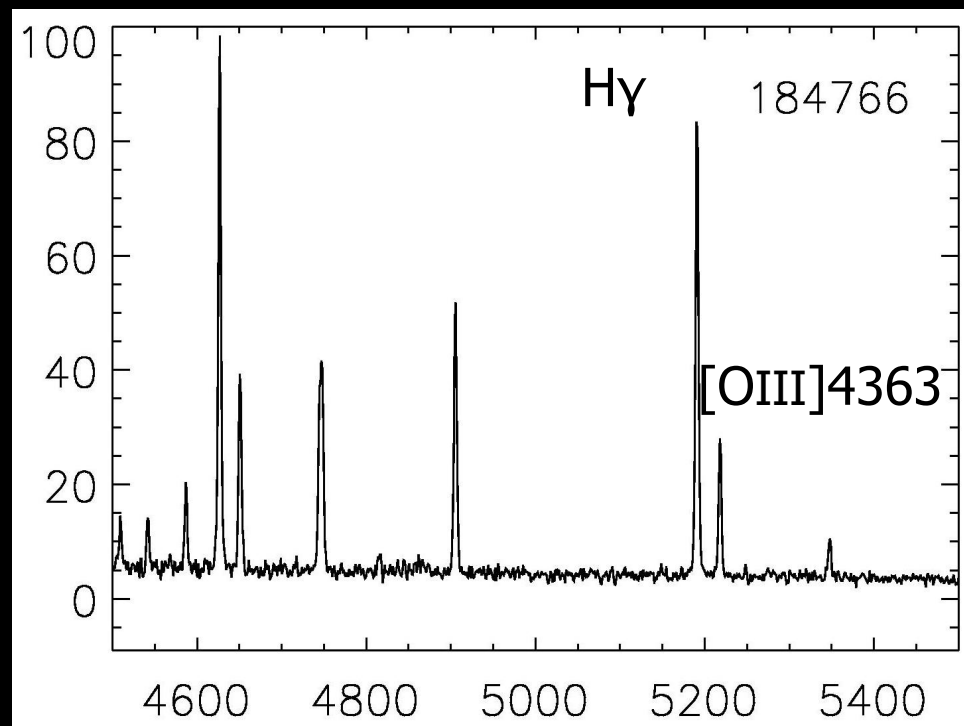
GP galaxies are very compact (3 kpc), with high  $\text{EW}([\text{OIII}])$  ( $> 200 \text{ \AA}$ ) and SSFR. They can be considered as Local Universe “Lyman Break Analogs” but, what about their metallicity?

Cardamone et al. (2009)

# THE “GREEN PEA” GALAXIES:

## *An example of bad usage of [NII] indicators*

Cardamone et al. (2009) measured solar metallicities using the N2O2 ... but GPs indeed have low O/H combined with high N/O ratios (i.e. bright [OIII] 4363 Å and [NII] 6584 Å).



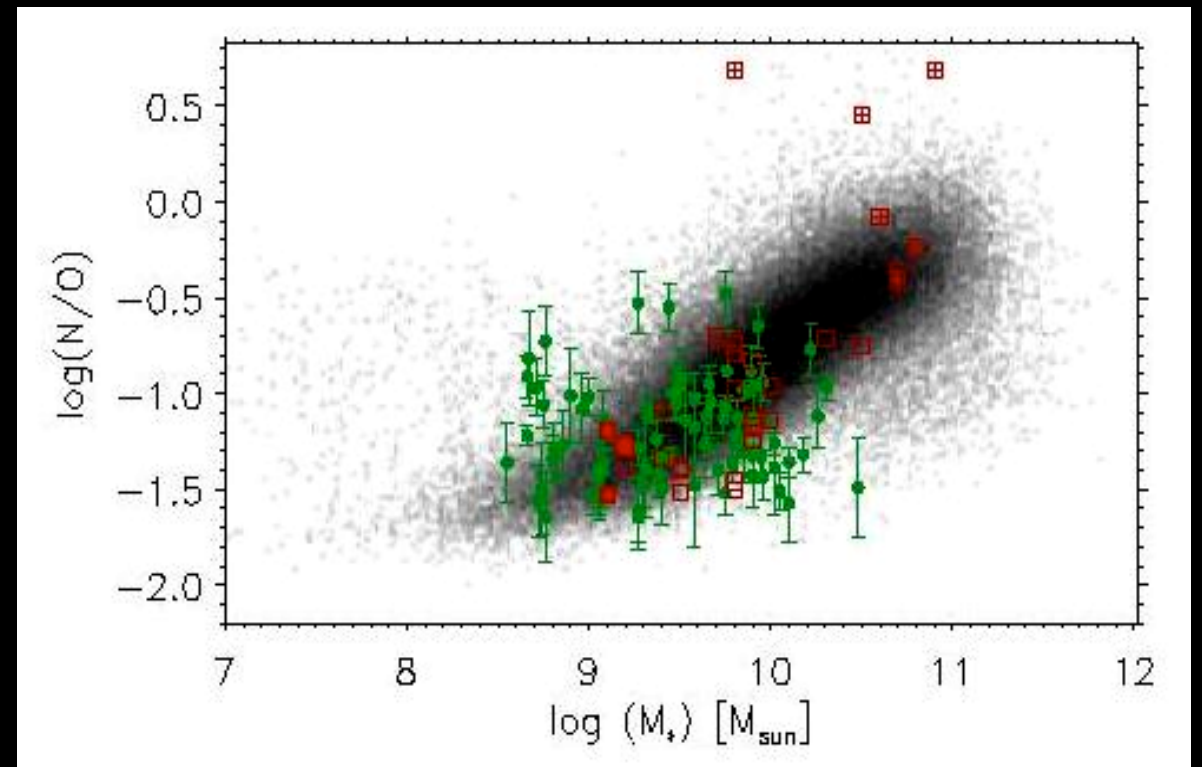
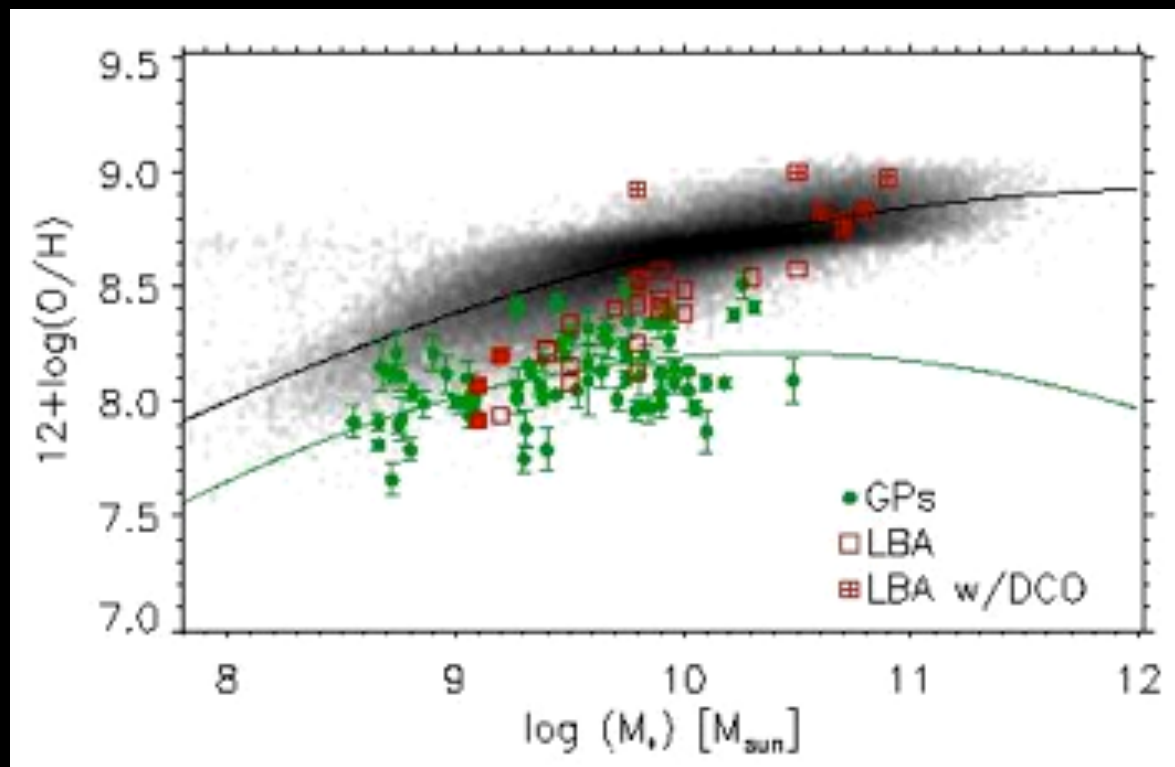
Amorín, Pérez-Montero & Vílchez (2010)



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Amorín, Pérez-Montero & Vílchez (2010)

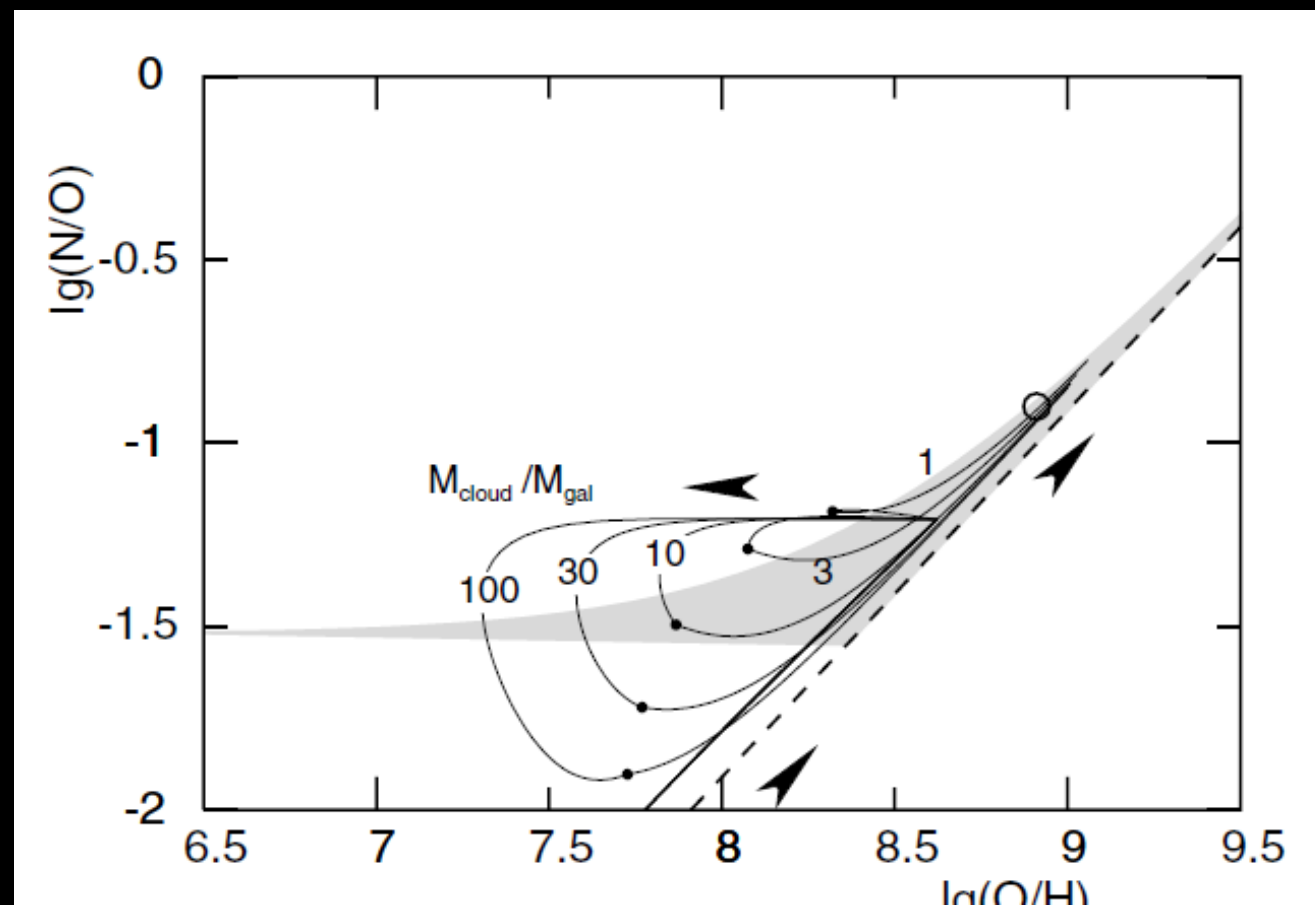


The study of the relation of both O/H and N/O with stellar mass gives us some clues about the origin of the extra N:

- GPs are metallicity-deficient as compared to other galaxies of the same stellar mass, but they have their same N/O.

# NITROGEN OVERABUNDANT GALAXIES

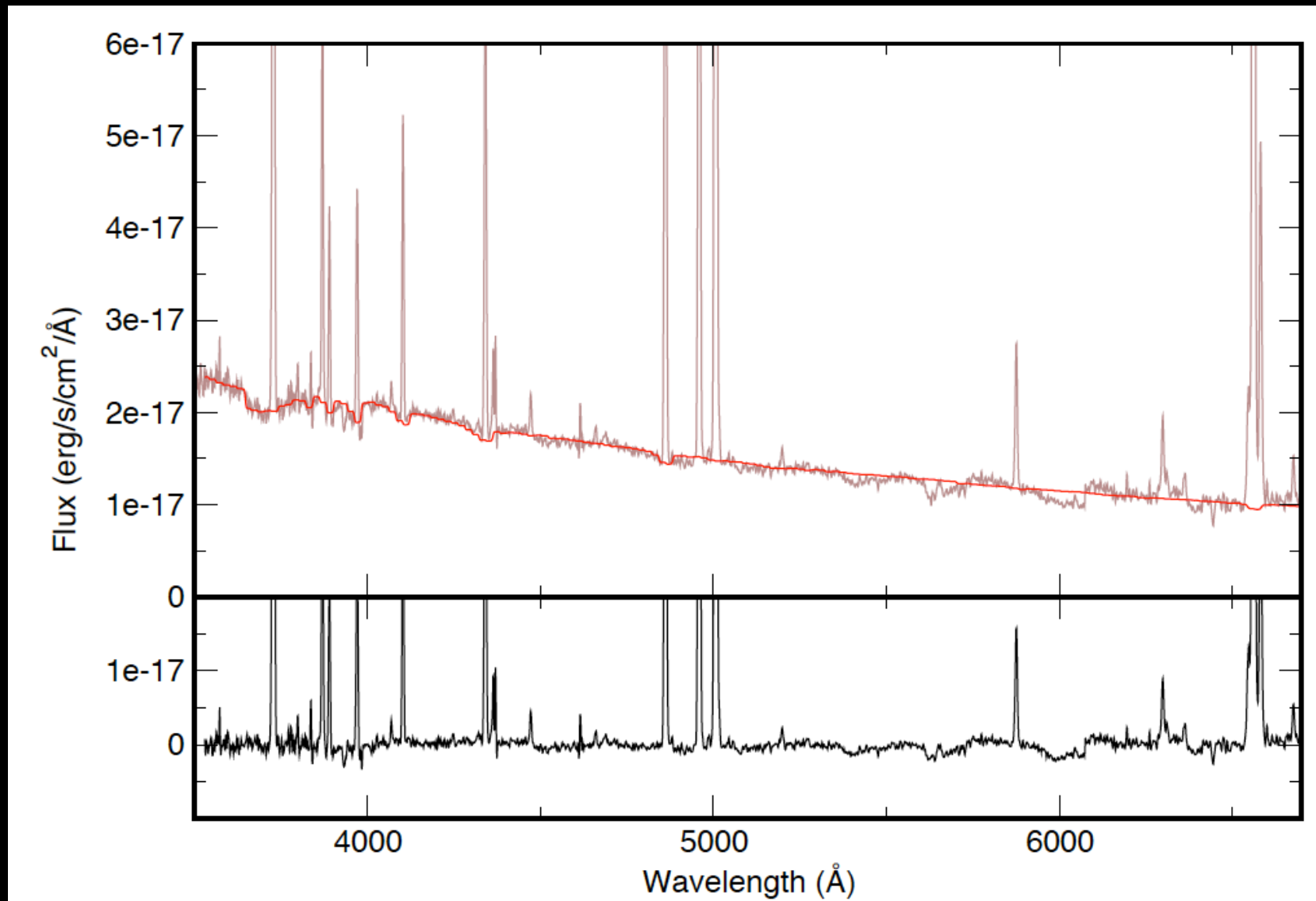
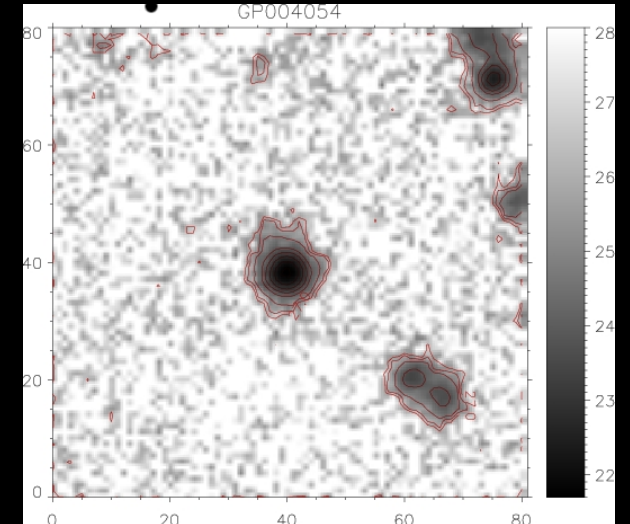
Köppen & Hensler (2005)



Although Edmunds (1990) demonstrates that an inflow of unenriched gas exponentially time-decreasing cannot enhance the N/O ratio significantly, later work by Köppen & Hensler (2005) show that some HVCs are able to largely affect the O/H ratio if its gas mass is much larger than that of the galaxy.

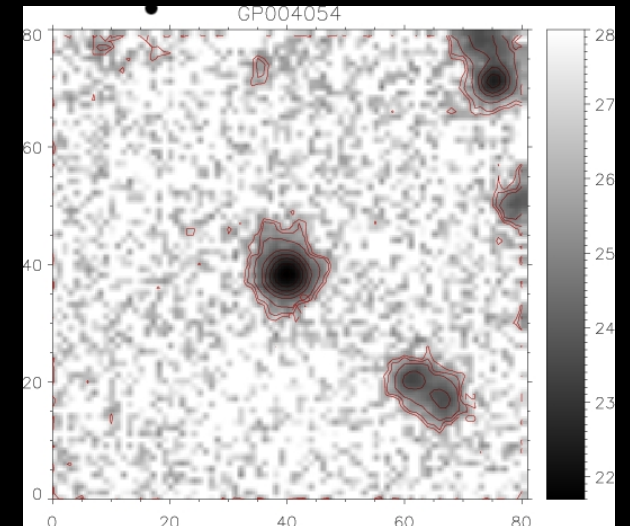
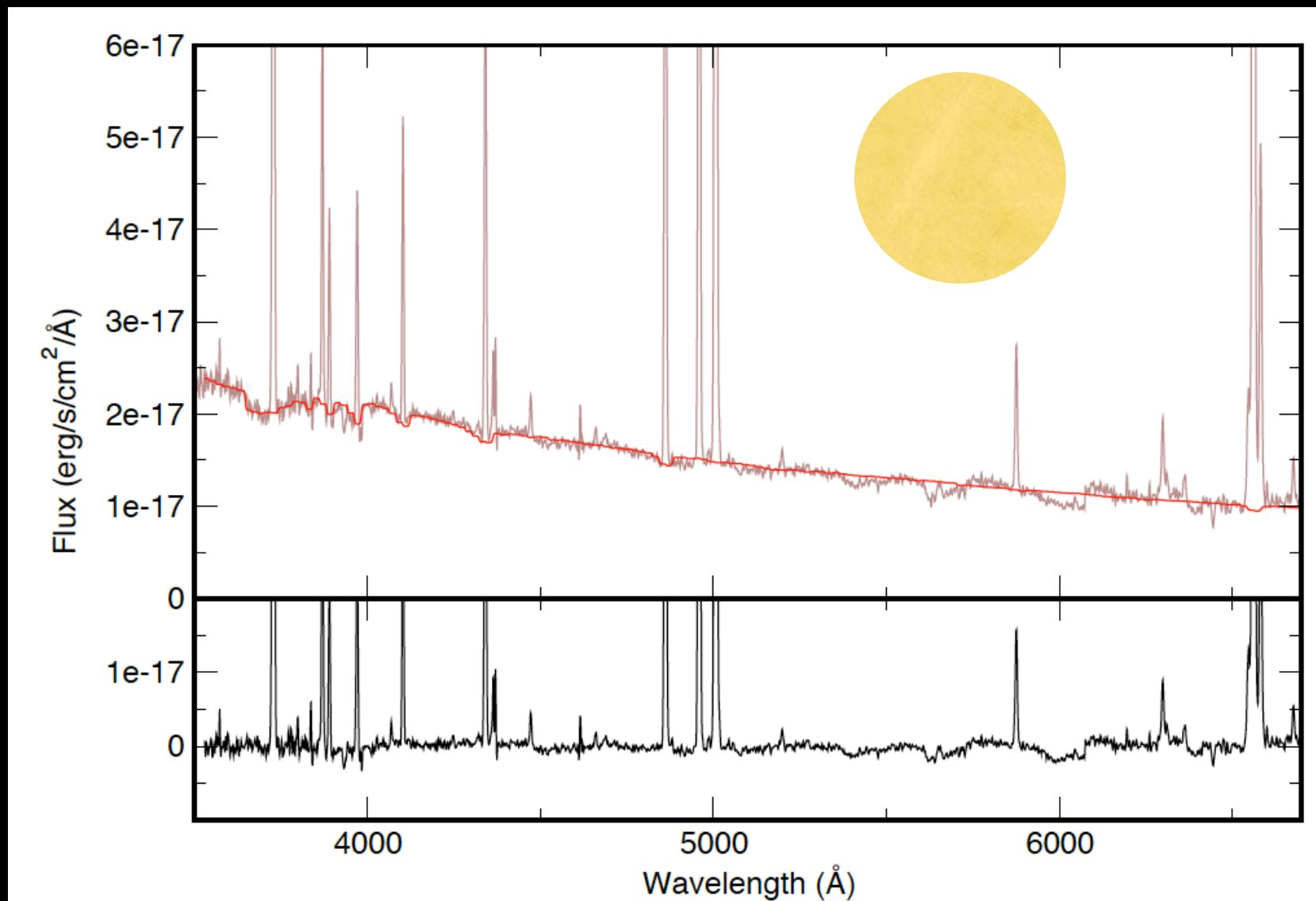
# NITROGEN OVERABUNDANT GALAXIES

... and GPs have very old stellar populations  
(z images and synthesis stellar population fitting  
to deep optical spectroscopy from OSIRIS-GTC,  
Amorín et al. 2012)

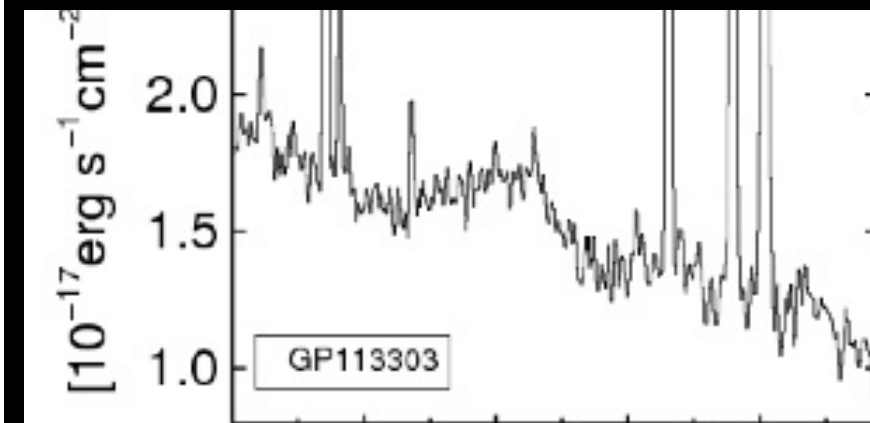


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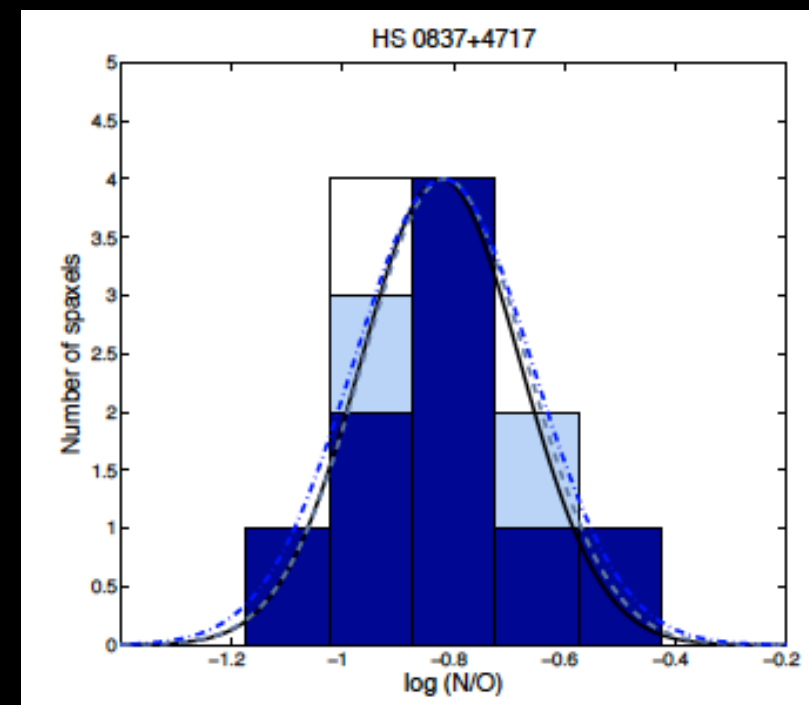
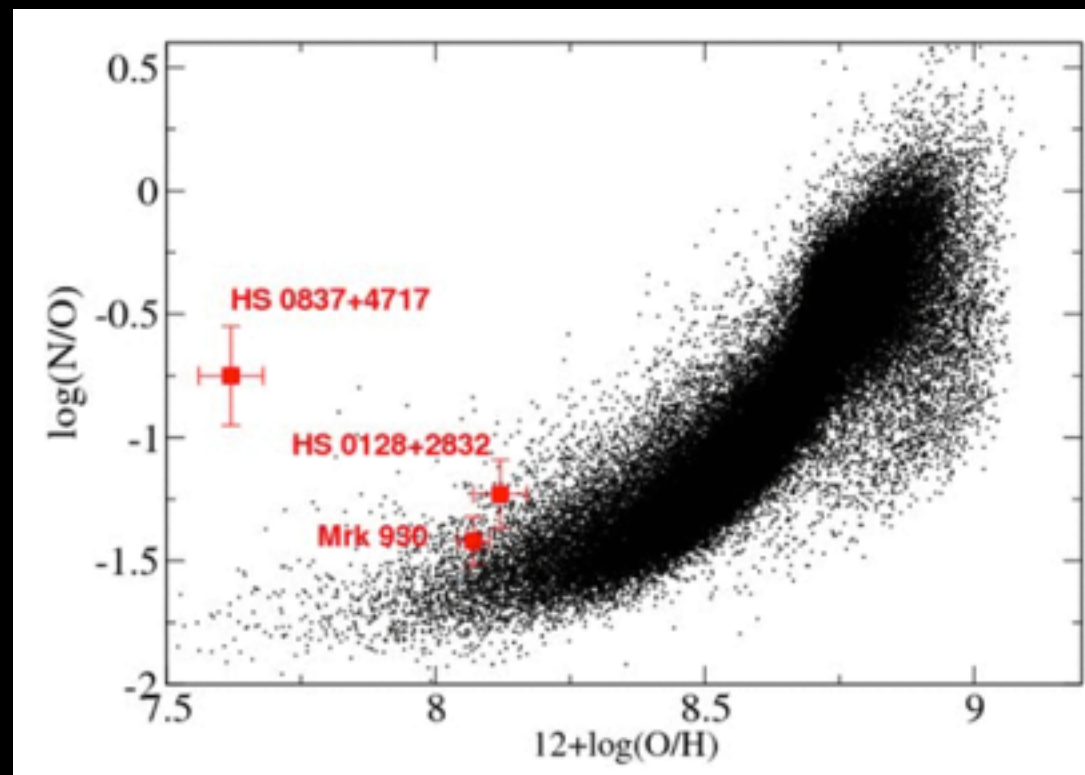
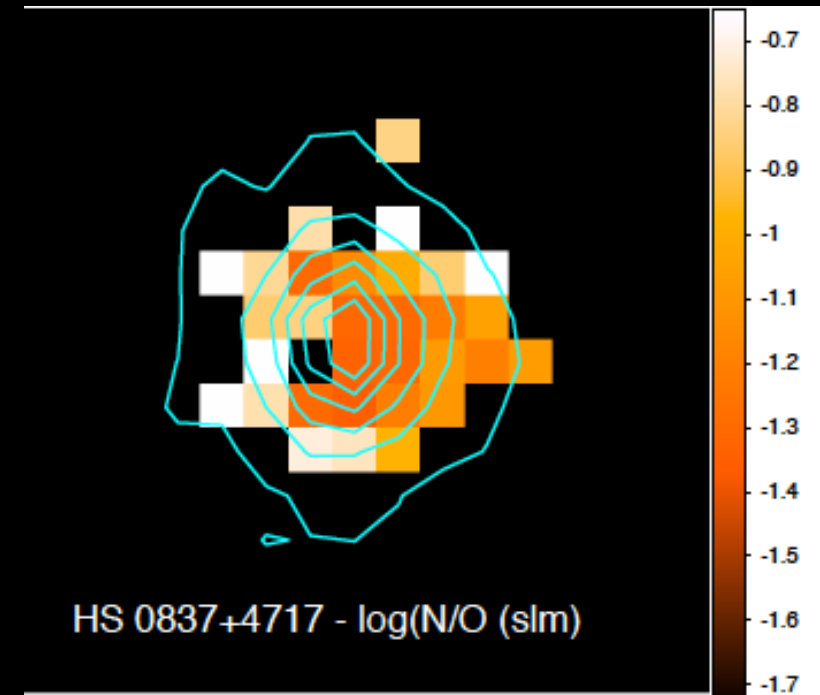
WR blue bump:  
N pollution?



# NITROGEN OVERABUNDANT GALAXIES

PMAS Integral Field Unit observations of BCDs with very low- $Z$  and high  $N/O$  shows that these chemical properties are homogeneous at the spatial scale of several kpc.

This implies that chemo-dynamical effects (e.g. inflows of pristine gas) affecting the whole galaxy are involved.

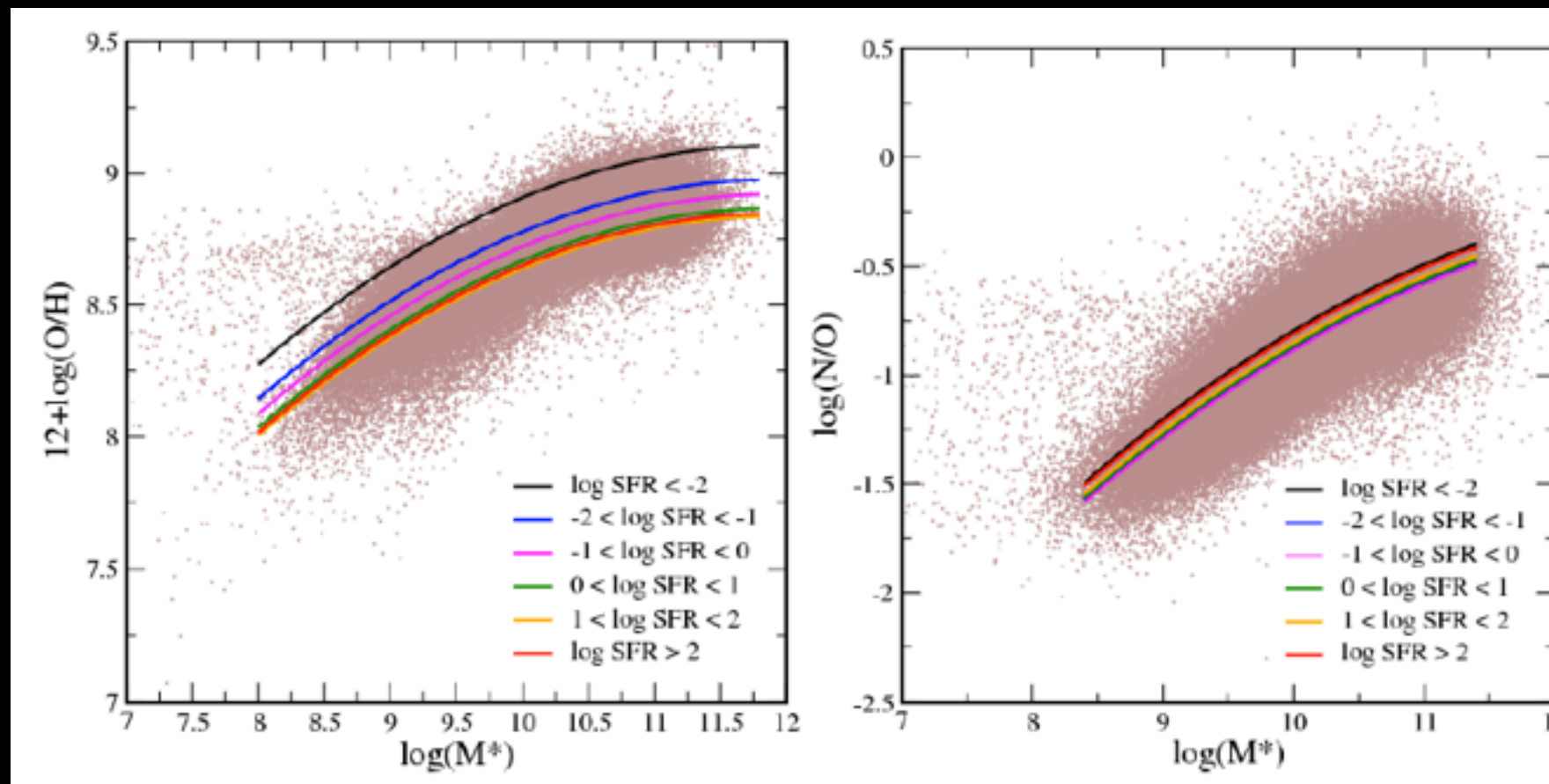


Pérez-Montero et al. (2011)



# N-to-O AS INDICATOR OF CHEMICAL EVOLUTION OF GALAXIES

Pérez-Montero et al. (in prep.)



$N/O$  is a chemical indicator much more independent on SFR and chemodynamical variations from the closed-box model than  $O/H$  and, hence, much more appropriate to study the evolution of some fundamental properties.

# SUMMARY AND CONCLUSIONS

- \* As N is produced by low mass stars, the study of N/O give clues about star formation history of galaxies.
- \* Strong-line methods based on [NII] emission-line also depend on N/O (e.g. N2 at 2nd order, N2O2 and N2S2 at 1st order).
- \* This makes these parameters not suitable to study some classes of N overabundant galaxies (e.g. GPs), which are affected by chemo-dynamical global effects.
- \* As N/O is independent on SFR in their relation with stellar mass, it is very convenient for studies of the cosmic evolution of galaxies.