A comparative study of Star Formation processes in different environments

Guillermo F. Hägele

Supervisors:
Ángeles I. Díaz Beltrán
Elena Terlevich

Collaborators: Roberto Terlevich, Enrique Pérez-Montero,
Mónica Cardaci, Marcelo Castellanos

A thesis submitted for the admission to the degree of Doctor en Ciencias Físicas
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Introduction: Overview

Gas ionization, metallicity and massive star formation

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Among these conditions, the most important are:

- the density of the molecular and gaseous material
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In particular, the *metallicity* is a *key parameter* that *controls* many aspects in the *formation and evolution of stars and galaxies*.

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Due to the *nature of the galaxies* (except for the nearest systems) almost all the information about their *star formation properties is collected from integrated light measurements* of the ultraviolet continuum, far-infrared and nebular emission recombination lines.

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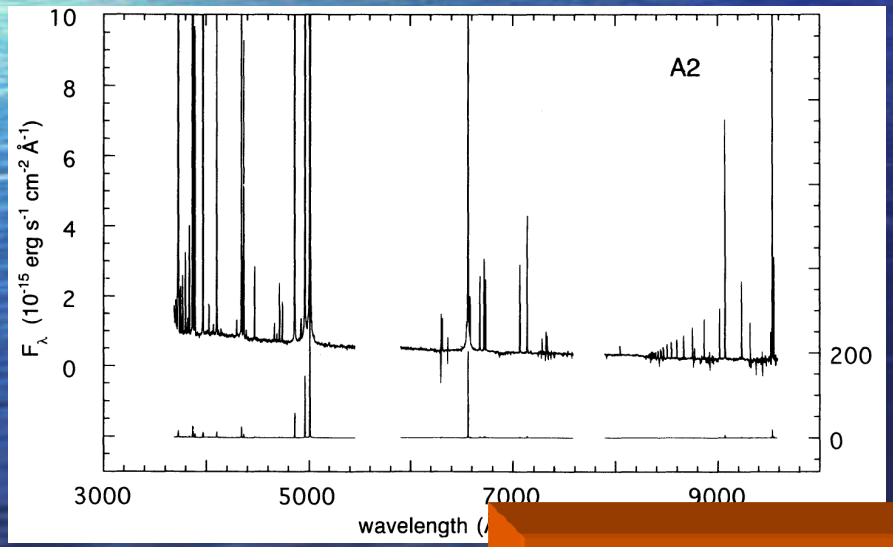
Due to the ***nature of the galaxies*** (except for the nearest systems) almost all the information about their ***star formation properties is collected from integrated light measurements*** of the ultraviolet continuum, far-infrared and nebular emission recombination lines.

In particular, the study of the gas ionized by the most massive stars can provide information about their *masses, temperatures and evolutionary state*.

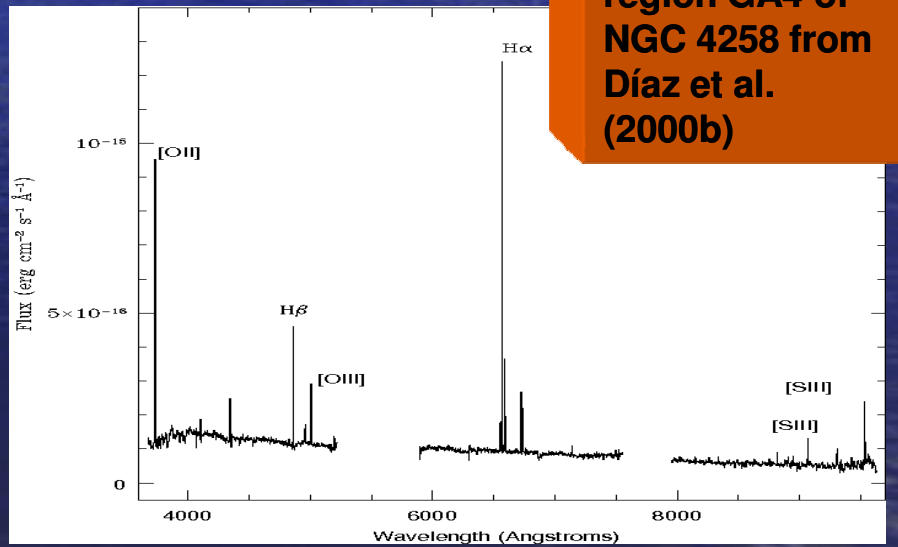
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Photoionized gas shows a *characteristic emission line* spectrum



knot A of NGC 2363 from González-Delgado et al. (1994)



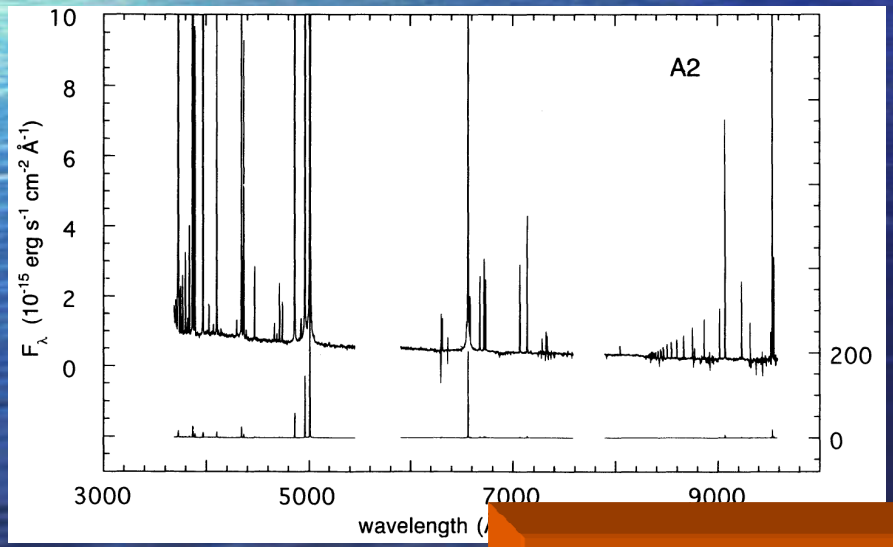
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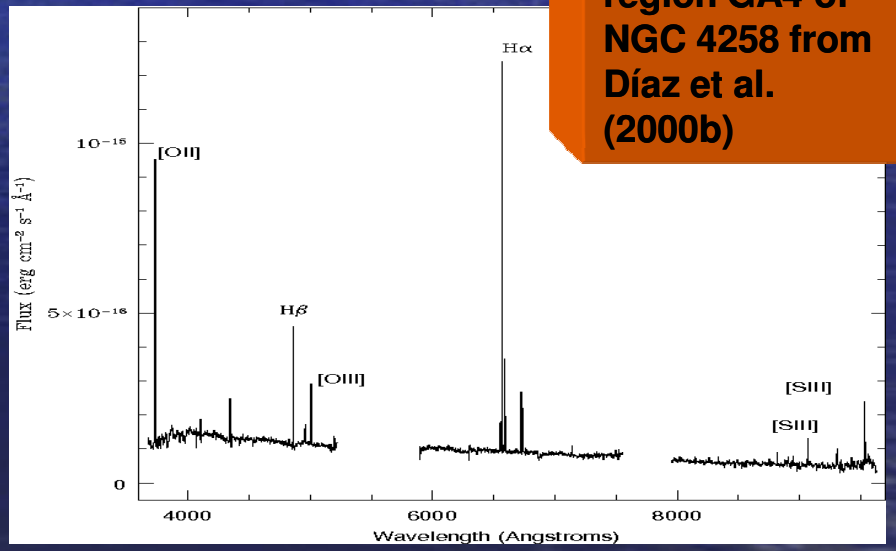
Gas ionization, metallicity and massive star formation

Photoionized gas shows a *characteristic emission line* spectrum

In principle, the spectra of HII galaxies, galactic HII regions, giant extragalactic HII regions (GEHRs), circumnuclear and even nuclear regions, *can be analyzed in the same way*.



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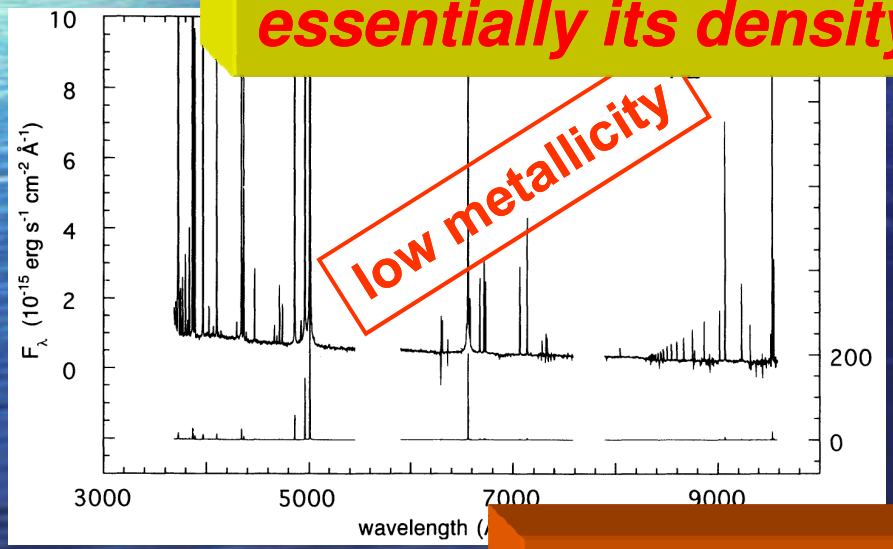
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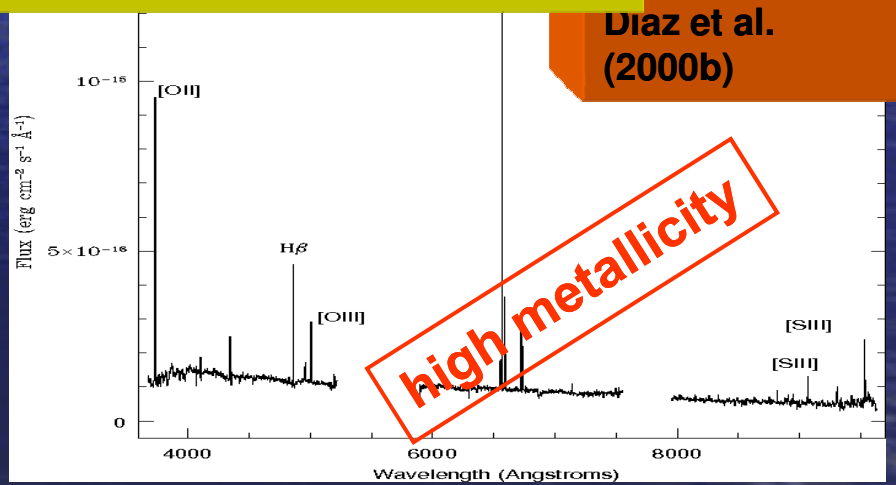
In princi
extragal
can be
egions,

The *emission line intensities* are controlled by: the *energy distribution* of the ionizing photons, the *spatial configuration* of the ionized gas and its *local properties*,
***essentially its density and metal content*.**



knot A of NGC 2363 from González-Delgado et al. (1994)

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Evolution of the Main objectives of this work:

- The first main objective of this thesis was to *design a methodology to perform a self-consistent analysis of the emitting gas in HII galaxies* adequate to the data that can be obtained with the XXI century technology. This methodology requires the *production and calibration of empirical relations between the different line temperatures* that should replace the commonly used ones based on simplistic, and poorly contrasted, photoionization model sequences.

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Related to one main research line of Estallidos

Star Formation in HII Galaxies.

Properties of the ionized gas

- The temperature and ionization structure of the emitting gas in HII galaxies: Implications for the accuracy of abundance determinations.
G. F. Hägele, E. Pérez-Montero, A.I. Díaz, E. Terlevich and R. Terlevich.
2006, MNRAS, 372, 293.
- Precision abundance analysis of bright HII galaxies.
G. F. Hägele, A.I. Díaz, E. Terlevich, R. Terlevich, E. Pérez-Montero and M.V. Cardaci.
2008, MNRAS, 383, 209.

Introduction:

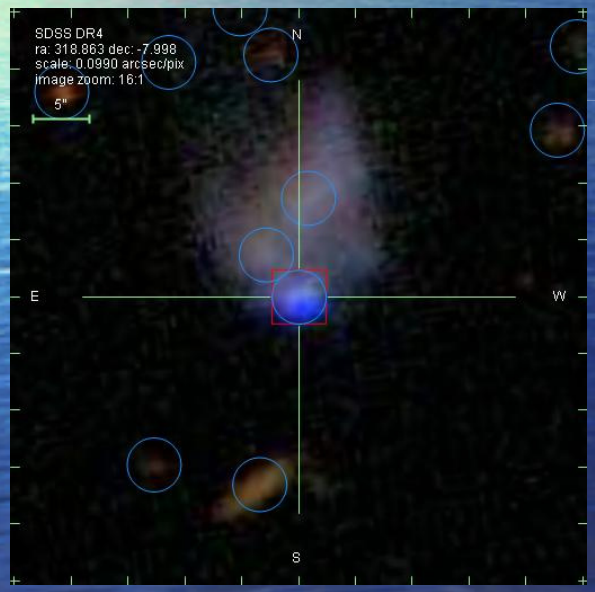
HII Galaxies: SF in low metallicity environments

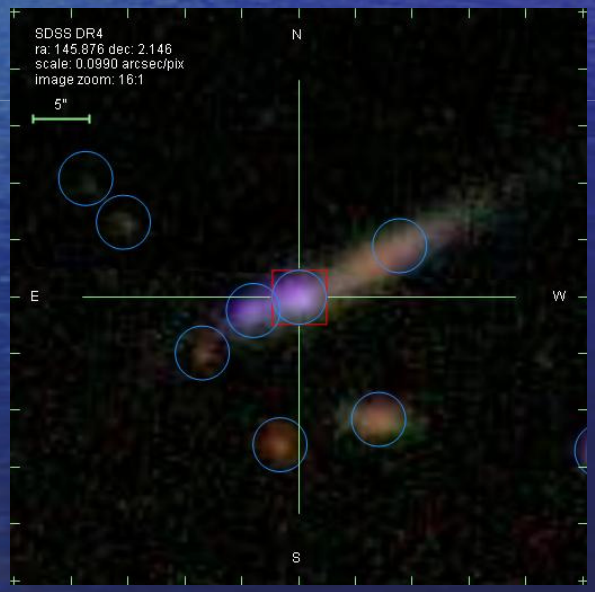
HII galaxies are low mass irregular galaxies with, at least, a recent episode of violent star formation concentrated in a few parsecs close to their cores.

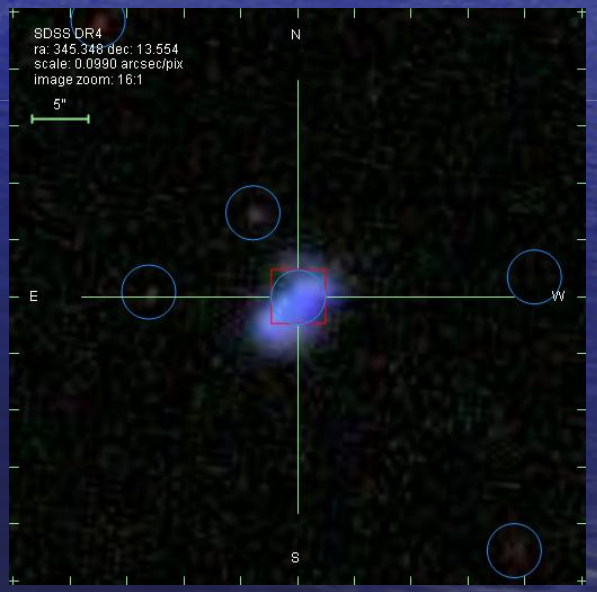
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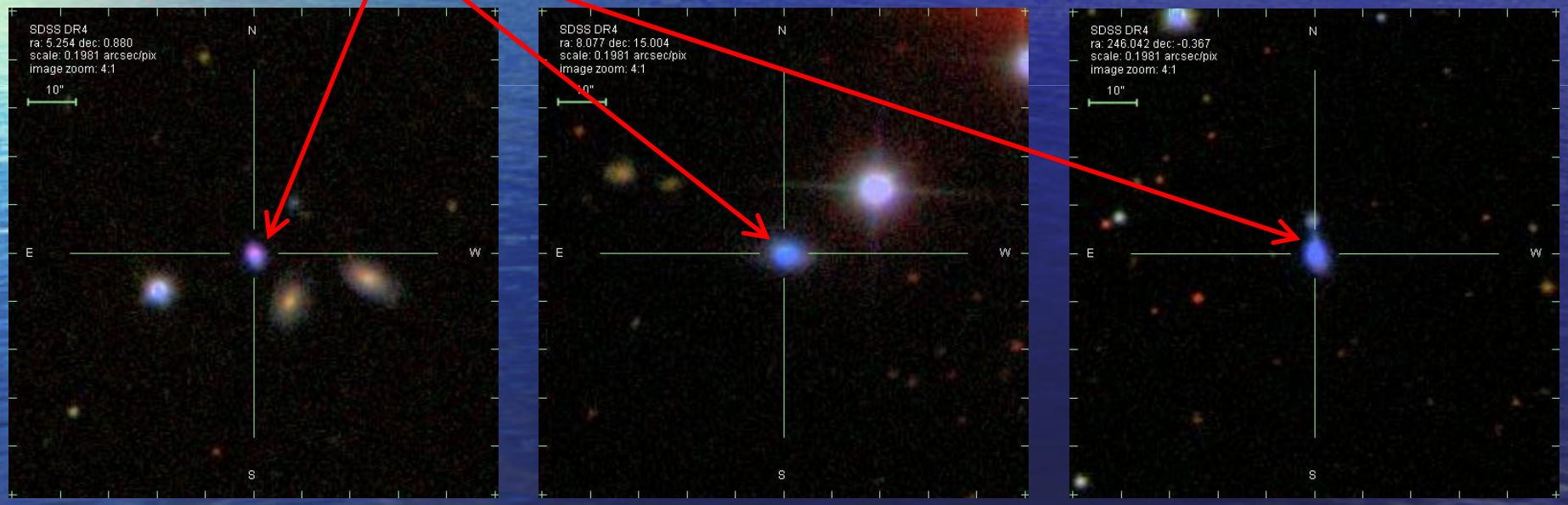


images from SDSS

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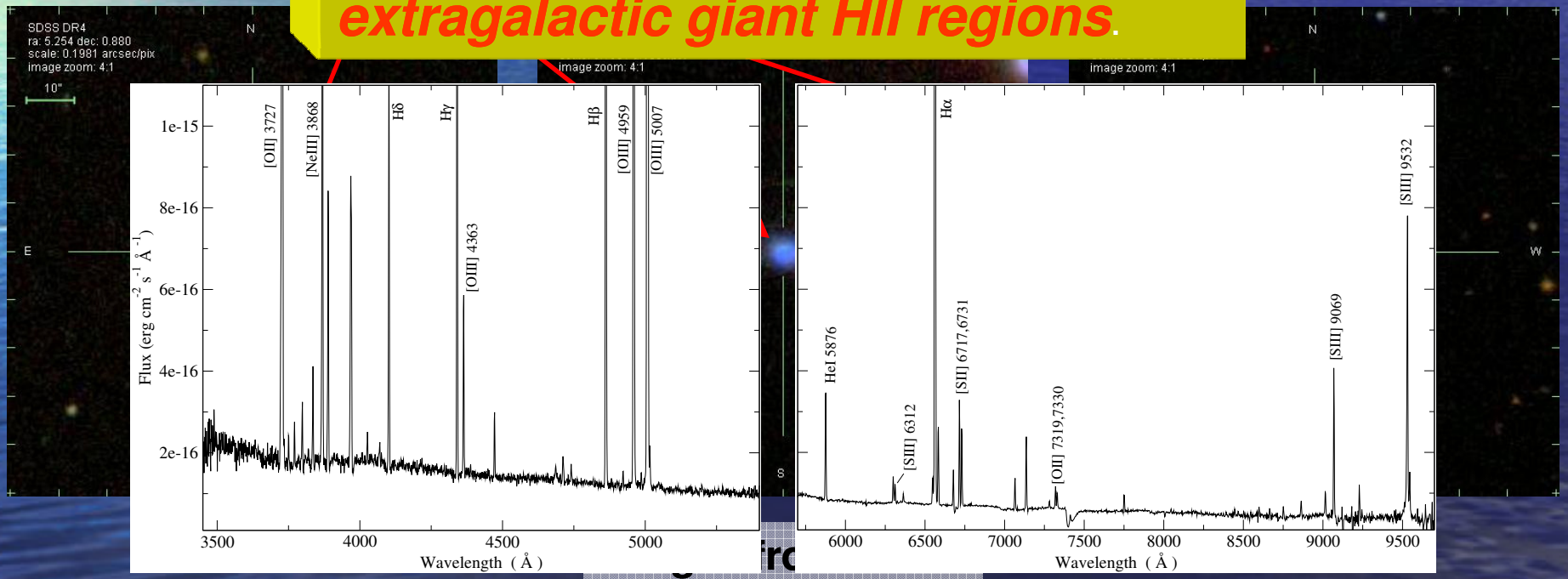
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Thus, these systems have an emission line spectrum very similar to those of the extragalactic giant HII regions.

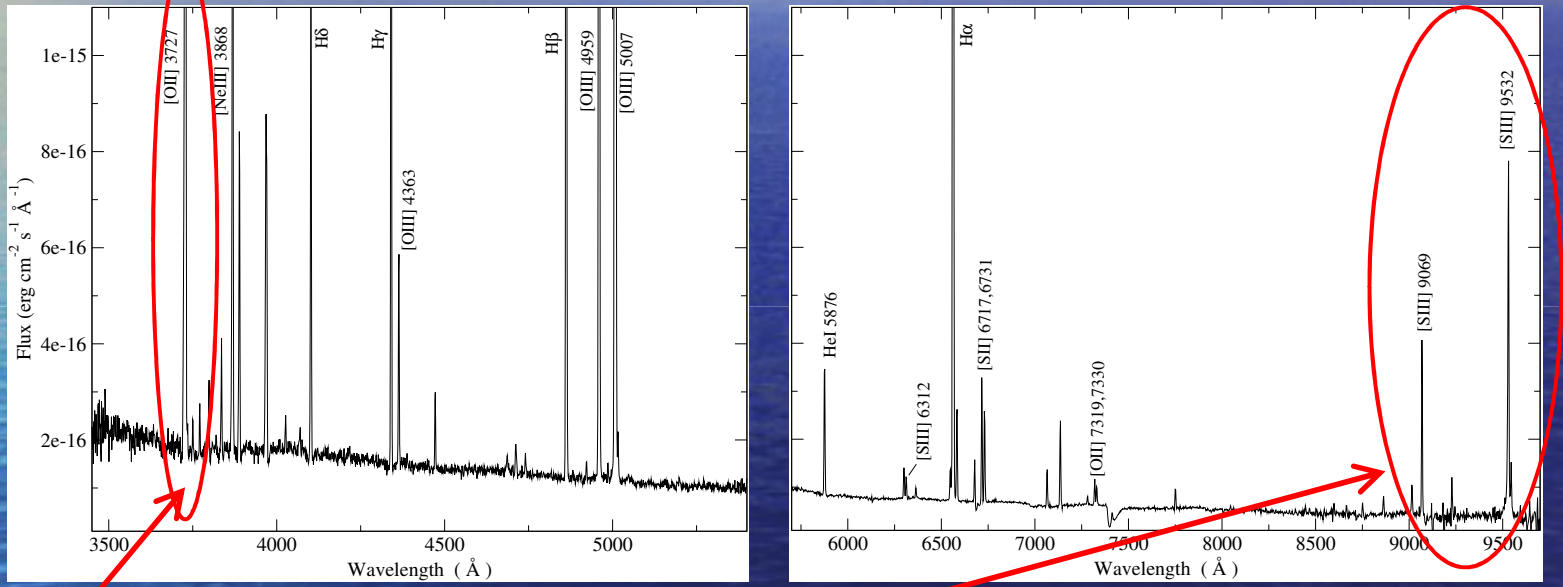


Observations:

Intermediate resolution blue and far red longslit spectra of bright HII galaxies were simultaneously obtained.

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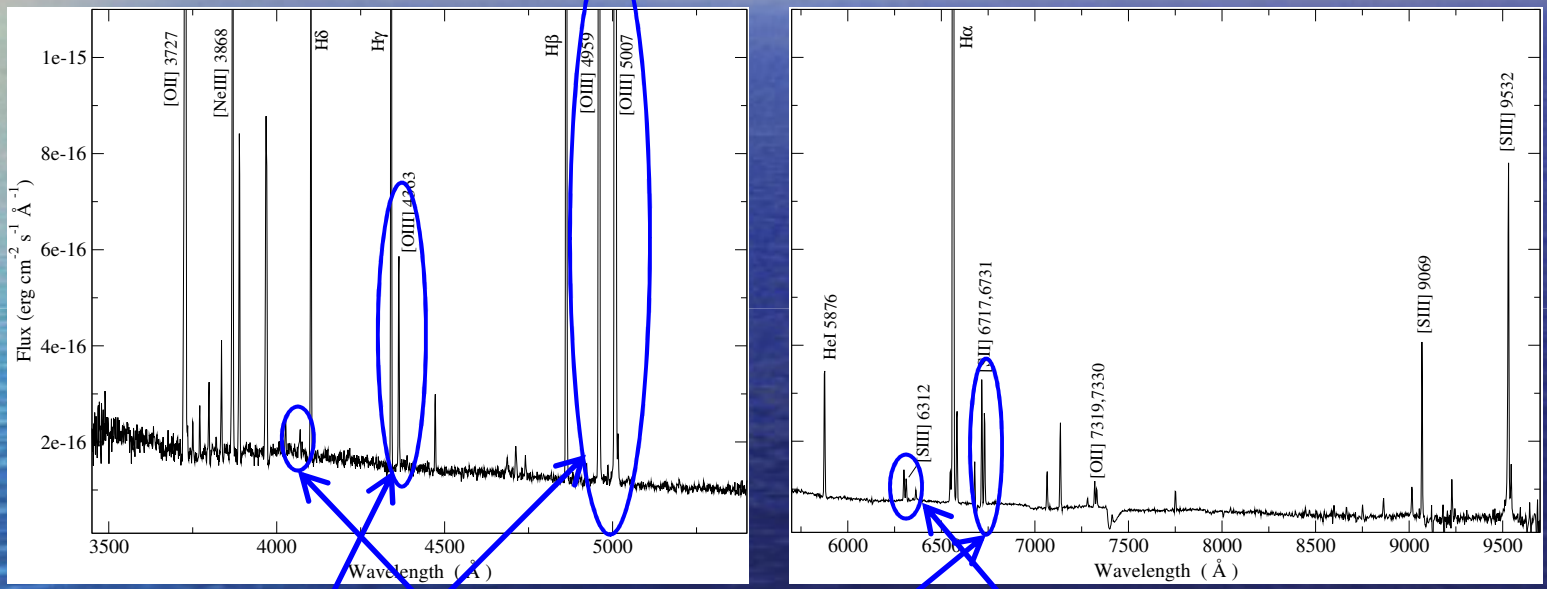
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We have chosen the spectral range to measure simultaneously the nebular lines **[OII]3727 and [SIII]9069,9532**. Besides, we have measured other important lines such as **[OIII]4363,4959,5007, [SII]4068,6717,6731, and [SIII]6312**.

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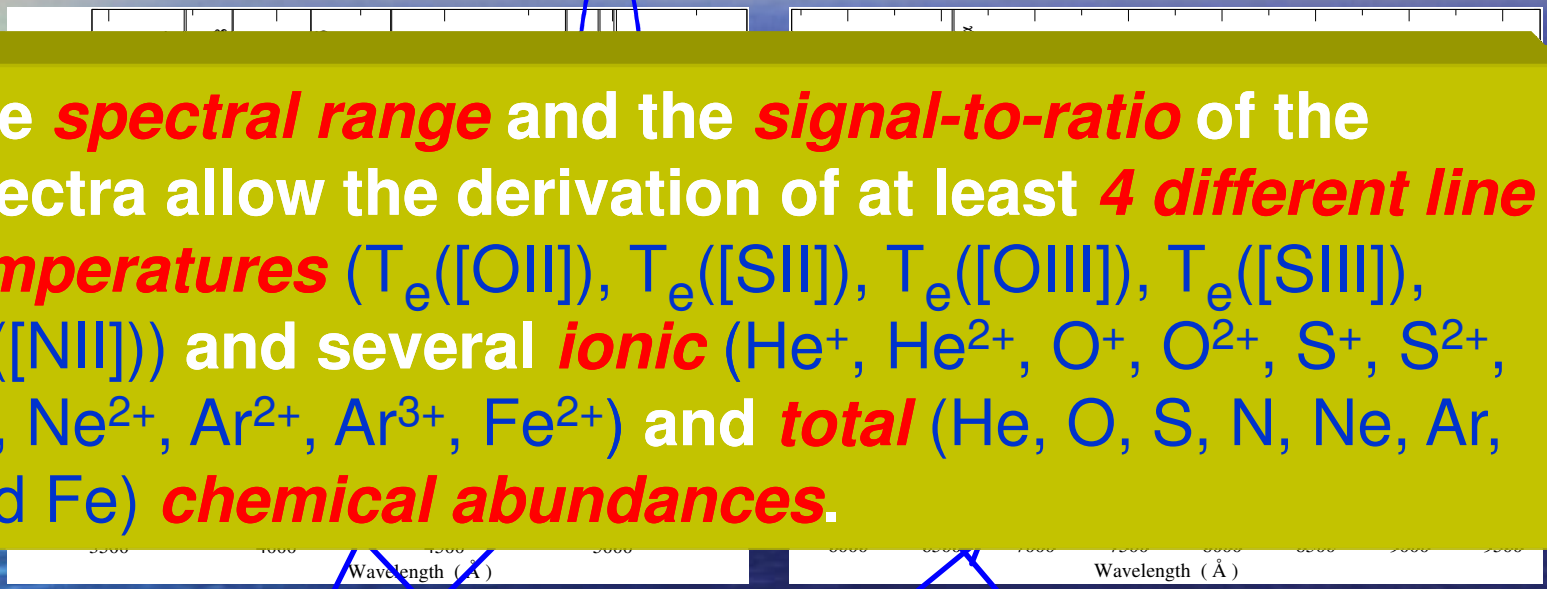
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The *spectral range* and the *signal-to-ratio* of the spectra allow the derivation of at least *4 different line temperatures* (T_e([OII]), T_e([SII]), T_e([OIII]), T_e([SIII]), T_e([NII])) **and several *ionic*** (He^+, He^{2+}, O^+, O^{2+}, S^+, S^{2+}, N^+, Ne^{2+}, Ar^{2+}, Ar^{3+}, Fe^{2+}) **and *total*** (He, O, S, N, Ne, Ar, and Fe) ***chemical abundances*.**

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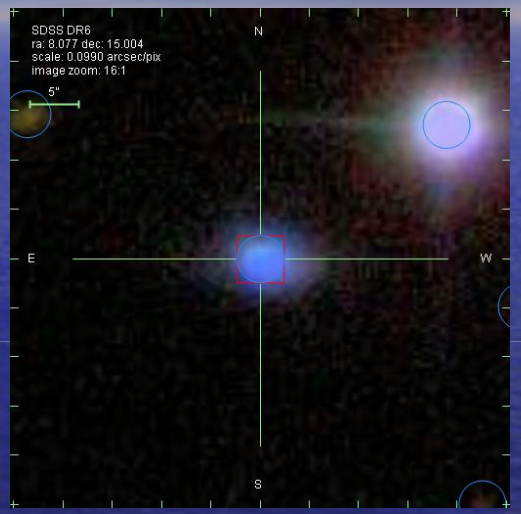
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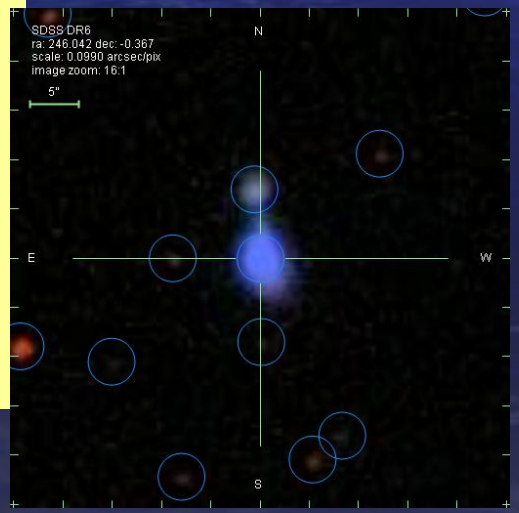
4.2 m WHT+ISIS
One single night observing run
Average seeing ≈ 0.5-0.8´´
Slit width 0.5´´

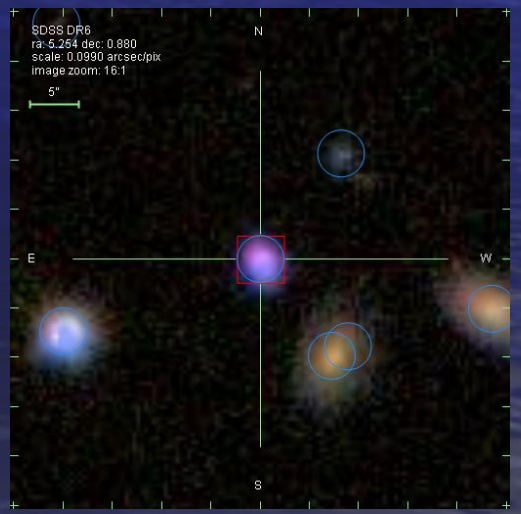
Spectral resolution:
0.86 Å/px blue (R_{FWHM}=1780)
1.64 Å/px red (R_{FWHM}=1670)

Spectral range:
3200-5700 Å blue
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3 bright HII galaxies







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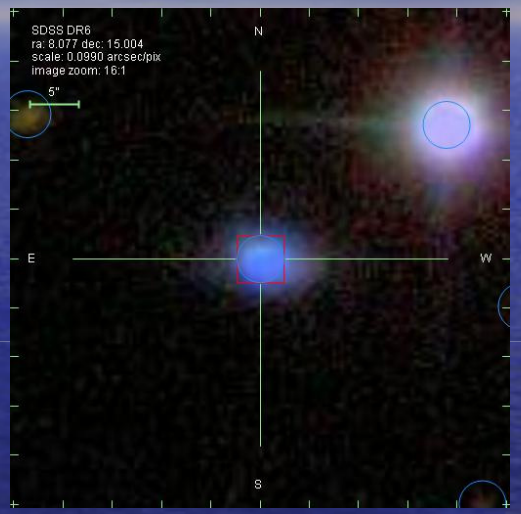
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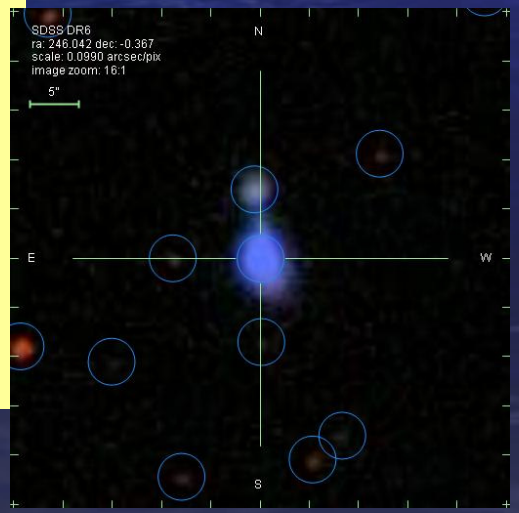
July 2004

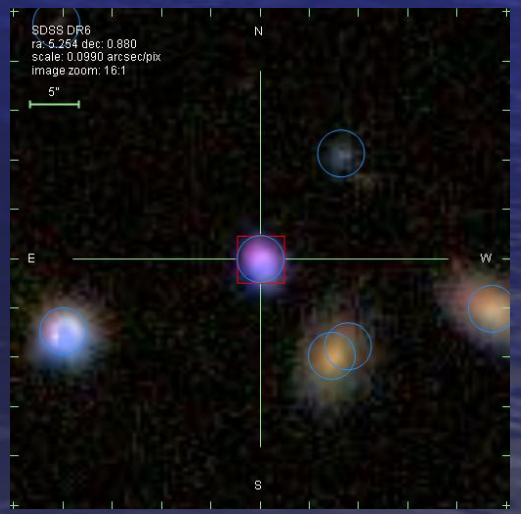
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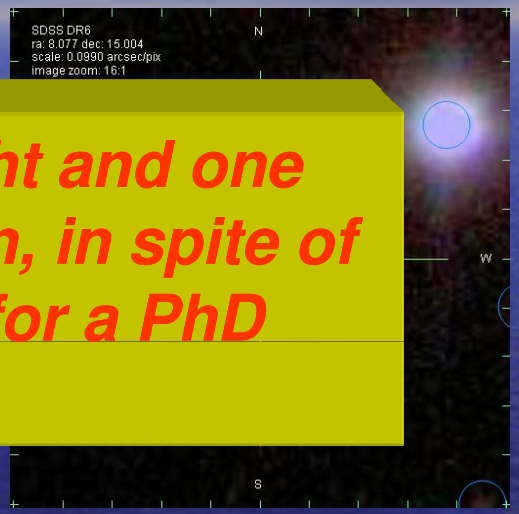
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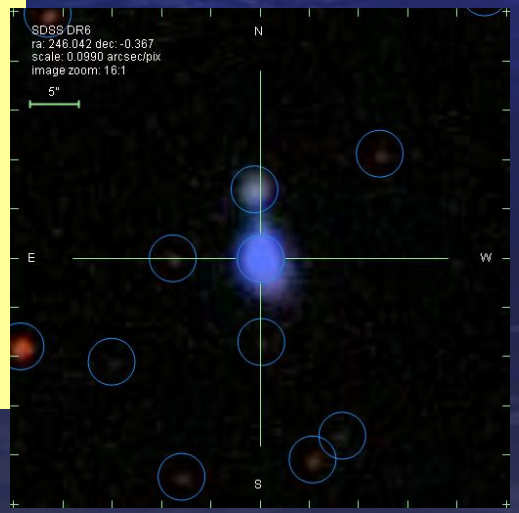
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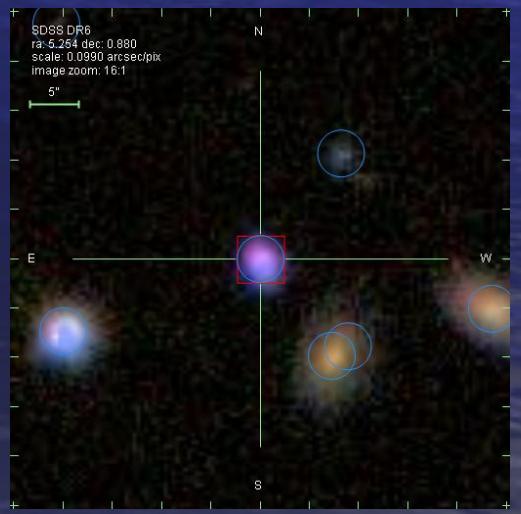
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Spectr
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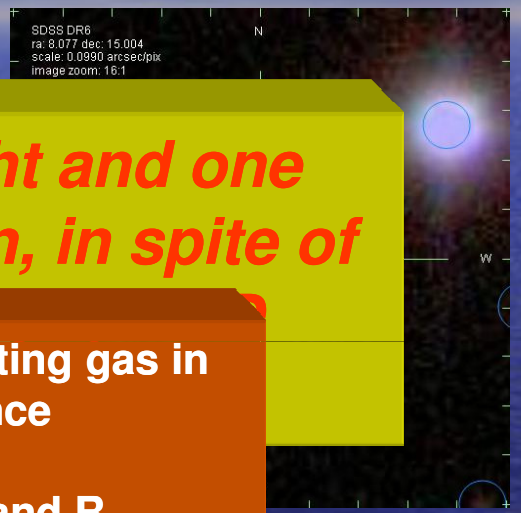
Spectr
3200-5
5500-1

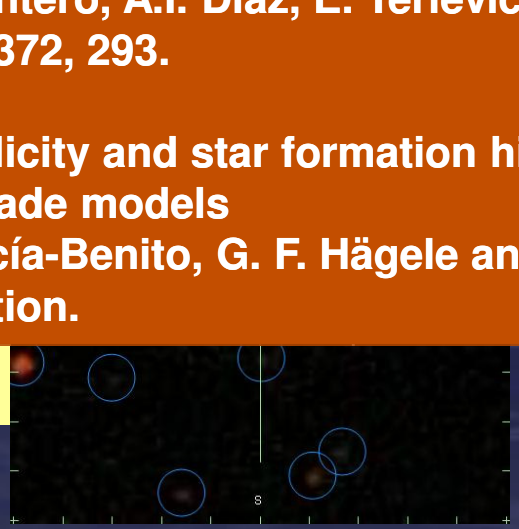
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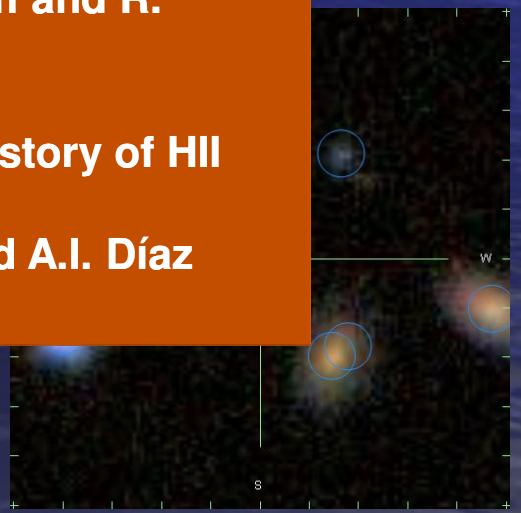
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- **Disentangling the metallicity and star formation history of HII galaxies through tailor-made models**
E. Pérez-Montero, R. García-Benito, G. F. Hägele and A.I. Díaz 2009, MNRAS, in preparation.

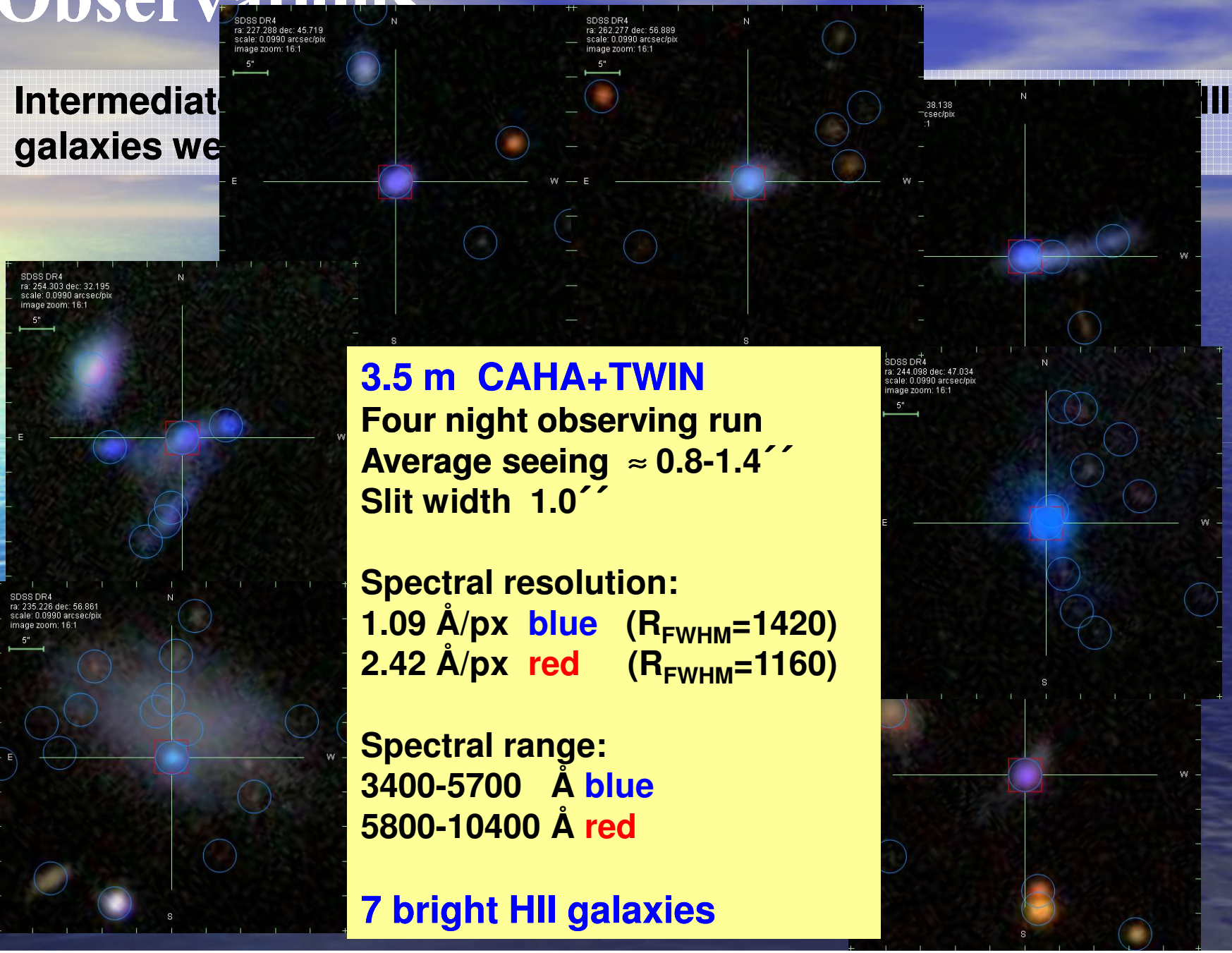






Observations:

Intermediat… galaxies we… …III



3.5 m CAHA+TWIN
Four night observing run
Average seeing ≈ 0.8-1.4´´
Slit width 1.0´´

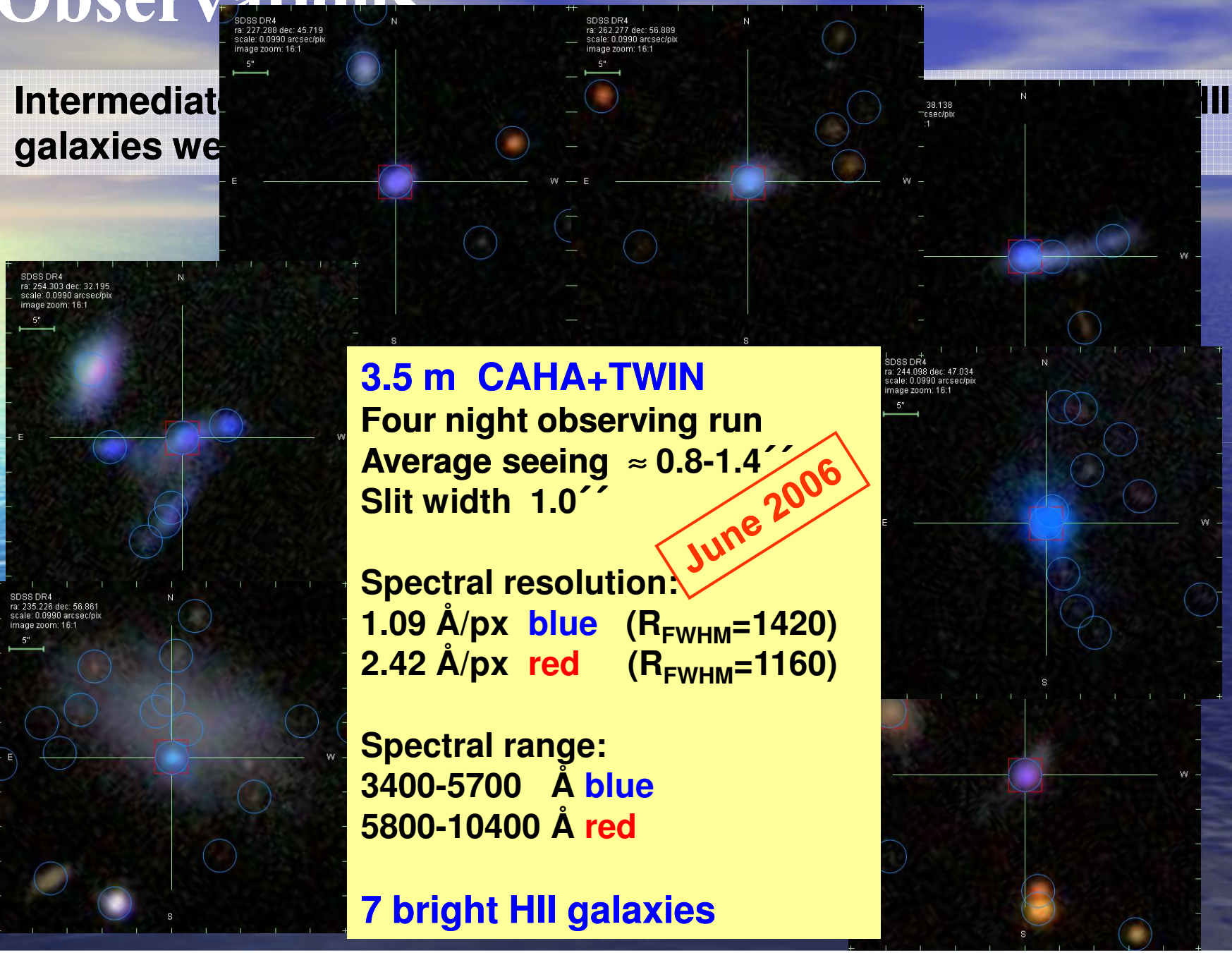
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7 bright HII galaxies

Observations:

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June 2006

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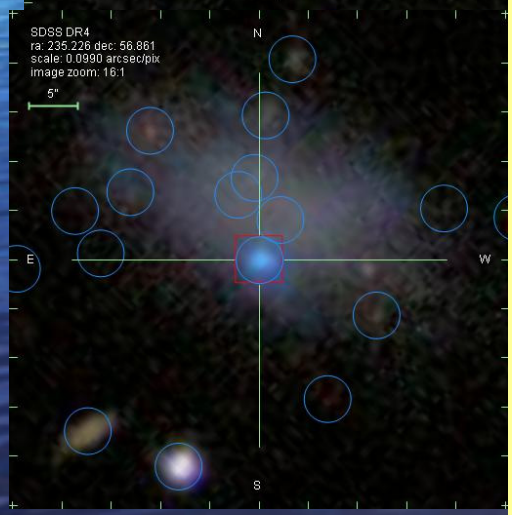
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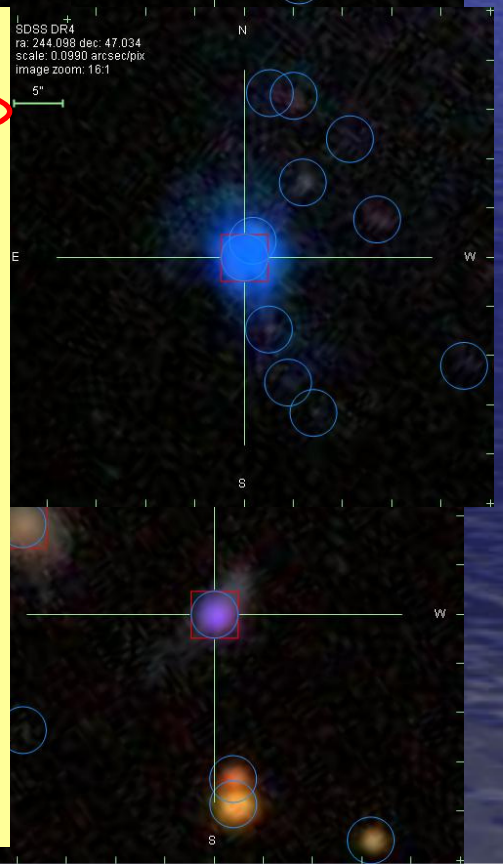
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1.09 Å/px blue (R_{FWHM}=1420)
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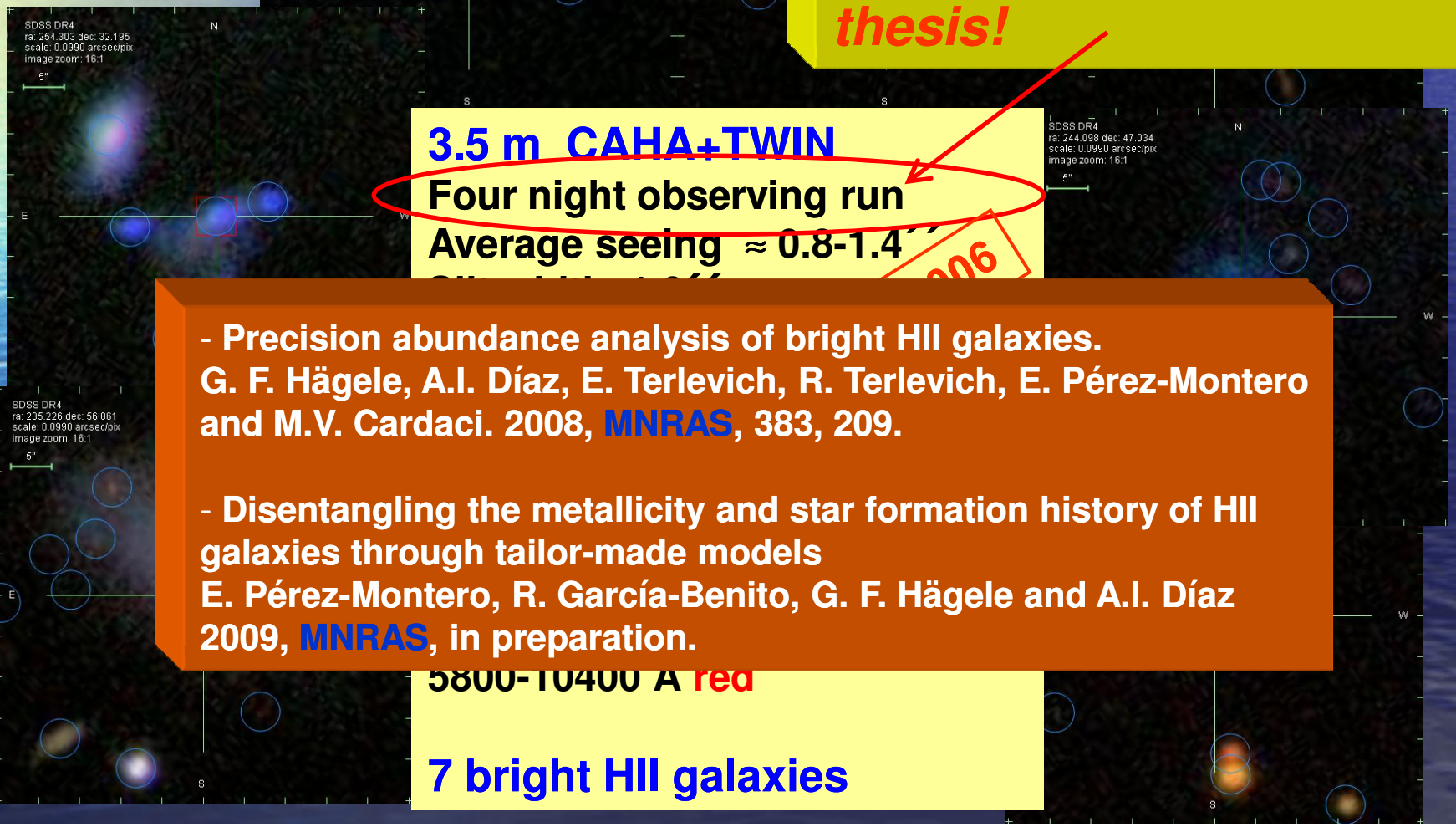
Spectral range:
3400-5700 Å blue
5800-10400 Å red

7 bright HII galaxies

Observations:

Intermediat
galaxies we





Again, only one observing run, in spite of being asked for a PhD thesis!

3.5 m CAHA+TWIN

Four night observing run

Average seeing ≈ 0.8-1.4''

5800-10400 Å red

7 bright HII galaxies

- **Precision abundance analysis of bright HII galaxies.**
G. F. Hägele, A.I. Díaz, E. Terlevich, R. Terlevich, E. Pérez-Montero and M.V. Cardaci. 2008, MNRAS, 383, 209.

- **Disentangling the metallicity and star formation history of HII galaxies through tailor-made models**
E. Pérez-Montero, R. García-Benito, G. F. Hägele and A.I. Díaz 2009, MNRAS, in preparation.

Evolution of the Main objectives of this work:

- **Obvious questions:** **Are these data enough for a thesis???**
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The second observing run was on June 2006!!!!

Meanwhile, we decided to use "our personal archive" of uncompleted projects.

Evolution of the Main objectives of this work:

- A second objective has been to ***develop a semi-empirical method for the derivation of abundances in high metallicity HII regions*** that can be applied to the CNSFRs of our study. Given the weakness of the oxygen emission lines in their spectra our study has been ***based mainly on the sulphur emission lines*** observed in the far red spectral region.

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- **A third objective of this work has been to *measure the stellar velocity dispersions of selected CNSFRs from the CaT lines and derive their dynamical masses*. The comparison of these masses with those inferred from the number of ionizing photons in the region will give an *estimate of the contribution of the present star formation episode* to the mass proceeding from previous stellar generations *and* will help to *characterize the star formation history of these objects*.**

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Related to another main research line of Estallidos

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Introduction:

CN regions: SF in high metallicity environments

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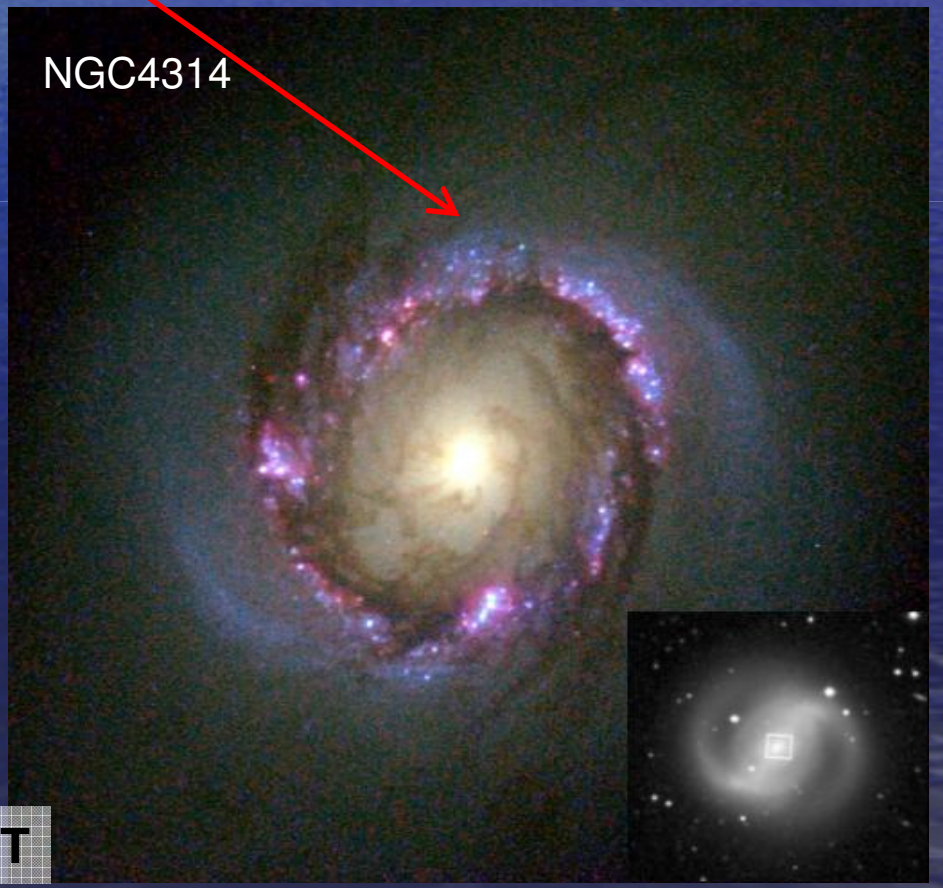


image from HST

Introduction:

CN regions: SF in high metallicity environments

In the ultraviolet (UV), *massive stars* dominate the observed circumnuclear emission

Introduction:

CN regions: SF in high metallicity environments

In the ultraviolet (UV), *massive stars* dominate the observed circumnuclear emission *even in the presence of an active* nucleus (González-Delgado et al., 1998; Colina et al., 2002).

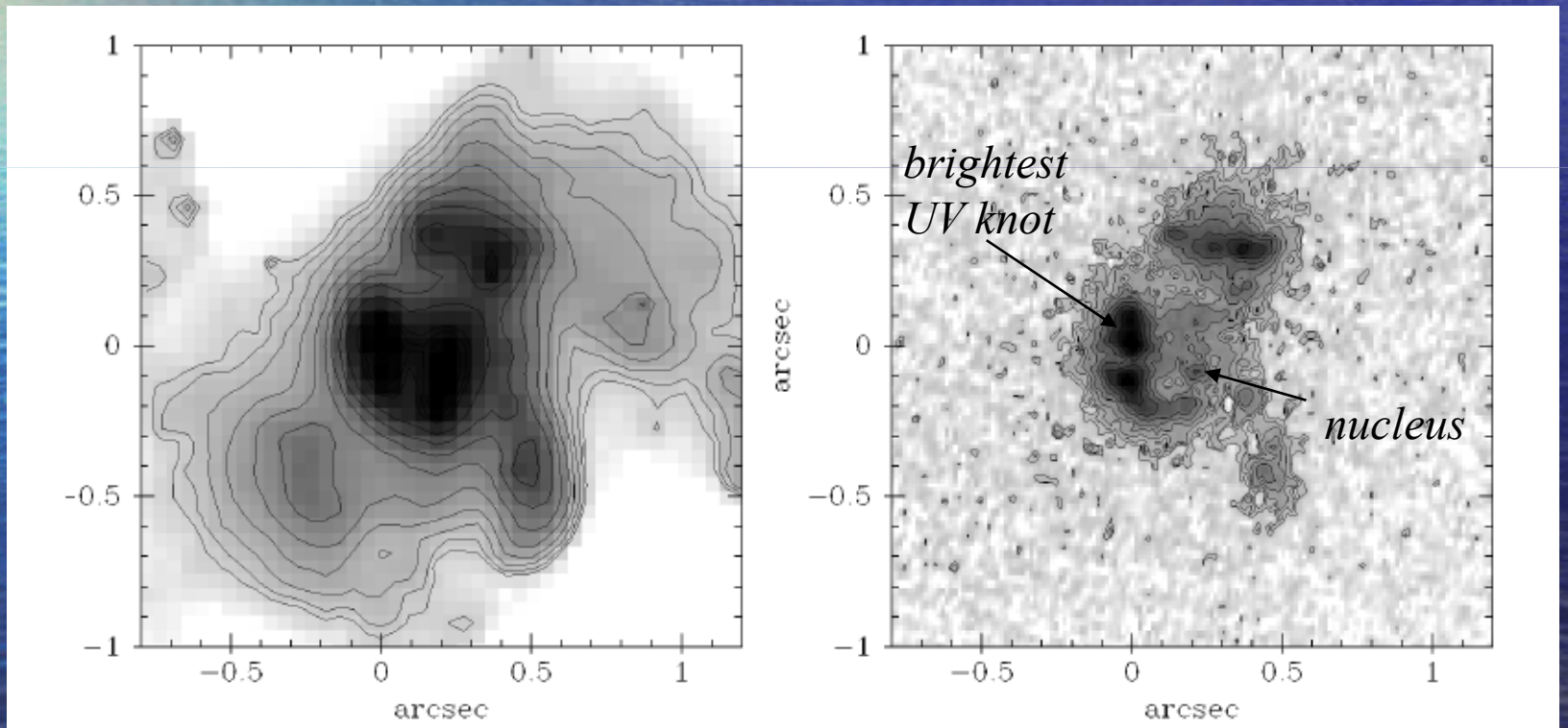


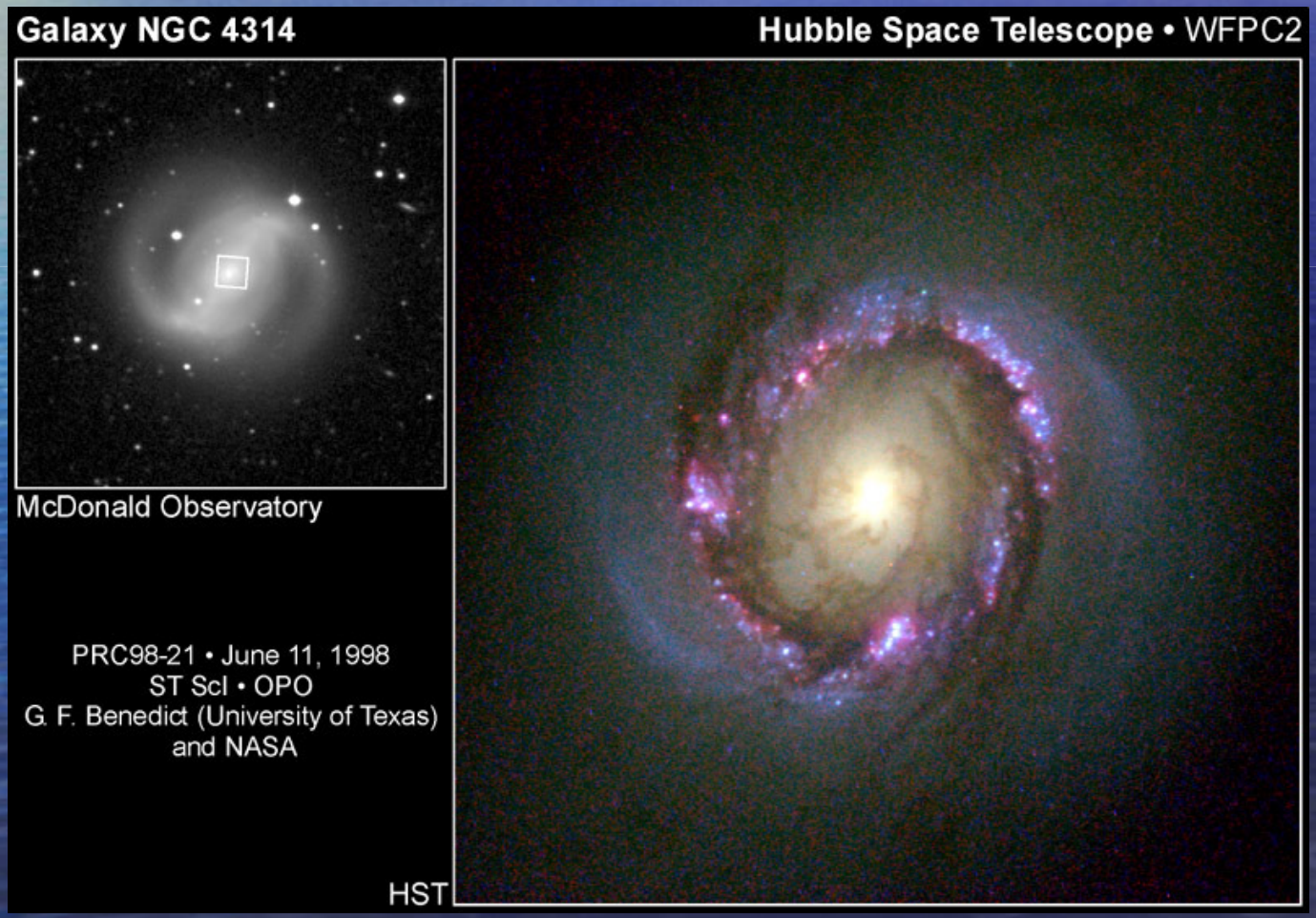
FIG. 4.—Central 2″ × 2″ (620 by 620 pc) of NGC 7130 in (*a*) optical light and (*b*) UV light. The origin of the plot is the knot with the highest UV surface brightness. The presumed nucleus is placed at 0.″2 west and 0.″1 south of the origin.

(González-Delgado et al., 1998)

Introduction:

CN regions: SF in high metallicity environments

CNSFRs in early type galaxies *are expected to be of high metallicity, as corresponds to their position near the galactic bulge*.

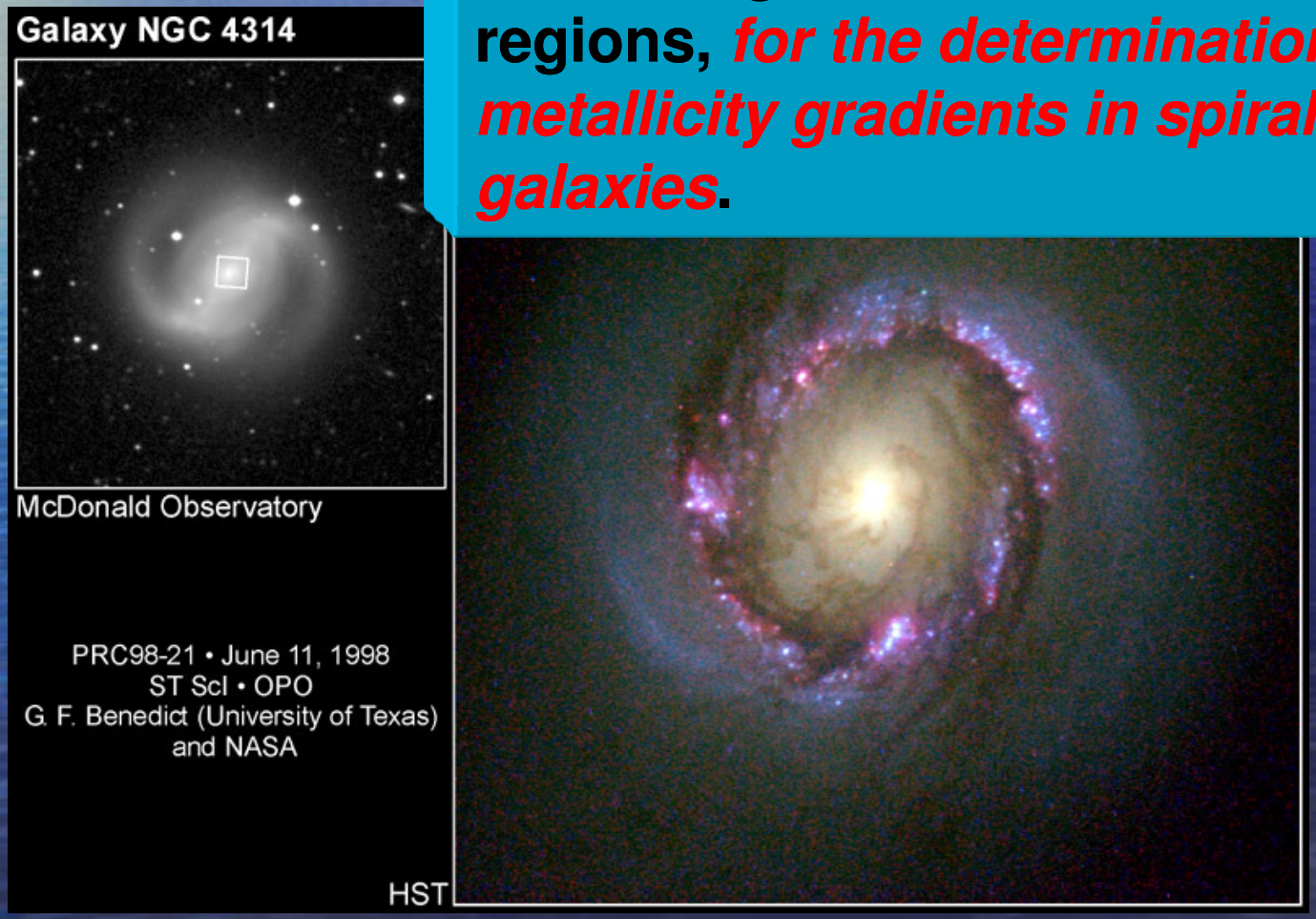


Introduction:

CN regions: SF in

CNSFRs in early type galaxie
corresponds to their posit

therefore *they provide clues for the understanding of star formation phenomena at large metallicities*, *and*, being close to the nuclear regions, *for the determination of metallicity gradients in spiral galaxies*.



Star Formation in Circumnuclear Regions:

The metal abundances

- The metal abundace of circumnuclear star forming regions in early type spirals. Spectrophotometric observations.
A.I. Díaz, E. Terlevich, M. Catellanos and G. F. Hägele.
2007, MNRAS, 382, 251.

Observations

Intermediate resolution blue and far-red spectra (≈ 2 Å/px) were acquired *simultaneously* using the blue and red arms of ISIS, mounted on the 4.2m WHT.

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We observed three early type spiral galaxies





Observations

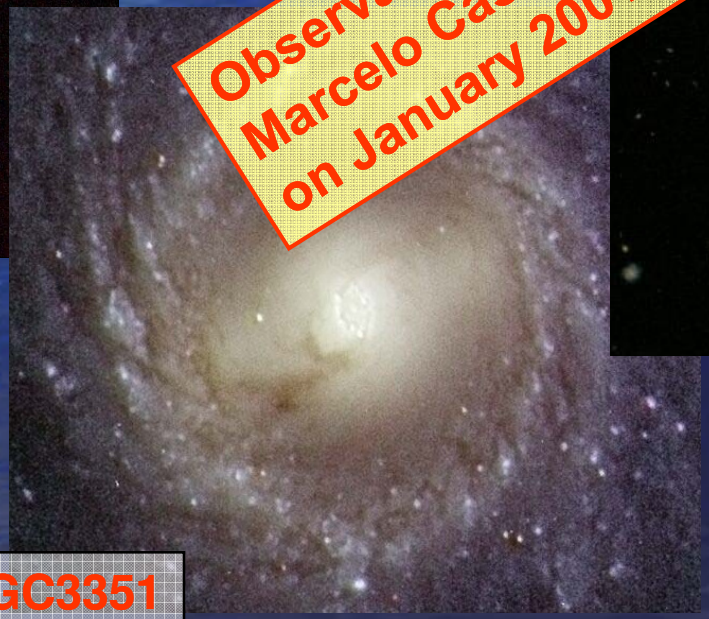
Intermediate resolution blue and far-red spectra (≈ 2 Å/px) were acquired *simultaneously* using the blue and red arms of ISIS, mounted on the 4.2m WHT.



NGC2903

We observed three early type spiral galaxies

Observations made by Marcelo Castellanos on January 2001!!!!!



NGC3351



NGC3504

Observations

4.2 m WHT + ISIS
Average seeing ≈ 1.2´´
Slit width 1.5´´

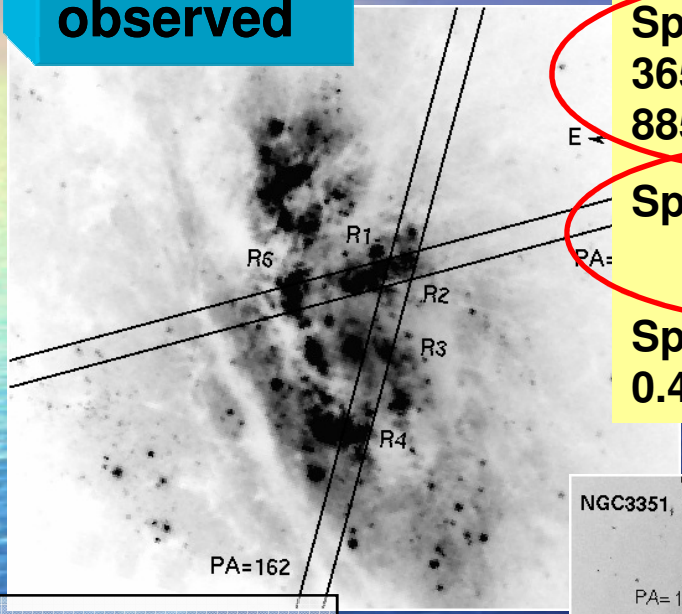
Spectral range:
3650-7000 Å blue
8850-9650 Å red

Spectral resolutions:
≈ 2 Å/px

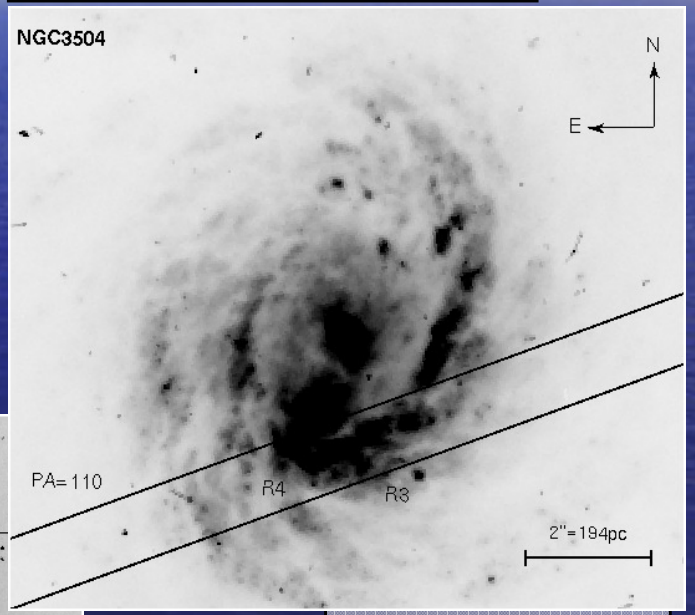
Spatial resolution:
0.4 ´´/pix

Two wide spectral ranges with moderate spectral resolution

5 CNSFRs observed



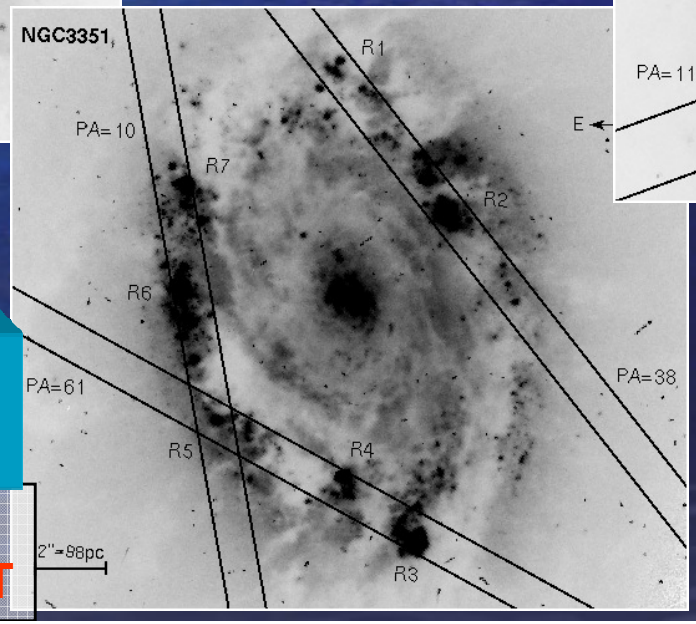
NGC2903 F606W – HST



NGC3504 F606W – HST

2 CNSFRs observed

7 CNSFRs observed



NGC3351 F606W – HST

Star Formation in Circumnuclear Regions:

On the derivation of dynamical masses of the stellar clusters

- Kinematics of gas and stars in the circumnuclear starforming ring of NGC3351.
G. F. Hägele, A.I. Díaz, M.V. Cardaci, E. Terlevich and R. Terlevich.
2007, MNRAS, 378, 163.
- On the derivation of dynamical masses of the stellar clusters in the circumnuclear region of NGC 2903.
G. F. Hägele, A.I. Díaz, M.V. Cardaci, E. Terlevich and R. Terlevich.
MNRAS, submitted.
- Circumnuclear star-forming regions in NGC 3310.
G. F. Hägele, A.I. Díaz, M.V. Cardaci, E. Terlevich and R. Terlevich.
MNRAS, in preparation (almost finished).

Observations

High resolution blue and far-red spectra (0.2 and 0.36 Å/px) were acquired simultaneously using the blue and red arms of ISIS, mounted on the 4.2m WHT.

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NGC2903

We observed three early type spiral galaxies



NGC3310

Again



NGC3351

Observations

High resolution blue and far-red spectra (0.2 and 0.36 Å/px) were acquired simultaneously using the blue and red arms of ISIS, mounted on the 4.2m WHT.



NGC2903

We observed three early type spiral galaxies

Observations made by Ángeles, Elena and Roberto on February 2000!!!!



Again

NGC3351



NGC3310

Observations

4.2 m WHT + ISIS
Average seeing ≈ 1.2´´
Slit width 1.0´´

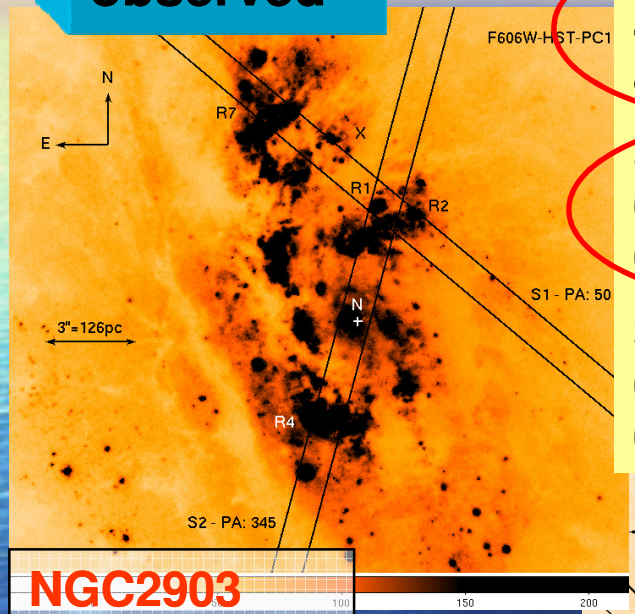
Spectral range:
4779-5199 Å blue
8363-8763 Å red

Spectral resolutions:
0.21 Å/pix blue
0.39 Å/pix red

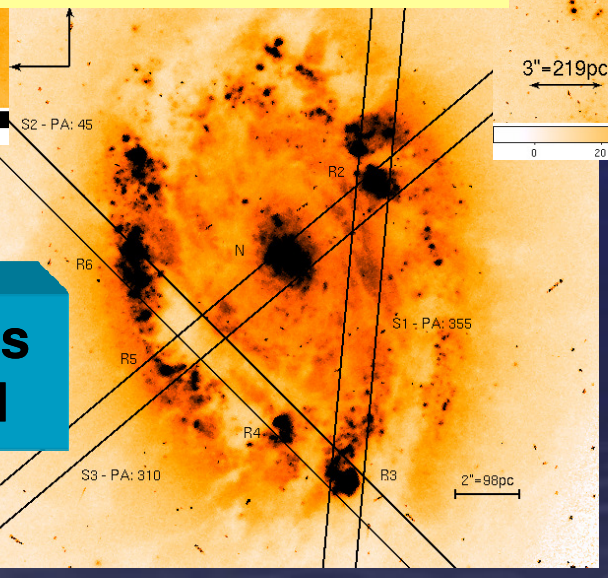
Spatial resolution:
0.38 ´´/pix blue
0.36 ´´/pix red

Two small spectral ranges with high spectral resolution

4 CNSFRs observed

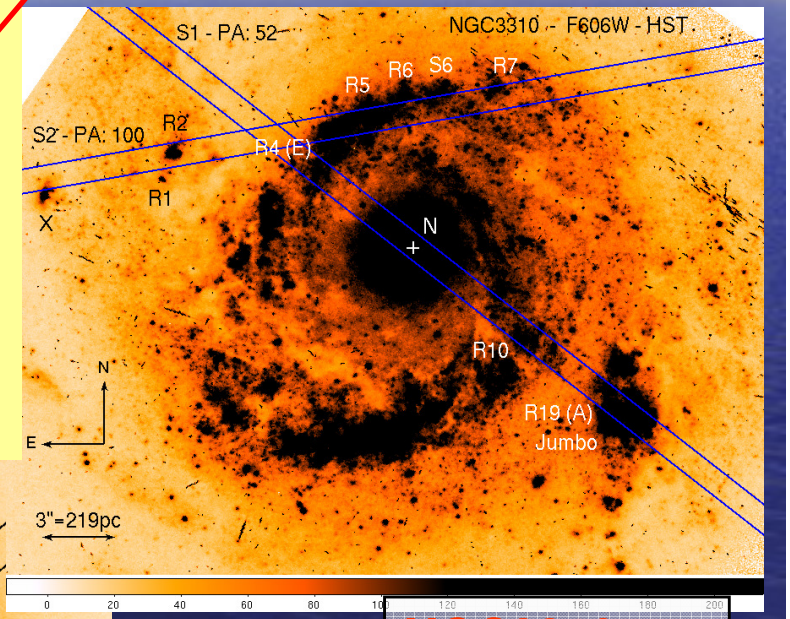


NGC2903
F606W – HST



5 CNSFRs observed

NGC3351
F606W – HST



NGC3310
F606W – HST

8 CNSFRs + Jumbo region observed

Main conclusions of the Thesis

Conclusions

• We have studied large scale star formation processes in galaxies in two very different environments that can be considered extreme in terms of metal content: relatively compact HII galaxies and circumnuclear star-forming regions in spiral galaxies.

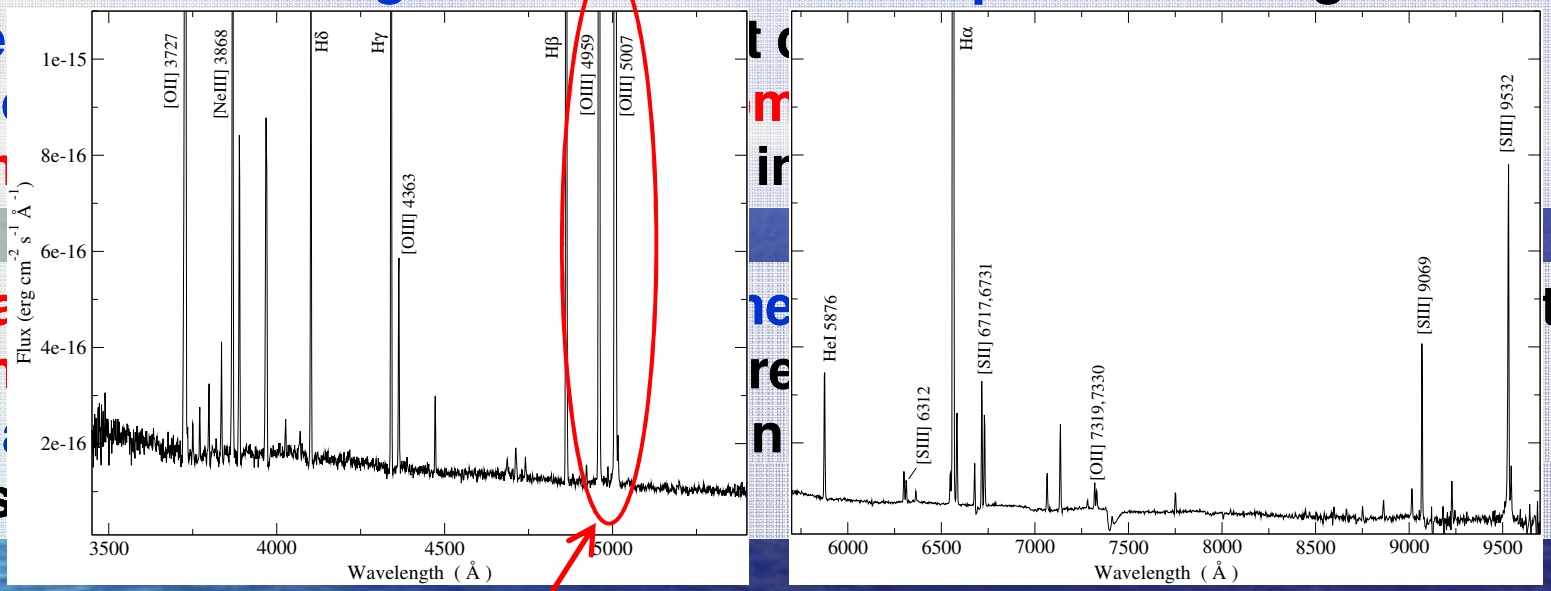
Conclusions

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• HII galaxies are among the most metal-poor objects known while the circumnuclear regions of galaxies are expected to be very high abundance sites due to their location in the inner part of galactic bulges.

Conclusions

• We have studied large scale star formation processes in galaxies in two ve… t… terms … m… circum… ir…



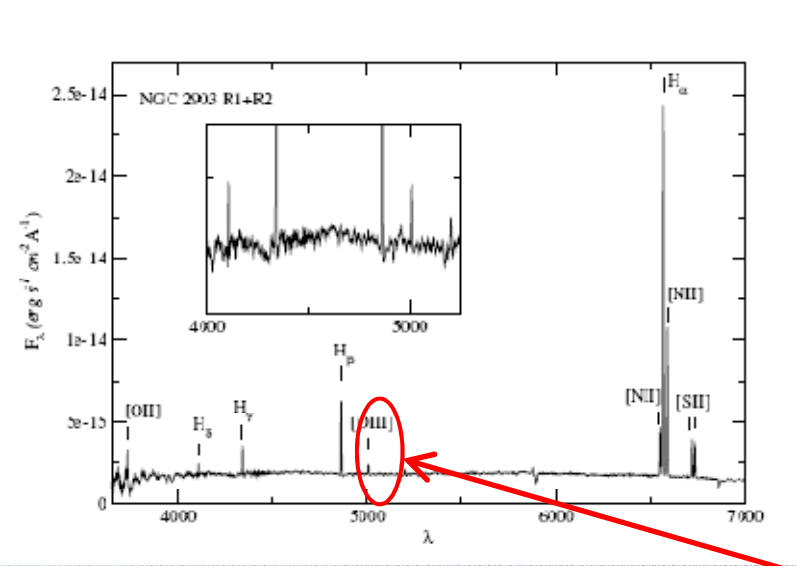
• HII ga… ne… the circum… re… abunda… n… bulges…

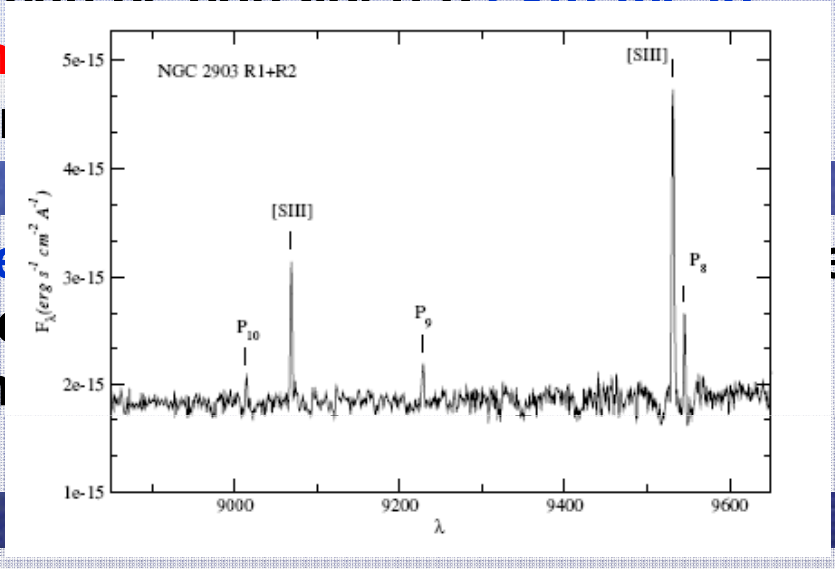
• In the first case the spectra show a high excitation, being dominated by strong forbidden oxygen lines ([OIII]5007/Hβ >4);

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• H t me ci s ar ab tion bu e

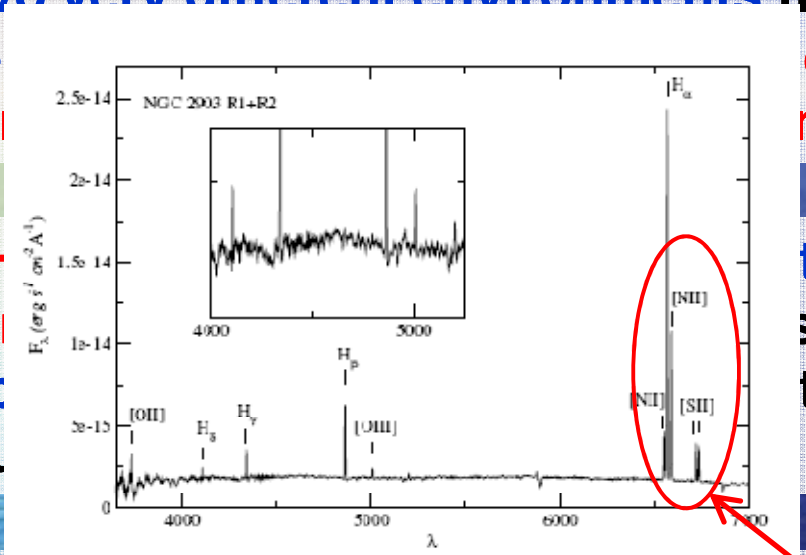


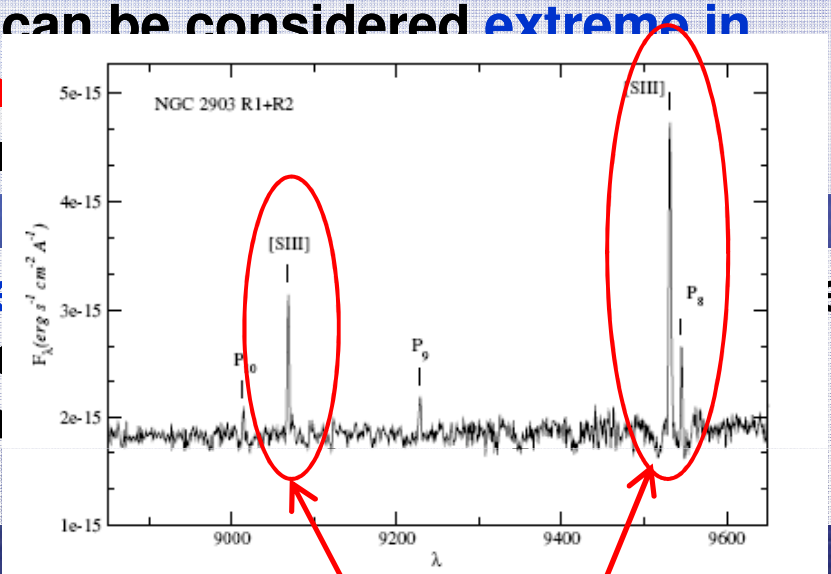


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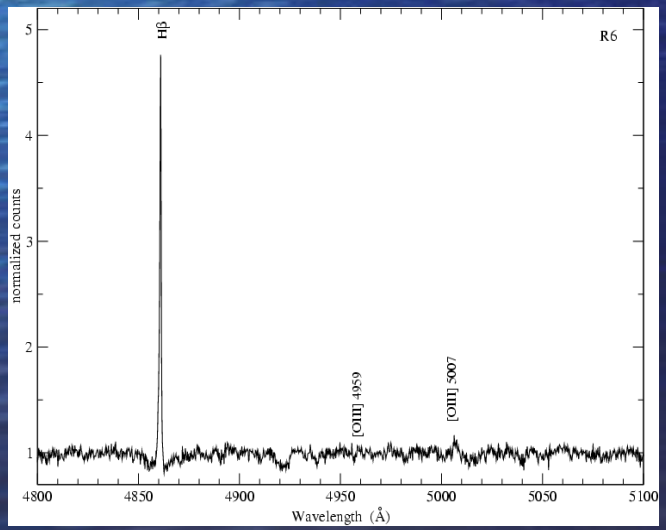
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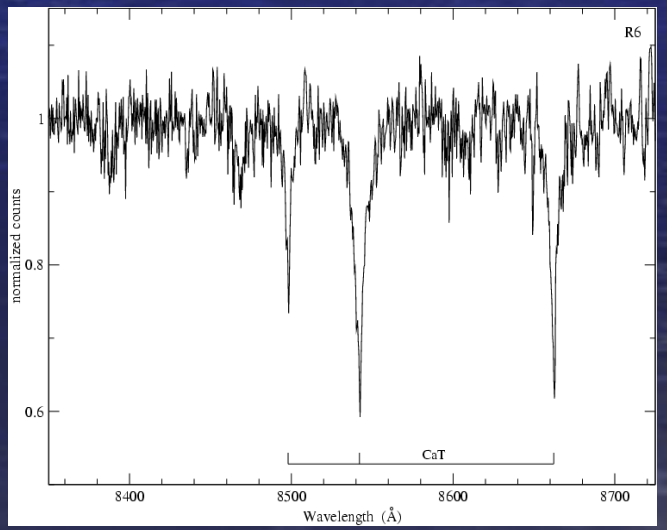
• We have analyzed the physical properties of the gas in 10 HII galaxies and 12 CNSFRs in 3 early type spirals using intermediate resolution spectroscopy obtained with double arm spectrographs which provide the best spectrophotometry attainable, since it allows to cover the whole spectral range from 3600 to 10000Å simultaneously in the same position in the object.

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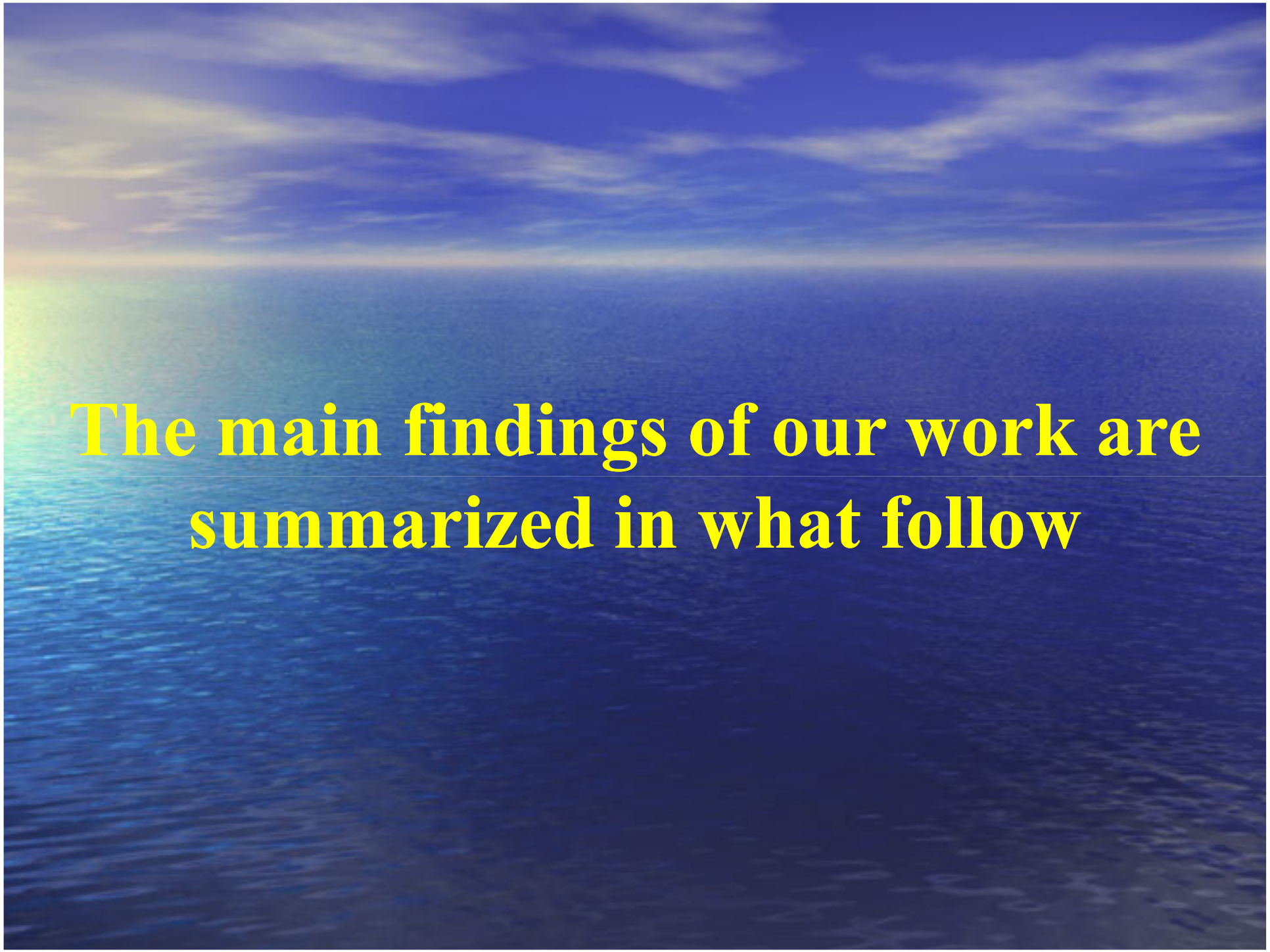
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• We have also investigated the kinematical properties of the gas and stars in a total of 17 CNSFRs using high dispersion spectroscopy.

• The first set of data has been used to infer the properties of the ionizing stellar populations using photo-ionization and stellar population synthesis models.

•The second set of data has been used mainly to determine the dynamical masses of the CNSFRs, but has yielded some very interesting information about the gas kinematics in the galactic circumnuclear environments.


The main findings of our work are summarized in what follow

Conclusions

• The star formation processes in HII galaxies are found to occur in low density environments, electron densities have been found to be lower than 150 cm^{-3}, well below the critical density for collisional de-excitation.

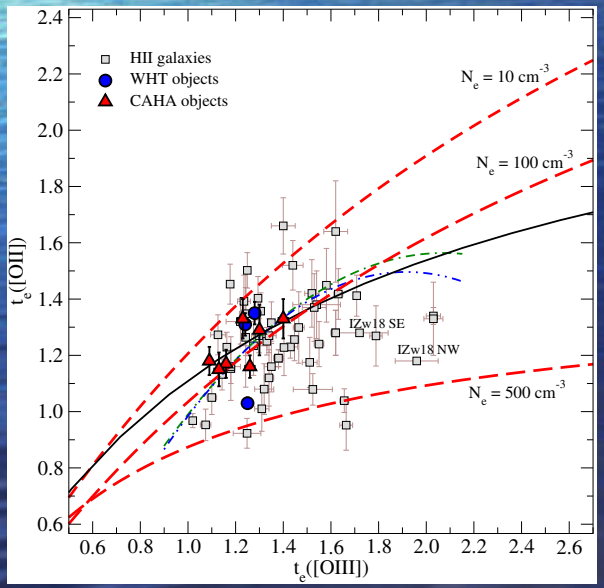
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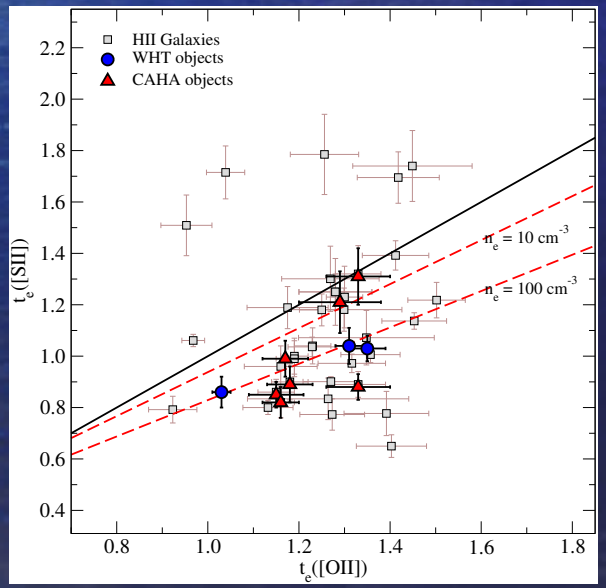
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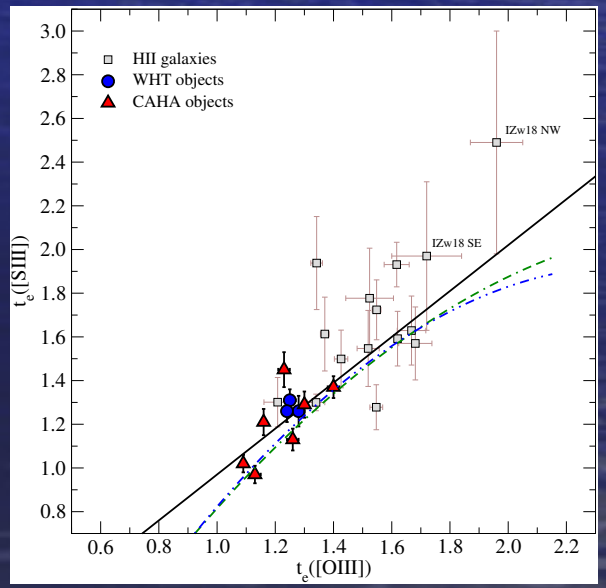
• In contrast, in the CNSFRs the densities are relatively high, with typical values around 300 cm^{-3}, and in some cases as high as 440 cm^{-3}. These values are higher than those usually derived for disc HII regions, although still below the critical value for collisional de-excitation.

Conclusions

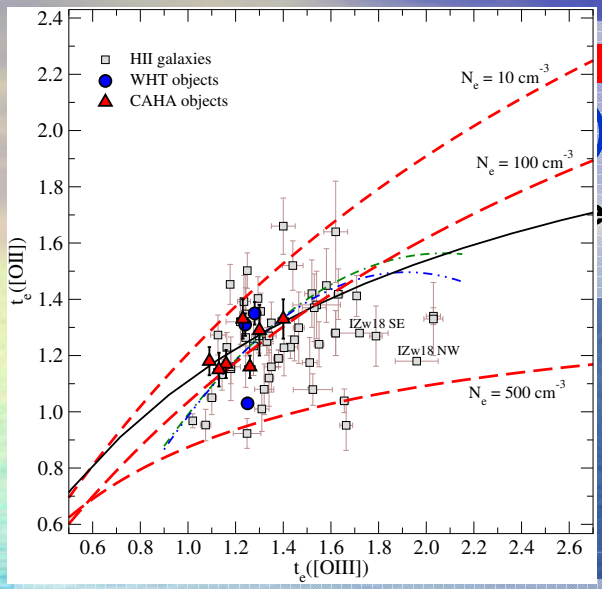
- **For all our observed HII galaxies we have measured at least four line temperatures: $T_e([OIII])$, $T_e([SIII])$, $T_e([OII])$ and $T_e([SII])$ reaching accuracies of 1% in $T_e([OIII])$, 3% in $T_e([OII])$ and 5% in $T_e([SIII])$ in the best cases.**

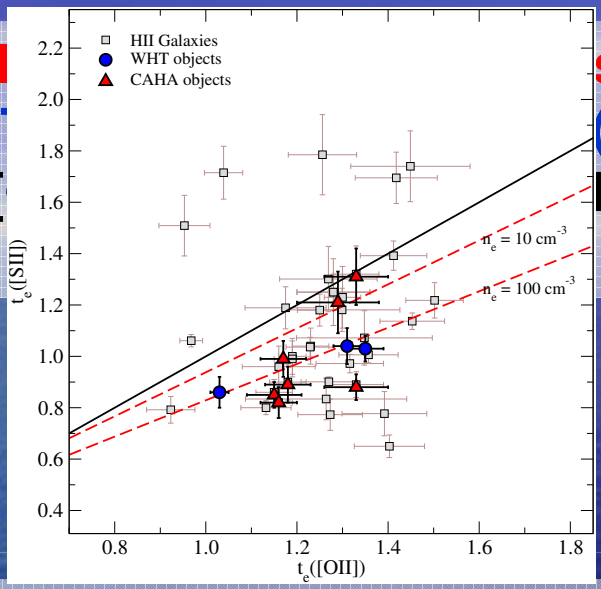


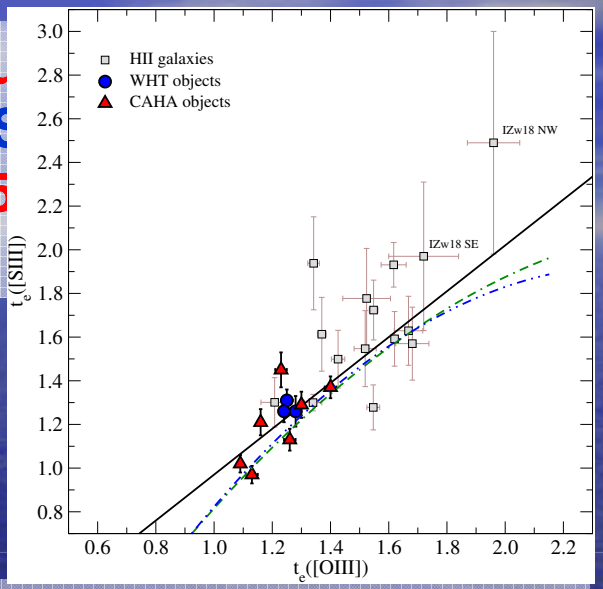




Conclusions

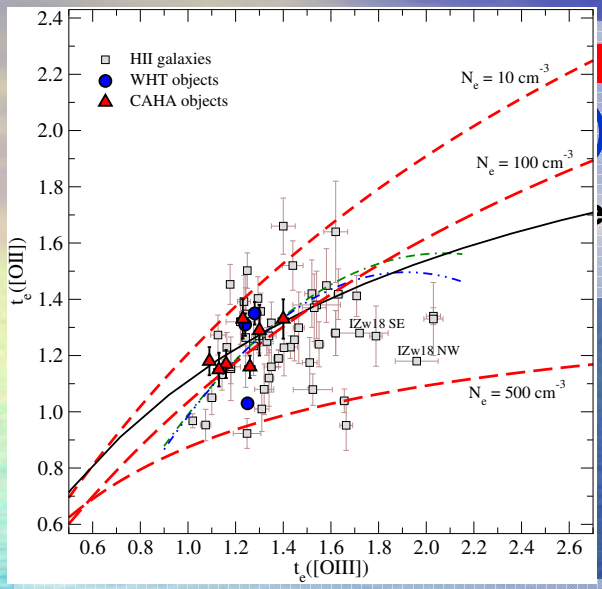


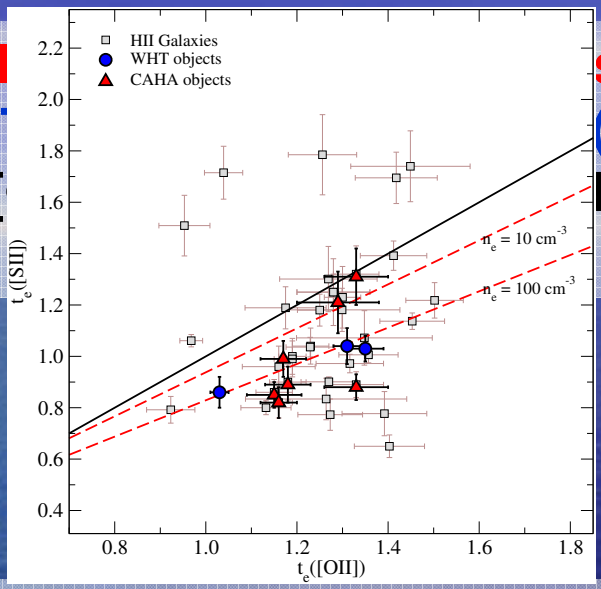


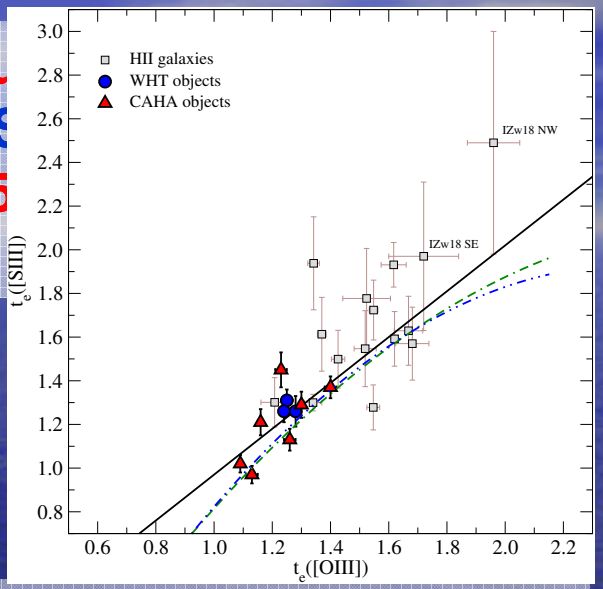


- **The obtained values for the temperatures** (in the high ionization zone are between ~11000 and ~14500K, and in the low ionization zone between ~9000 and ~13500K) **means that the observed objects are of intermediate excitation**

Conclusions





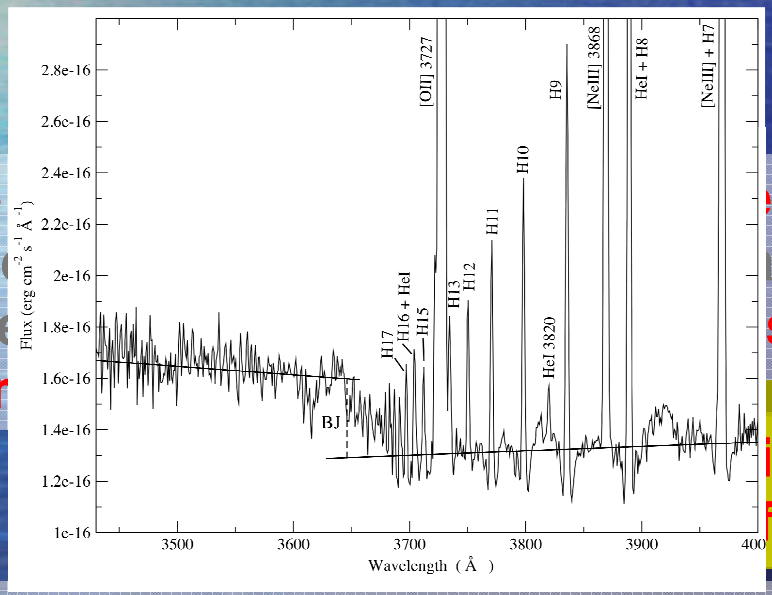


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the cooling is dominated by the oxygen forbidden lines.

Conclusions

• For all our observed HII galaxies we have measured at least four line temperatures: T_e([OIII]), T_e([SIII]), T_e([OII]) and T_e([SII]) reaching accuracies of 1% in T_e([OIII]), 3% in T_e([OII]) and 5% in T_e([SIII]) in the best cases.



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• For three of the HII galaxies of the sample, we measured the Balmer continuum temperature [T(Bac)] and estimated the temperature fluctuations according to the scheme introduced by M. Peimbert.

Conclusions

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jects are of intermediate
e

Only one of the objects shows significant temperature fluctuations which would lead to higher oxygen abundances than derived by about 0.20 dex.

• For three of the HII galaxies of the sample, we measured the Balmer continuum temperature [T(Bac)] and estimated the temperature fluctuations according to the scheme introduced by M. Peimbert.

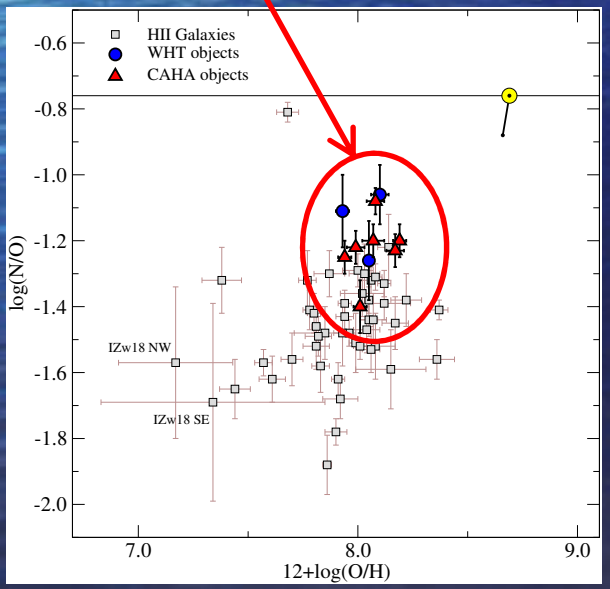
Conclusions

• The temperature measurements for the observed HII galaxies and a careful and realistic treatment of the observational errors yielded total oxygen abundances between 7.93 and 8.19 (Z/Z_o between ~0.19 and ~0.34, using $12+\log(O/H)_o=8.66\pm0.05$ from Asplund et al., 2005) with accuracies between 1 and 9%.

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• When compared to a **large sample** of HII galaxies, the **observed ones** show **higher N/O** abundance ratios **than the average**.

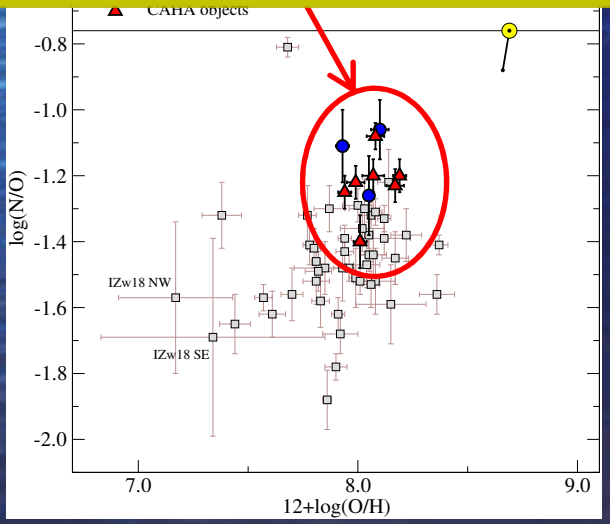


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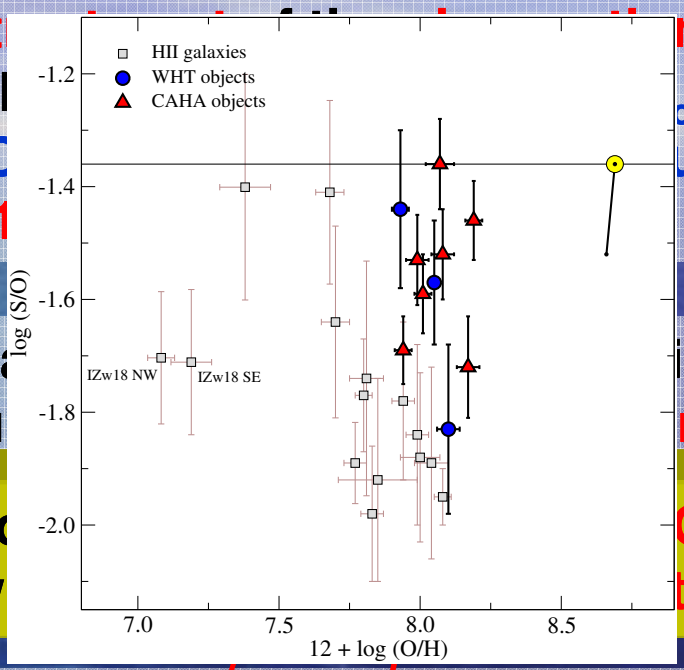
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These ratios would be even higher if the [OII] temperatures were derived with the use of photo-ionization models.



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Conclusions

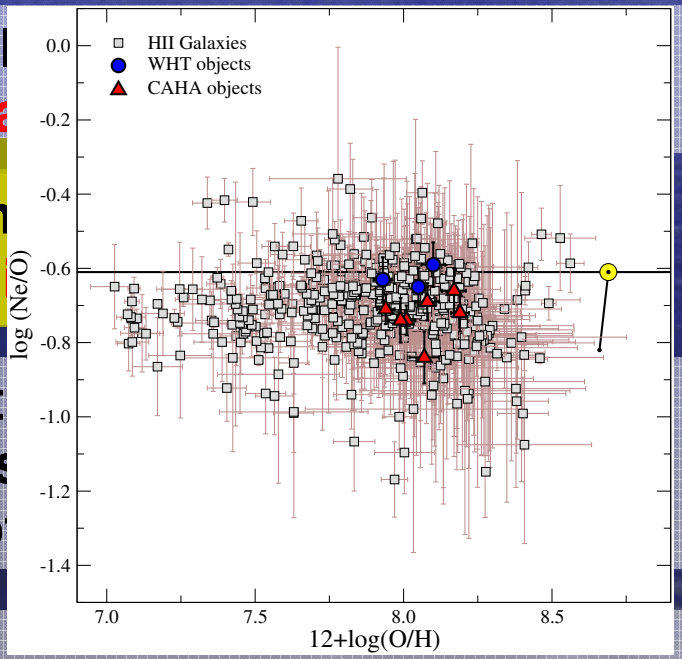
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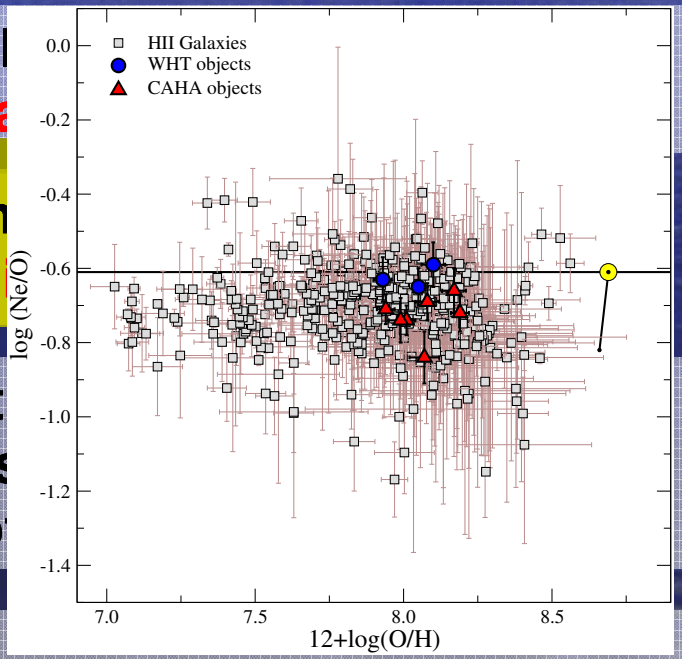


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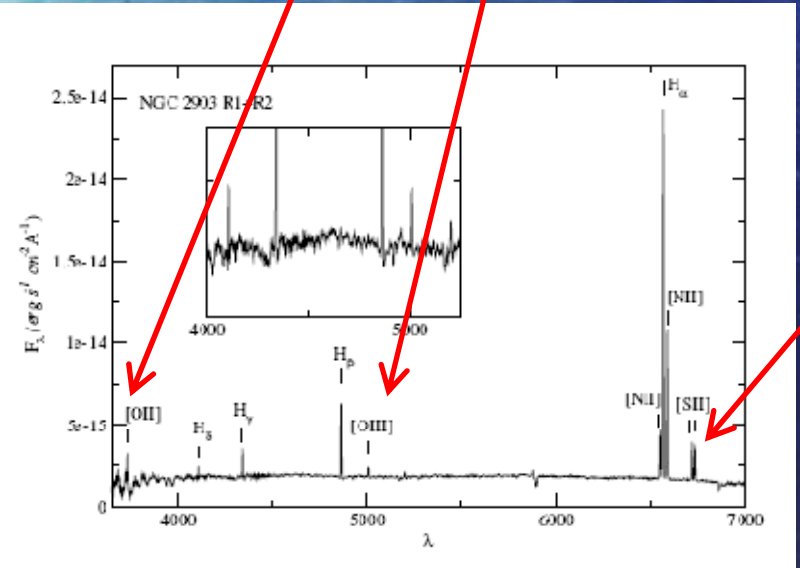
which points to the same nucleosynthesis sites for both elements

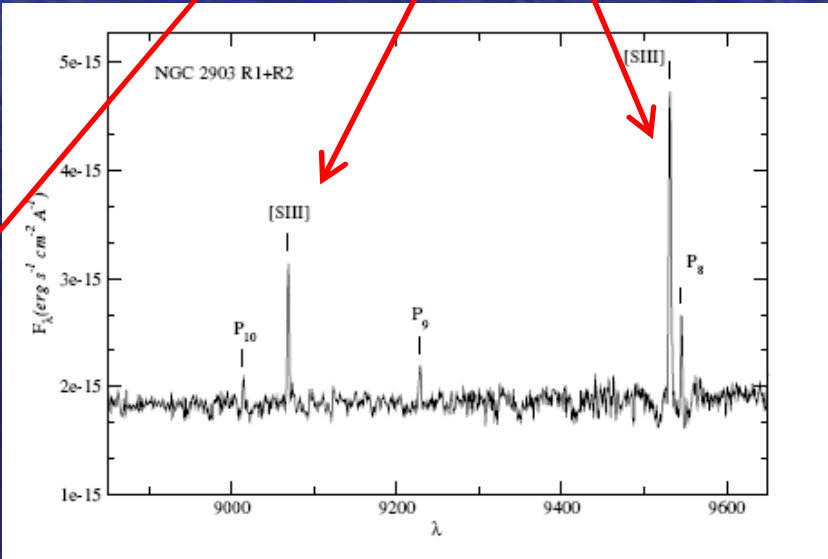
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• **The high average metallicity of the CNSFRs require a different methodology for abundance determinations involving empirical calibrators.**

O_{23} = ([OII]+[OIII])/Hβ
(Pagel et al. 1979)

S_{23} = ([SII]+[SIII])/Hβ
(Vílchez and Esteban 1996)

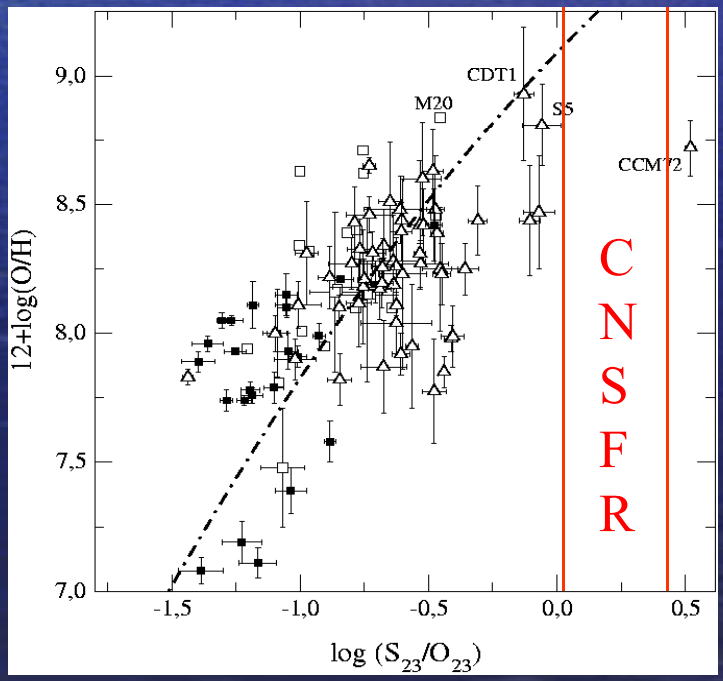




Conclusions

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We have developed a scheme for abundance determination using the oxygen and sulphur lines.

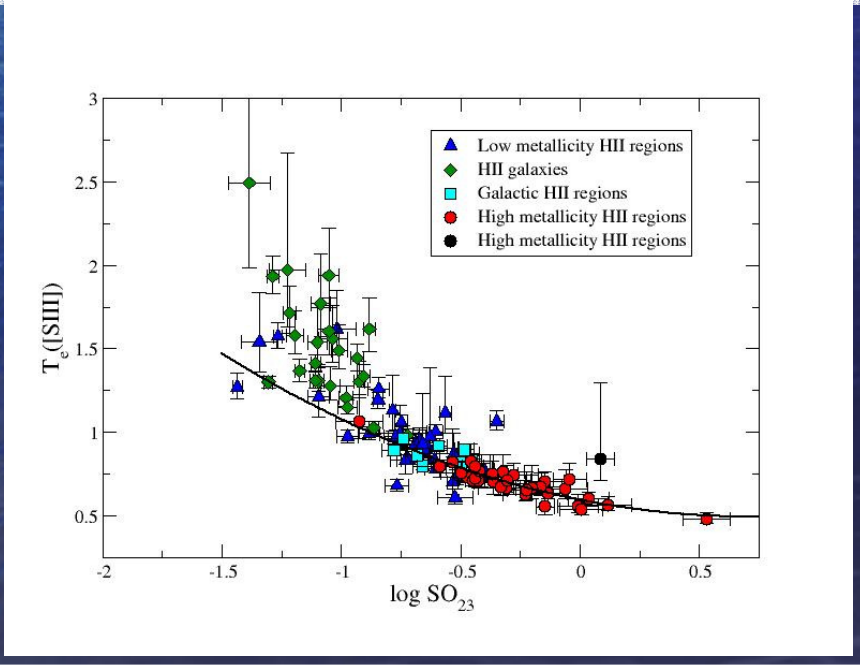


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• The scheme involves the calibration of T_e([SIII]) in terms of the SO_{23} parameter, and its use in combination with the observed line intensities of the different elements to derive the ionic abundances.



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• In all the observed CNSFRs the estimated T_e([SIII]) are substantially lower than for the HII galaxies, ranging between ~5400 and ~6700K.

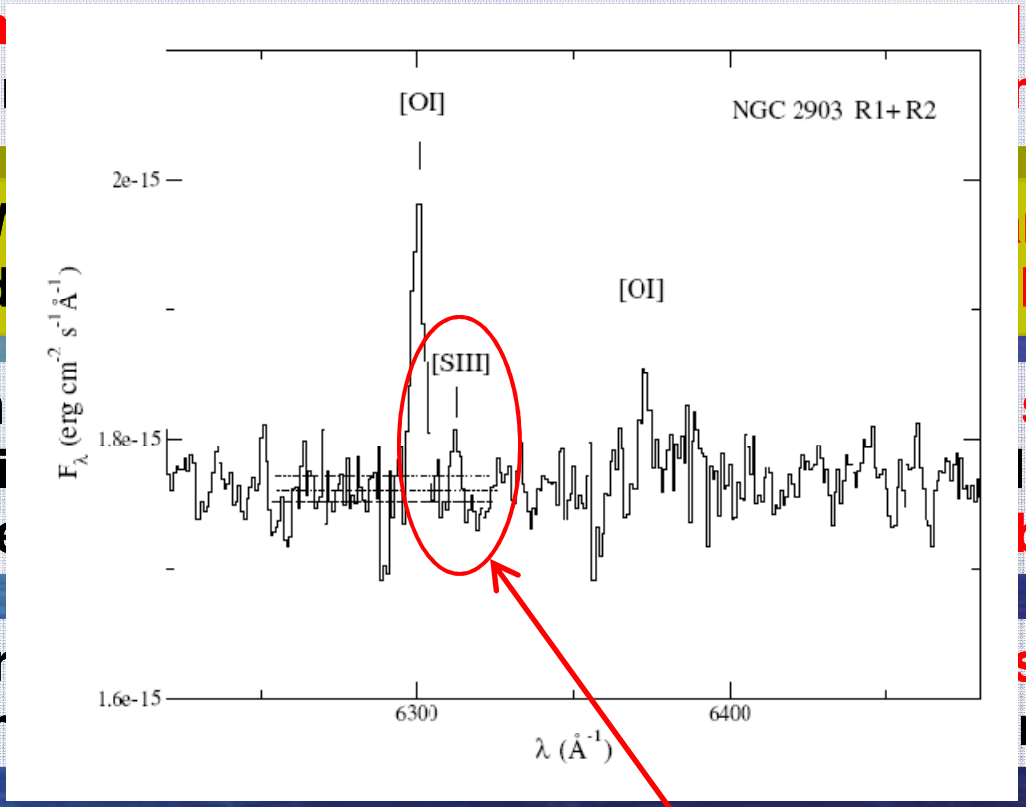
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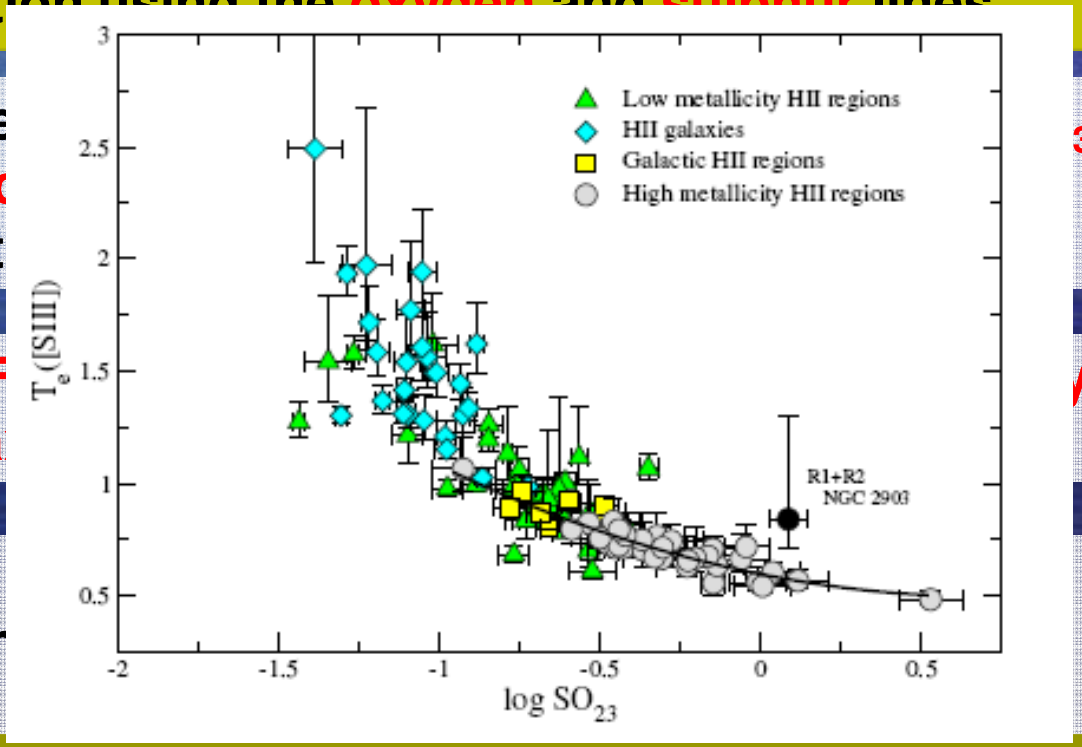
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consistent with our derived empirical calibration, although slightly higher than predicted.

Conclusions

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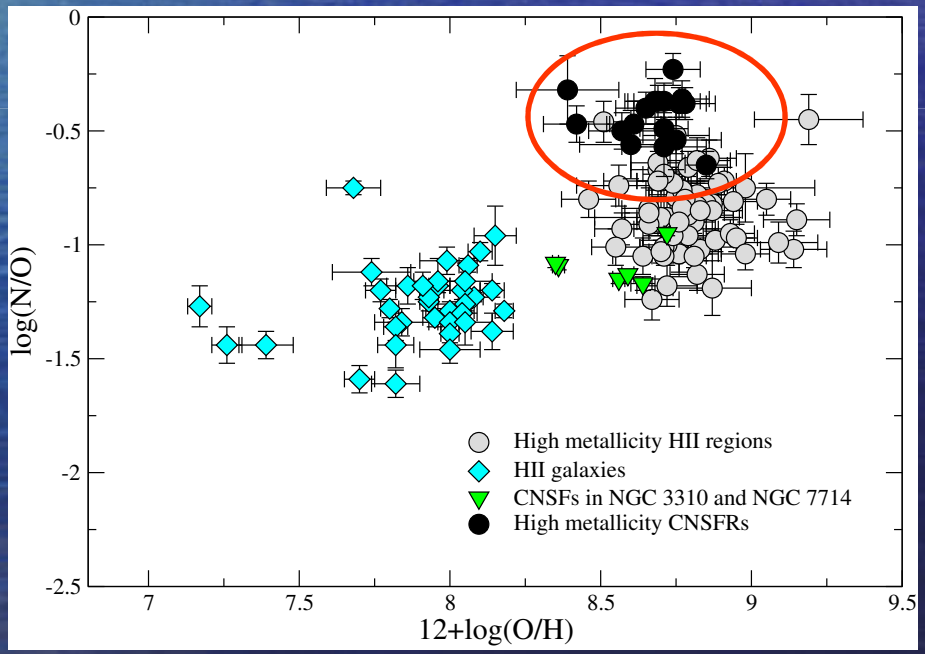
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different from the case of high metallicity disc HII regions for which, in general, the sulphur abundances are dominated by S^{2+}/H^+.

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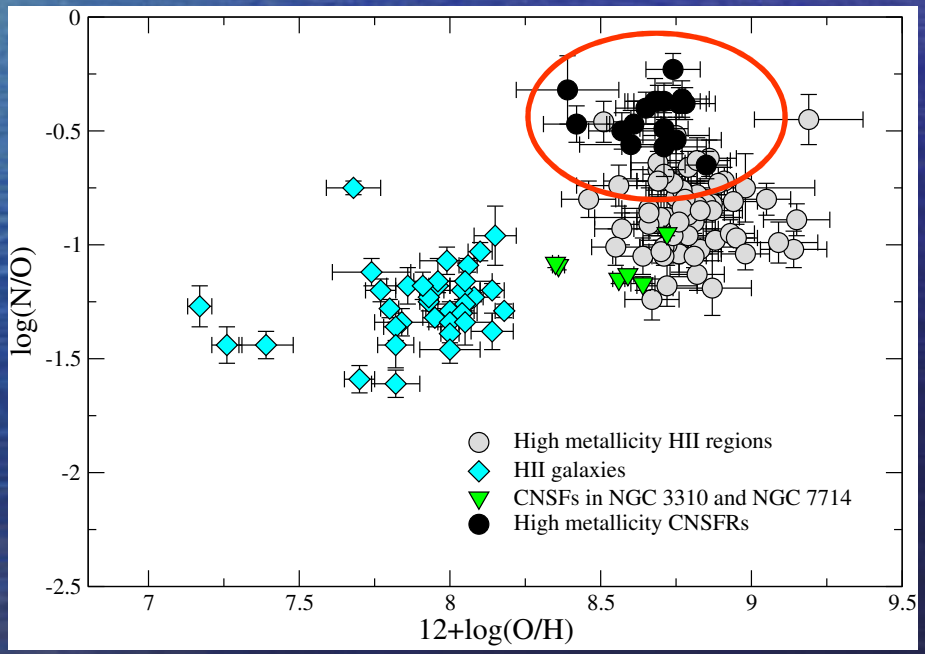
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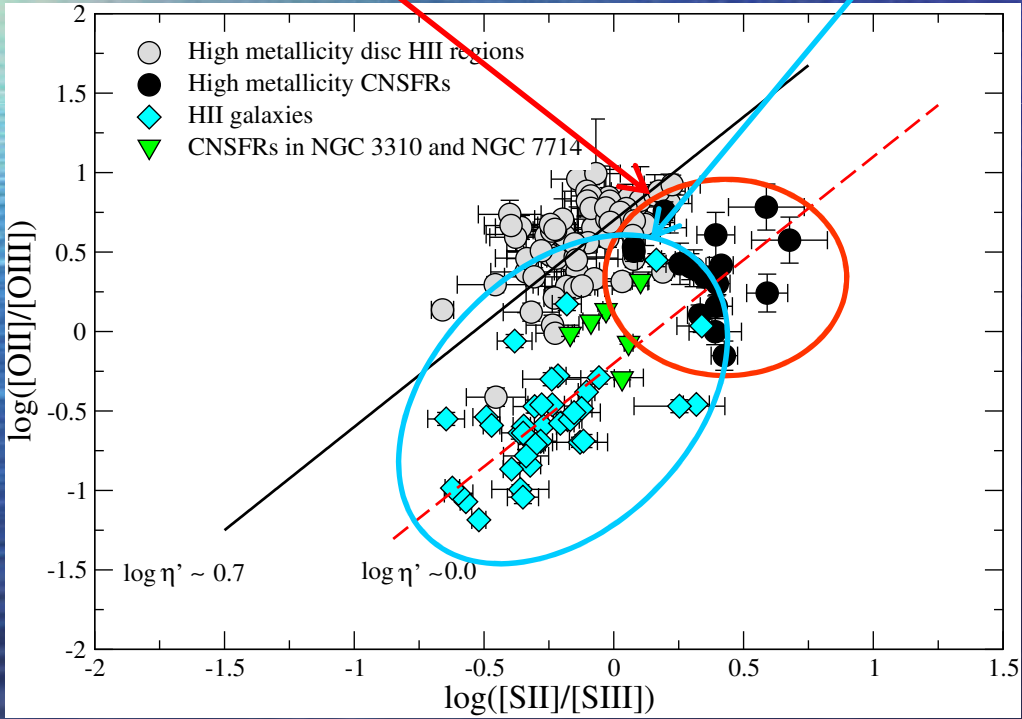
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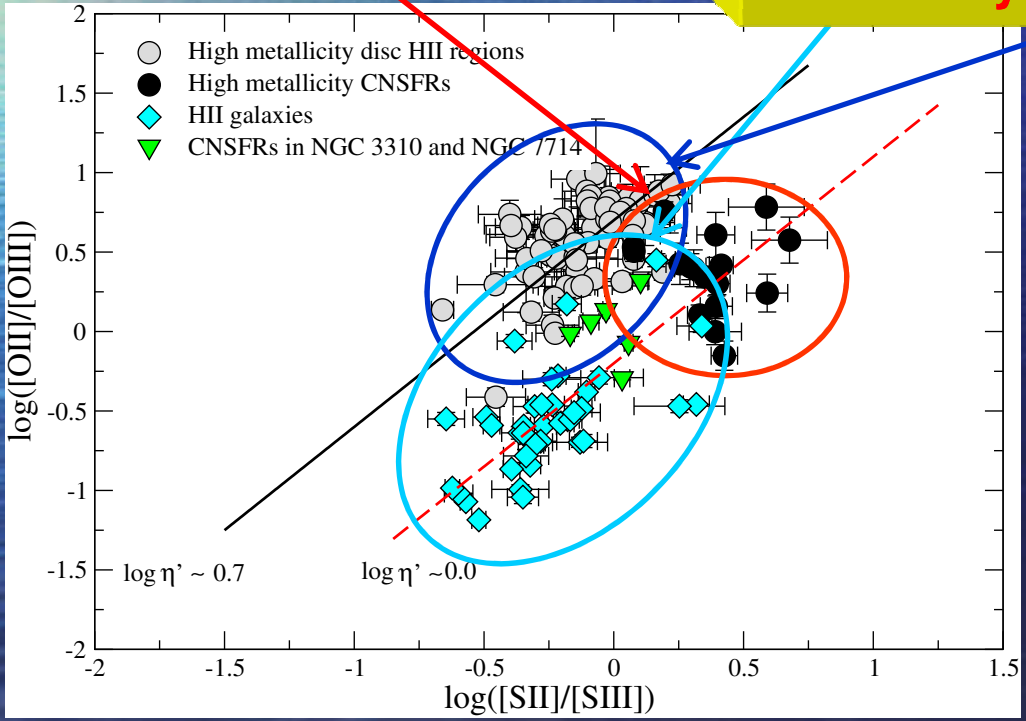
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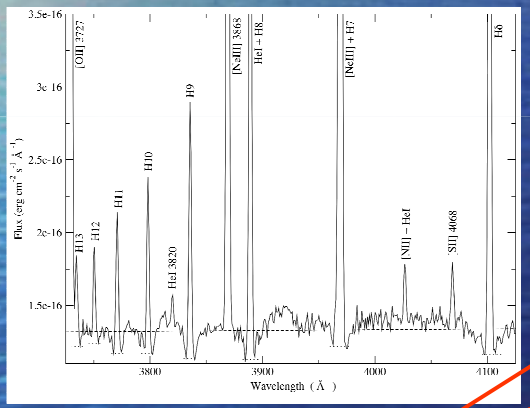
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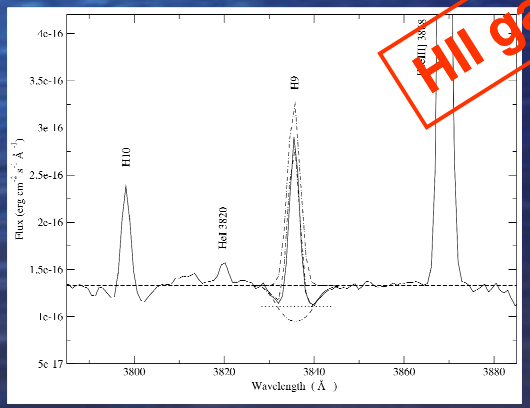
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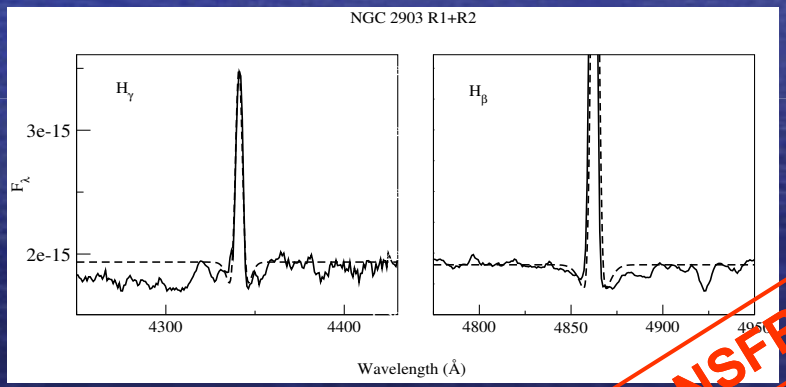
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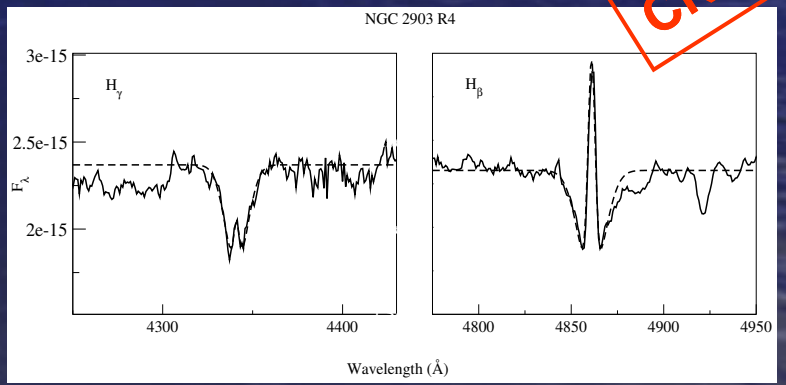




HII galaxy



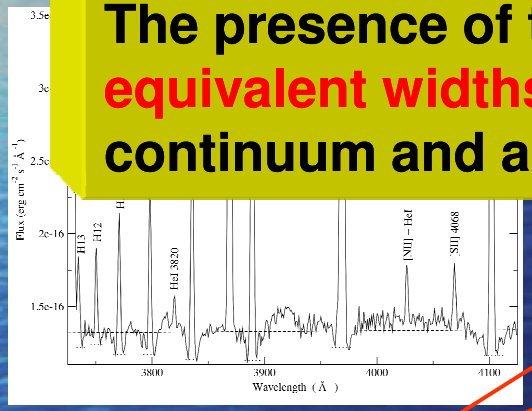
CNSFR



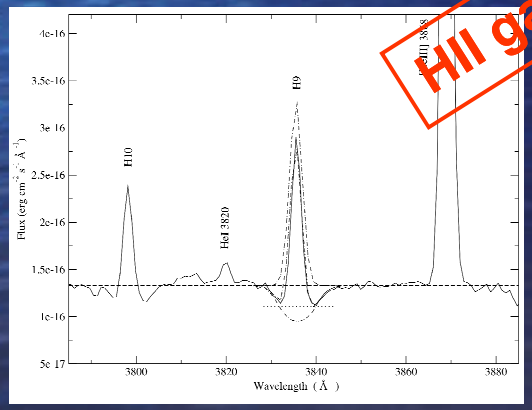
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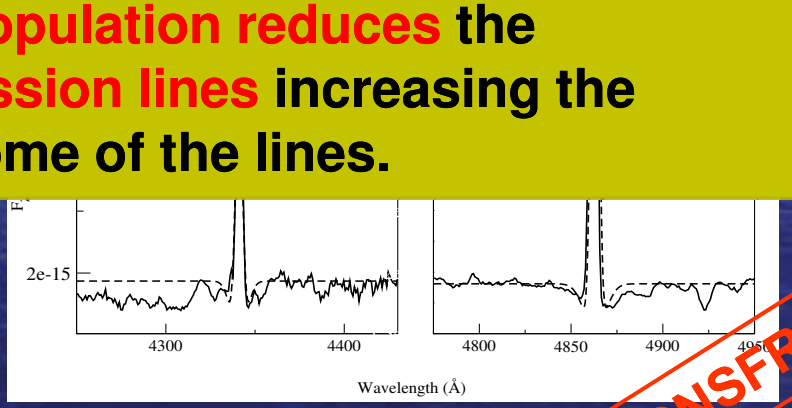
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The presence of this older population reduces the equivalent widths of the emission lines increasing the continuum and absorbing some of the lines.

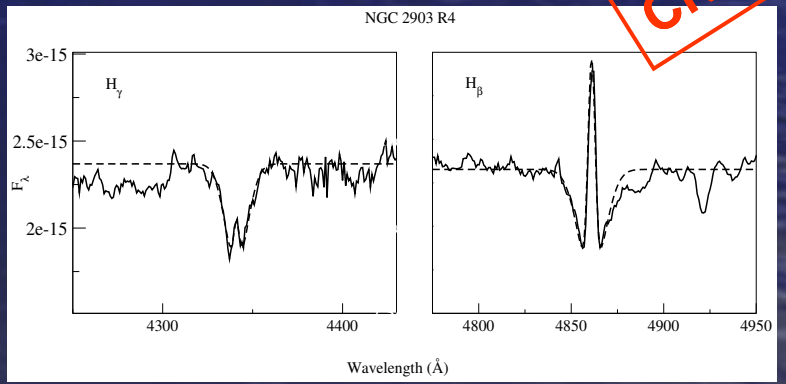


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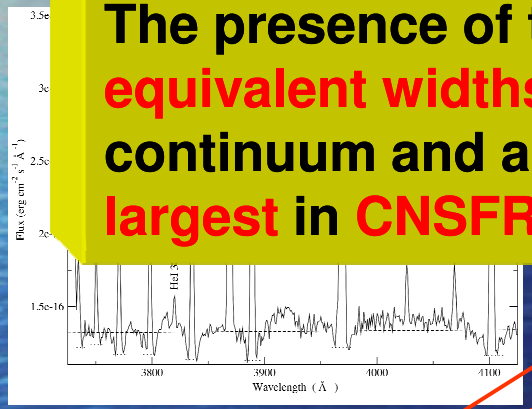
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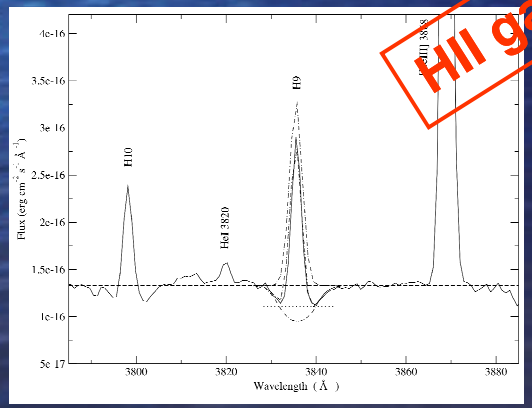
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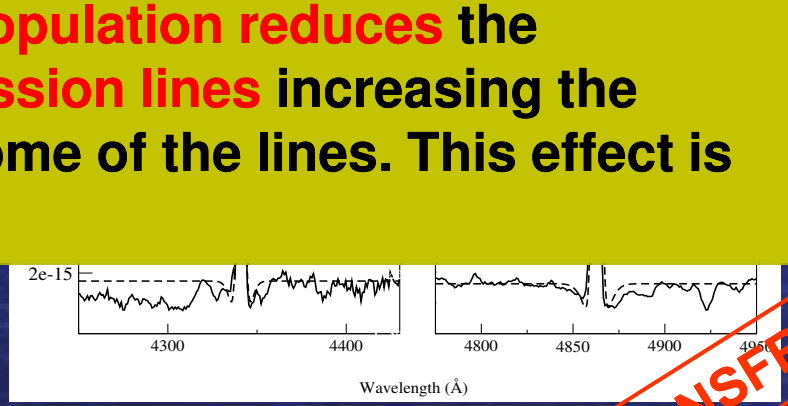
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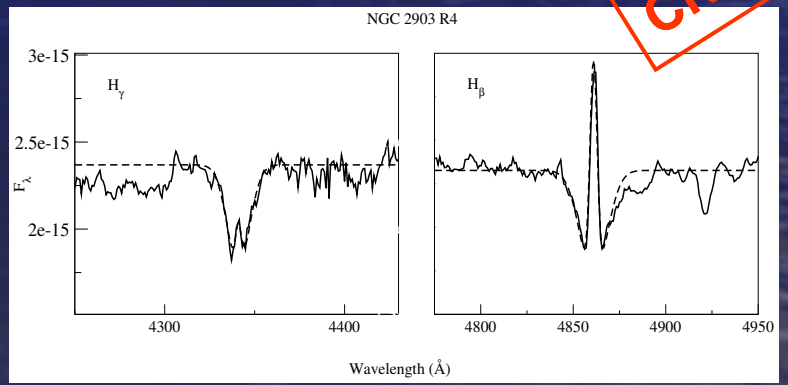


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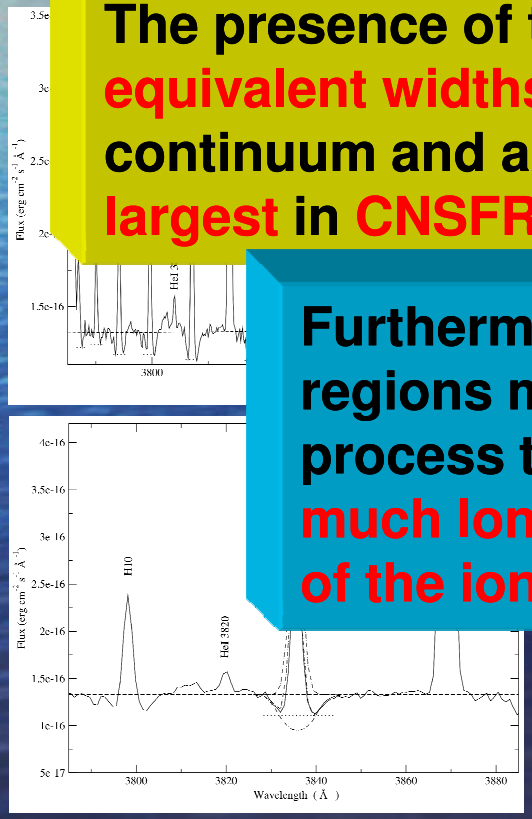


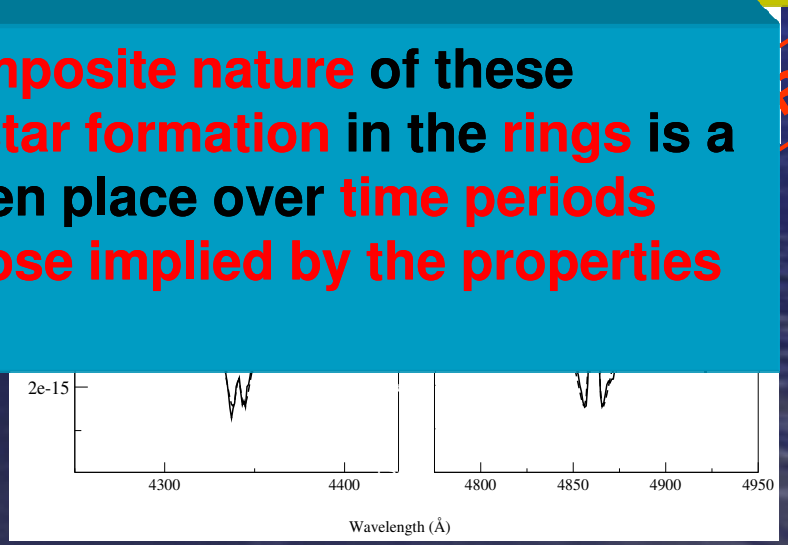
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Furthermore, the composite nature of these regions means that star formation in the rings is a process that has taken place over time periods much longer than those implied by the properties of the ionized gas.





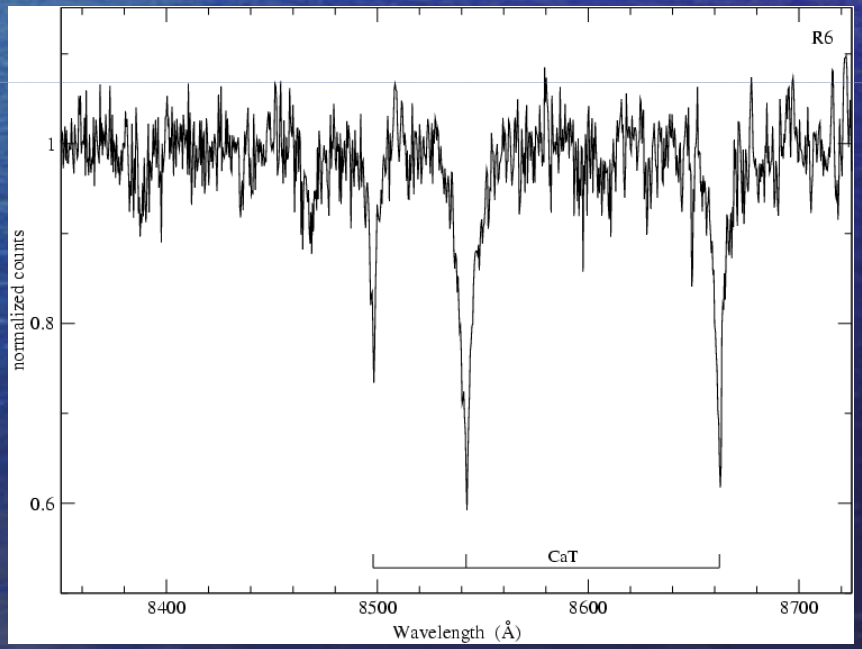
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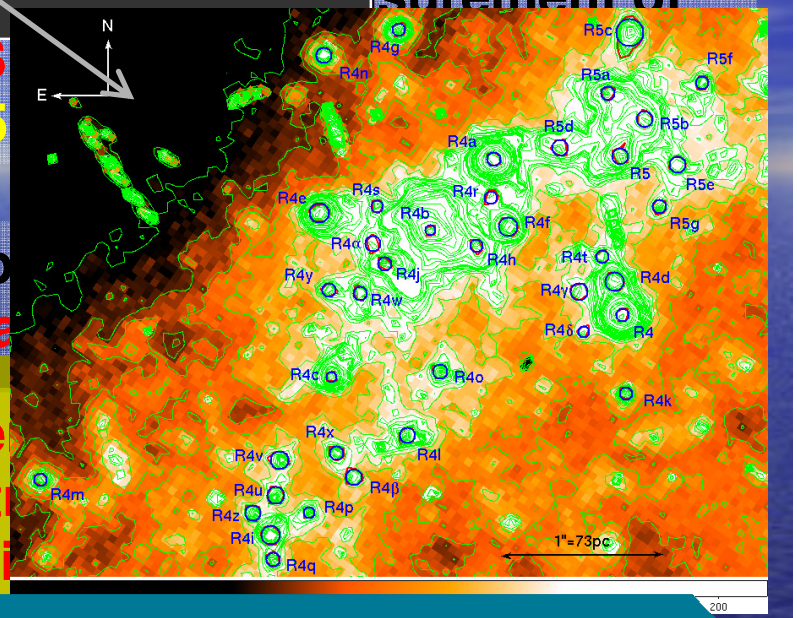
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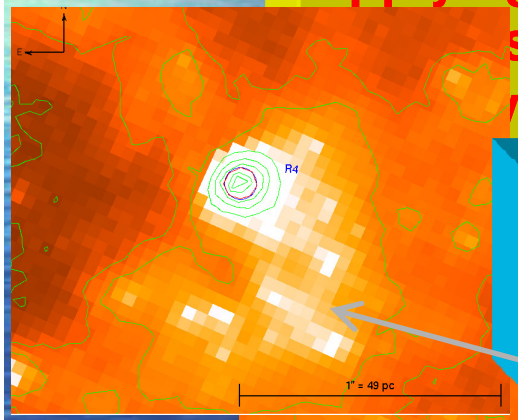
In the most **extreme case**, **R4 in NGC3310**, we find **at least 31 knots**.

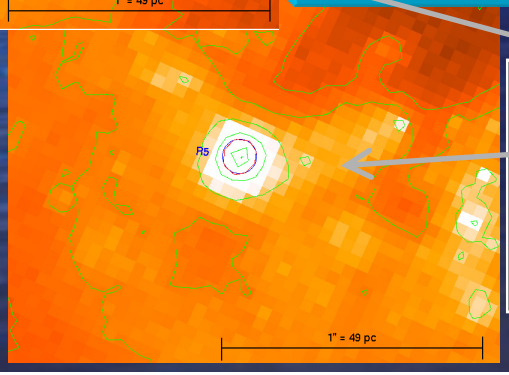


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This provides upper limits to the masses inside the half light radius (typically between 3 and 5pc) for each observed knot.

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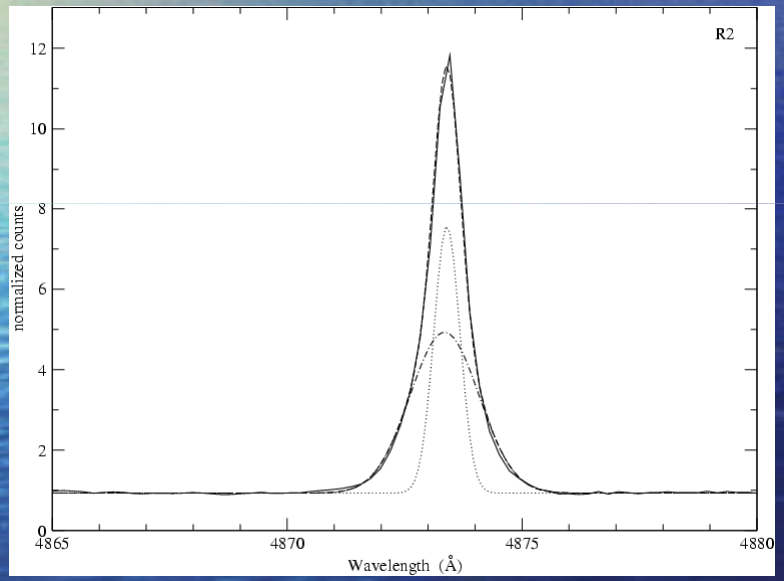
applying the virial theorem under the assumption that the systems are spherically symmetric, gravitationally bound

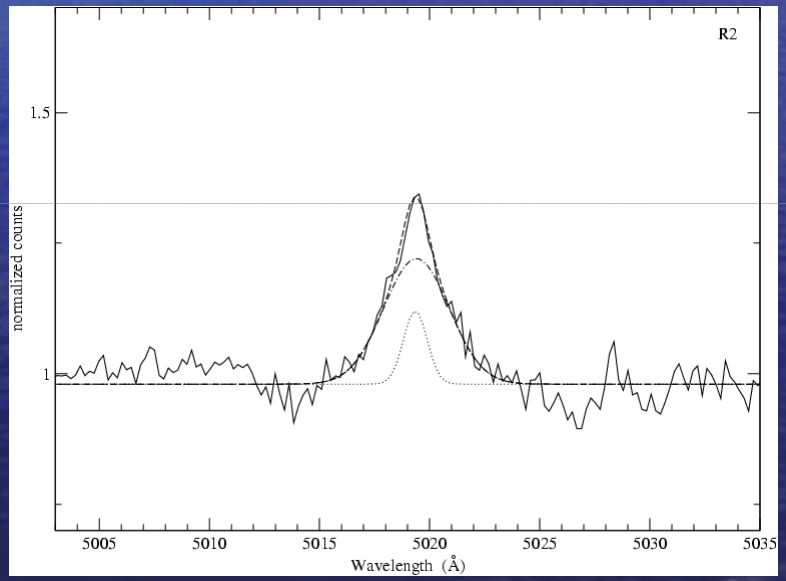
These masses are about 10 times larger than those inferred from the observed number of ionizing photons emerging from the regions, using simple and robust stellar population models under the assumption of no photon leakage and without taking into account any absorption by dust.

• The total dynamical masses of the CNSFRs are taken as the "sum" of the individual stellar clusters and are between 4.9×10^6 and 1.9×10^8 $M_\odot$.

Conclusions

• An **unexpected result** from our study has been the **finding** of the existence of **more than one velocity component** in the **ionized gas** when Gaussian fits are performed, both in the hydrogen recombination and the [OIII] lines.

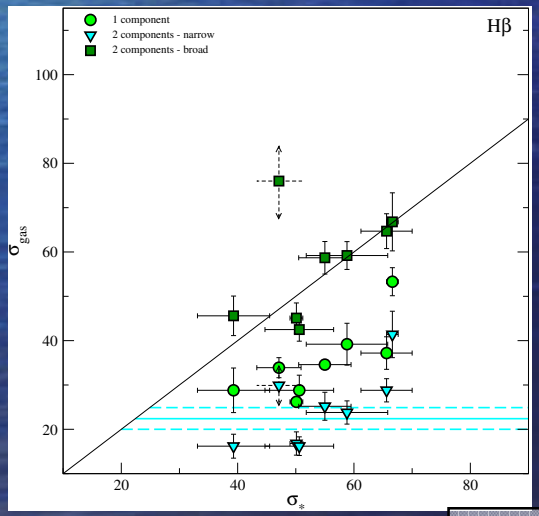


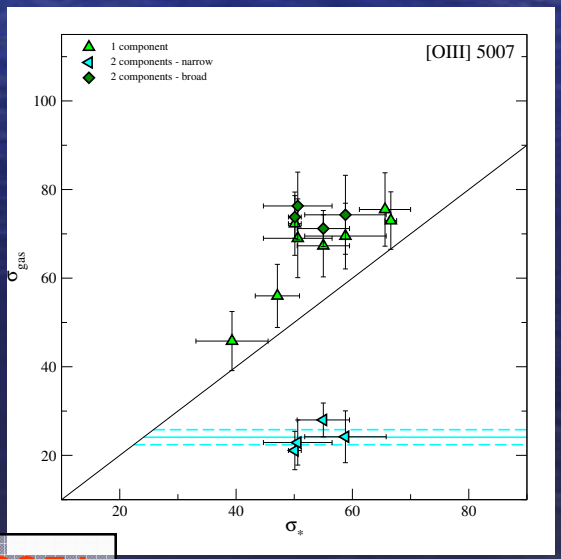


Conclusions

• An unexpected result from our study has been the finding of the existence of more than one velocity component in the ionized gas when Gaussian fits are performed, both in the hydrogen recombination and the [OIII] lines.

• A component with a velocity dispersion substantially lower than that measured from the stellar lines, is clearly present in the hydrogen recombination lines and also seems to be present in the [OIII] lines.





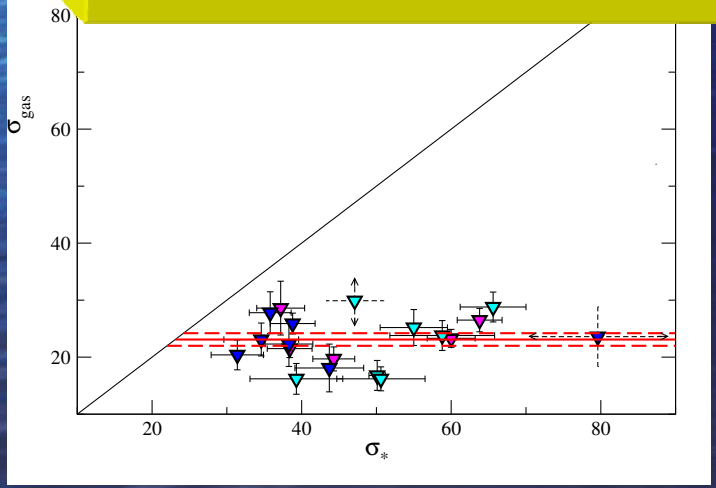
NGC3351

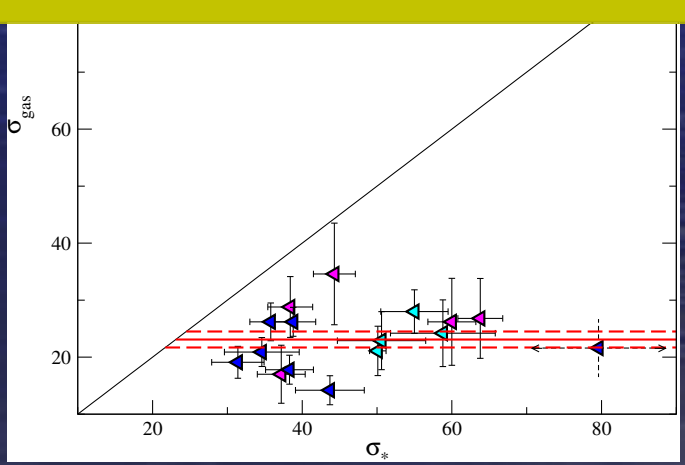
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The narrow component of the two-component Gaussian fits seems to be relatively constant for all the studied CNSFRs, with an estimated mean value close to 25 km s^{-1}.





Conclusions

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The narrow component of the two-component Gaussian fits seems to be relatively constant for all the studied CNSFRs, with an estimated mean value close to 25 km s^{-1}.

This narrow component could be identified with ionized gas in a rotating disc, while the stars and the fraction of the gas (responsible for the broad component) related to the star-forming regions would be mostly supported by dynamical pressure (Pizzella et al., 2004).

Conclusions

• The fact that the emission lines show velocity components corresponding to kinematically distinct systems, could affect somewhat the results derived from the observations described above, among others, the gas abundance determinations.

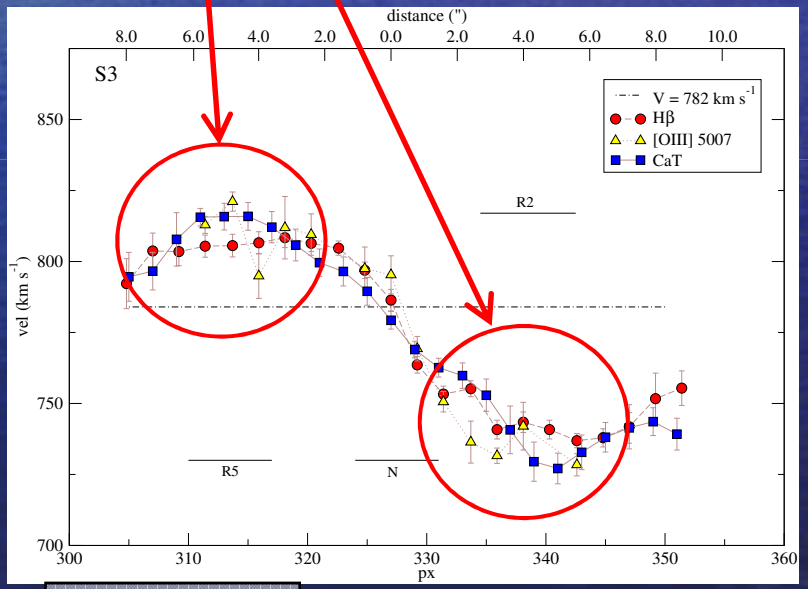
Conclusions

• The fact that the emission lines show velocity components corresponding to kinematically distinct systems, could affect somewhat the results derived from the observations described above, among others, the gas abundance determinations.

Also, masses derived from the Hβ velocity dispersions under the assumption of a single component for the gas would have been underestimated by factors of approximately 2 to 4.

Conclusions

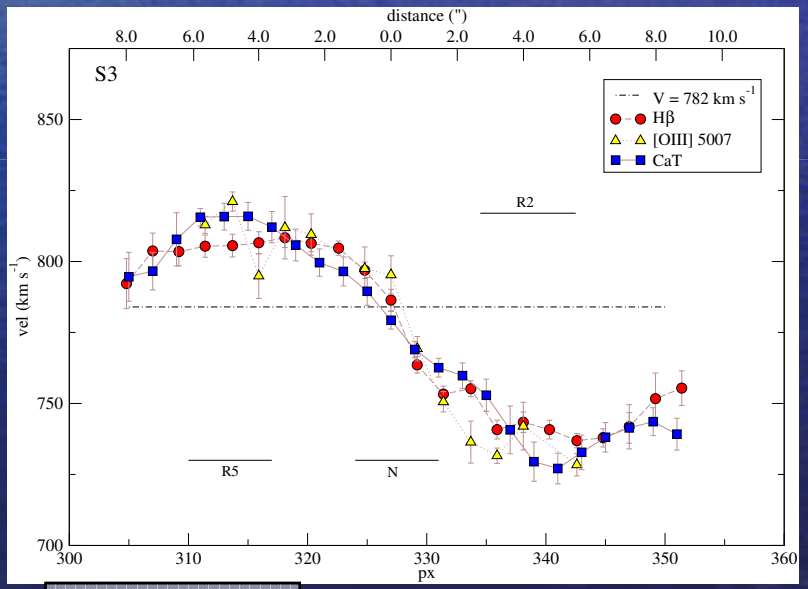
• The rotation curve of the central zones of the studied early type spiral galaxies seem to have the turnover points at the same position as the star-forming ring, as found in other galaxies (Telesco and Decher, 1988; Díaz et al., 1999),



NGC3351

Conclusions

• The rotation curve of the central zones of the studied early type spiral galaxies seem to have the turnover points at the same position as the star-forming ring, as found in other galaxies (Telesco and Decher, 1988; Díaz et al., 1999), and the velocity distribution is consistent with that expected for this type of galaxies (Binney and Tremaine, 1987).



NGC3351

Articles:

- “The temperature and ionization structure of the emitting gas in HII galaxies: Implications for the accuracy of abundance determinations”. G. F. Hägele, E. Pérez-Montero, A.I. Díaz, E. Terlevich and R. Terlevich. 2006, MNRAS, 372, 293.

- “Precision abundance analysis of bright HII galaxies”. G. F. Hägele, A.I. Díaz, E. Terlevich, R. Terlevich, E. Pérez-Montero and M.V. Cardaci. 2008, MNRAS, 383, 209.

- “Neon and Argon optical emission lines in ionized gaseous nebulae: Implications and applications”. E. Pérez-Montero, G. F. Hägele, A. I. Díaz and T. Contini. 2007, MNRAS, 381, 125.

- “The metal abundace of circumnuclear star forming regions in early type spirals”. Spectrophotometric observations. A.I. Díaz, E. Terlevich, M. Catellanos and G. F. Hägele. 2007, MNRAS, 382, 251.

- “Kinematics of gas and stars in the circumnuclear starforming ring of NGC3351”. G. F. Hägele, A.I. Díaz, M.V. Cardaci, E. Terlevich and R. Terlevich. 2007, MNRAS, 378, 163.

- “On the derivation of dynamical masses of the stellar clusters in the circumnuclear region of NGC 2903”. G. F. Hägele, A.I. Díaz, M.V. Cardaci, E. Terlevich and R. Terlevich. MNRAS, submitted.

- “Circumnuclear star-forming regions in NGC 3310”. G. F. Hägele, A.I. Díaz, M.V. Cardaci, E. Terlevich and R. Terlevich. MNRAS, in preparation (almost finished).

FPU fellowship:

- Instituto Nacional de Astrofísica, Óptica y Electrónica (INAOE), Puebla, Mexico (2 months and a half, 2005).

- Institute of Astronomy, University of Cambridge, England (2 months, 2006).

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Estallidos:

- Institute of Astronomy, University of Cambridge, England (10 days, 2005).

- Facultad de Ciencias Astronómicas y Geofísicas (FCAGLP), Universidad Nacional de La Plata (UNLP), Argentine (1 month and a half, 2006).

- Institite d´Astrophysique de Toulouse-Tarbes, Observatoire Midi-Pyrénées, Toulouse, France (1 week, 2007).

- INAOE, Puebla, México (10 days, 2007).

- Instituto de Astronomía, Universidad Nacional Autónoma de México (1 week, 2007).

- FCAGLP, Argentine (2 weeks, 2008).

- FCAGLP, Argentine (1 month, 2008).

Meetings ("thesis presentations", 11):

- Joint European and National Astronomical Meeting, The Many Scales in the Universe. Granada, Spain, 2004.

- IV Workshop Estallidos de Formación Estelar en Galaxias: Una Aproximación Multifrecuencia, Madrid, Spain, 2006.

- The Metal Rich Universe, La Palma, Spain, 2006.

- IAU 26th General Assembly, Praha, Czech Republic, 2006.

- VII reunión de la Sociedad Española de Astronomía, Barcelona, Spain, 2006.

- From Stars to Galaxies: Building the pieces to build up the Universe, Venice, Italy, 2006.

- Massive Stars: Fundamental Parameters and Circumstellar Interactions, Cariló, Argentine, 2006.

- V Workshop Estallidos de Formación Estelar en Galaxias: Star Formation and Metallicity, Granada, Spain, 2007.

- Young massive star clusters: Initial conditions and environments, Granada, Spain, 2007.

- II Workshop ASTROCAM, Madrid, Spain, 2007.

- Star-Forming Dwarf Galaxies: Following Ariadne's Thread in the Cosmic Labyrinth, Crete, Greece, 2008.

Meetings (colaboration presentations, 4):

- IAU 26th General Assembly, Praha, Czech Republic, 2006.

- VII reunión de la Sociedad Española de Astronomía, Barcelona, Spain, 2006.

- The Nuclear Region, Host Galaxy and Environment of Active Galaxies: A symposium to celebrate the 60th birthday of Deborah Dultzin-Hacyan, Huatulco, Mexico, 2007.

- II Workshop ASTROCAM, Madrid, Spain, 2007.

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- II Workshop ASTROCAM, Madrid, Spain, 2007.

Meetings (formation, 7):

- The X-ray Universe, El Escorial, Spain, 2005.
- Visions for Infrared Astronomy, Paris, France, 2006.
- High resolution X-ray spectroscopy: towards XEUS and Con-X, Holmury St Mary, England, 2006.
- Calar Alto Colloquium 2006, Granada, Spain, 2006.
- Variable and Broad Iron Lines around Black Holes, Madrid, Spain, 2006.
- Formation and Evolution of Galaxy Disks, Rome, Italy, 2007.
- 3D2008 - Gas and stars in galaxies. A multi-wavelength 3D perspective, Garching, Germany, 2008.

Future work

HII galaxies:

- **expand the sample of HII galaxies**

  observing time requested several times...

Future work

HII galaxies:

- exp… …xies

2 nights observing run awarded for July, after the thesis was finished!!!!!

…me requested …veral times...

Future work

HII galaxies:

- **exp… …xies**

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- **spatial variations of temp. and abund. across a given galaxy**

project in progress

Future work

HII galaxies:

- exp… …xies
  - …e requested several times...
- spatial va… a…
  - project in progress

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works with Ruben and Enrique on one side and with Vero and Guille Bosch on the other

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CAHA observations

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du Pont and Magellans (Las Campanas) and GEMINI observations.
See Vero´s talk.

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- temperature fluctuations

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- supernova remnants (SNRs) and compact HII regions

project in progress

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Radio – MERLIN
Project with Daniel, Yago...

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project in progress

Radio – MERLIN
Project with Daniel, Yago...

- abundance determinations of the very hot gas

project in progress

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- spatial va… …d abundances on galaxy

…roject in progress

- temperature fluctuati…

planing...

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CNSFRs:

- …spatial sampling …d abundances on galaxy

…progress

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project in …gress

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X-rays – XMM-Newton
Project with María Santos, Matthias Ehle...

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- abund… …ons in the v… …gas

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- abund… …f the v…

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Several future joint projects between La Plata and Estallidos, the original objective!!!!

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Several future joint projects between La Plata and Estallidos, the original objective!!!! Including the co-supervision of Vero´s thesis with Guille Bosch.