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Serbia

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OSSERVATORIO ASTRONOMICO DI PADOVA
ISTITUTO NAZIONALE DI ASTROFISICA
INAF

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14th Serbian Conference on Spectral Line Shapes in Astrophysics

Joint analysis of the iron emission in the optical and near-infrared spectrum of I Zw 1

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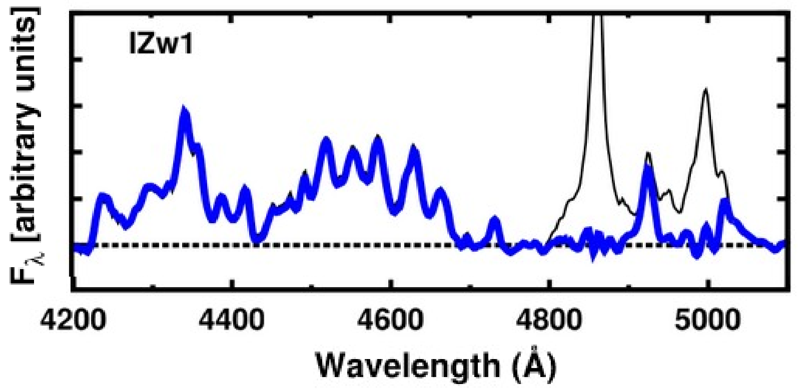
Swayamtrupta Panda (LNA)
Murilo Marinello (LNA)

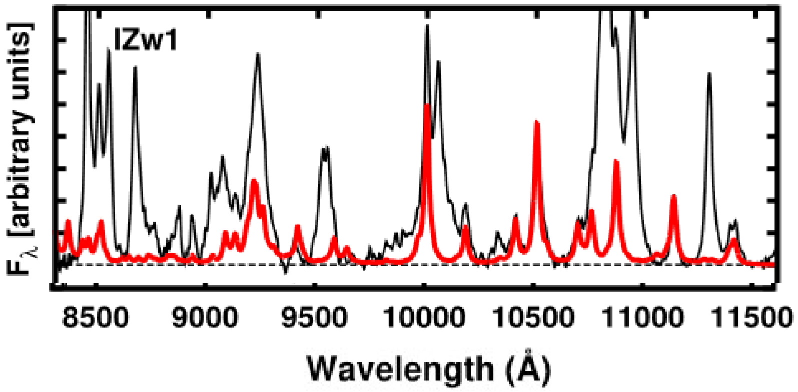
Programa Institucional de Internacionalização – CAPES - PrInt

Long stand FeII problem

- **Strongest coolant**
  (Wills et al. 1985, Marinello et al., 2016)
- **FeII spectrum from the UV to NIR**
  (Sigut & Pradhan 2003, (Bruhweiler & Verner 2008)

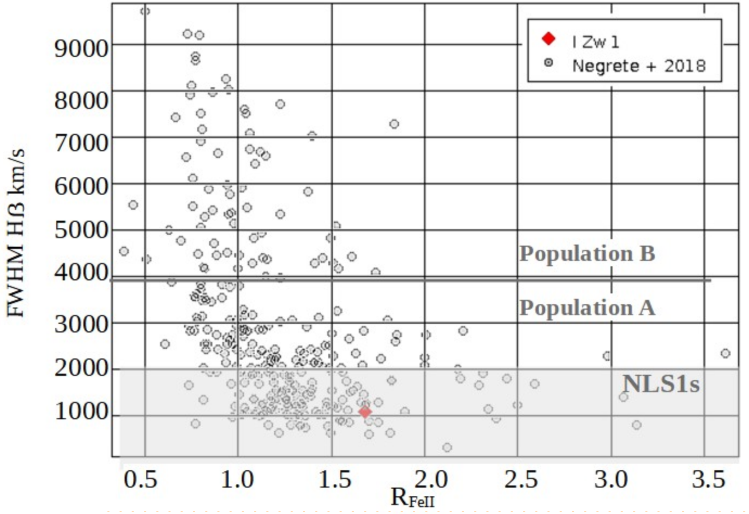
Marinello et al., 2016





Optical plane Eigenvector 1

(Boroson & Green, 1992; Marziani et al., 2003, Shen & Ho, 2014 +)

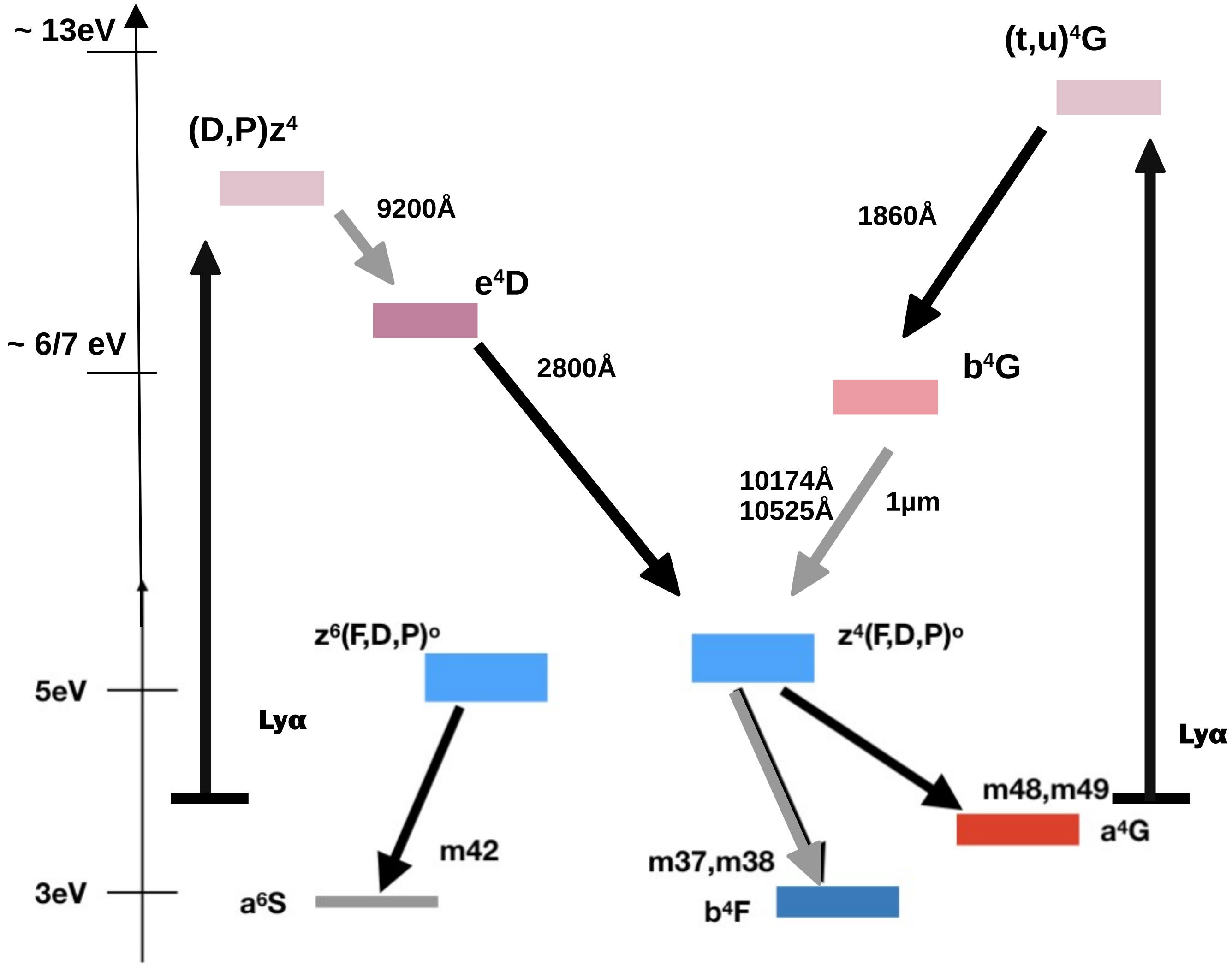


Fell emission

Fell in the optical can be produced by a combination of collisional+fluorescent resonance Lyα

Only the collision excitation mechanism cannot explain the strong Fell emission

Fell emission in the optical and near-infrared are intrinsically correlated
(MARINELLO et al., 2016)

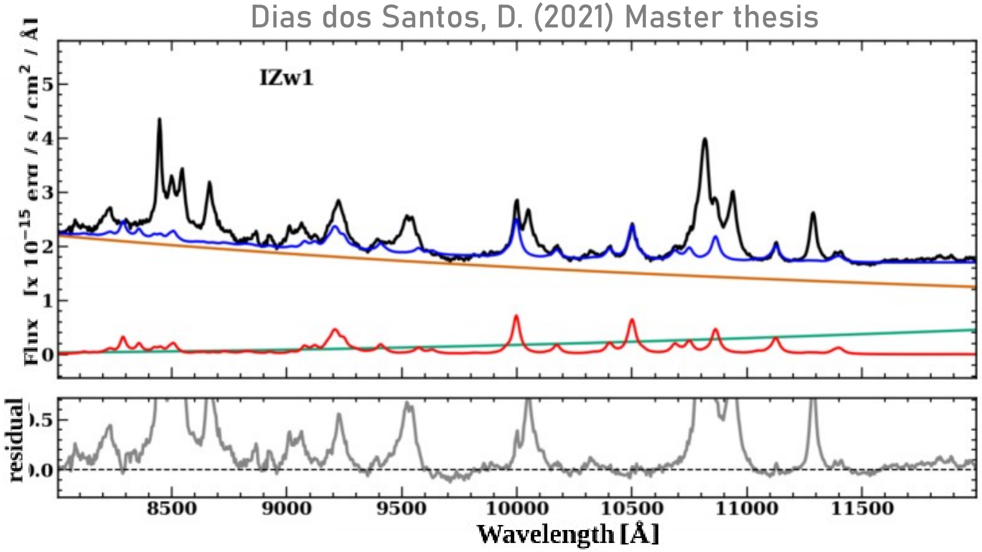


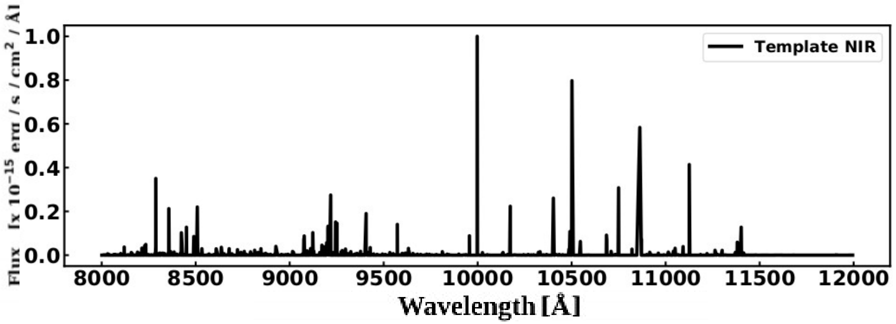
Modified from Marinello et al. (2020), Rodríguez-Ardila et al. (2002), and Marziani et al. (2021).

Some works that explored the FeII in the NIR

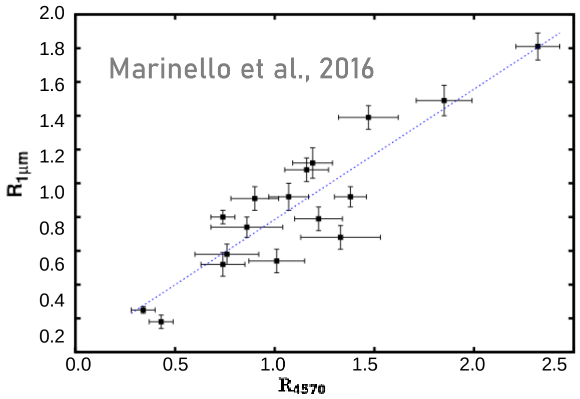
- Sigut & Pradhan (1998, 2003) and Sigut et al., 2004 } Lyα fluorescence 8500–9500 Å
- Rudy et al., 2000 Rodríguez-Ardila et al., 2002 } (λ9997, λ10502, λ10862, and λ11127)
- Garcia-Rissmann, A. et al., 2012
- Rodríguez-Ardila et al., 2002 Marinello et al., 2016 + Dias dos Santos, D. (Master)

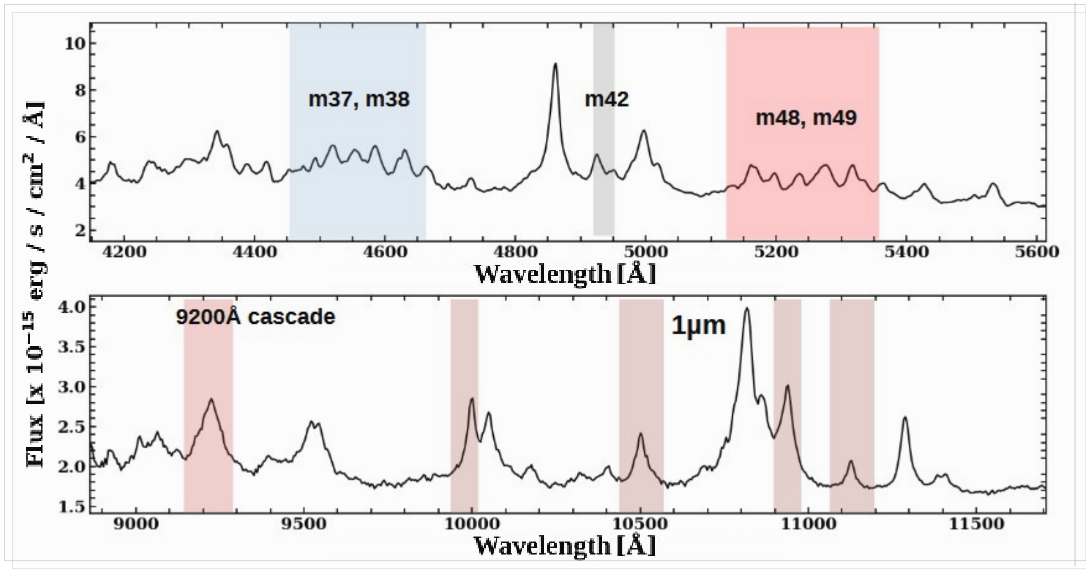
Dias dos Santos, D. (2021) Master thesis





OPTICAL and NIR correlation





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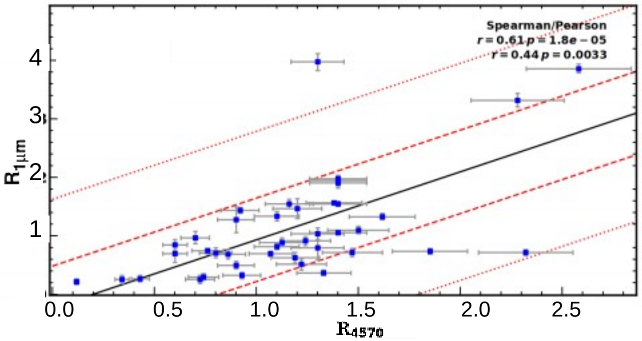


Dias dos Santos, D. (2021)
Master thesis

The NIR FeII emission lines are isolated or semi-isolated, unlike in UV-optical

Main goals - Joint analysis of the iron emission in the optical and near-infrared spectrum of I Zw 1

WHAT ?

The main goal is to investigate the FeII emission simultaneously in the optical and NIR regarding the line formation and the gas physical conditions for different cases of strong FeII emission.

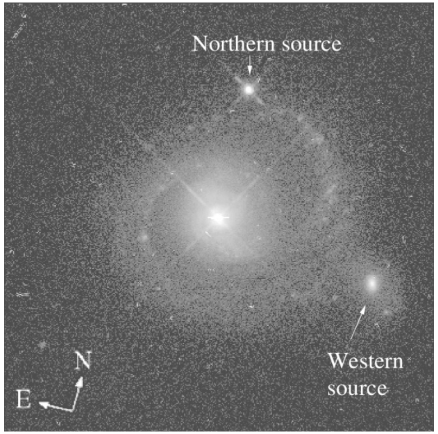
HOW ?

Photoionization modelling

- For this purpose, **we will use CLOUDY* simulations** to explore the optical and NIR spectral regions.

WHO ?

Proto-typical FeII emitter



I Zw1

Narrow Line Seyfert 1

(Osterbrock & Pogge, 1985; Goodrich 1989; Komossa et tal., 2006 +)

* FERLAND et al., 2017

How can we do it?

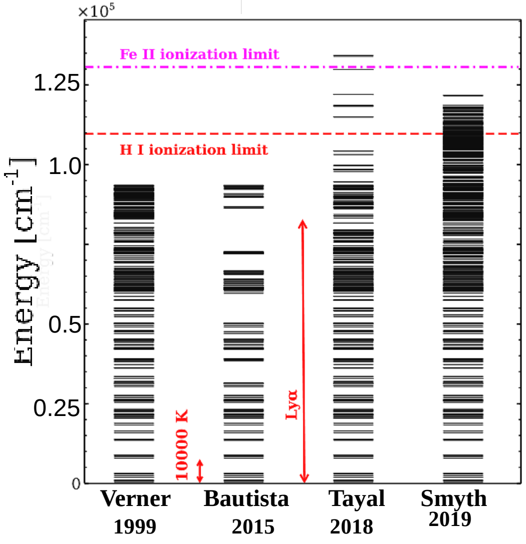
- **CLOUDY** simulations
  (Photo-ionization code)

In short words, what CLOUDY does:

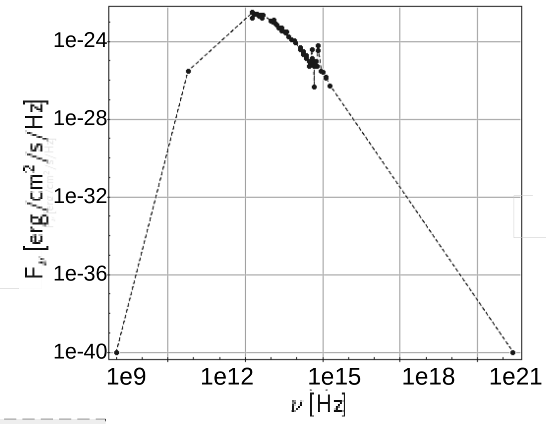
gas conditions (density, metal content) → atomic data → + radiation field → prediction of the observed spectrum

log N_H (cm^{-2}): **22-24**
log n_H (cm^{-3}): **7-14**
Metalicity Z☉: **0.1-10**

Panda, S. et al., 2019, 2020



Sarkar, A. et al., 2020



Panda, S. et al., 2020

Luminosity at 5100Å: 3×10^{44} $ergs^{-1}$
(Kaspi et al. 2000)

R_{BLR}: 9.63×10^{17}cm
or 37.2 light days
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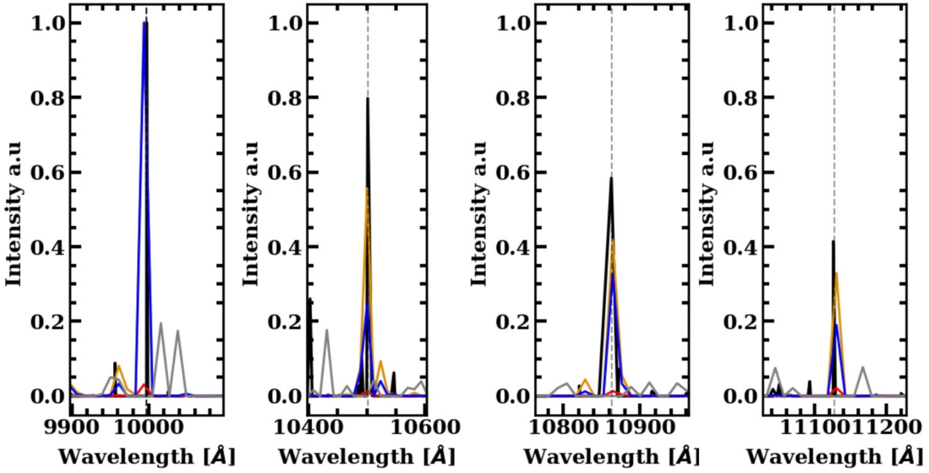

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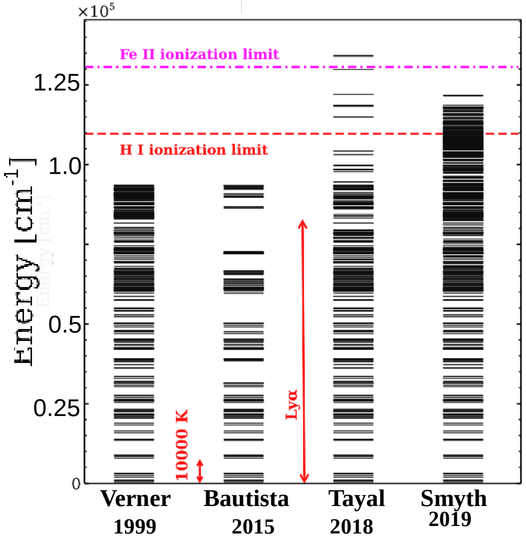

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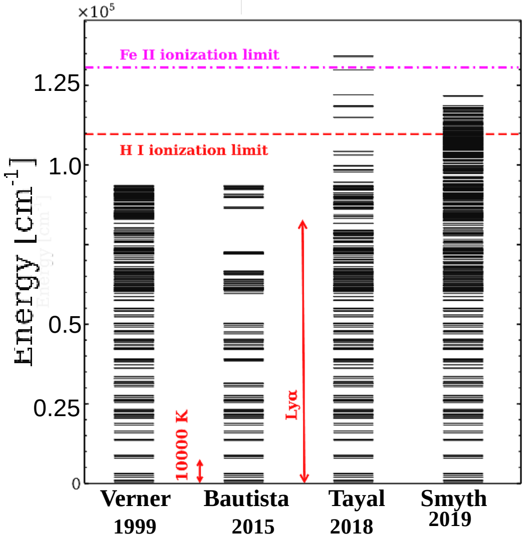

Sarkar, A. et al., 2020

Verner et al. (1999)
→ 371 energy levels (up to ~11.6 eV)

Smyth et al. (2019)
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Tayal & Zatsarinny (2018)
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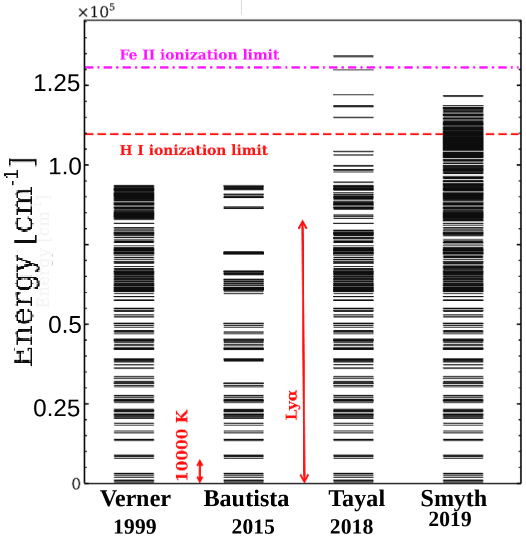

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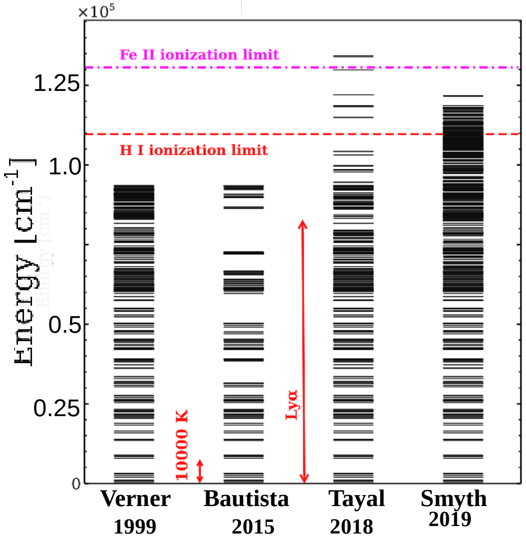

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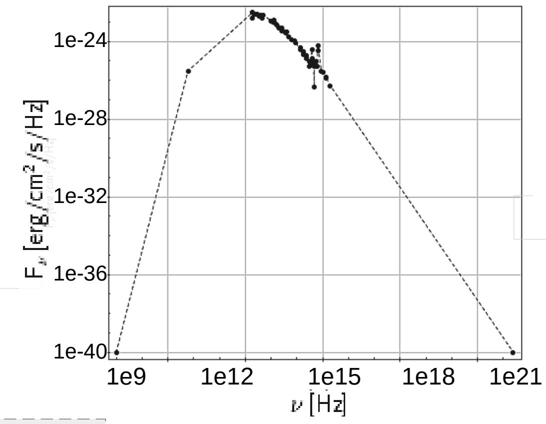

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Luminosity at 5100Å: 3×10^{44} $ergs^{-1}$
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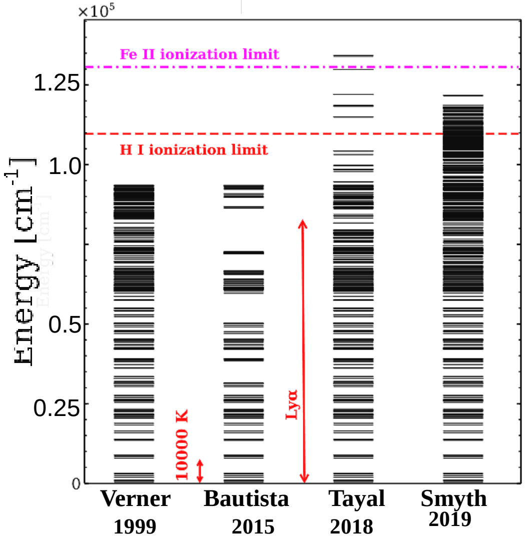

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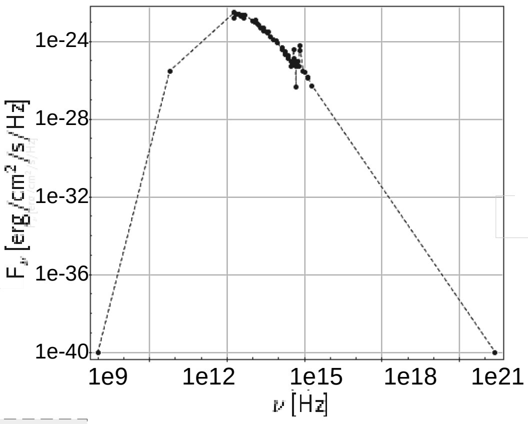

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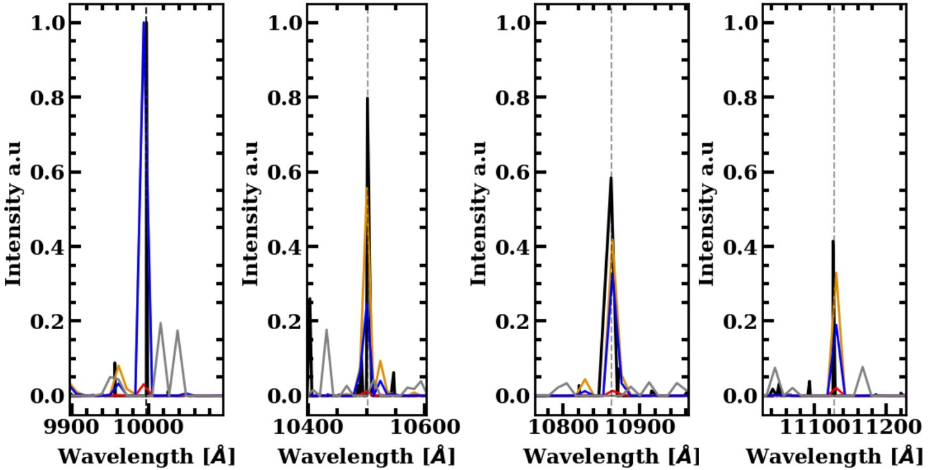

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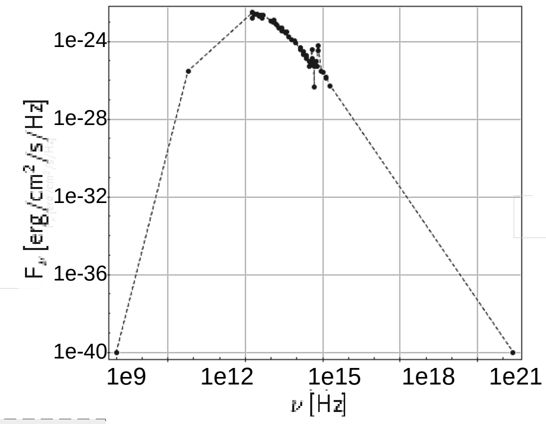

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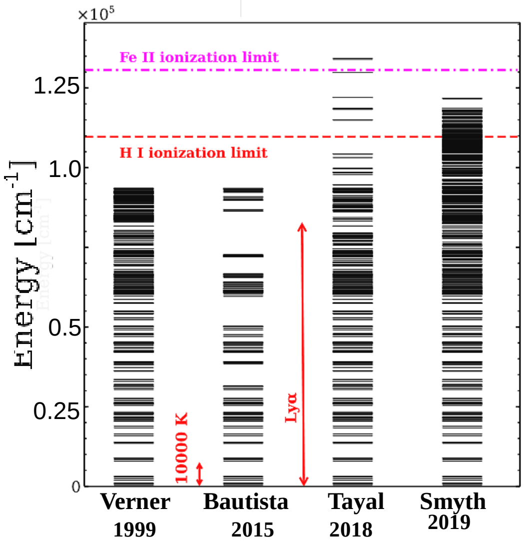

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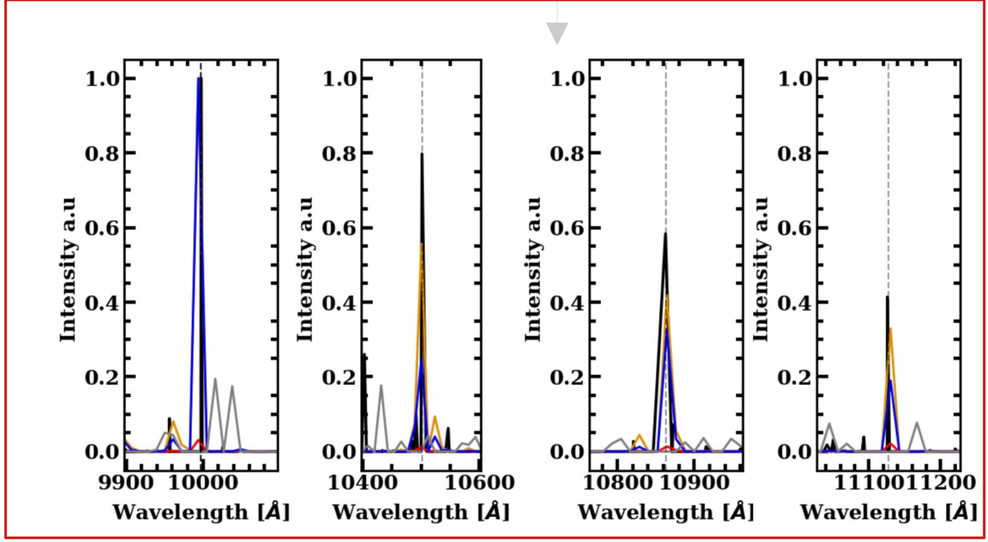
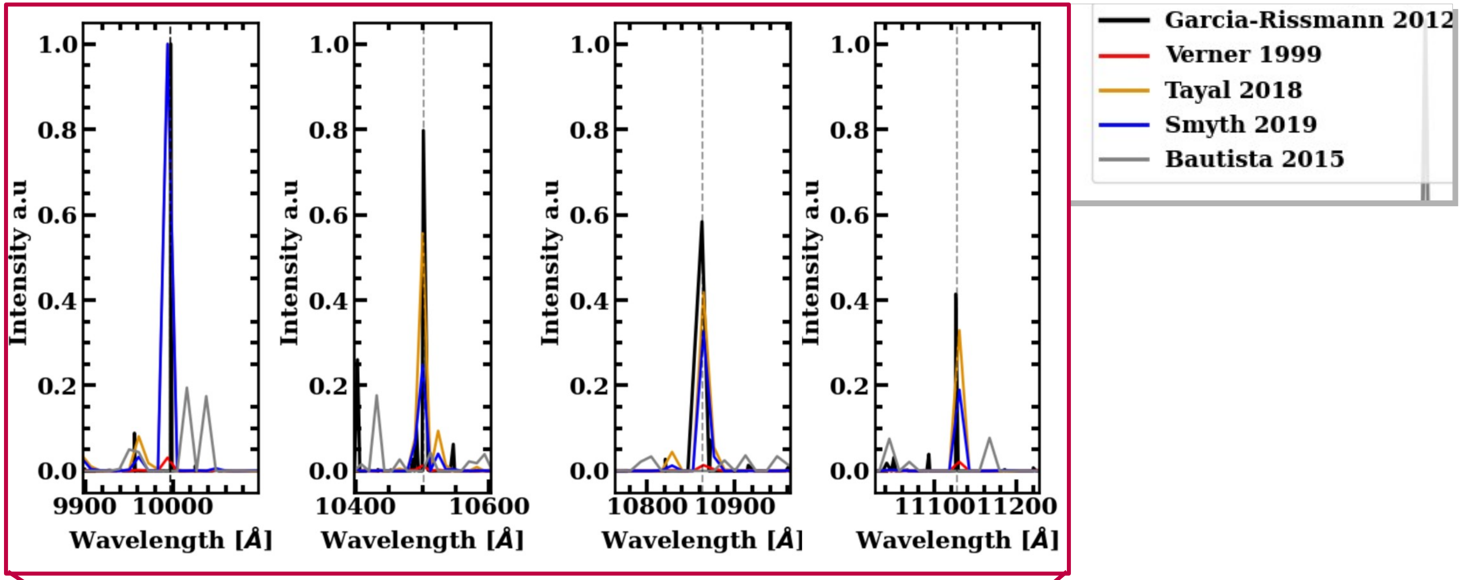
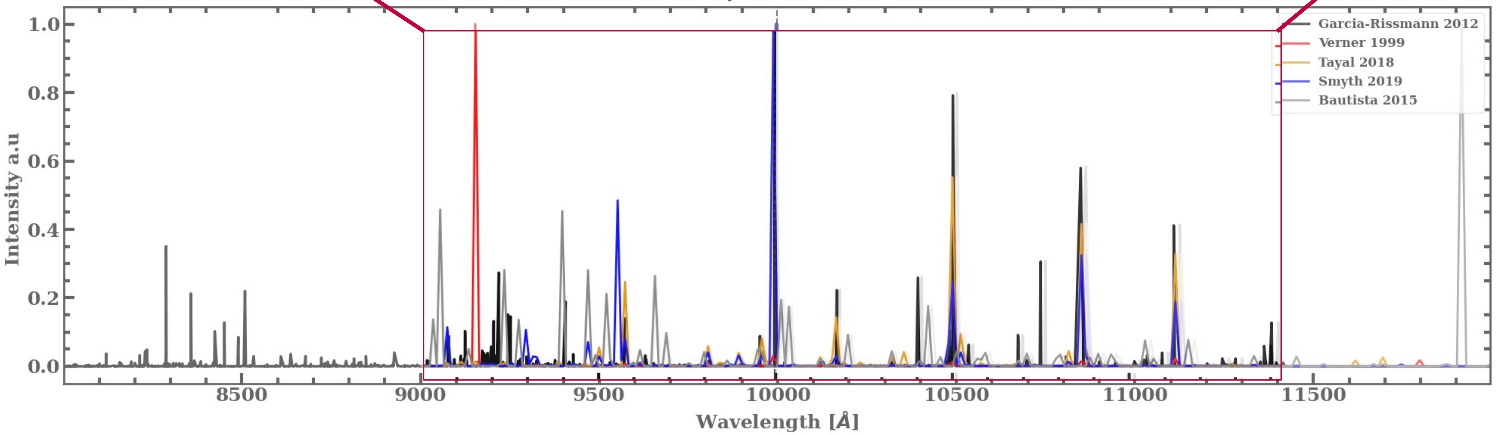


FeII datasets



$N_H = 10^{24}$ cm^{-2}, $n_H = 10^{9.75}$ cm^{-3} and 1 $Z_\odot$



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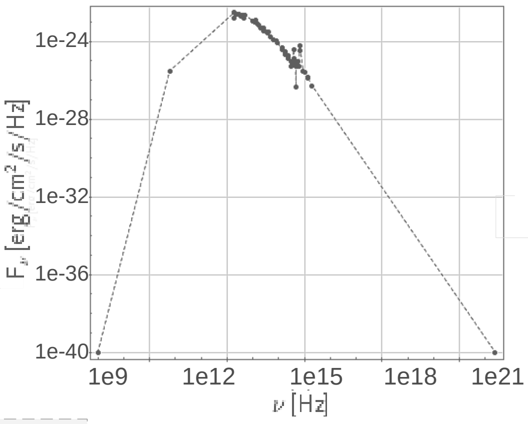

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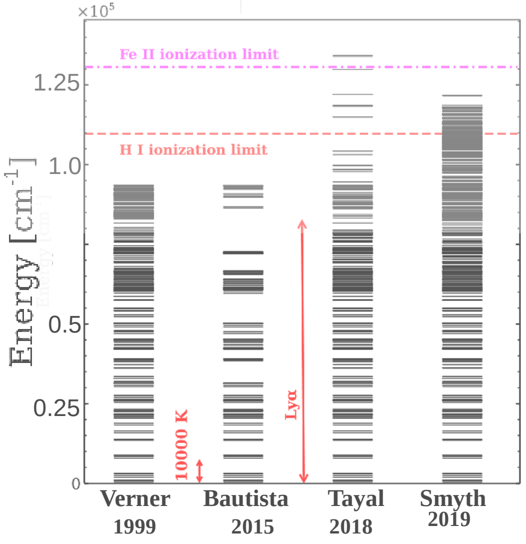
L_{5100}
R_{BLR}
SED
N_H (cm-2)
nH (cm-3)
Metalicity

609 models !



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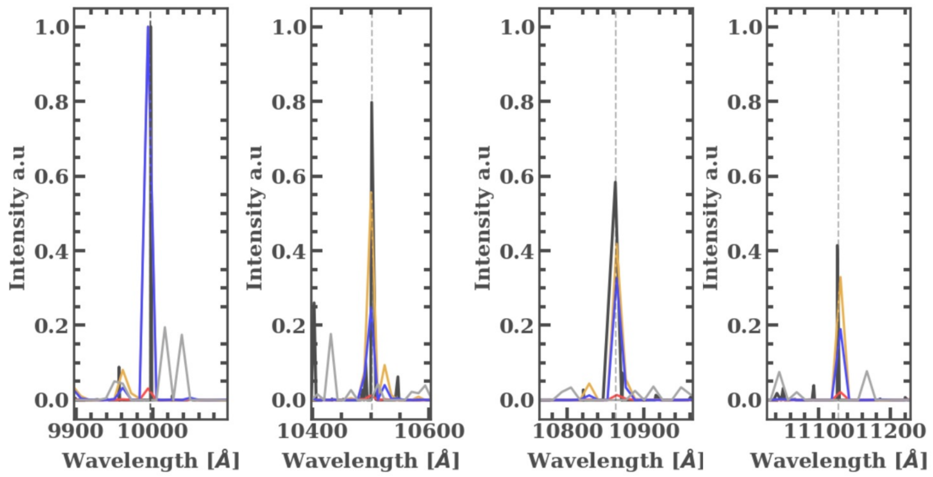


Computing quantities

Bump 4570Å: 4434 Å – 4684 Å

$$R_{4570} = \frac{\text{Flux (FeII } \lambda 4570)}{\text{Flux broad(H}\beta)}$$

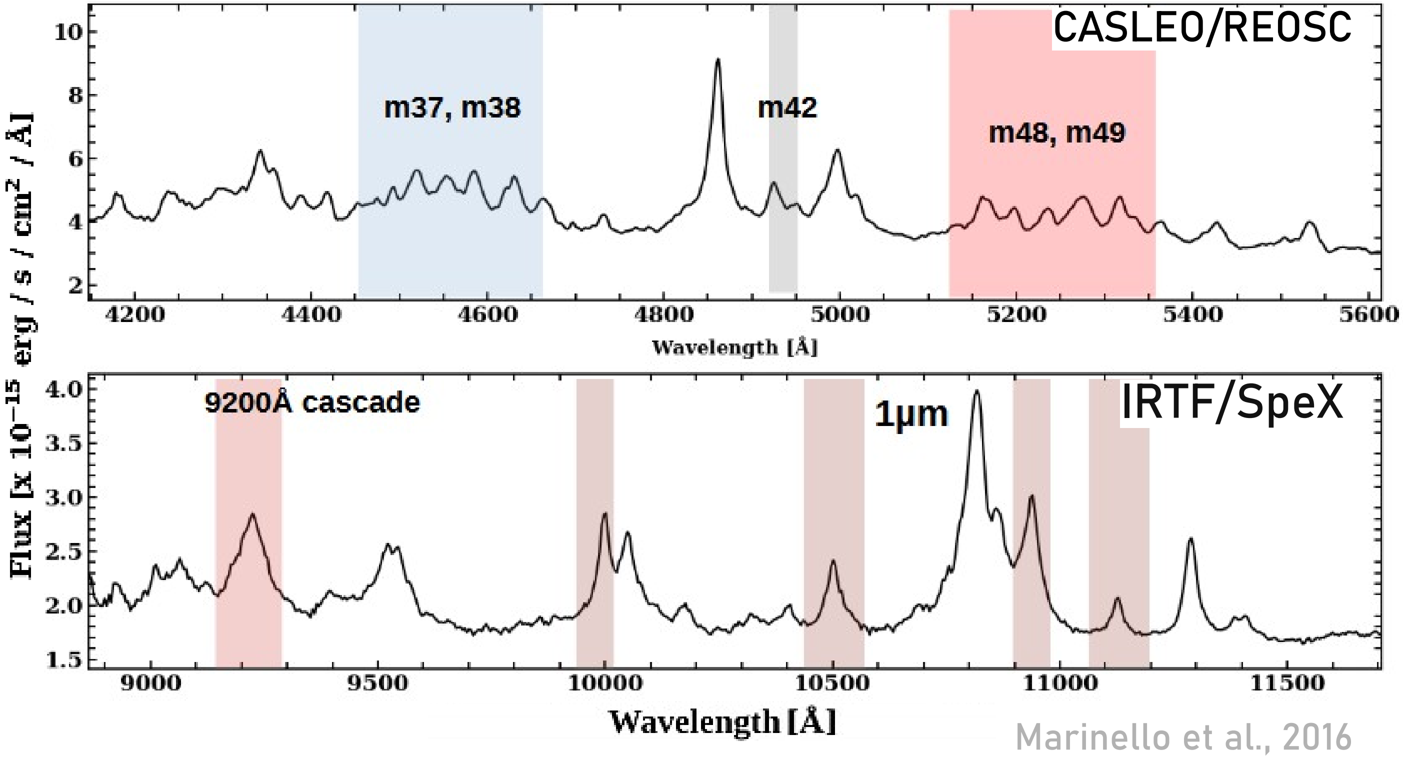
1.65±0.09

1-micron lines: λ 9997, λ 10502, λ 10863 and λ 11127

$$R_{1\mu m} = \frac{\text{Flux (1-micron lines)}}{\text{Flux broad (Pa}\beta)}$$

0.77±0.36

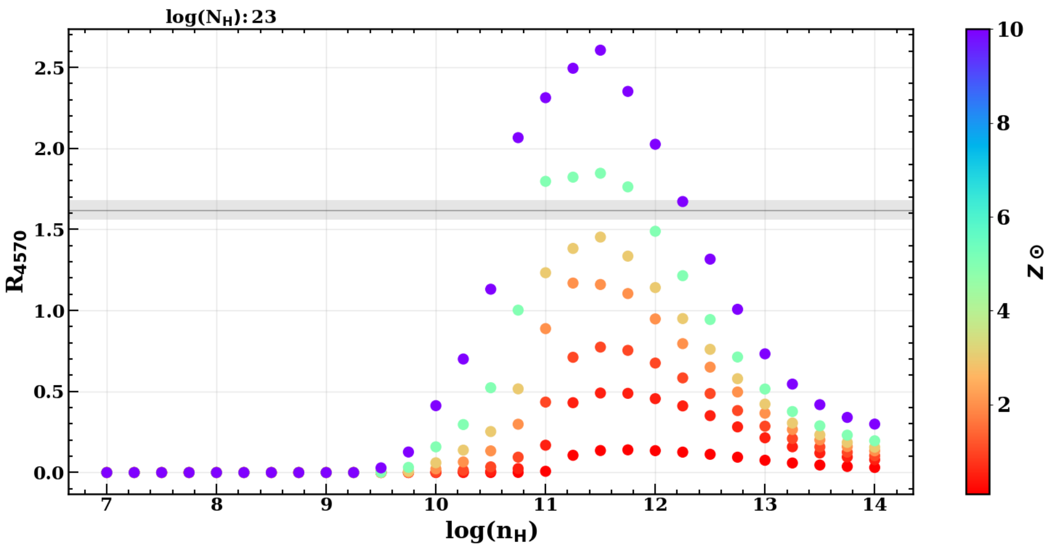
Dias dos Santos, D. et al. (in preparation)



Marinello et al., 2016

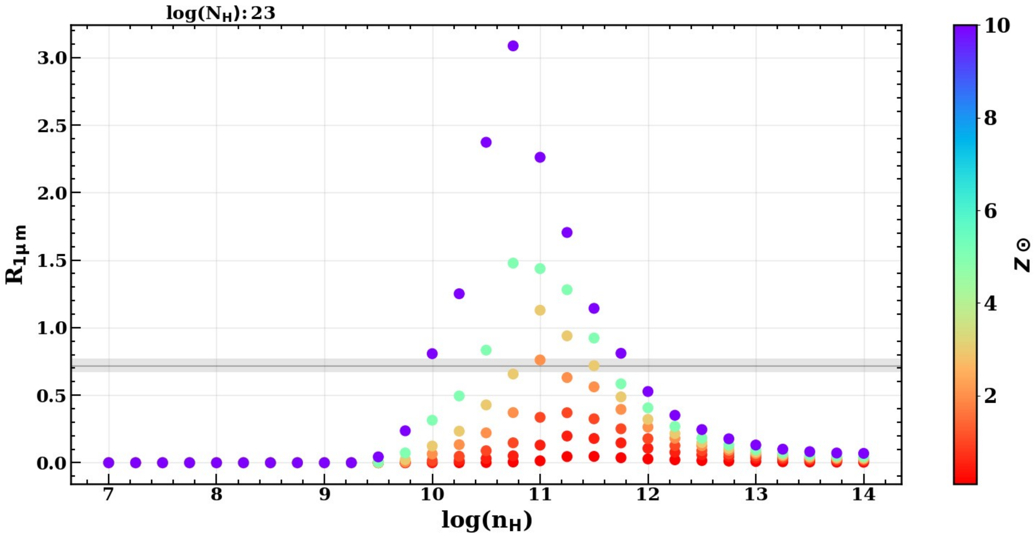
log (N_H) = 23 cm^{-2} – Smyth19

Optical



log n_H (cm^{-3}) = 10.75 – 12.25
> 3 Z⊙

NIR



log n_H (cm^{-3}) = 10.50 – 11.75
> 2 Z⊙

overlapping between log n_H (cm^{-3}) = 10.75 – 11.75

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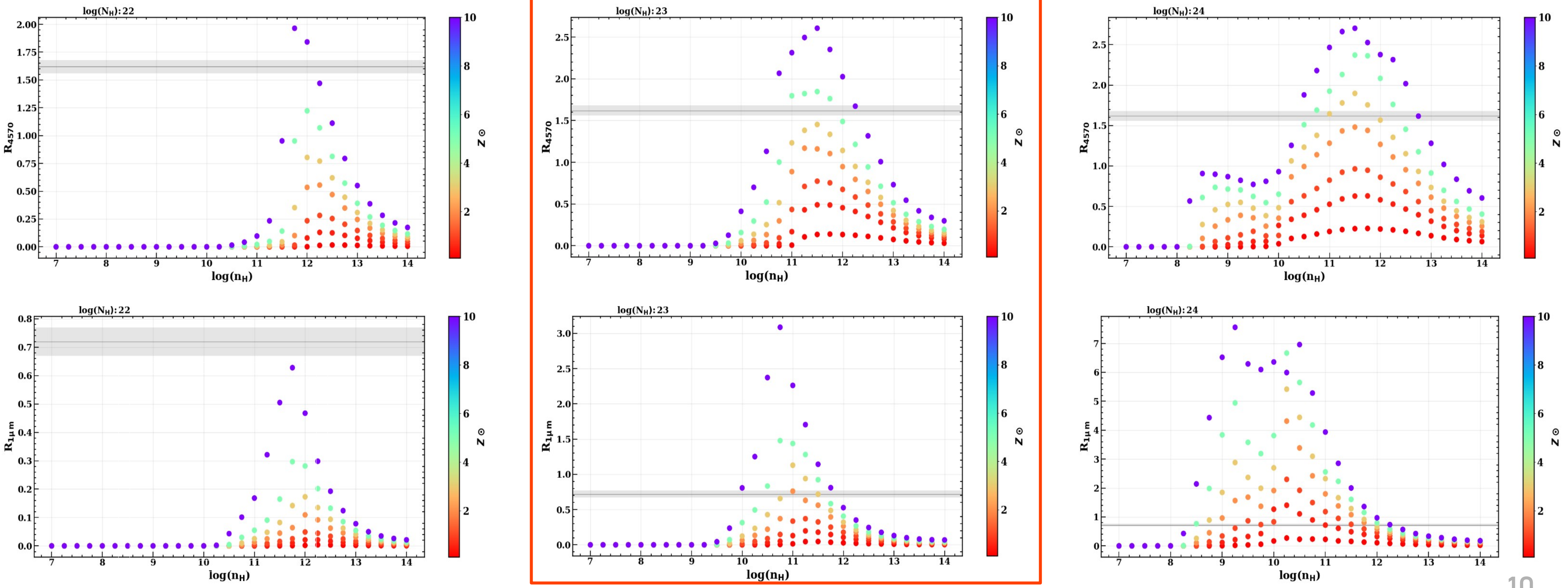


Dias dos Santos, D. et al. (in preparation)

We reproduce for the first time simultaneously the optical and NIR FeII emission

Reproduces IZw1 optical and NIR FeII simultaneously
- Log $(N_H) = 23$ cm^{-2}
- Log $(N_H) = 24$ cm^{-2}

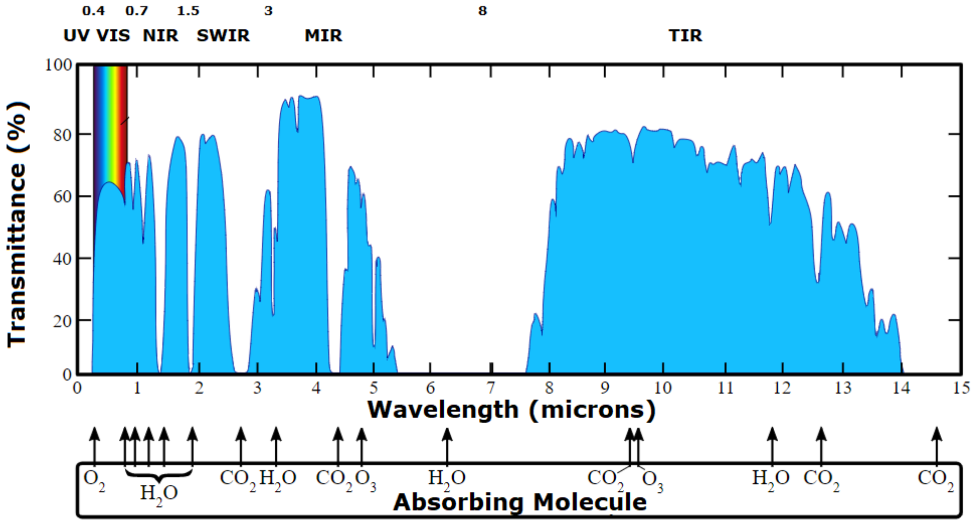
No reproduce simultaneously the FeII emission
- Log $(N_H) = 22$ cm^{-2}

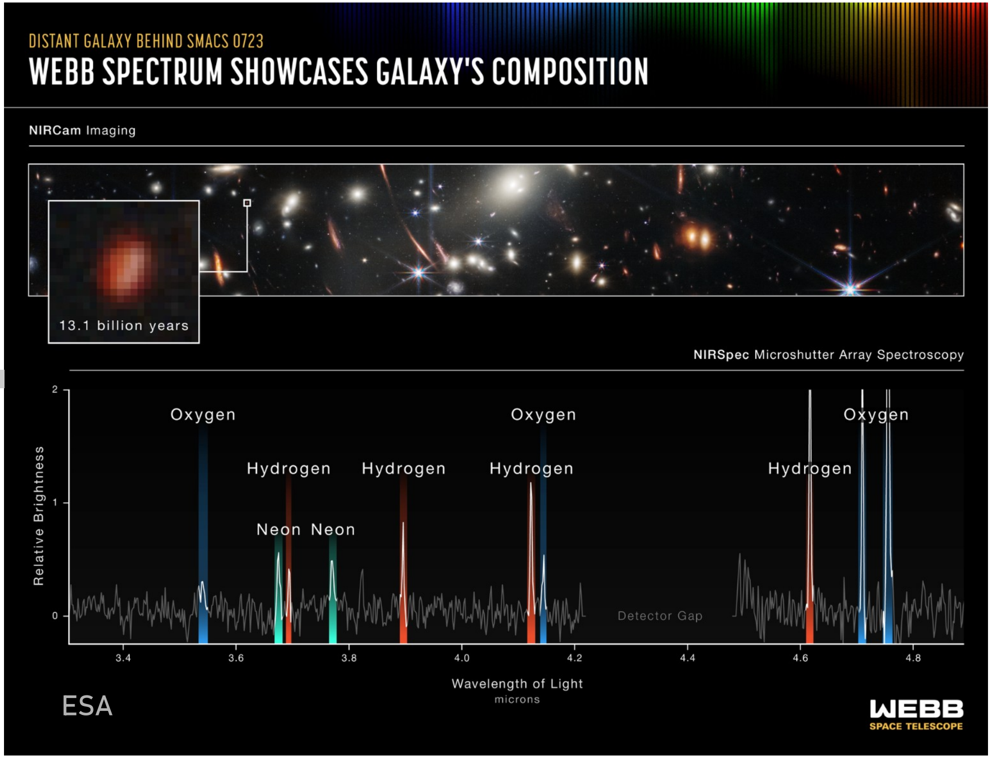
Metal and density limits are overall in agreement

- Only changing the atomic data set, we observed how it affects the results
- Future: we will apply our models in other IZw1-like AGNs

New generation of NIR telescopes

- 0.6 to 28.3 µm
- Telluric effects
- Explore distant galaxies





You're welcome to collaborate with us

4.1-meter Southern Astrophysical Research (SOAR) Telescope, Cerro Pachón - Chile

The International Gemini Observatory consists of twin 8.1-meter, Maunakea in Hawai'i and Cerro Pachón - Chile

Thank you!

Also, thank you Paola Marziani (PrInt Program advisor, INAF)

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denimaradias@gmail.com