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EVOLUTION OF DWARF GALAXIES: characterizing star formation scenarios

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Ciemat

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What is the SFH of dwarf galaxies?

HII galaxies: Metal poor systems with massive ionizing stars

Are they really young galaxies?

-**Intermediate age and old stars found**, even in I Zw18

(Loose & Thuan 1986, Papaderos et al. 2002, Izotov & Thuan, 2004, Aloisi et al. 2005)

- EW(Hβ) vs. O/H: Only possible due to galactic evolution.

- EW(Hβ) vs. color: HII galaxies show more redder colours than expected at low EW

(Terlevich et al. 2004)

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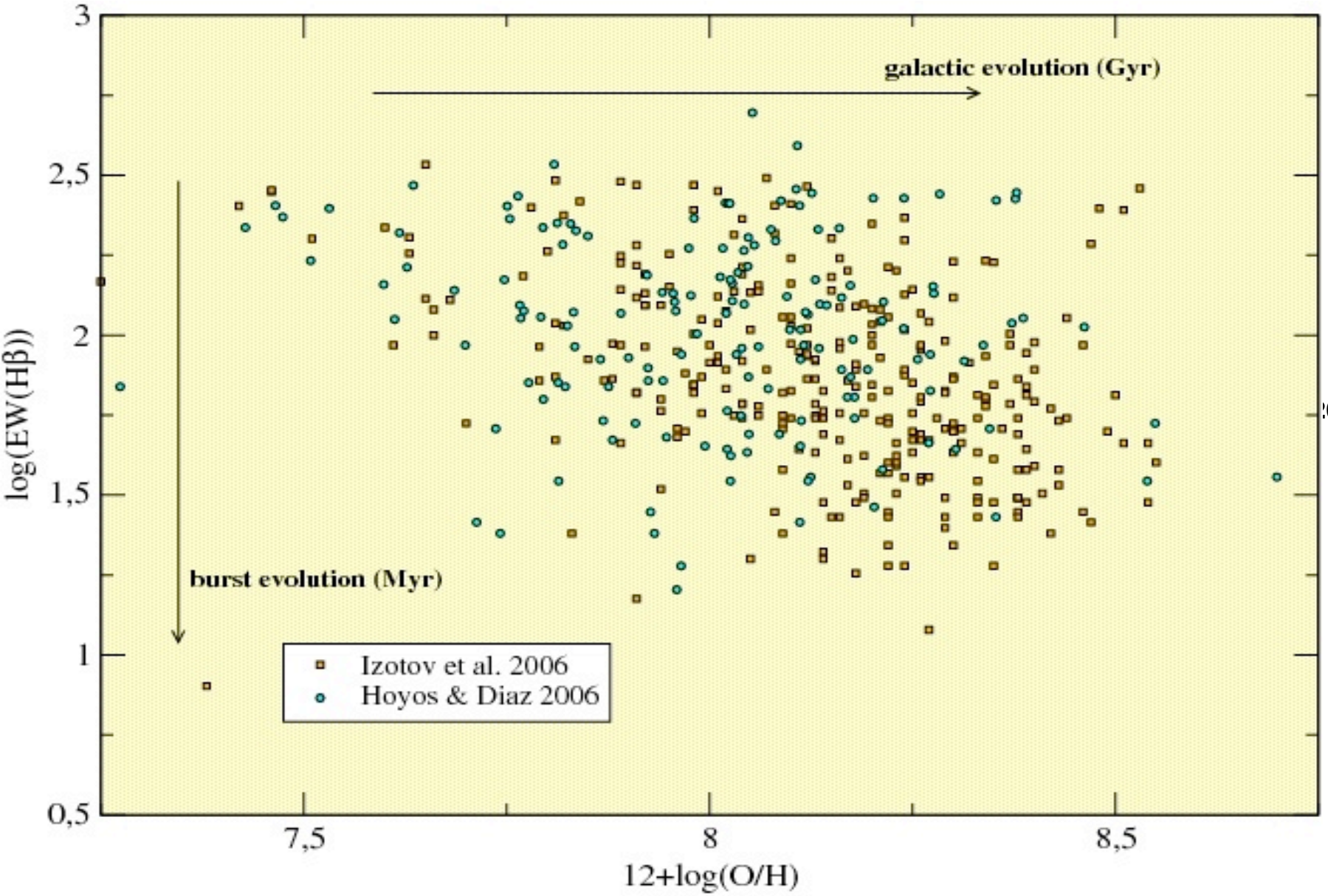

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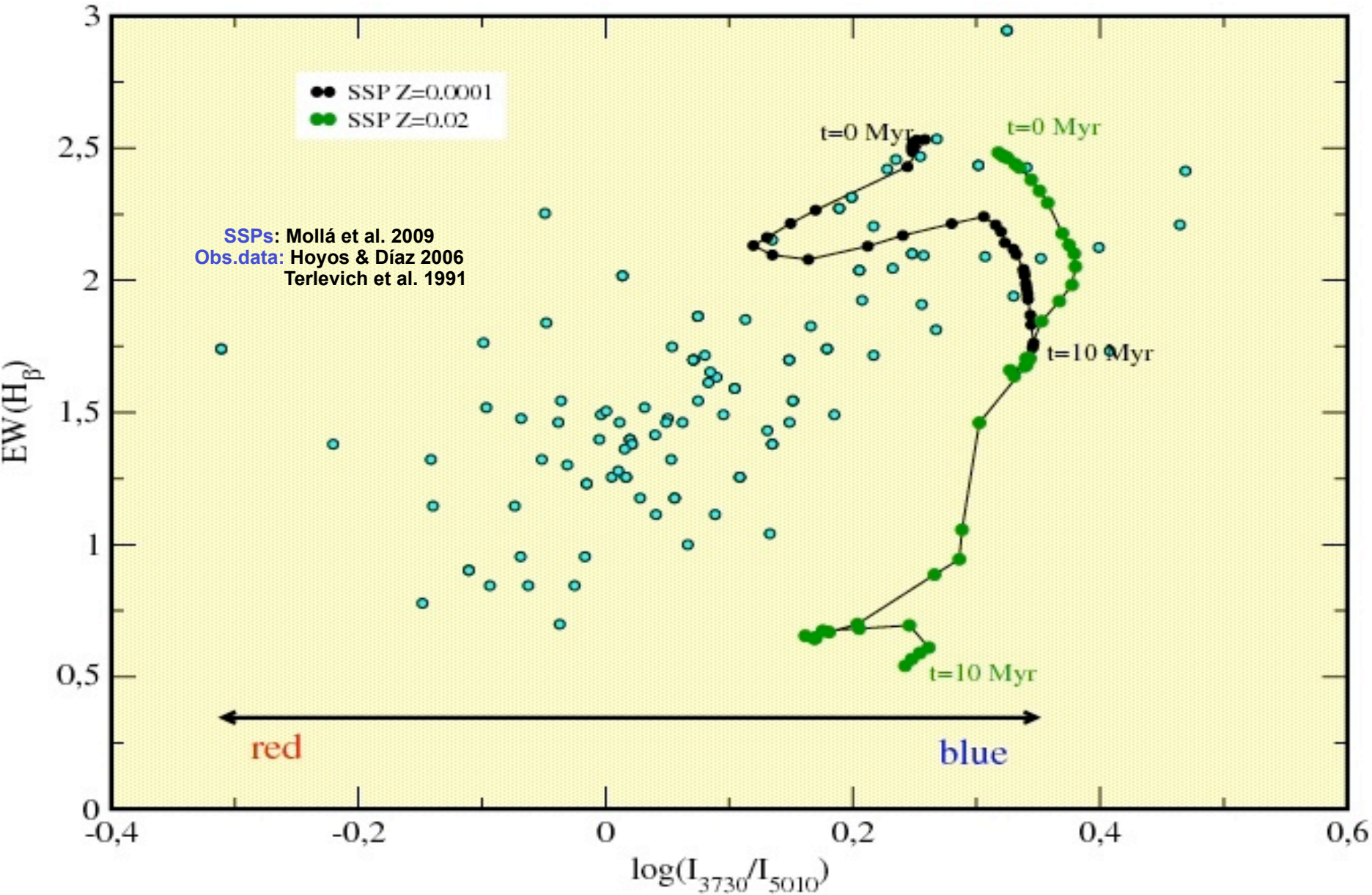

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NOT reproduced by SSPs

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* **Then, how is the star formation history?**

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* **Then, how is the star formation history?** ?

What is the SFH of dwarf galaxies?

There are 3 star formation scenarios postulated:

- **Bursting SF: short and intense SF bursts+long quiescent periods**
  (Davies & Phillips 1988, Bradamante et al. 1998)

- **Gasping SF: long moderate SF bursts+short quiescent periods**
  (Tosi et al.1991).

- **Continuous SF: low intensity continuous SF + sporadic bursts**
  (Legrand 2000)

The self-consistent star-bursting evolutionary models

based on Martin-Manjon et al 2008

Successive bursts star formation t=0-13.2 Gyrs, $M_{tot}=10^8 M_{sun}$

Initial Efficiency (ε):

The amount of gas consumed to form stars in the 1st burst of SF.

- High efficiency
- Low efficiency

Attenuation :

The strength of the successive bursts :

- soft attenuation
- strong attenuation

Time between bursts (Δt):

The quiet periods

Δt= 1.3 Gyr - 0.1 Gyr - 0.05 Gyr

Different scenarios can be reproduced by changing these three parameters

-Gasping: + attenuation, - Δt ; Continuous: - Δt , - ε

TOOLS:

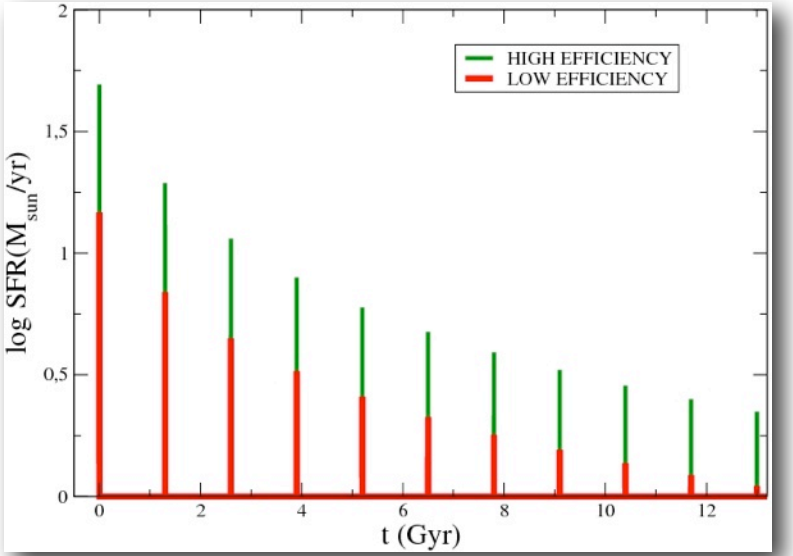
Chemical evolution code *(Mollá&Díaz 2005)* **: SFH, evolution of metallicity and abundances**

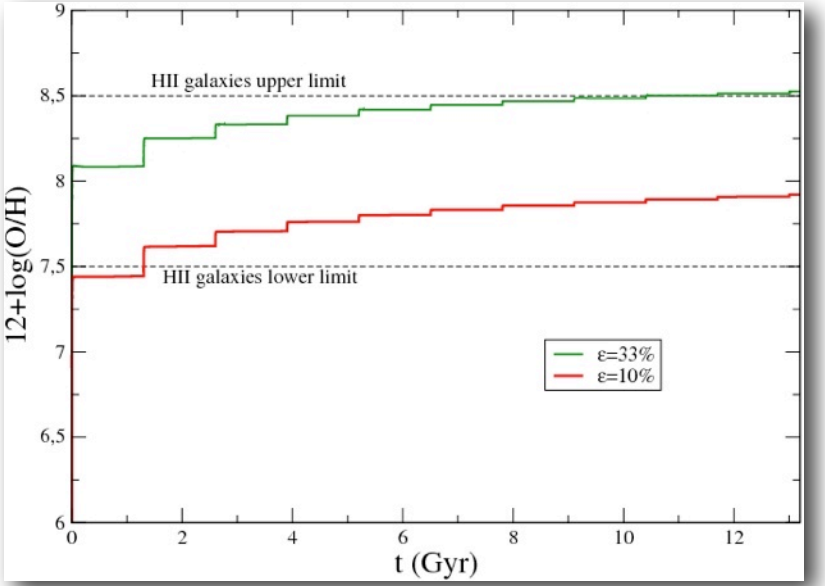
+ Evolutionary synthesis code *(PopStar- Mollá et al.2009)*: **S.E.D and colours.**

+ Photoionization code *(CLOUDY, Ferland 1998)*: **emission lines**

Initial Efficiency (ε)

Determines the SFR and the initial oxygen abundance *(Hoyos et al. 2004, Hoyos & Diaz 2006).*

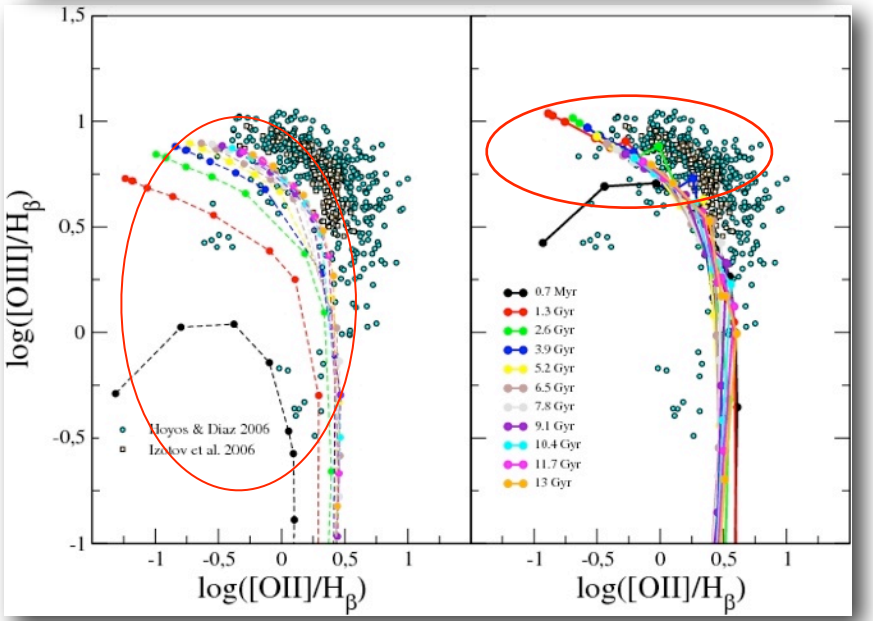




The initial efficiency also drives the behavior of the ionized gas:

The emission lines are produced by the ionizing photons of the massive stars born in the current burst.

- **high efficiency** high excitation and high abundance galaxies, high [OIII]/H_β
- **low efficiency:** less metallic galaxies, with high [OIII]/H_β and low [OII]/H_β ratios.



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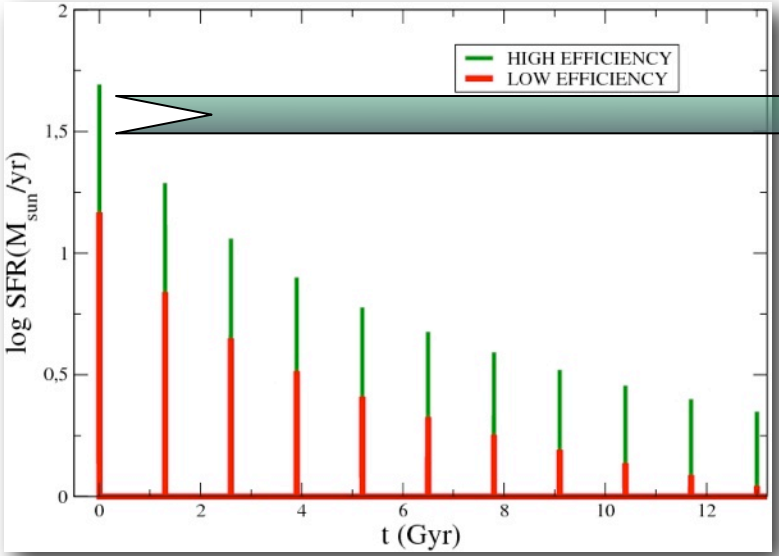

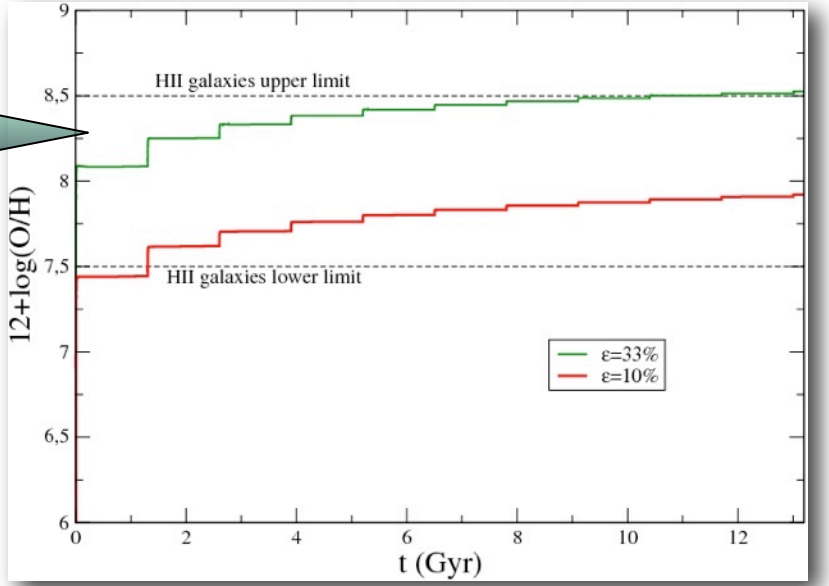

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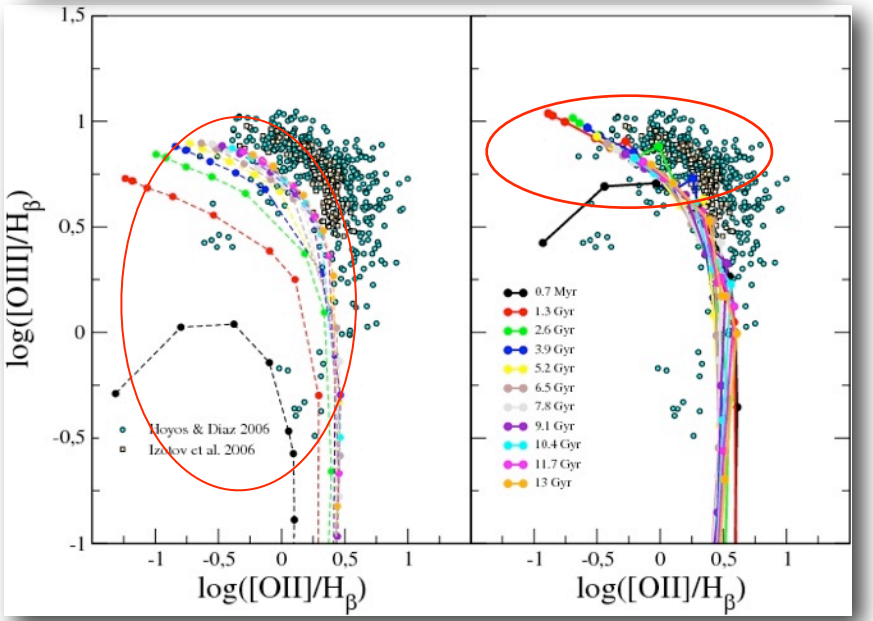

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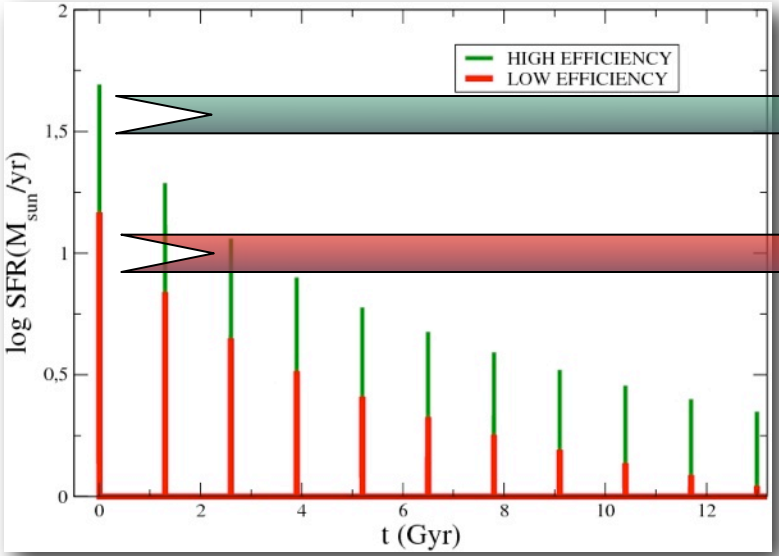

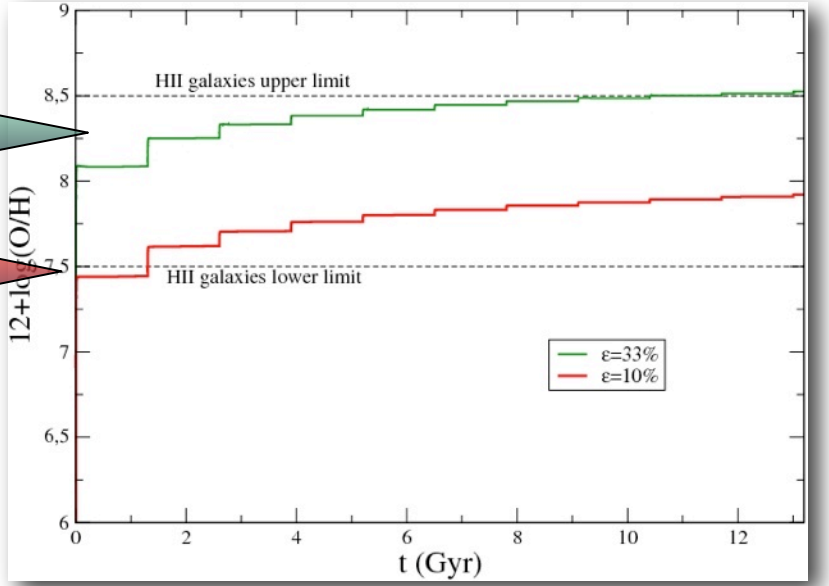

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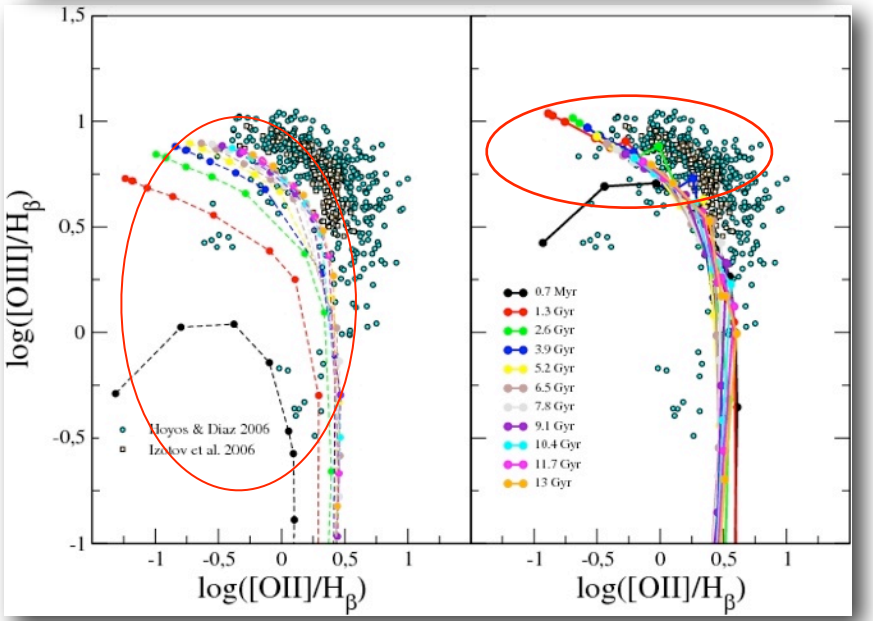


Attenuation

The strength of the bursts determines the contribution of the underlying non ionizing population:

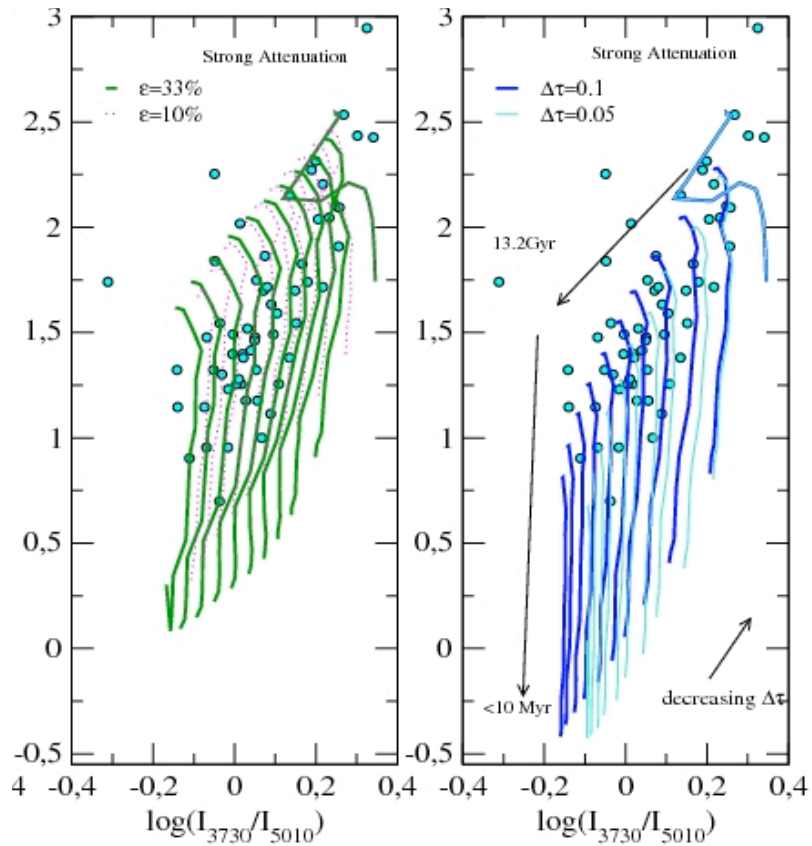
The higher attenuation the larger contribution from the previous bursts to the total SED.

- **EW(Hβ) vs. O/H**: cover both time scales.
- **EW(Hβ) vs. color**: The contribution of the underlying population to the total continuum must be **higher than the contribution of the current burst** which dominates the emission line spectrum.

Inter-burst time (Δt)

Sets the age of the underlying population.

The EW(H_β) decreases more from burst to burst but the **colours can be bluer !!**



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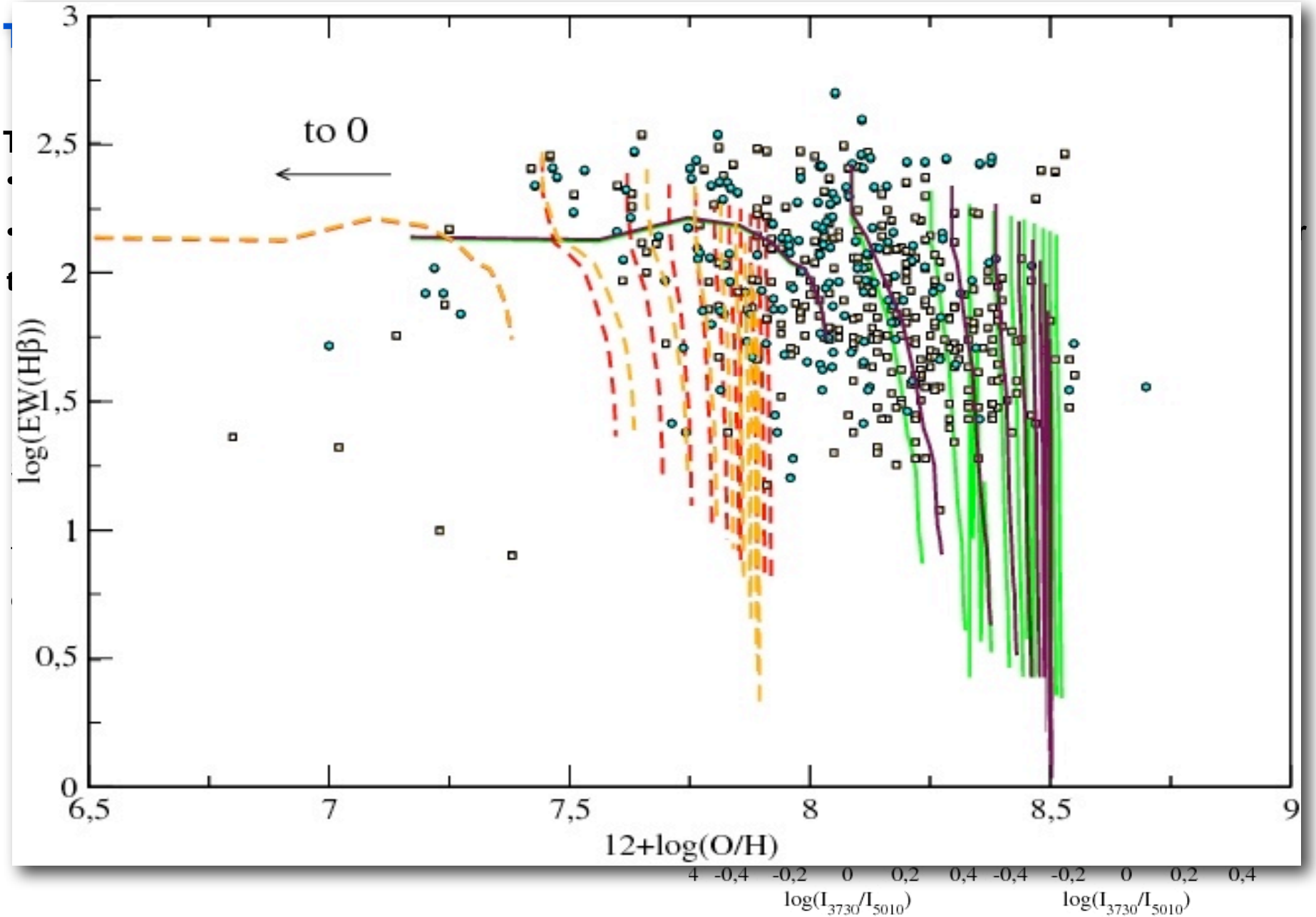

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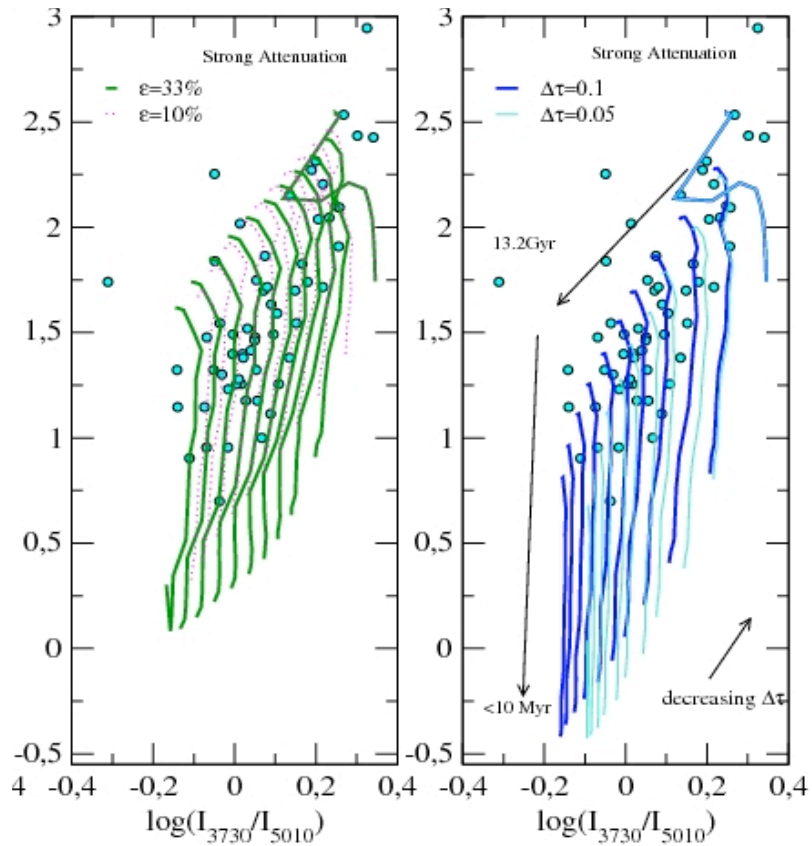

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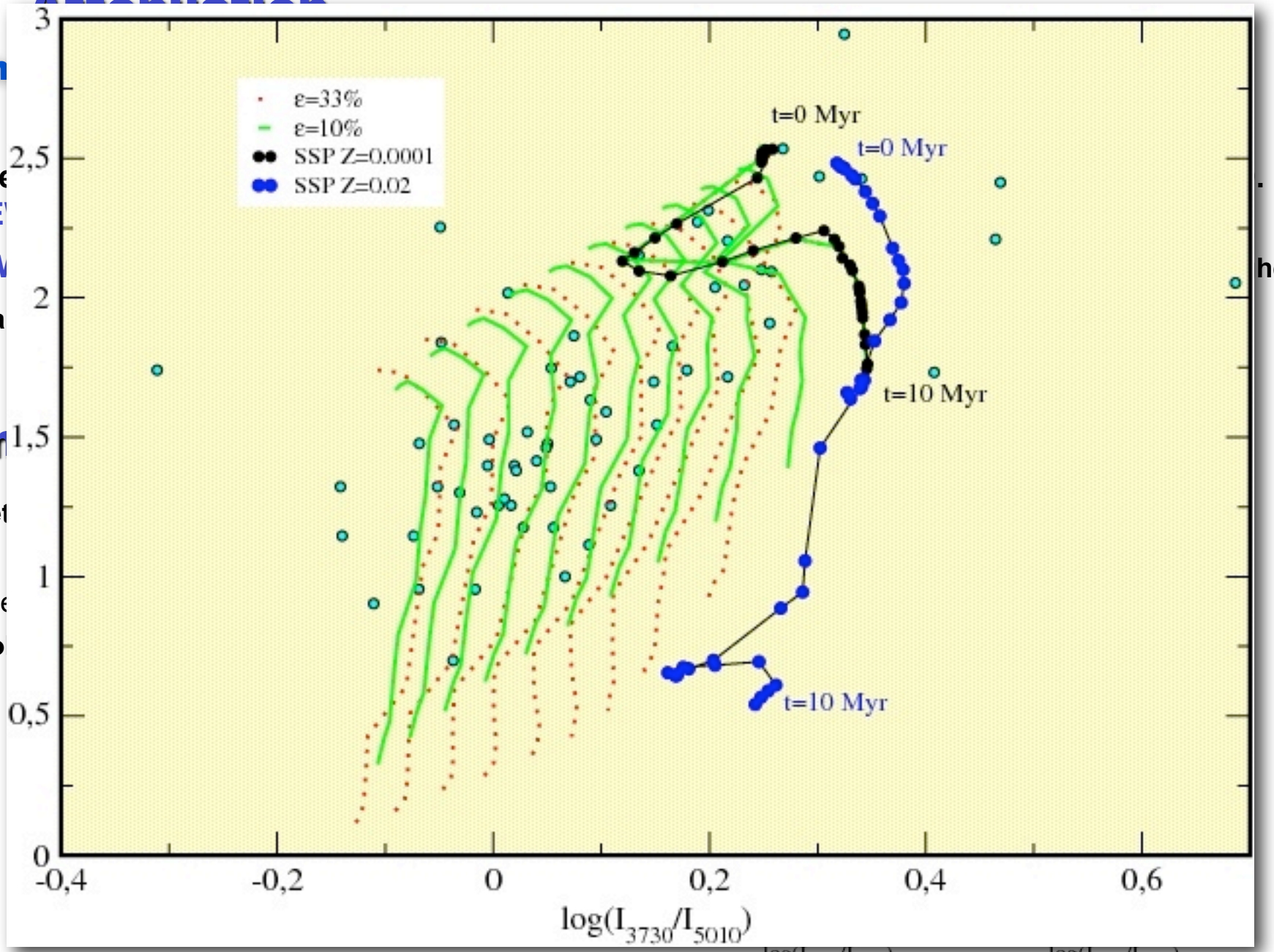

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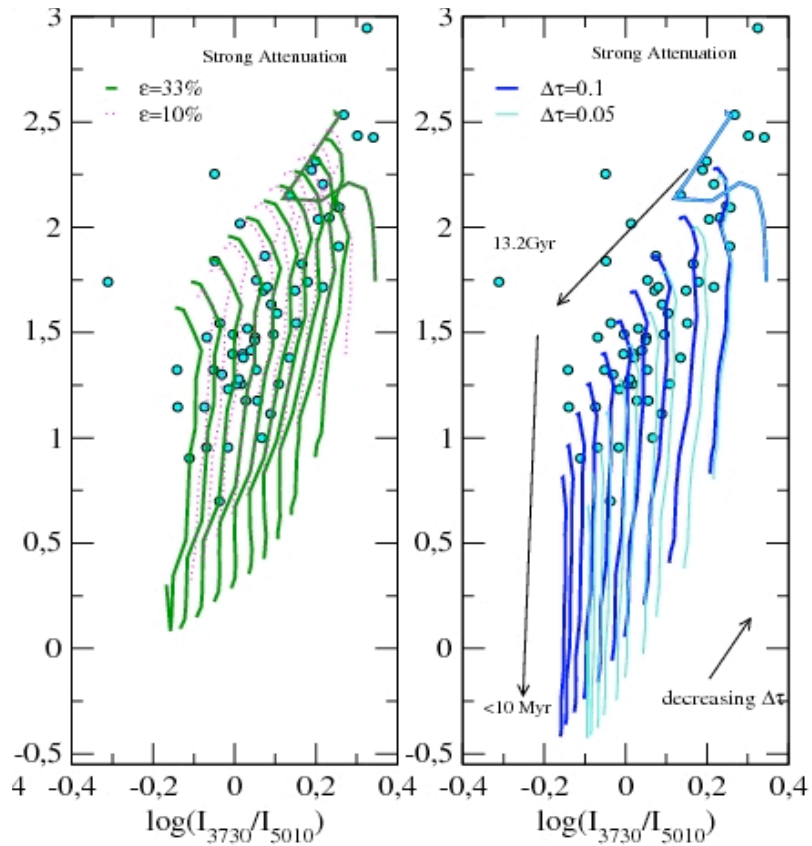

Summarizing...

In order to reproduce the characteristics of HII galaxies **under an specific star formation scenario**…3 parameters must be set:

Initial efficiency, Attenuation, Inter-burst time

Our models can reproduce every observable feature of HII galaxies

-abundances, colors and emission lines-

simultaneously

How can we use the models?

Martín-Manjón et al. MNRAS 2008
Martín Manjón et al. 2008 (arXiv0901.1186)
Martín Manjón et al. 2008 (ASPC)
Martin Manjón et. al 2010 (Popstars)
Martín Manjón et al. 2011 (in prep)

χ^2 tests: IIZw40

It measures the goodnes of fit models-observations

We will obtain for the observed galaxy:

- **age of the current ionizing population**
- **age of the underlying population.**

Parameter	Value	Error (%)
$[OII]3727Å$	0.275	5
$[NeIII]3869Å$	0.347	15
$[OIII]4363Å$	0.077	15
$[HeI]4471Å$	0.033	30
$[OIII]4959Å$	2.621	5
$[OIII]5007Å$	8.095	5
$[HeI]5876Å$	0.134	15
$[OI]6300Å$	0.019	20
$[NII]6548Å$	0.033	15
H_α	4.700	10
$[NII]6584Å$	0.089	10
$[SII]6716Å$	0.089	20
$[SII]6731Å$	0.087	20
$EW(H_\beta)$	268	10
I_{3730}/I_{5010}	4.890	20

Parameter	Value	Error
N/H	20×10^{-7}	1×10^{-7}
O/H	500×10^{-7}	6×10^{-7}
S/H	140×10^{-7}	50×10^{-7}
(V-I)	0.020	0.01
(R-I)	-0.230	0.01

$$\chi^2 = \Sigma_{n=1}^{15} \frac{(O_n - T_n)^2}{\sigma_n^2}$$

Terlevich et al 1991
Díaz et al. 2007
Telles &Terlevich 1997

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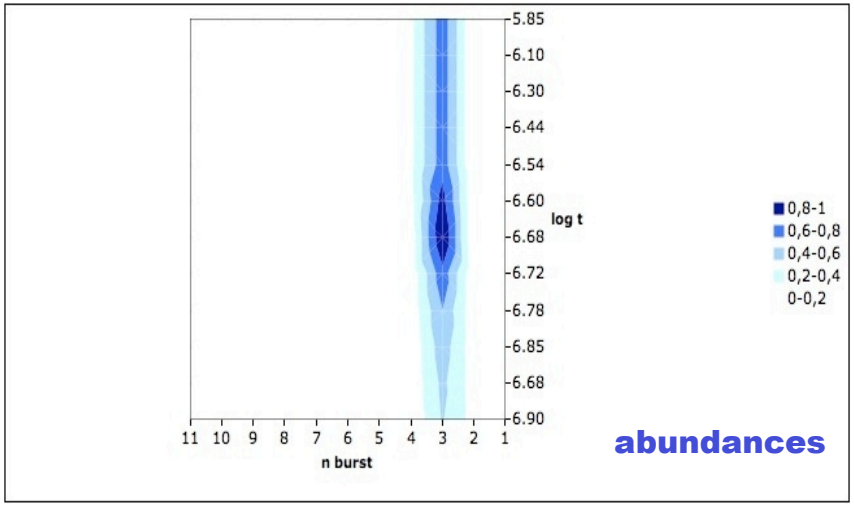

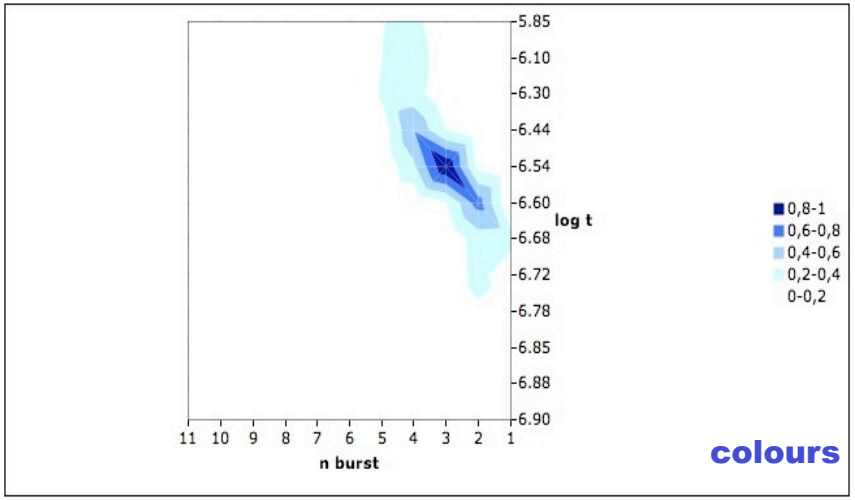

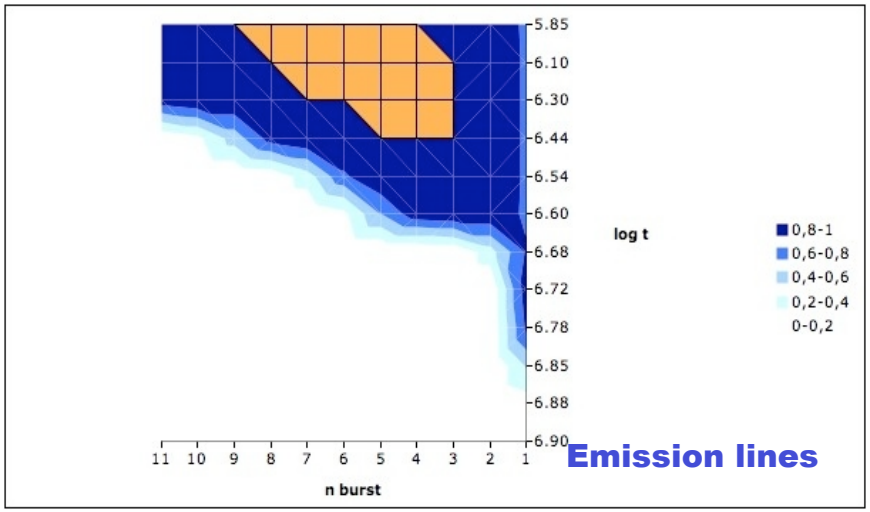

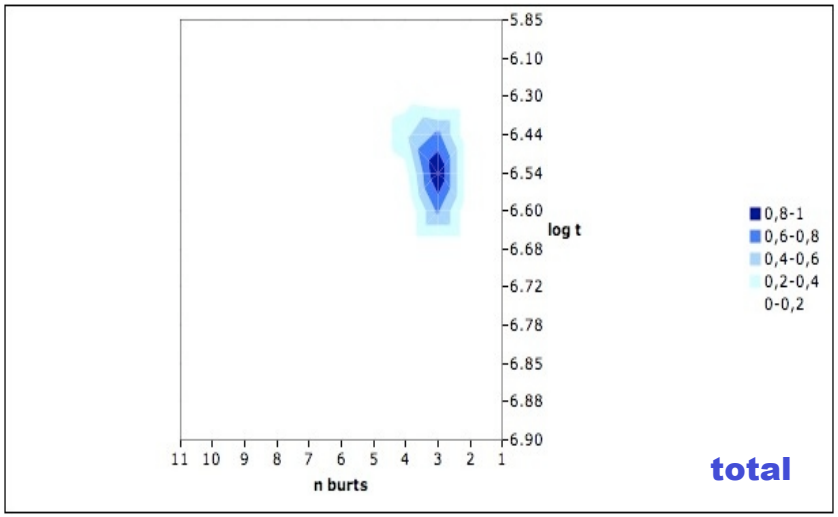

Ionizing population: 3 Myr

Underlying population: aprox 2.6 Gyr

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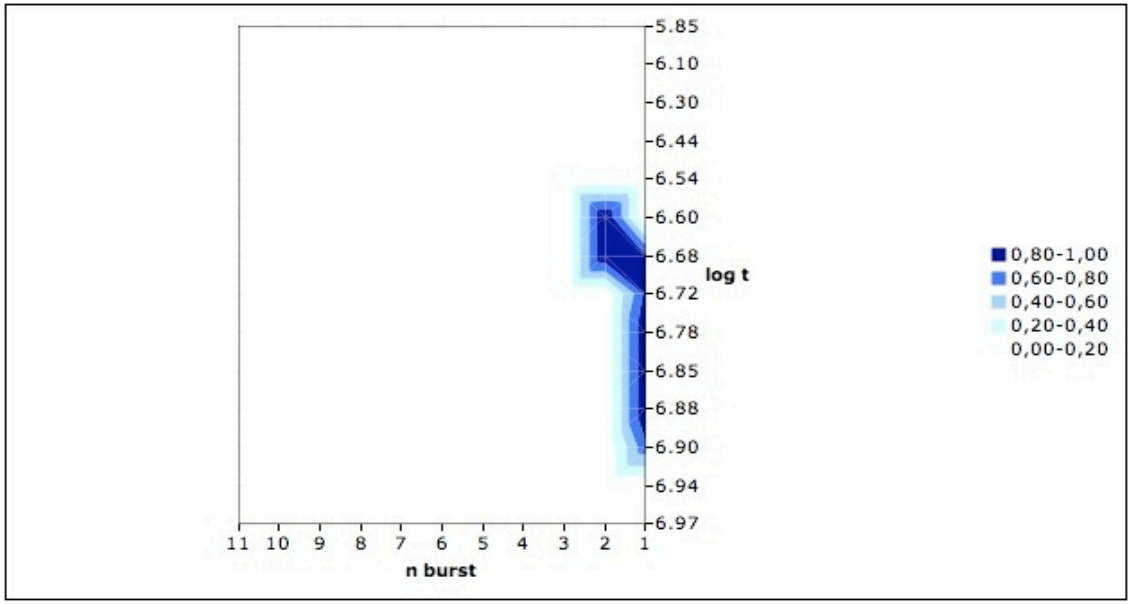
MODEL: low efficiency, intermediate attenuation, Δt= 50Myr

Ionizing population: 4 Myr

Age (underlying pop.) aprox. 100 Myr



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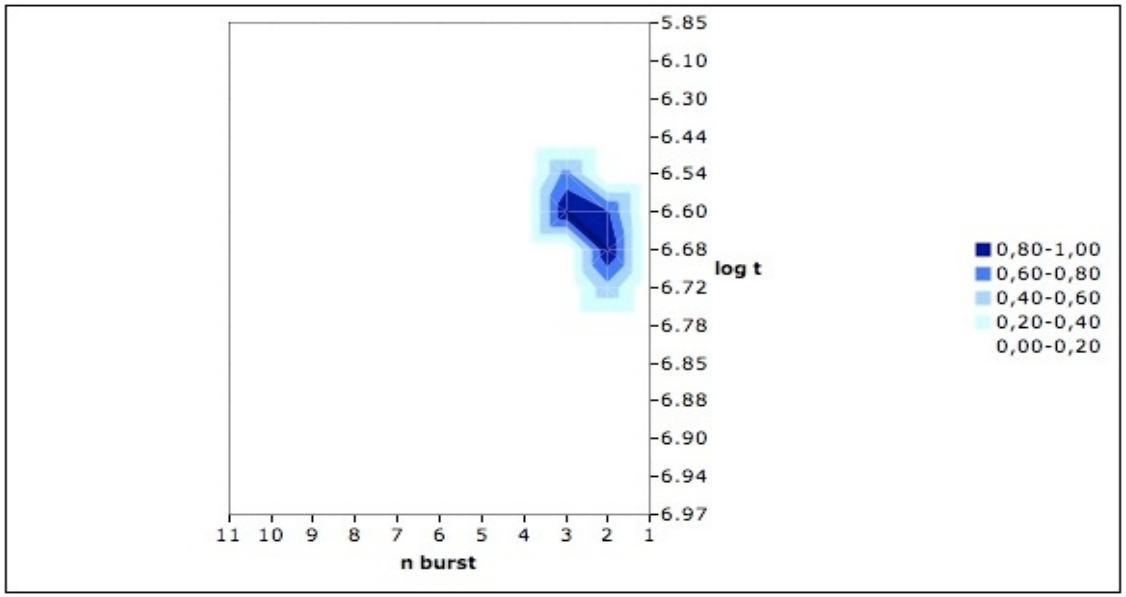
MODEL: low efficiency, strong attenuation, Δt= 1.3 Gyr

Ionizing population: 4 - 4.7 Myr

Age (underlying pop.) 1.3- 2.6 Gyr

Aloisi et al. (2005), underlying > 1.3 Gyr,
Yakobchuk (2008), underlying < 2 Gyr,
Ionizing <5 Myr



Martin-Manjon et al 2011 (in prep)