Photoionization models of the CALIFA regions.

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CALIFA for dummies

Calar Alto Legacy Integral Field spectroscopy Area survey

- ~ 600 galaxies observed with the PMAS/PPAK IFU spectrophotometer mounted on the Calar Alto 3.5m telescope.
- R ~1650, lambda in [3700-7000AA]
- ~ 20000 giant HII regions defined by HIIEXPLORER (Sánchez et al. 2012)

Photoionization models

P-space

- SED
  - shape (softness: T*, age)
  - intensity
- Gas
  - density
  - abundances
    - O/H
    - N/O
    - etc…
- Distance source-gas
- Morphologie (O or / /)

Model

O-space

- Halpha, Hbeta
- [NII]6584
- [OII]3727
- [OIII]5007
- No [OIII]4363 nor [NII]5755

Photoionization models

P-space

- SED
  - shape (softness: T*, age)
  - ~~intensity~~
- Gas
  - ~~density~~ → U=Q/r^2.n
  - abundances
    - O/H
    - N/O
    - etc…
- ~~Distance source-gas~~
- Morphologie (O or / /)

Model

O-space

- Halpha, Hbeta
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Photoionization models

P-space

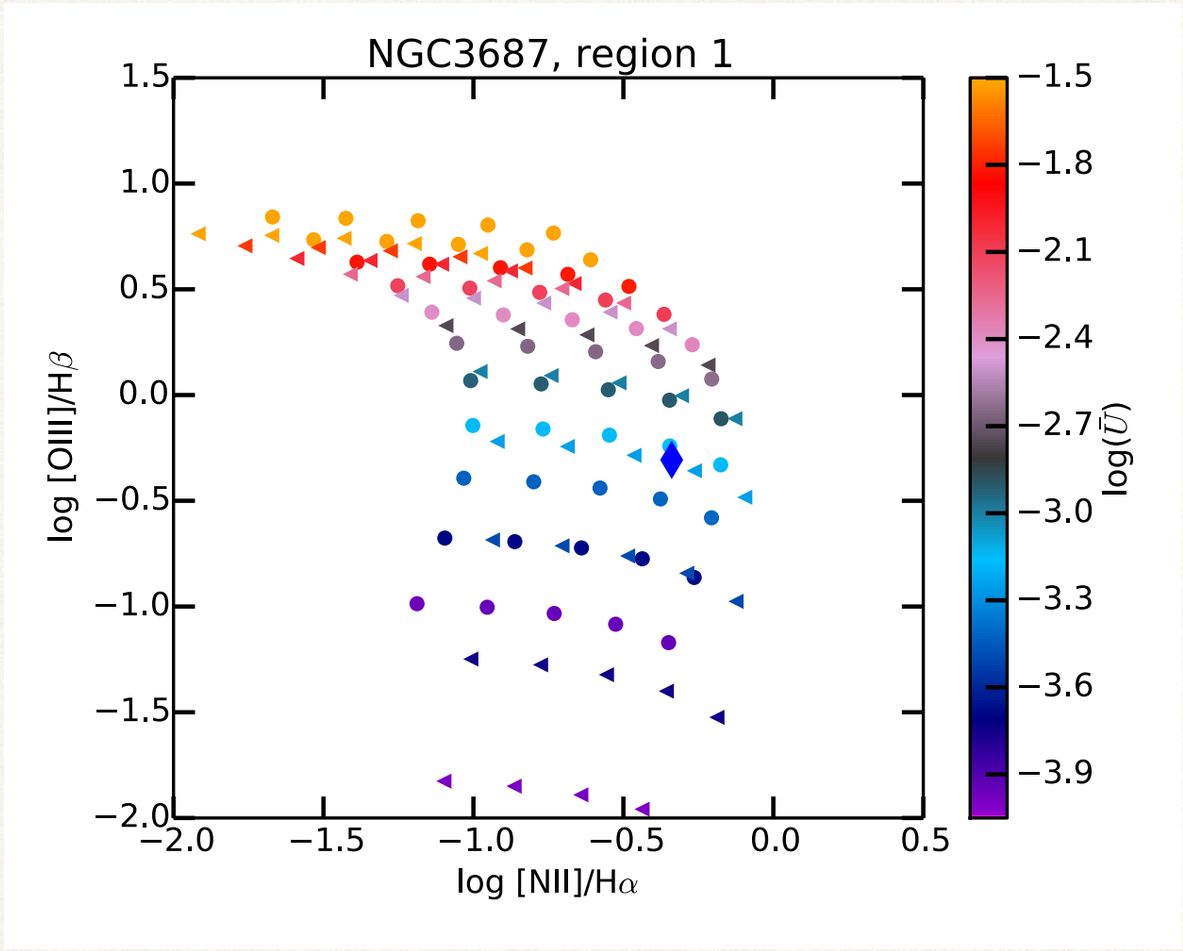
- SED
  - shape (softness: T*, age) -> FIT3D
  - ~~intensity~~
- Gas
  - ~~density~~ log(U)
  - abundances
    - O/H -> O3N2, Stel. pop
    - N/O
    - etc…
- ~~Distance source-gas~~
- Morphologie (O or / /)

Model →

O-space

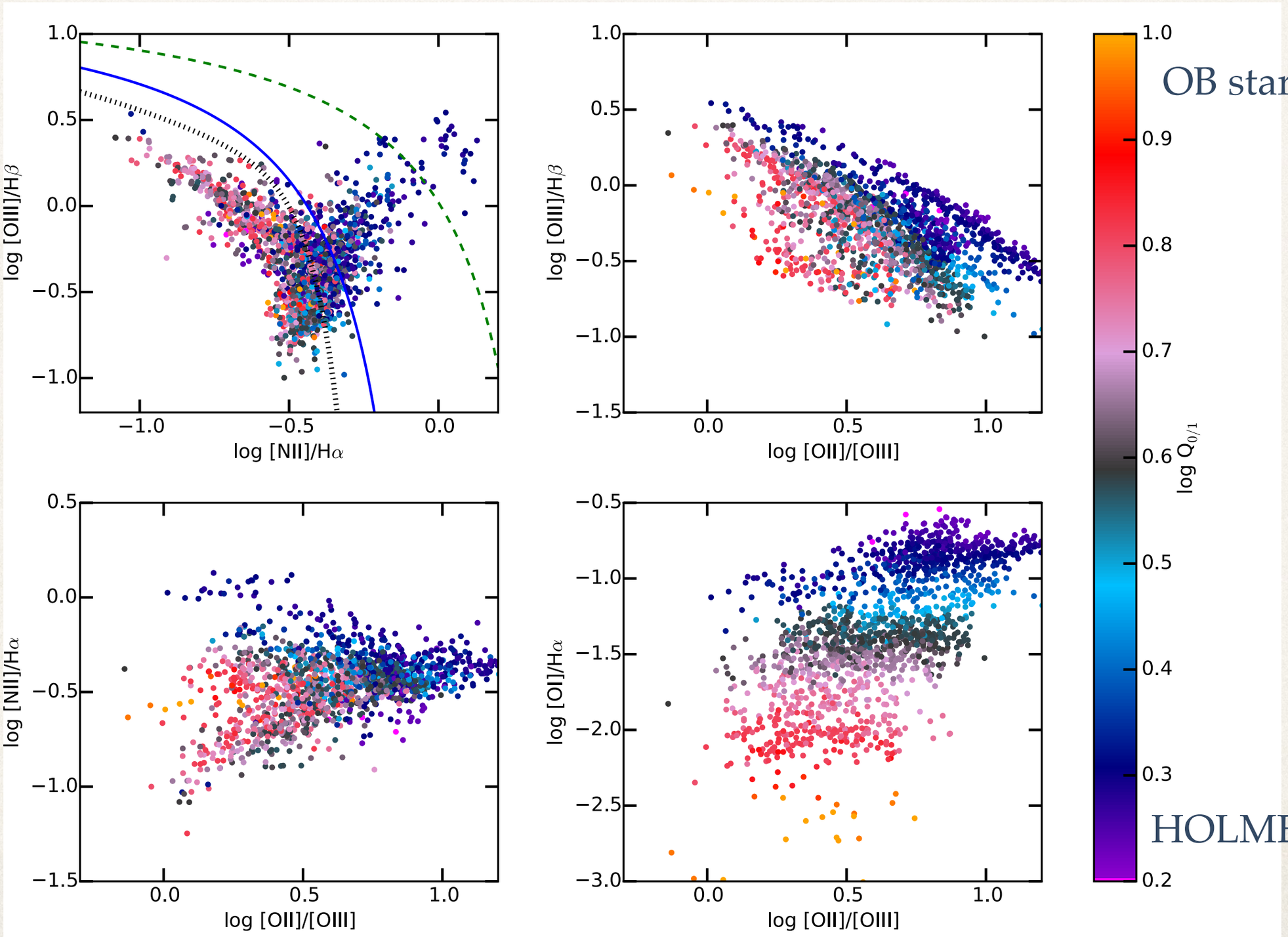
- Halpha/ Hbeta: E_{B-V}
- [NII]/Ha
- [OII]/Hb
- [OIII]/Hb

log(U) and N/O grids

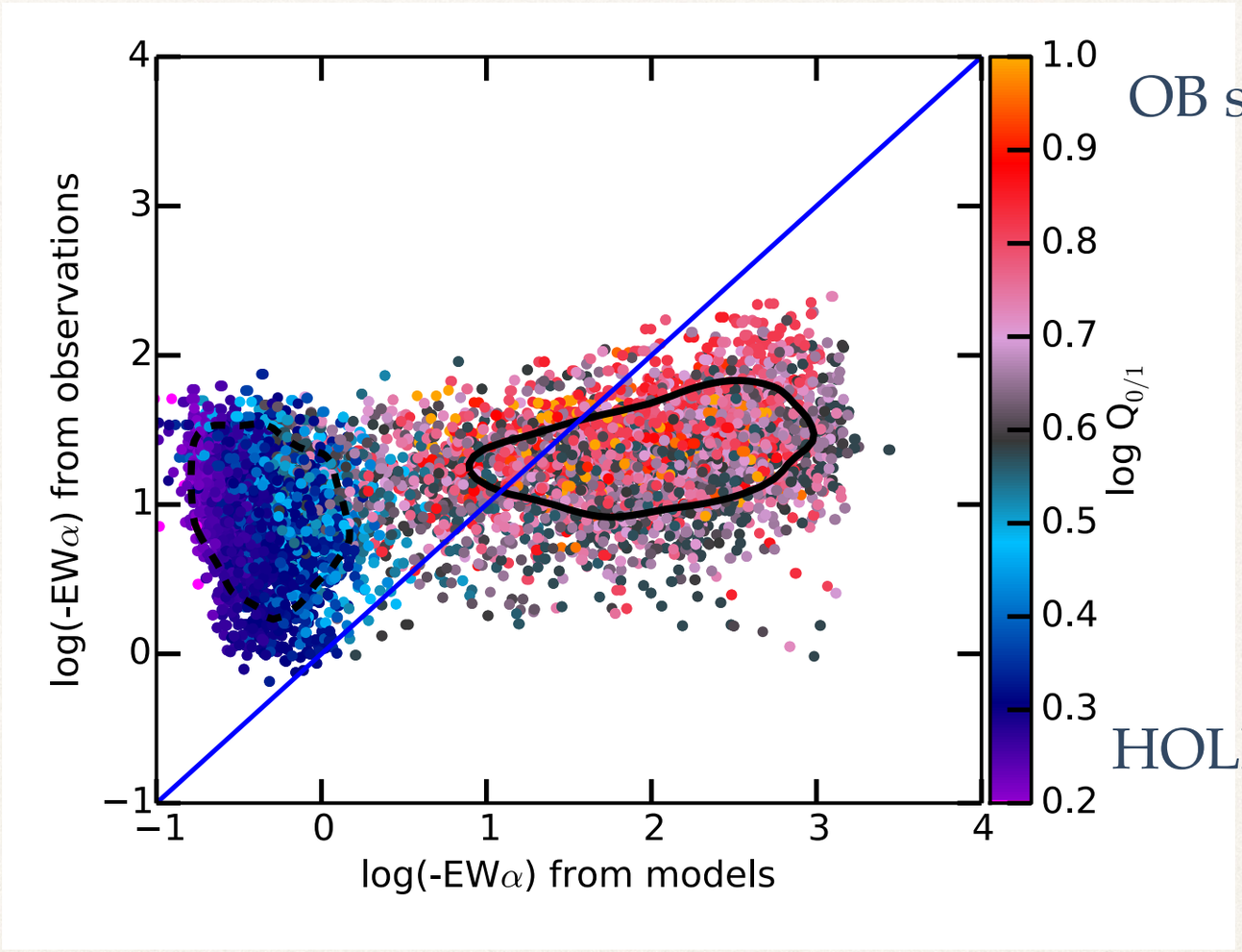


- **For each region** (> 9000): 11 values of log(U), 5 values of N/O, 2 morphologies (O or //) and 2 values for O/H -> 220 models with adapted SED and O/H. -> **Determination of log(U) and N/O.**
- A total or ~2 millions models are run for the meta-grid (*that's why O/H is not free!*)
- ad-hoc models with adequate log(U) and N/O are re-run and **stored in 3MdB.**
- [OII]/Hb used to filter the final set of models used for the following plots.

BPT diagrams

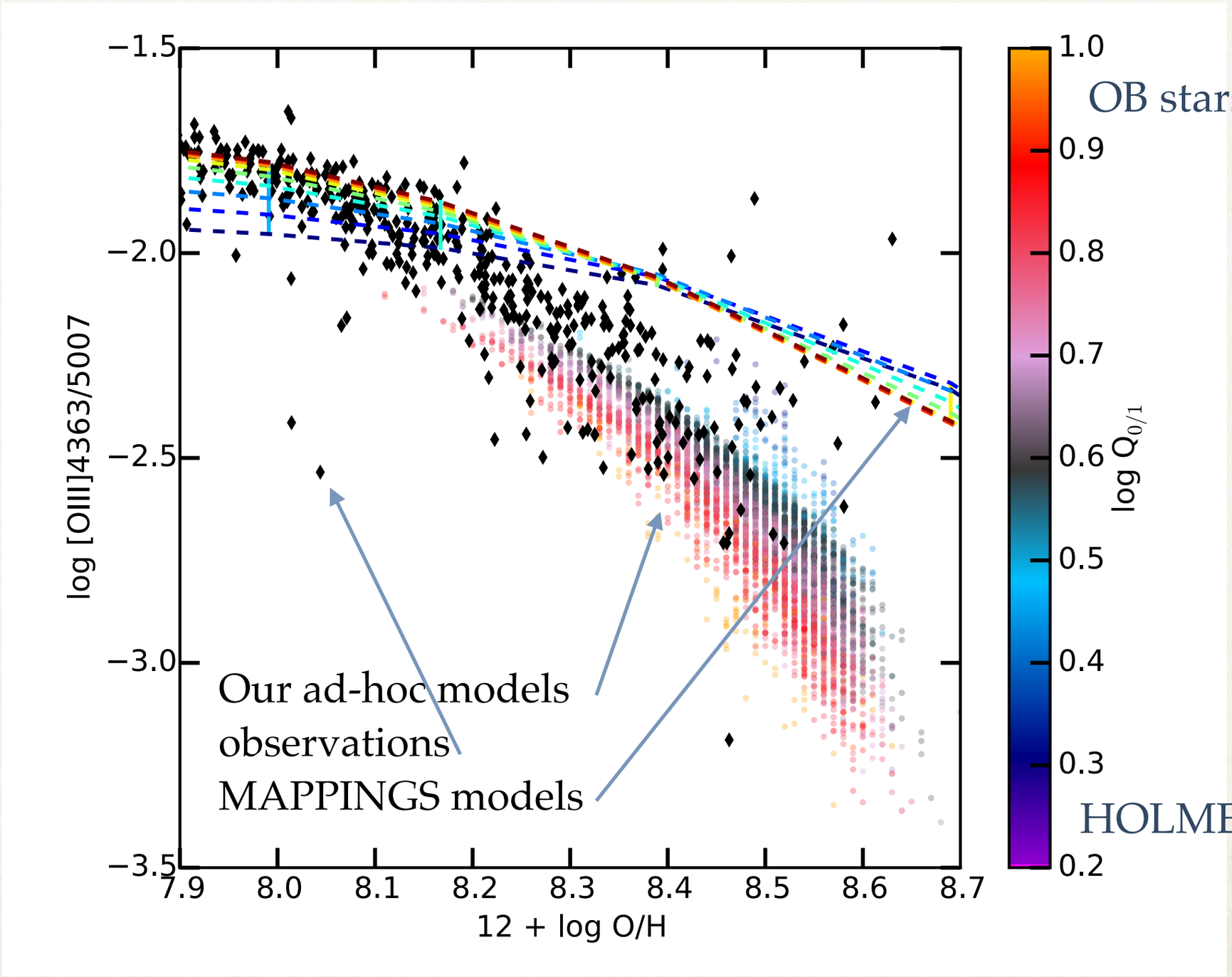


Eq. widths

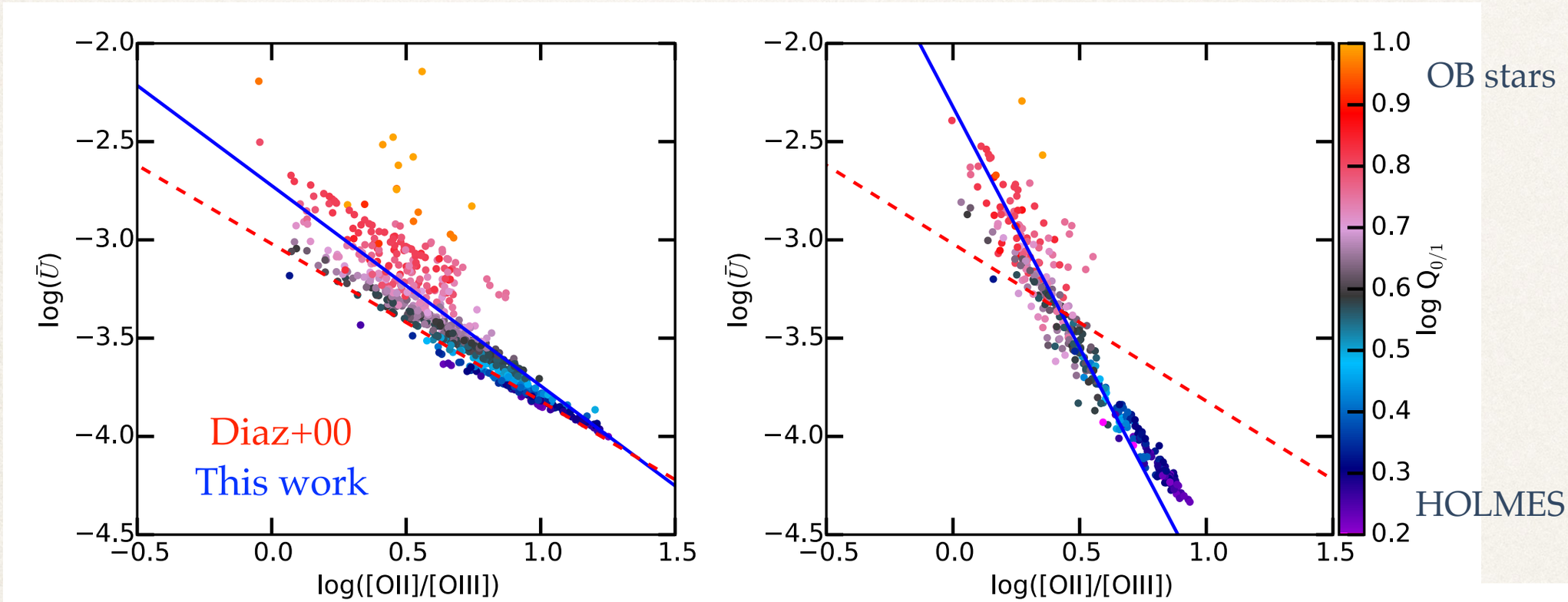


- Halpha Eq. width disagree between models and observations:
  - obs < mod ----> leaking (~80%)
  - mod < obs ----> missing ionizing photons (pb...)

[OIII] 4363/5007: observations reproduced!

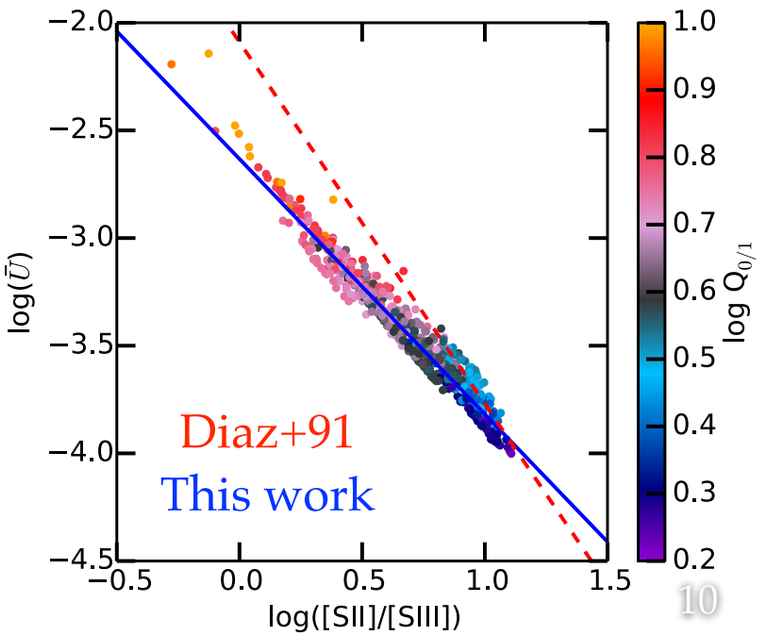


Determining U

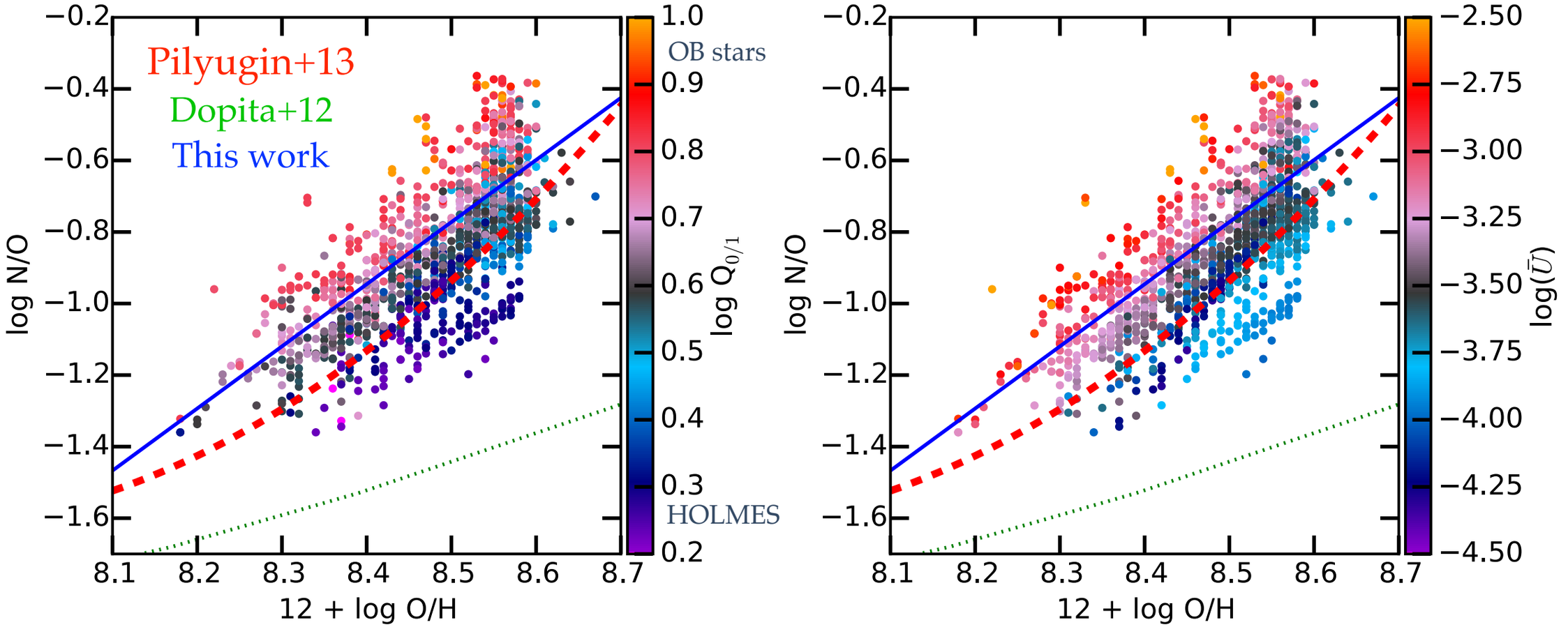


Morphology

- U is not easily determined from observations.
- [OII]/[OIII] depends on the morphology
- [SII]/[SIII] more acurate

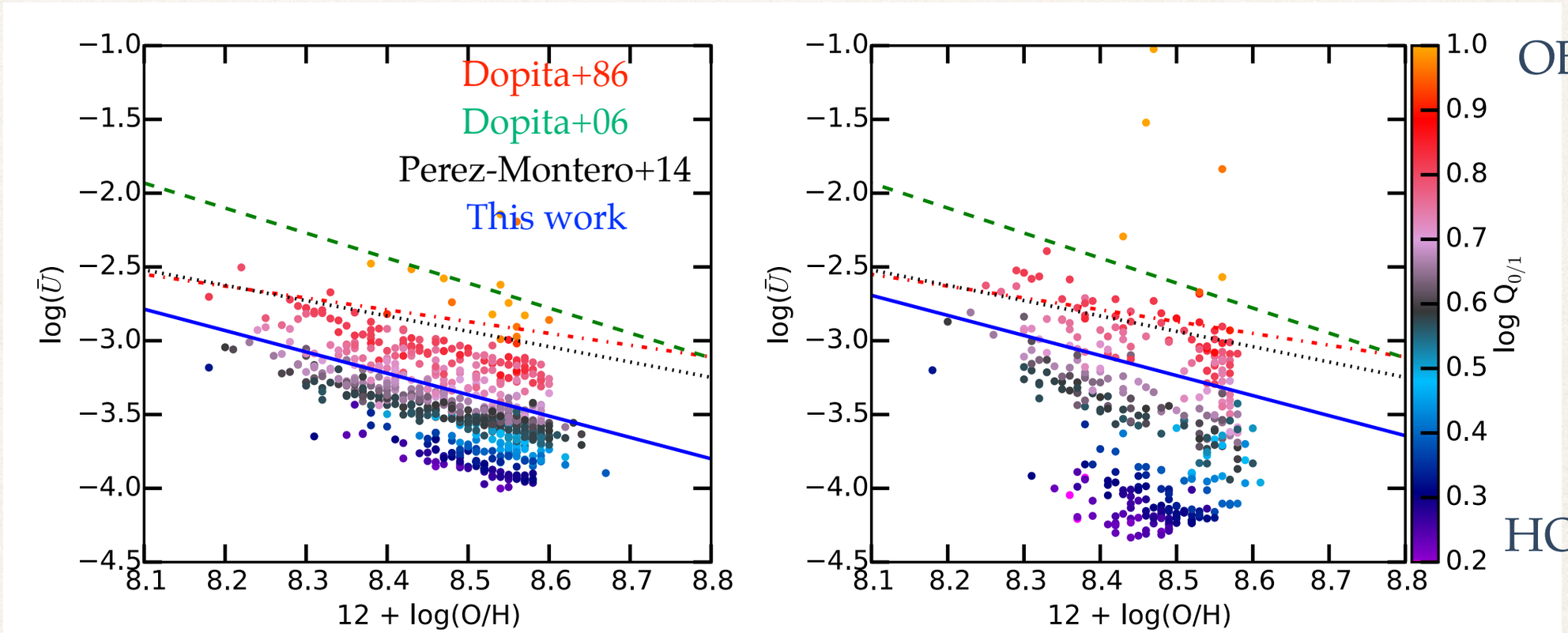


N/O vs. O/H



N/O vs. O/H: our results are closer to the ones from Pilyugin et al. than to Dopita et al.

Log(U) vs. O/H



O Morphology

- Since Dopita & Evans 1986 we suspect a relation between U and O/H.
- We determine a new fit, depending on the region morphology and the SED softness.

Models on 3MdB

- All the 20,793 ad-hoc models are available on 3MdB (Mexican Million Models database, Morisset et al. 2015), a mySQL database of photoionization models.
- input parameters, and a lot of outputs :
  - intensities for more than 150 emission lines (IR & UV included)
  - ionic fractions
  - ionic temperatures
- https://sites.google.com/site/mexicanmillionmodels

Future work

- Use the DR3 data
- Run a 3D grid changing **O/H**, N/O and log(U): this implies much more models (one more free parameter). To define models fitting **simultaneously** the 3 line ratios [NII]/Ha, [OII]/Hb and [OIII]/Hb (maybe 4 if we also fit [SII]/Hb, relaxing **S/H**) we will use kind of **genetic algorithms.**