Chemical abundances in nearby spirals: M33

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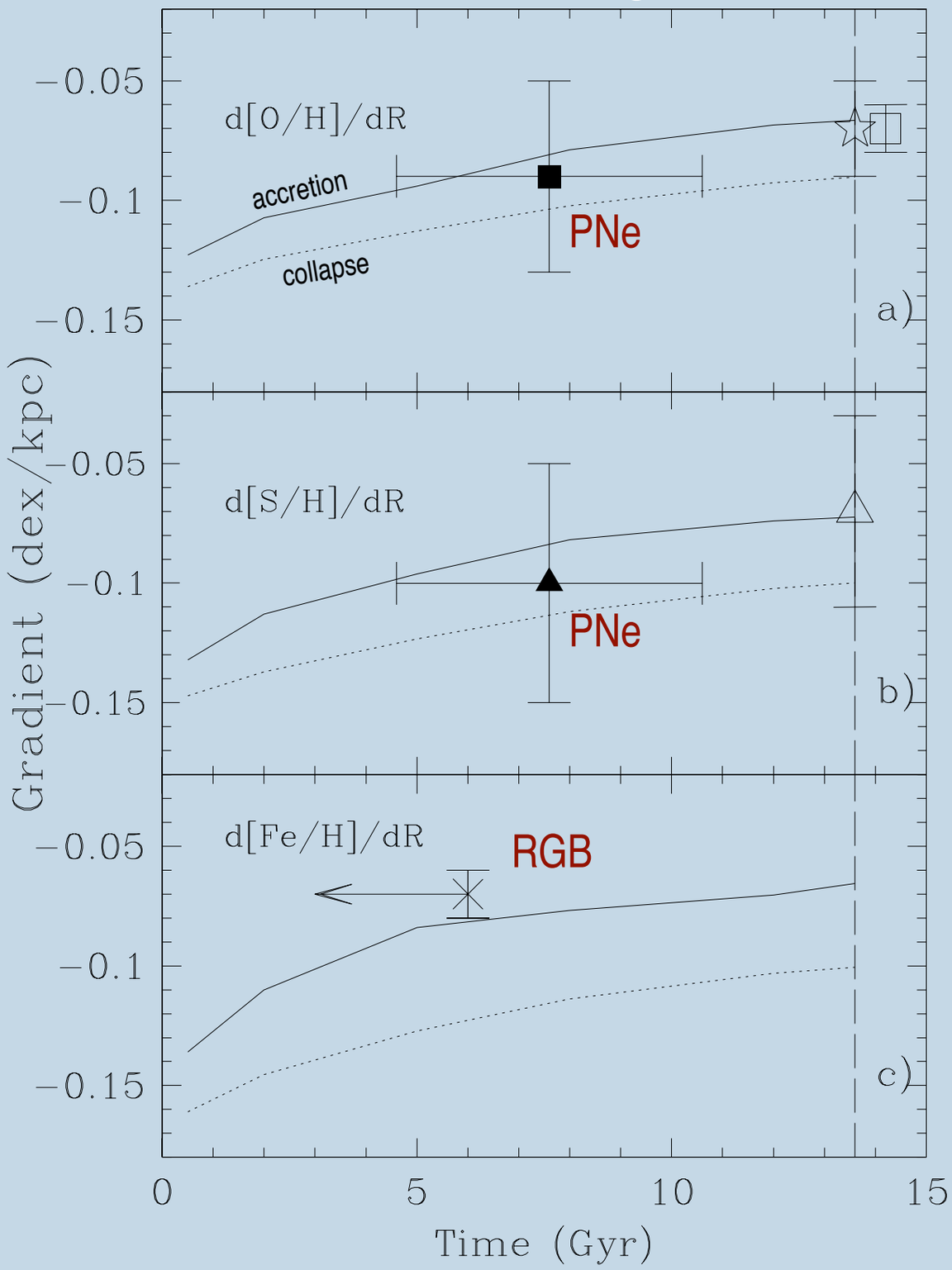
chemical abundance studies
constrain the evolution of
star-forming galaxies

- **HII regions**
- blue supergiant stars
- planetary nebulae

Constraints for galactic evolution models

- stellar yields
- IMF
- SFR
- SF efficiency
- stellar lifetimes
- inflows/outflows
- nucleosynthesis sites

Magrini et al. 2007

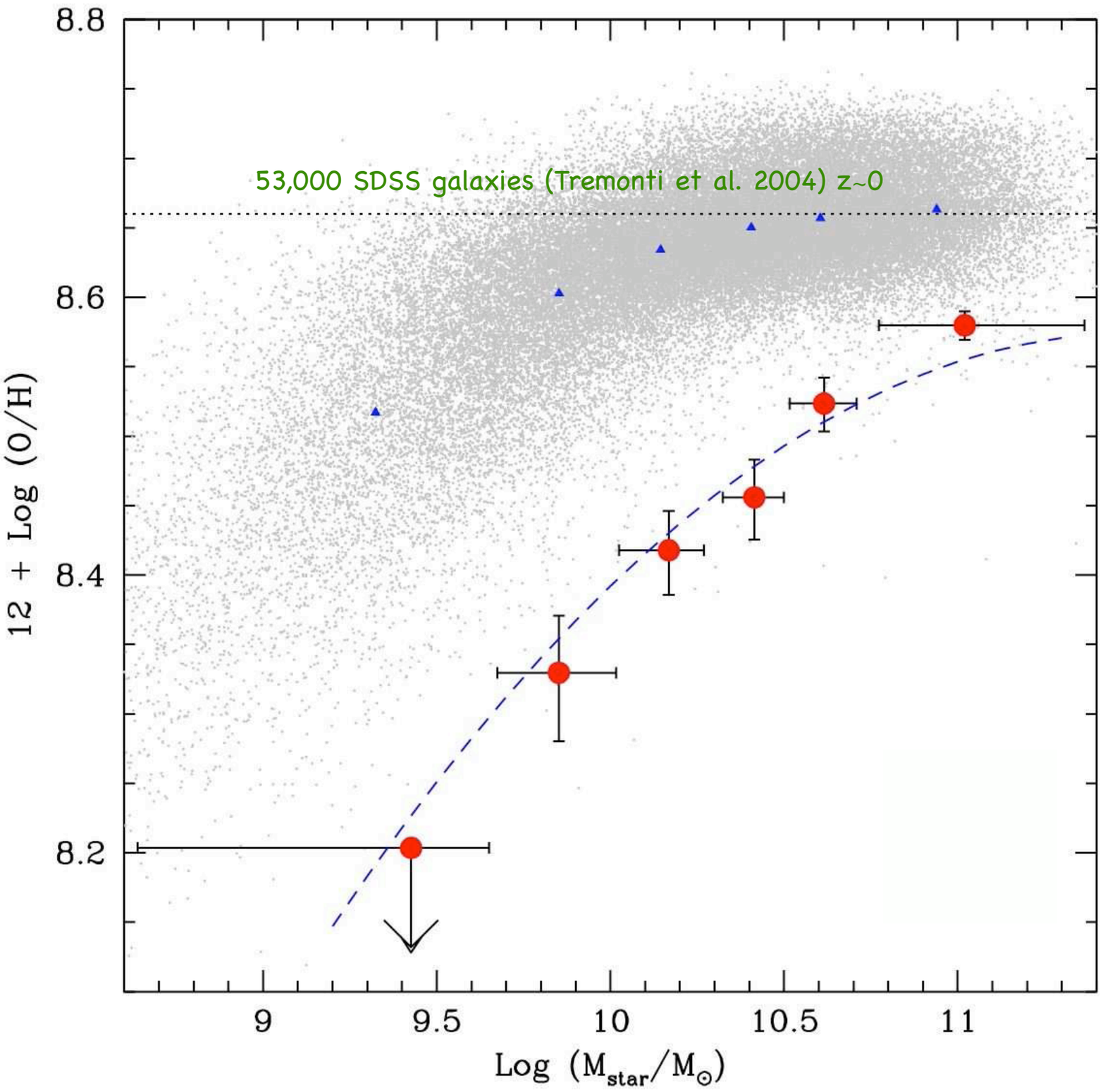


HII regions
B supergiants

HII regions

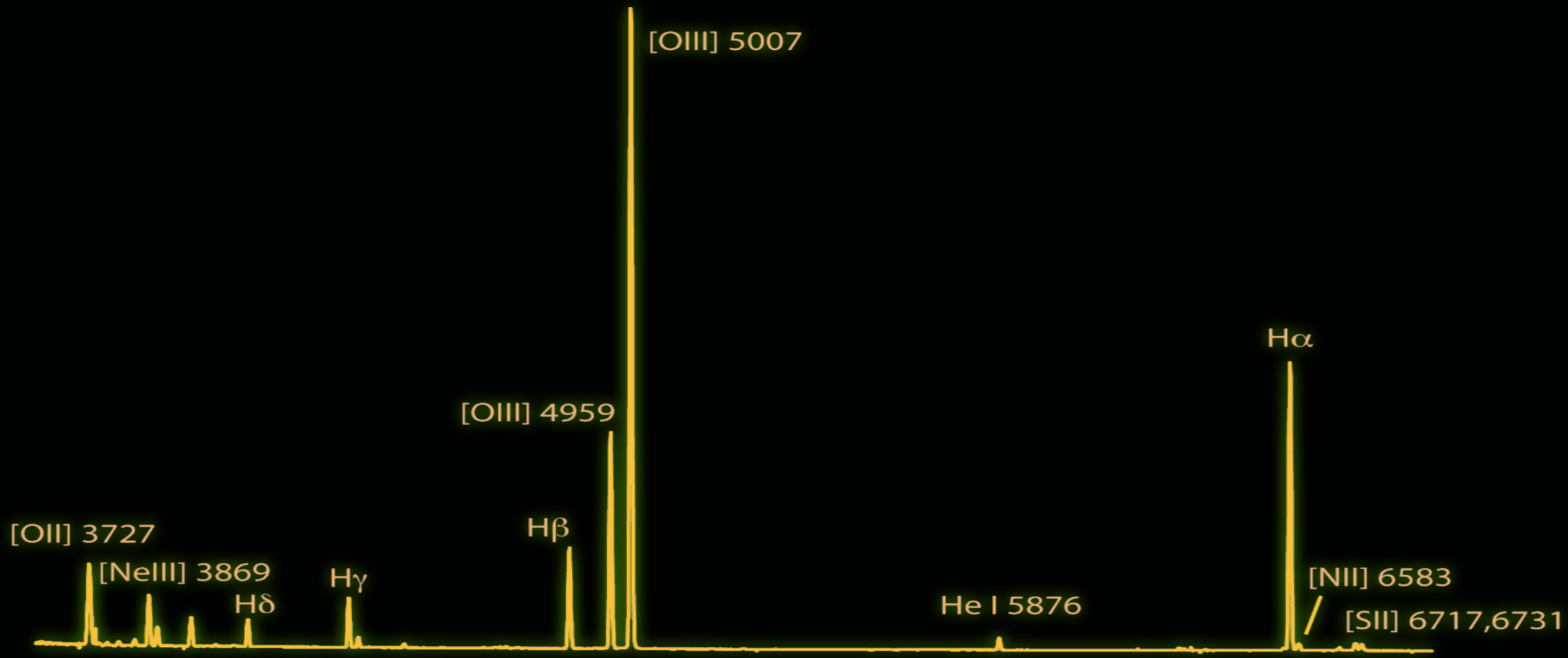
RGB

Mass-Metallicity Relation
high redshift galaxies (z ~ 2)



Erb et al. 2006

Spectroscopic studies of HII regions & PNe



Nebular abundances

low metallicity

[O III]

[O II]

4363 Å ‘auroral’ line

[O III]

4000 4500 5000 5500 6000 6500

Wavelength (angstroms)

low metallicity

[O III]

[O II]

4363 Å ‘auroral’ line

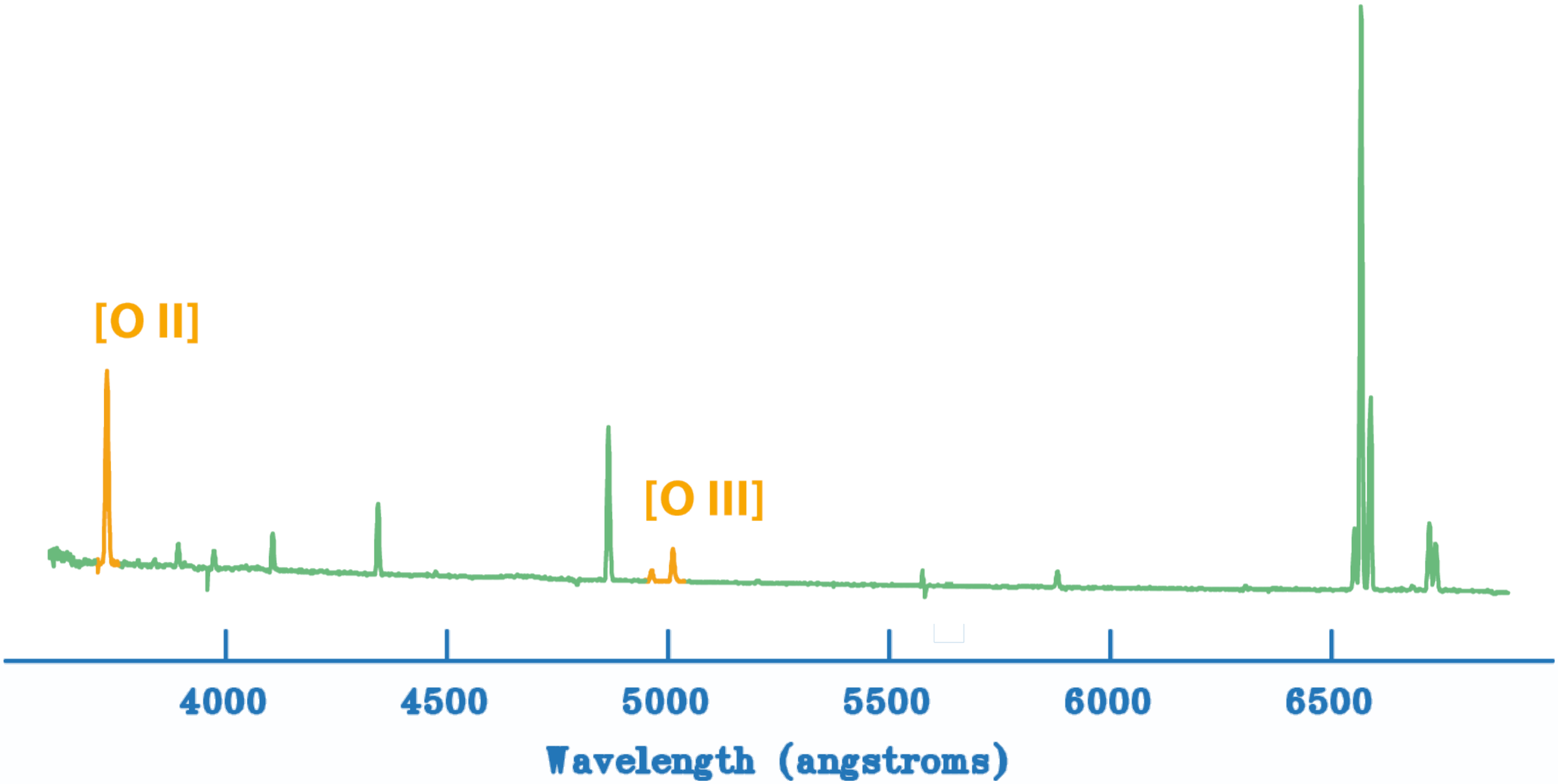
[O III]

electron temperature T_e

4000 4500 5000 5500 6000 6500

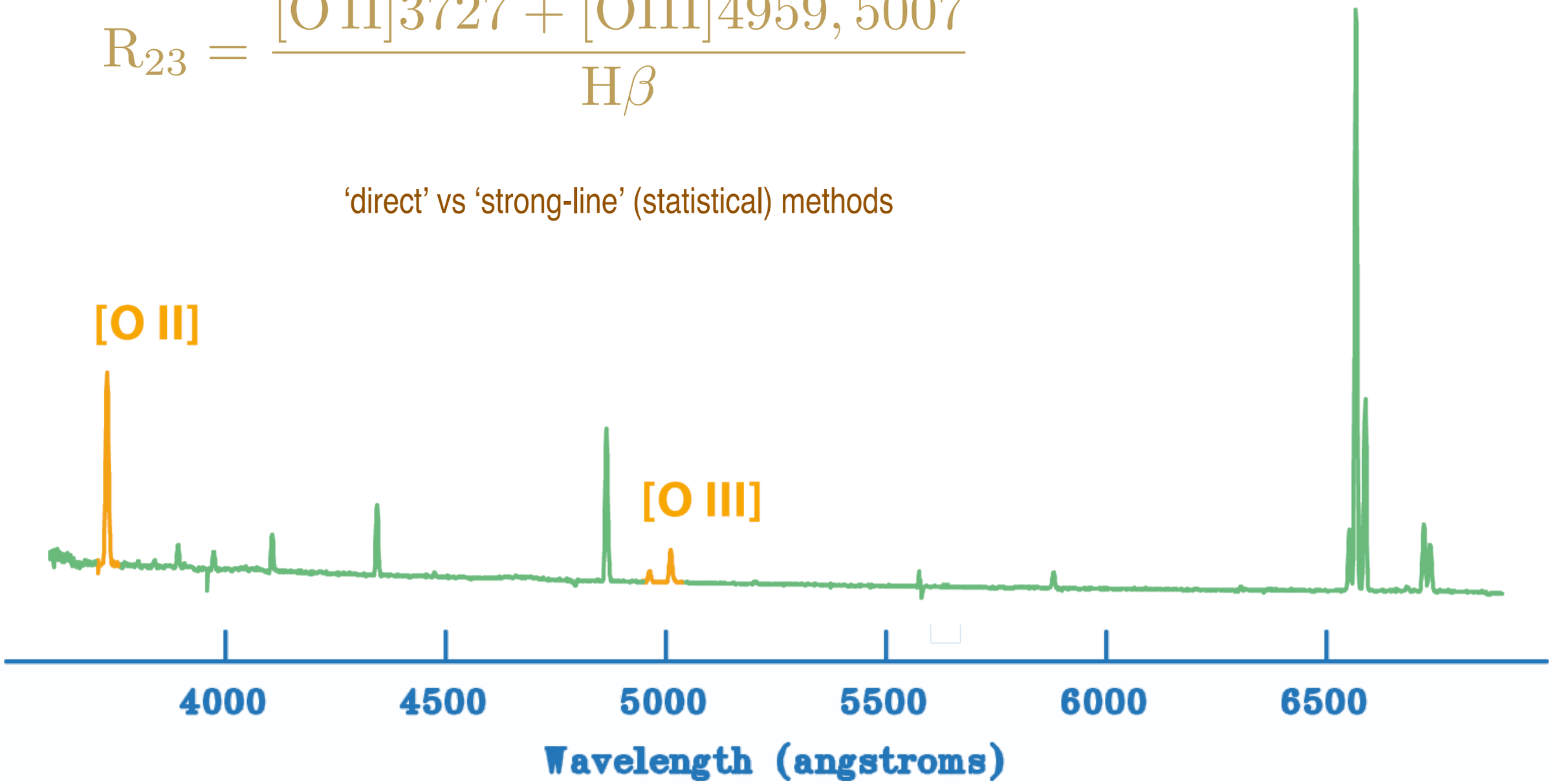
Wavelength (angstroms)

high metallicity

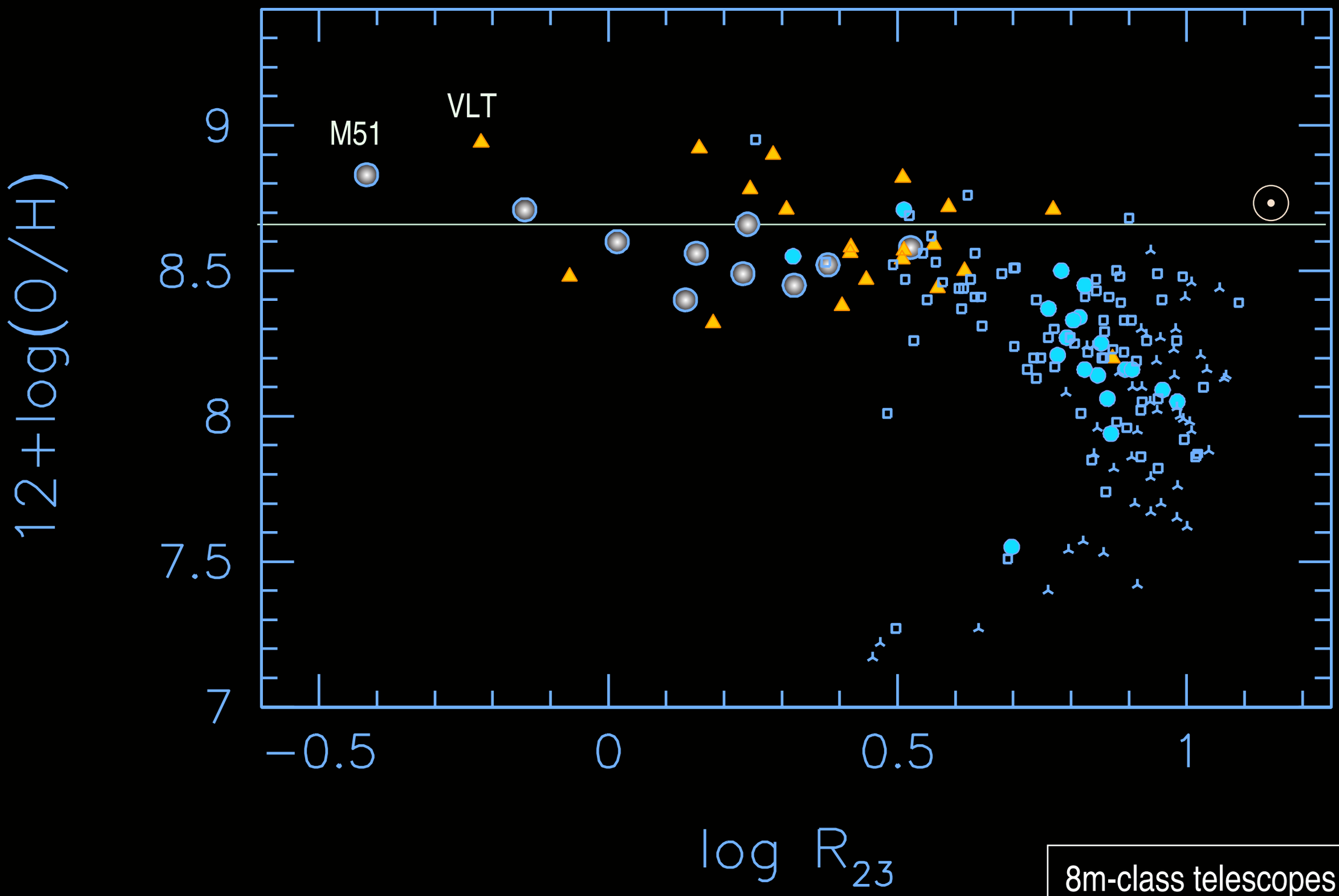


$$R_{23} = \frac{[\mathrm{O\,II}]3727 + [\mathrm{OIII}]4959, 5007}{\mathrm{H}\beta}$$

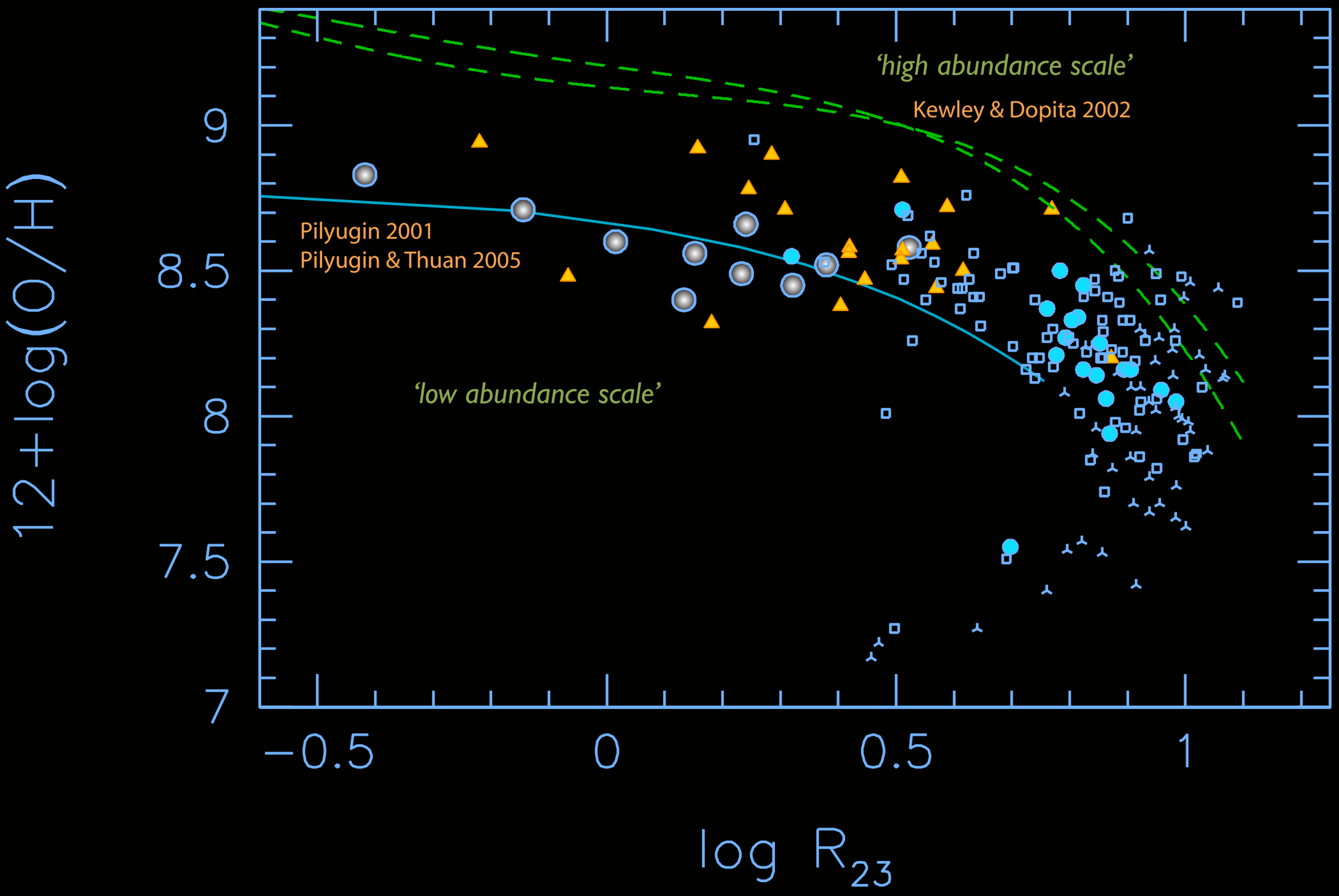
‘direct’ vs ‘strong-line’ (statistical) methods



Kennicutt, Bresolin & Garnett 2003
Bresolin, Kennicutt & Garnett 2004
Bresolin et al. 2005
Bresolin 2007



8m-class telescopes


'high abundance scale'
Kewley & Dopita 2002
Pilyugin 2001
Pilyugin & Thuan 2005
'low abundance scale'
12+log(O/H)
9
8.5
8
7.5
7
−0.5
0
0.5
1
log R23

HII region abundances *vs.* young stars

must worry about:

- dust depletion in gas
- mixing at stellar surface
- details of chemical analysis
- **abundance 'biases' at high metallicity**

HII region abundances vs. PNe

- sample populations of different ages
- are PNe abundances affected by AGB nucleosynthesis and mixing?

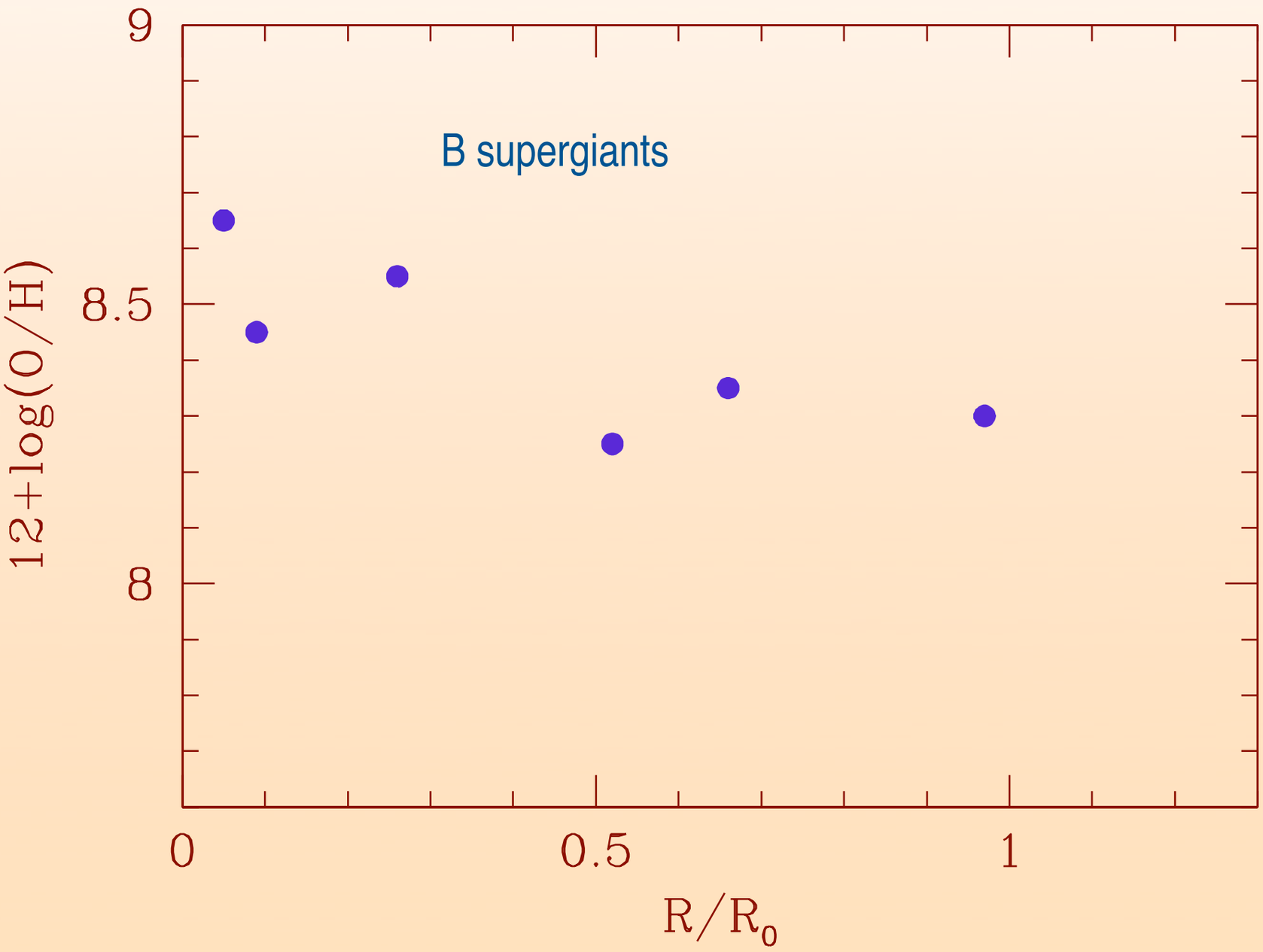
NGC 6946/Gemini

M33

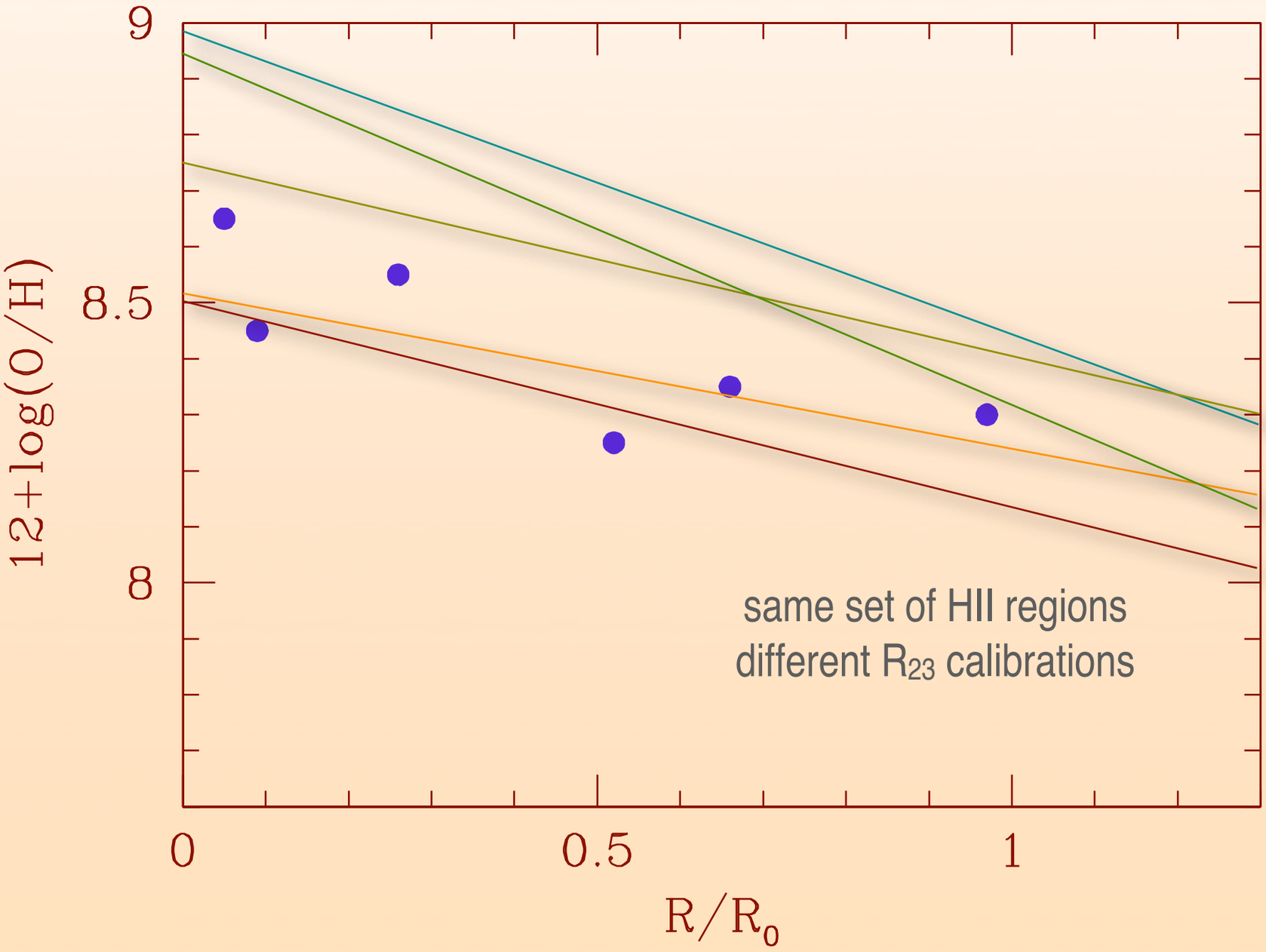
NGC 300

NGC 300 - end of 2007

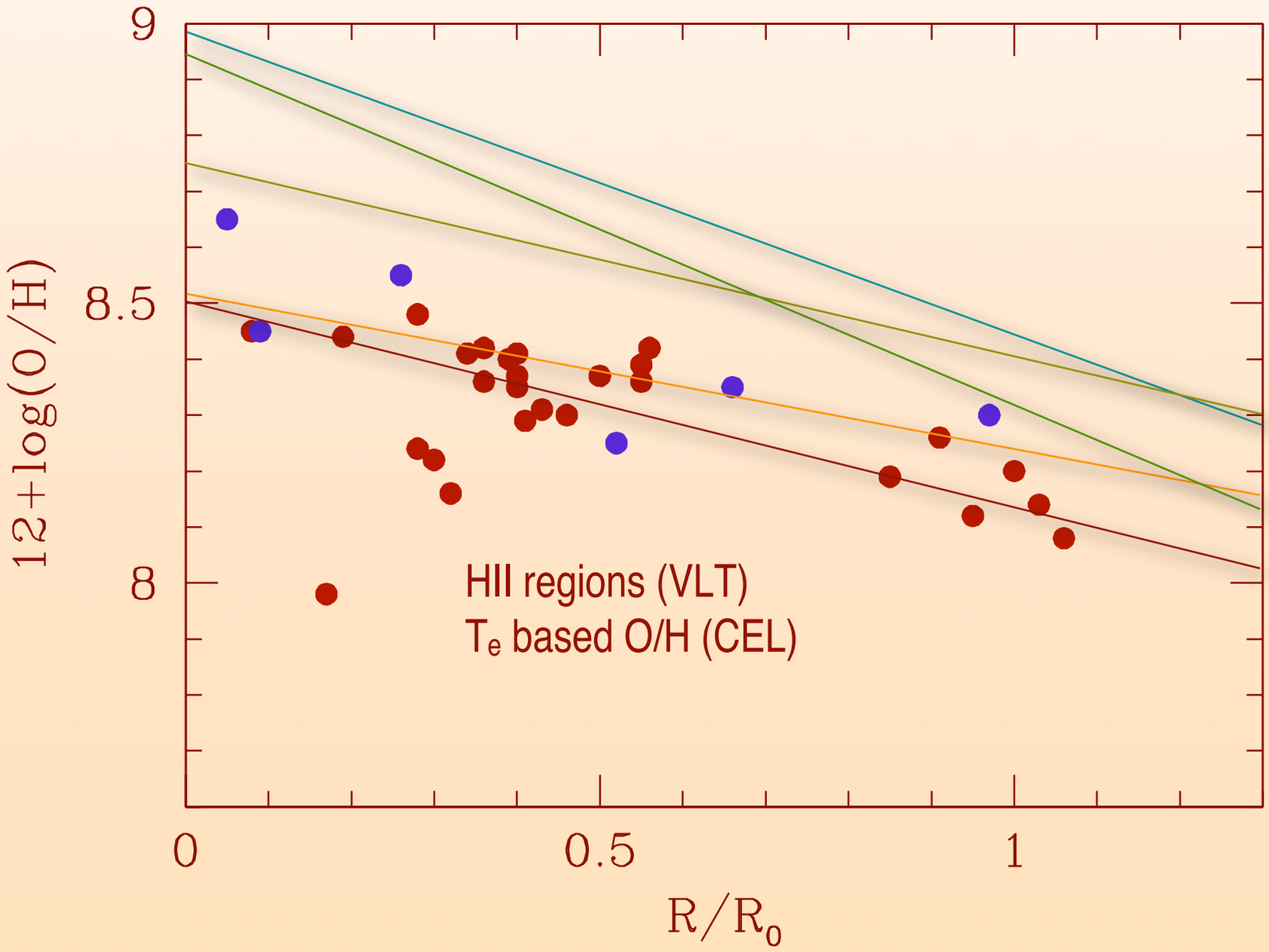
Urbaneja et al. 2005



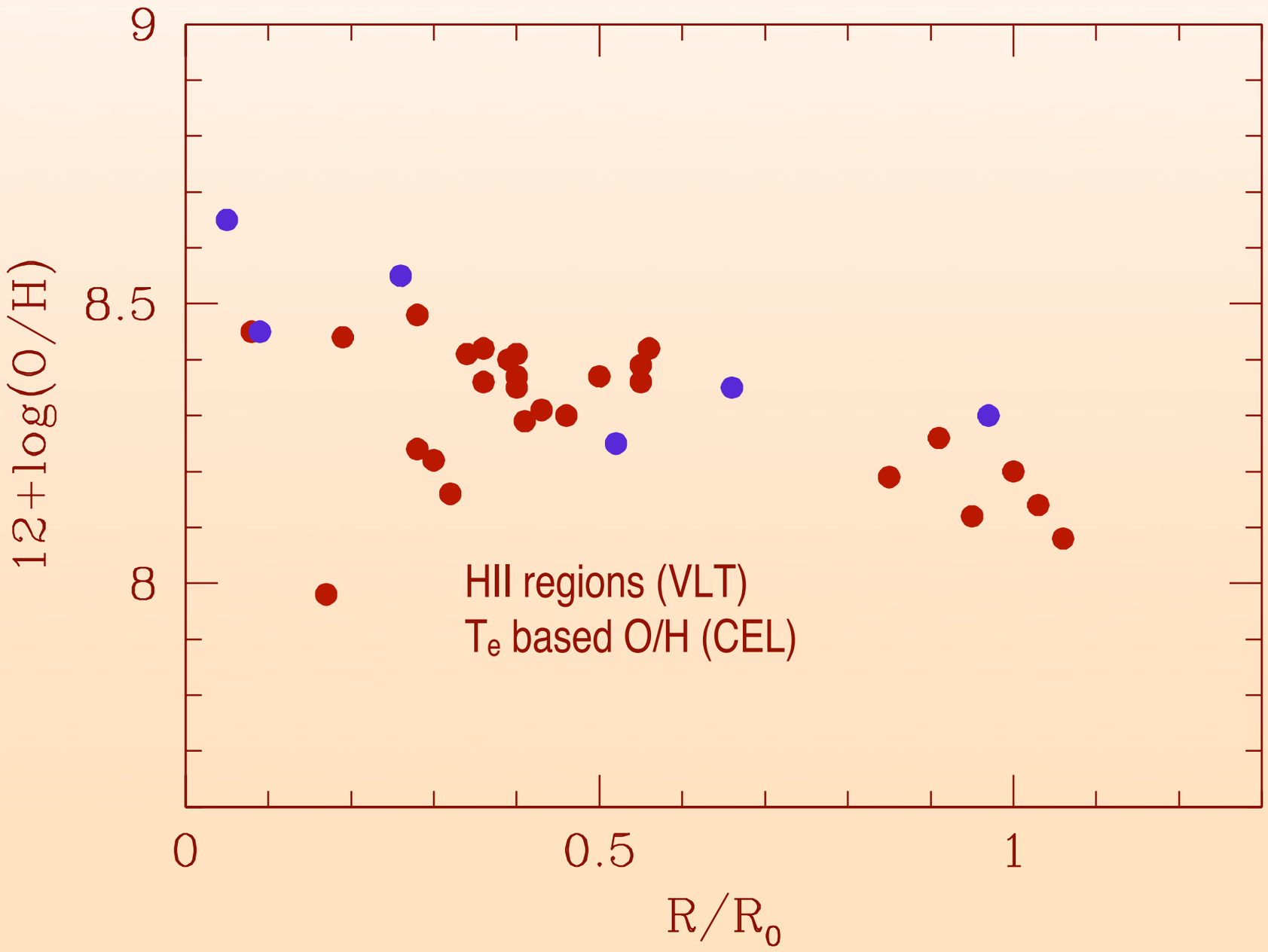
Urbaneja et al. 2005



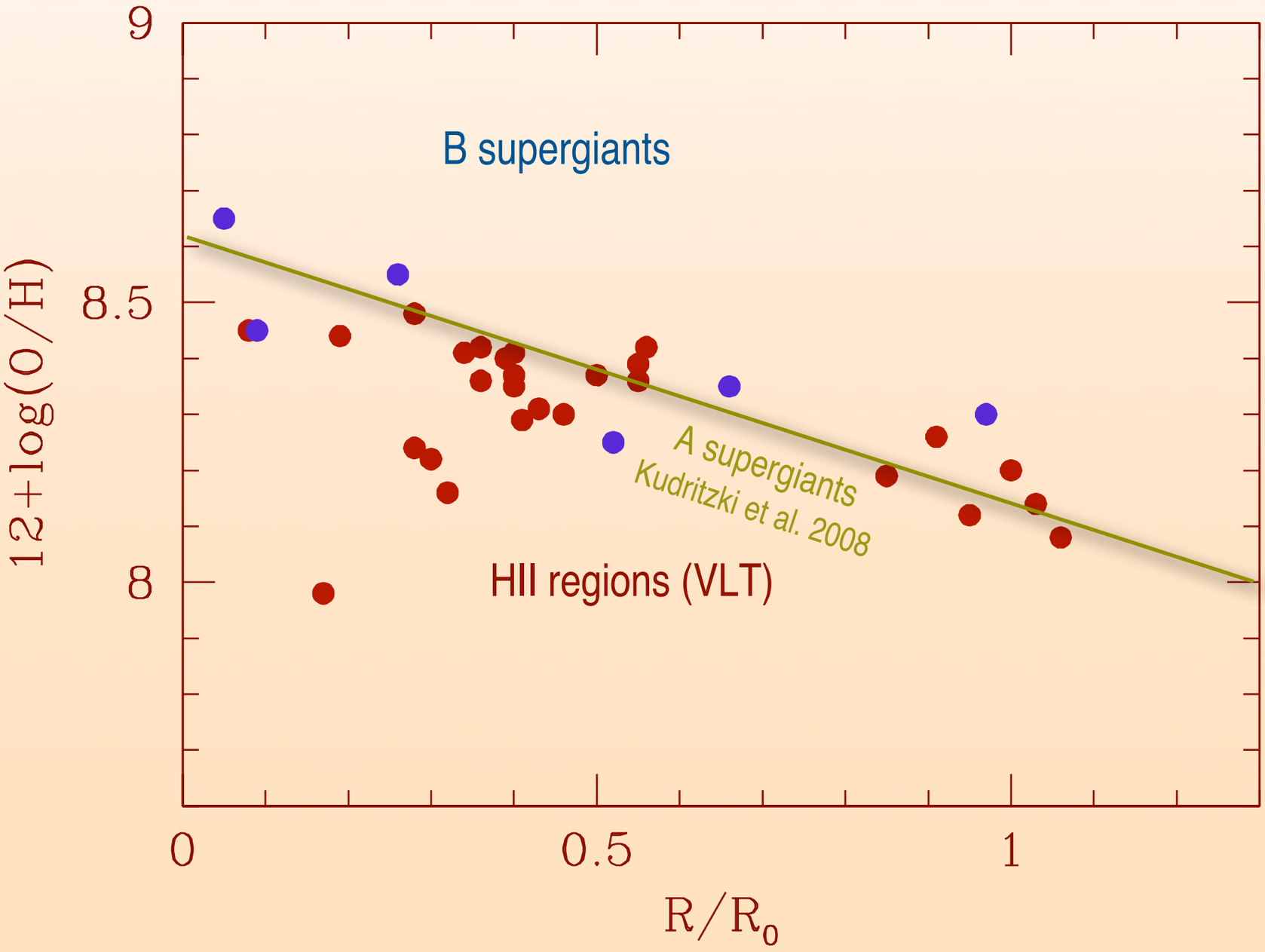
Bresolin et al. 2008



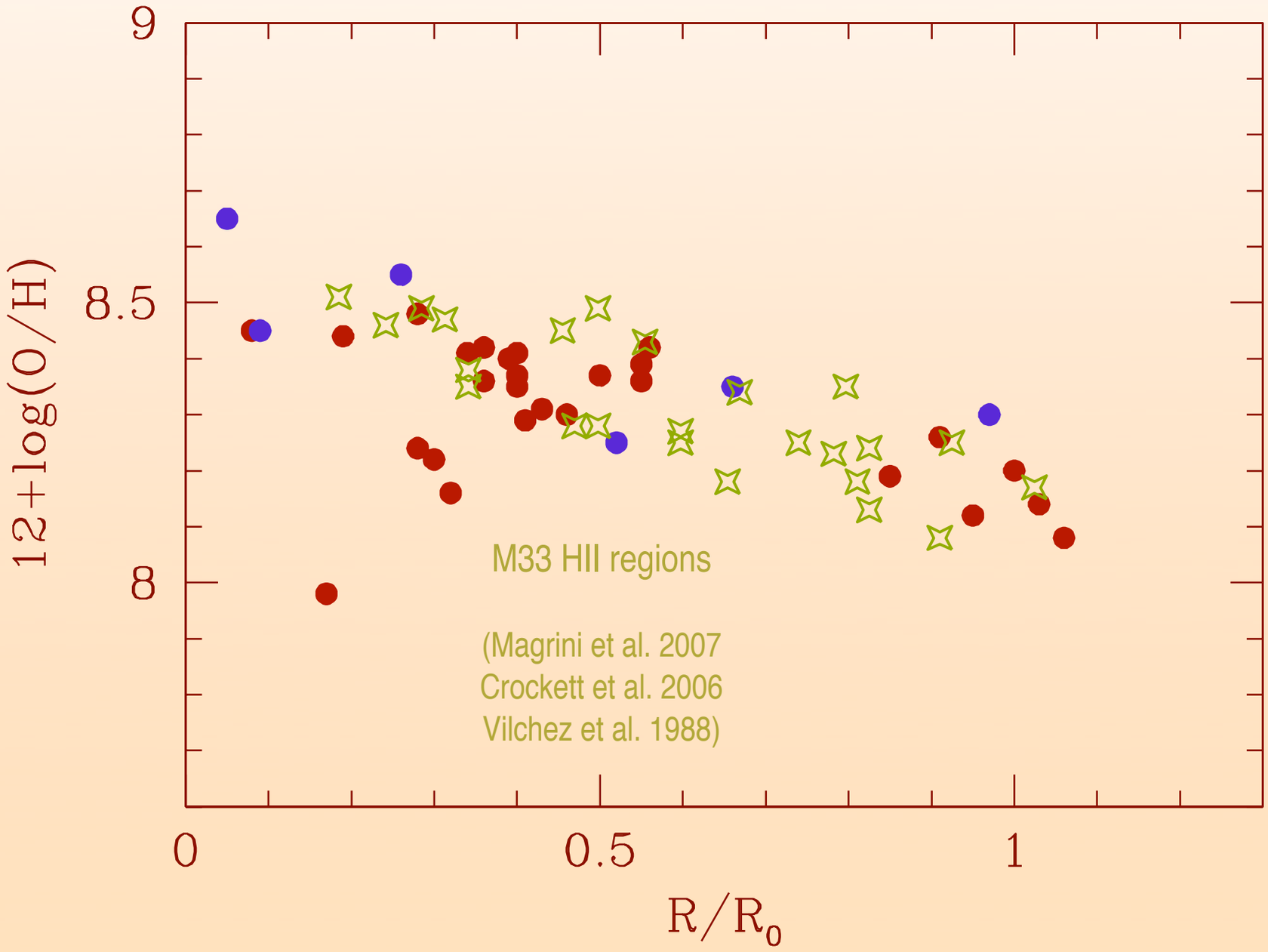
Bresolin et al. 2008



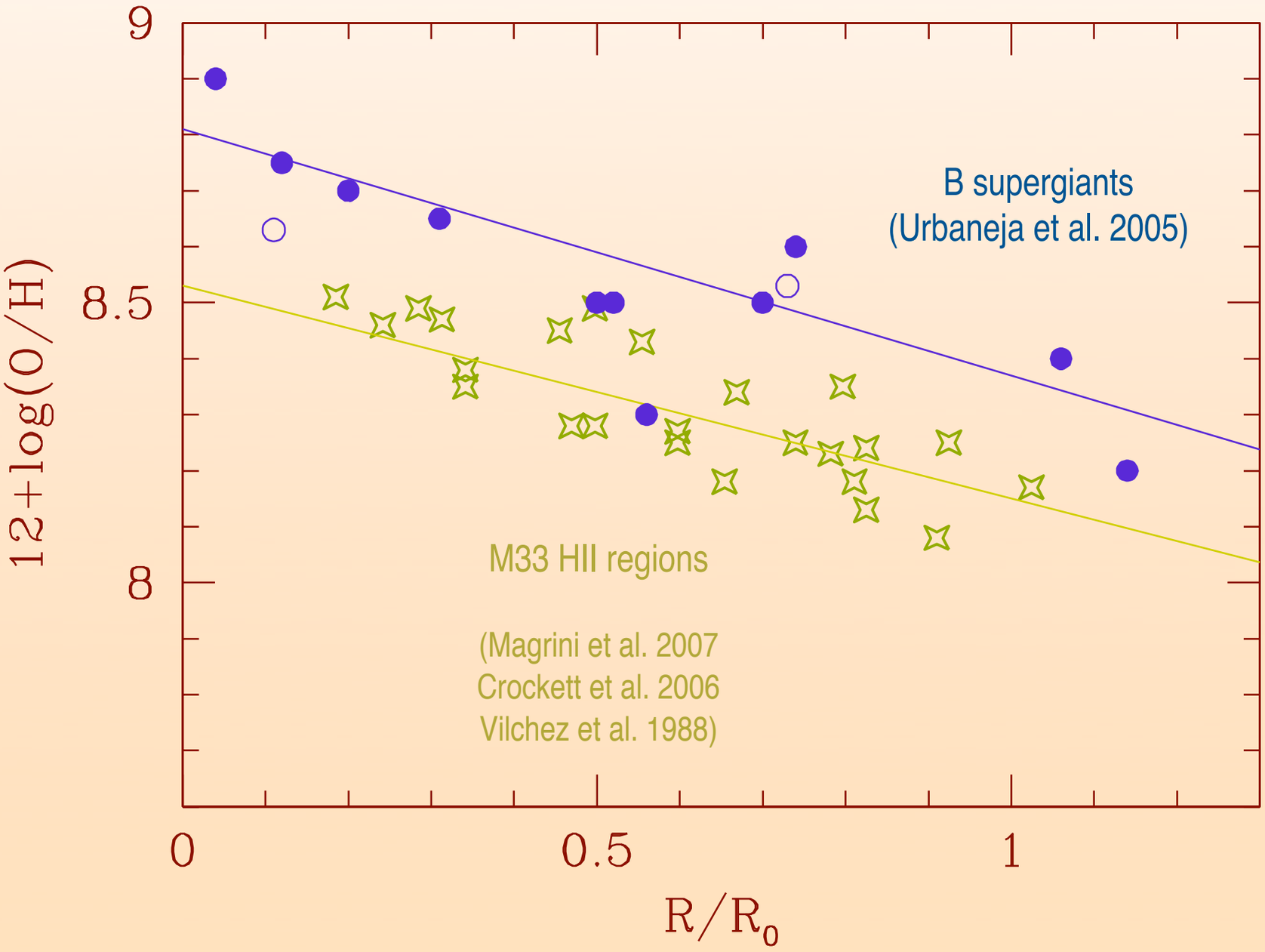
Bresolin et al. 2008

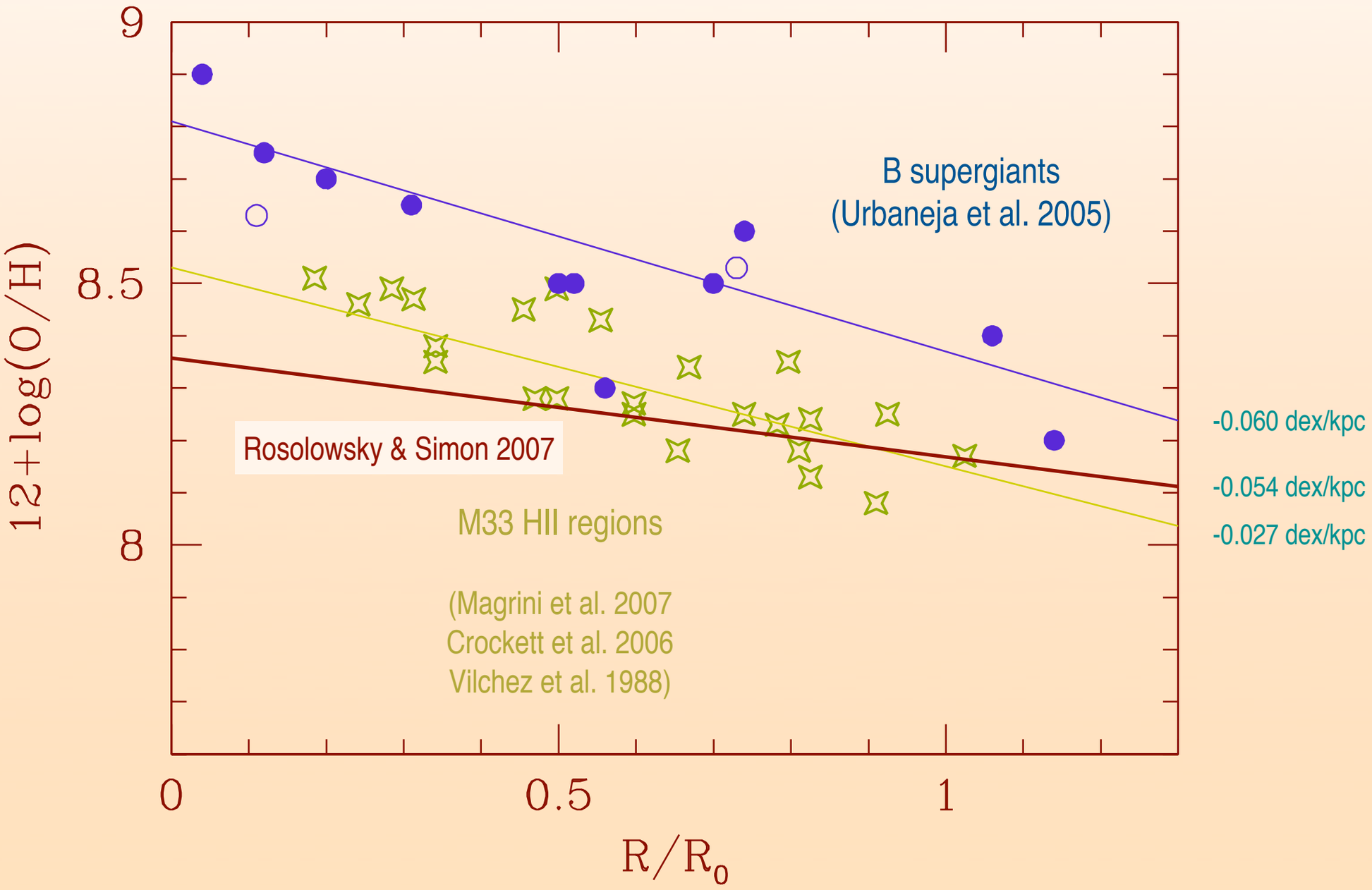


NGC 300 & M33- end of 2007



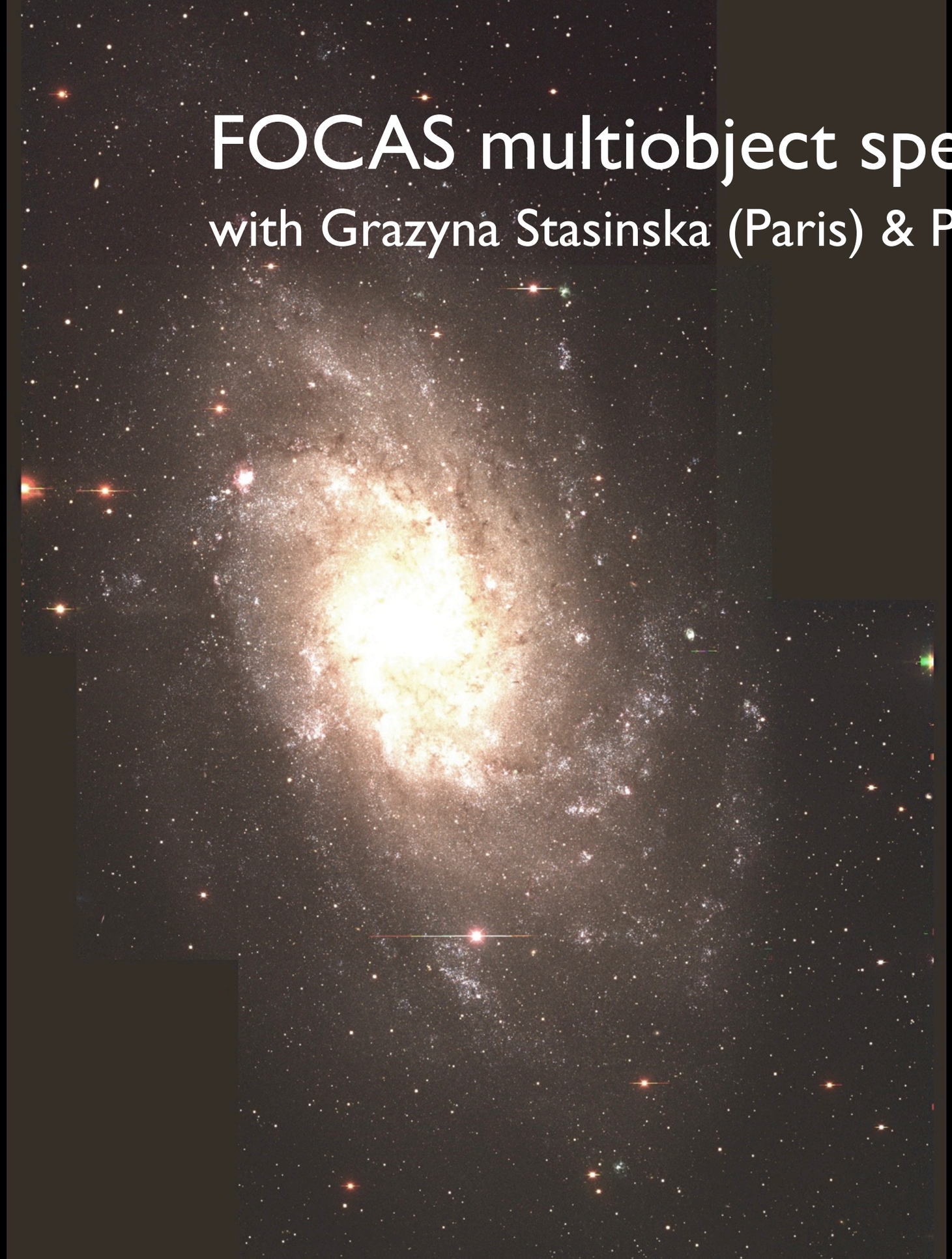
M33 - end of 2007



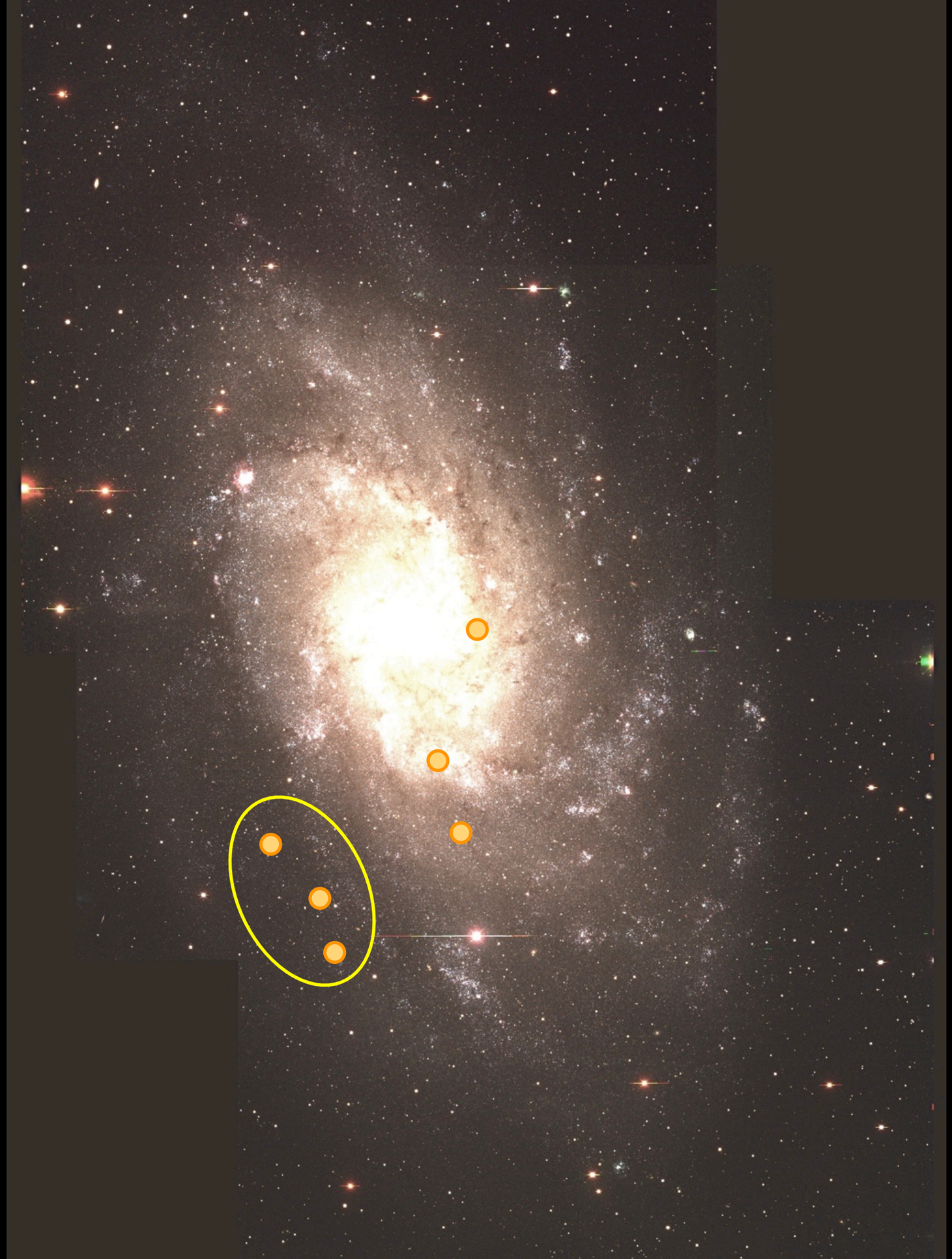

9
8.5
8
12+log(O/H)
0
0.5
1
R/R0
B supergiants
(Urbaneja et al. 2005)
Rosolowsky & Simon 2007
M33 HII regions
(Magrini et al. 2007
Crockett et al. 2006
Vilchez et al. 1988)
-0.060 dex/kpc
-0.054 dex/kpc
-0.027 dex/kpc

FOCAS multiobject spectroscopy

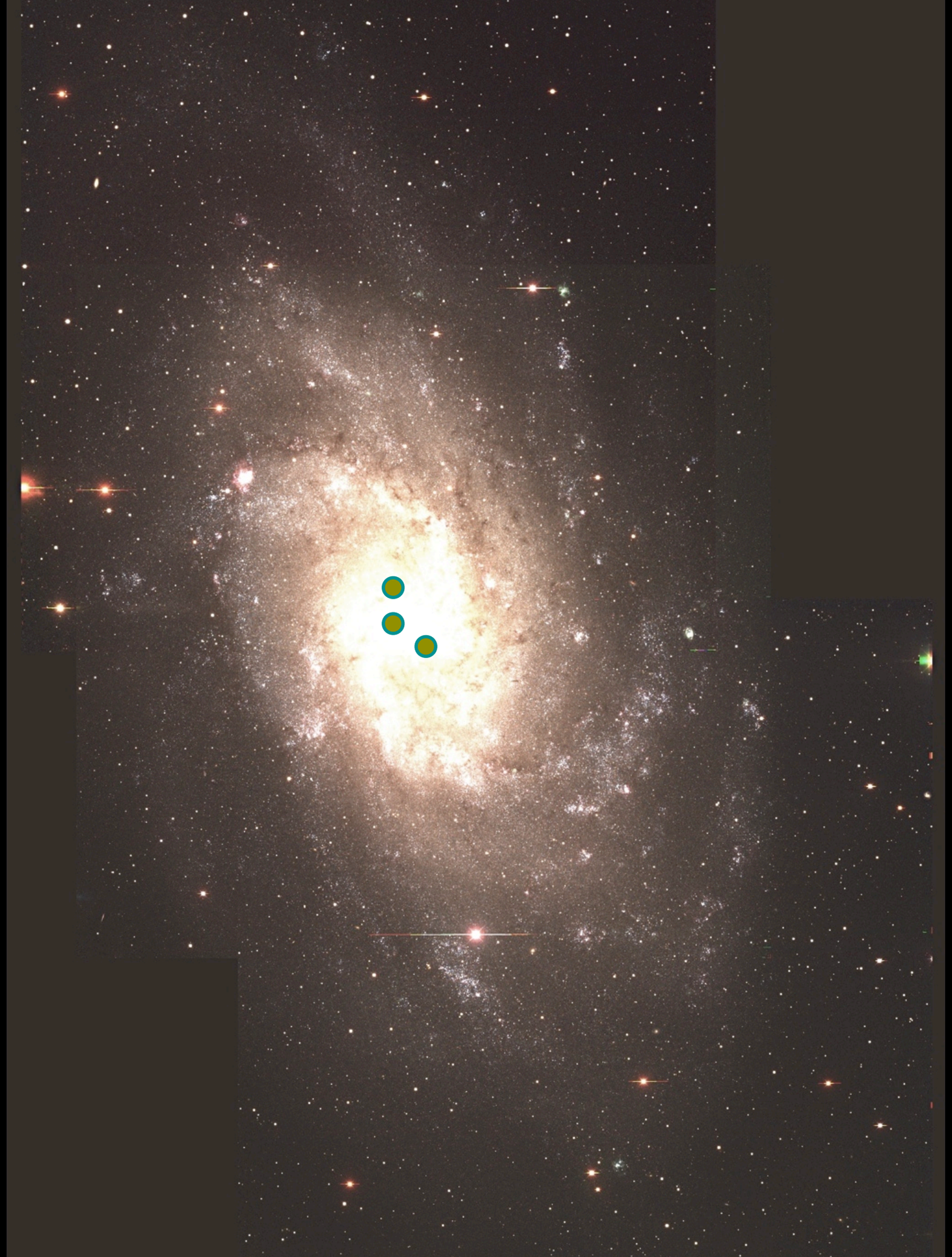
with Grazyna Stasinska (Paris) & Pepe Vilchez (Granada)



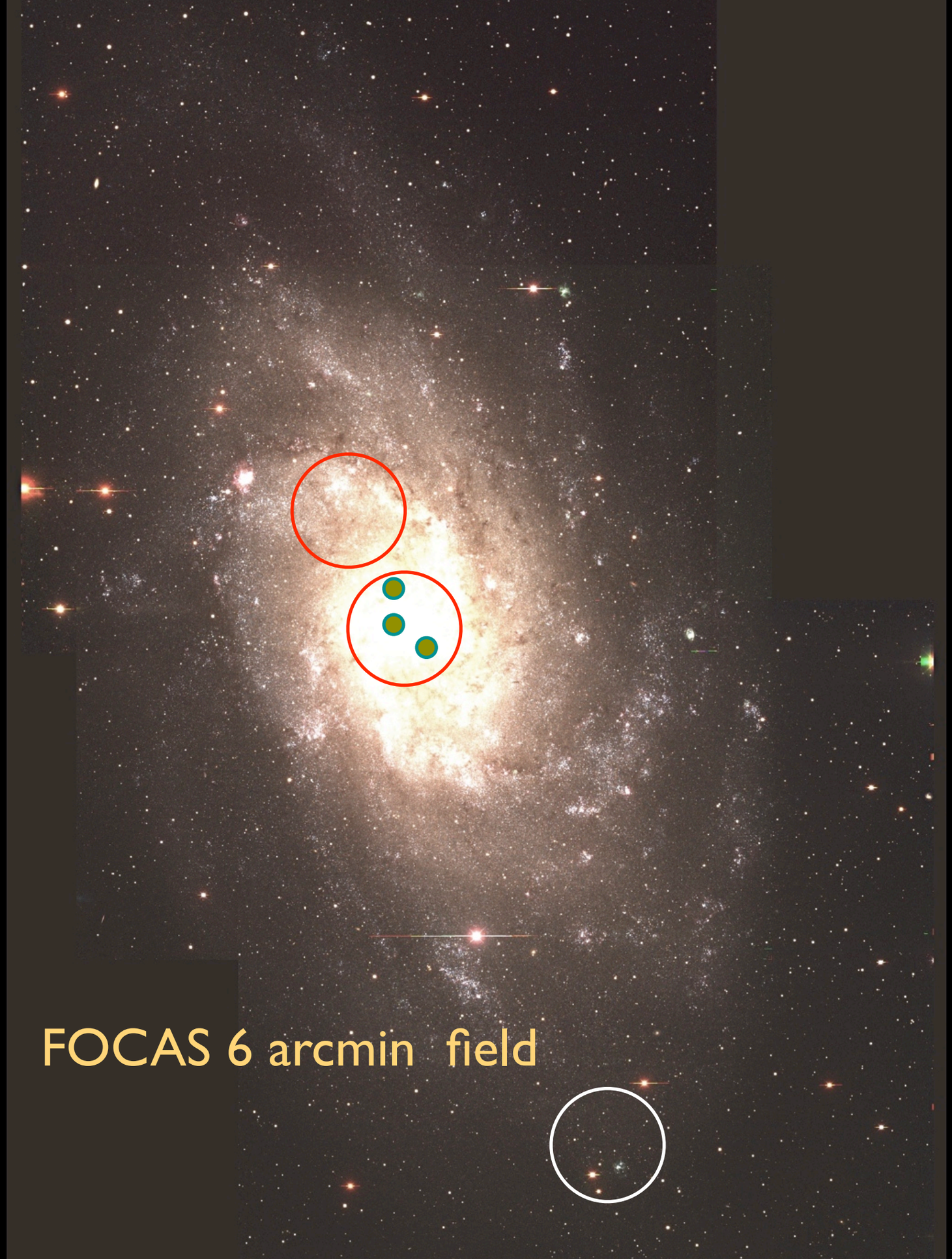
~130 PNe in M33
(Magrini et al. 2000)



6 [O III] 4363 detections with WHT (Magrini et al 2003), but only 3 usable for chemical abundances



3 [O III] 4363 detections with WHT in the central region (Stasinska et al. 2006)

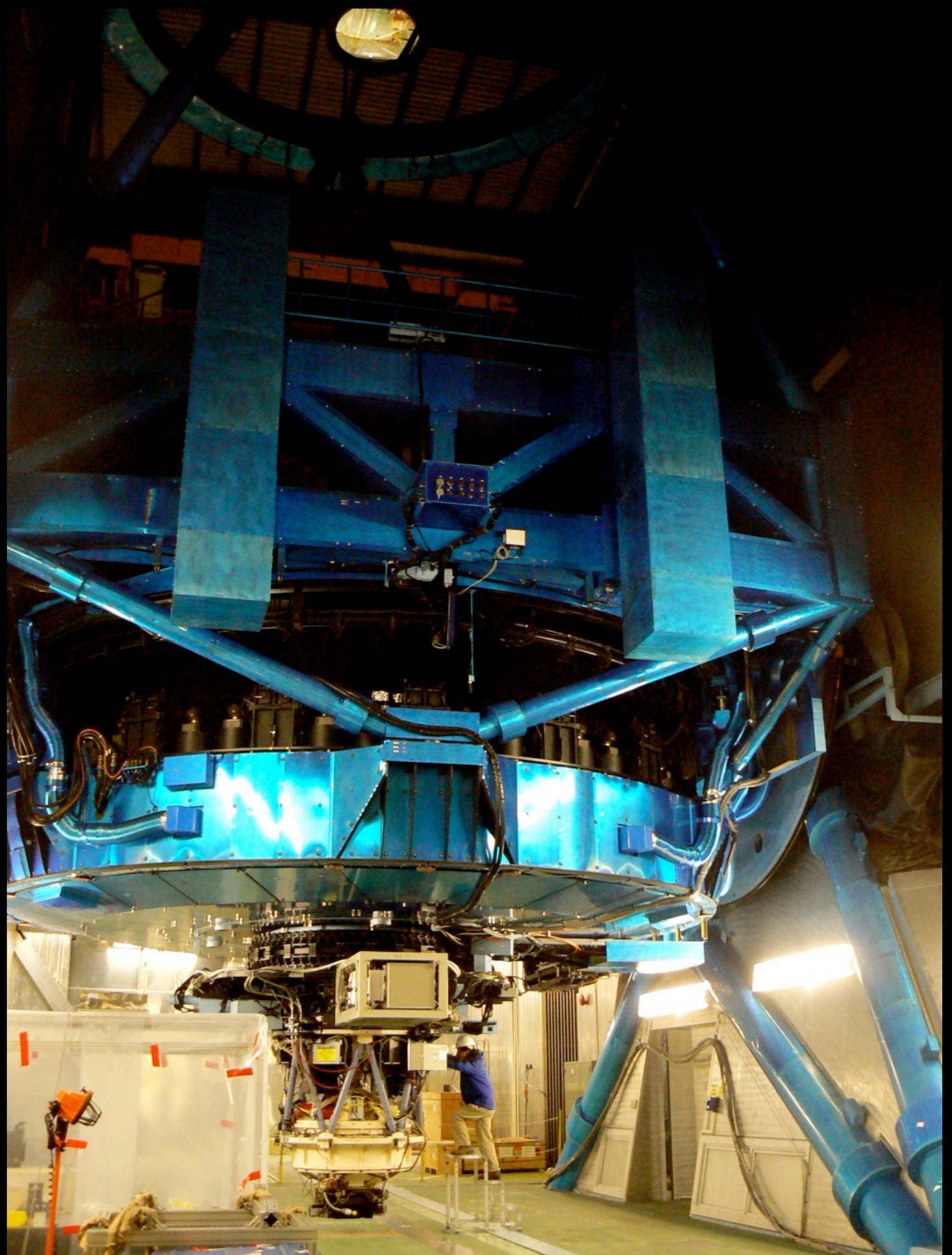

FOCAS 6 arcmin field

3 kpc field

○ PNe m_{5007} < 22.8 (Magrini et al. 2003)

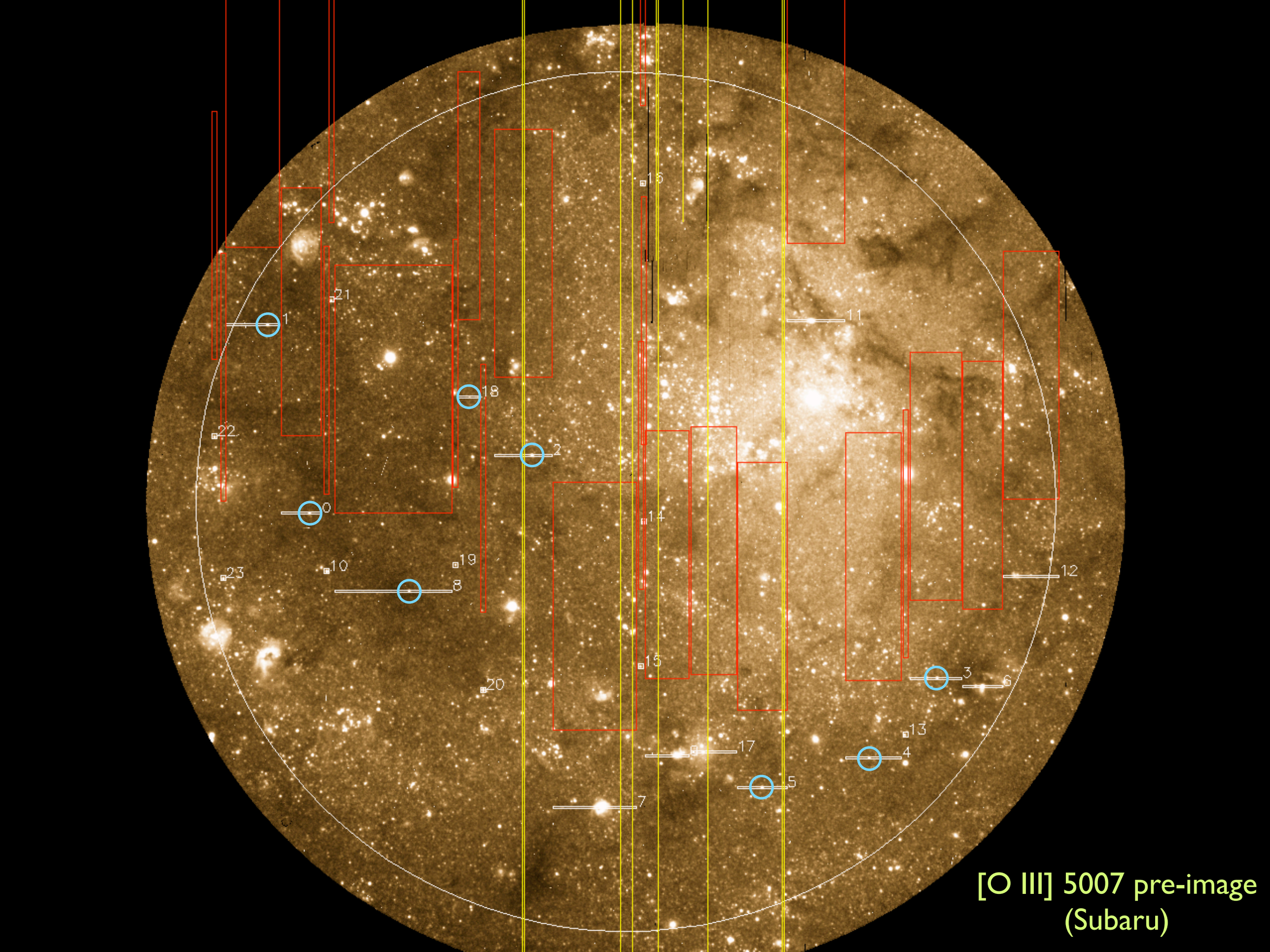
□ △ HII regions with published spectra

[O III] 5007 image (KPNO)



Oct 15-16, 2006

Oct 9-10, 2007



[O III] 5007 pre-image
(Subaru)

REQUIREMENTS

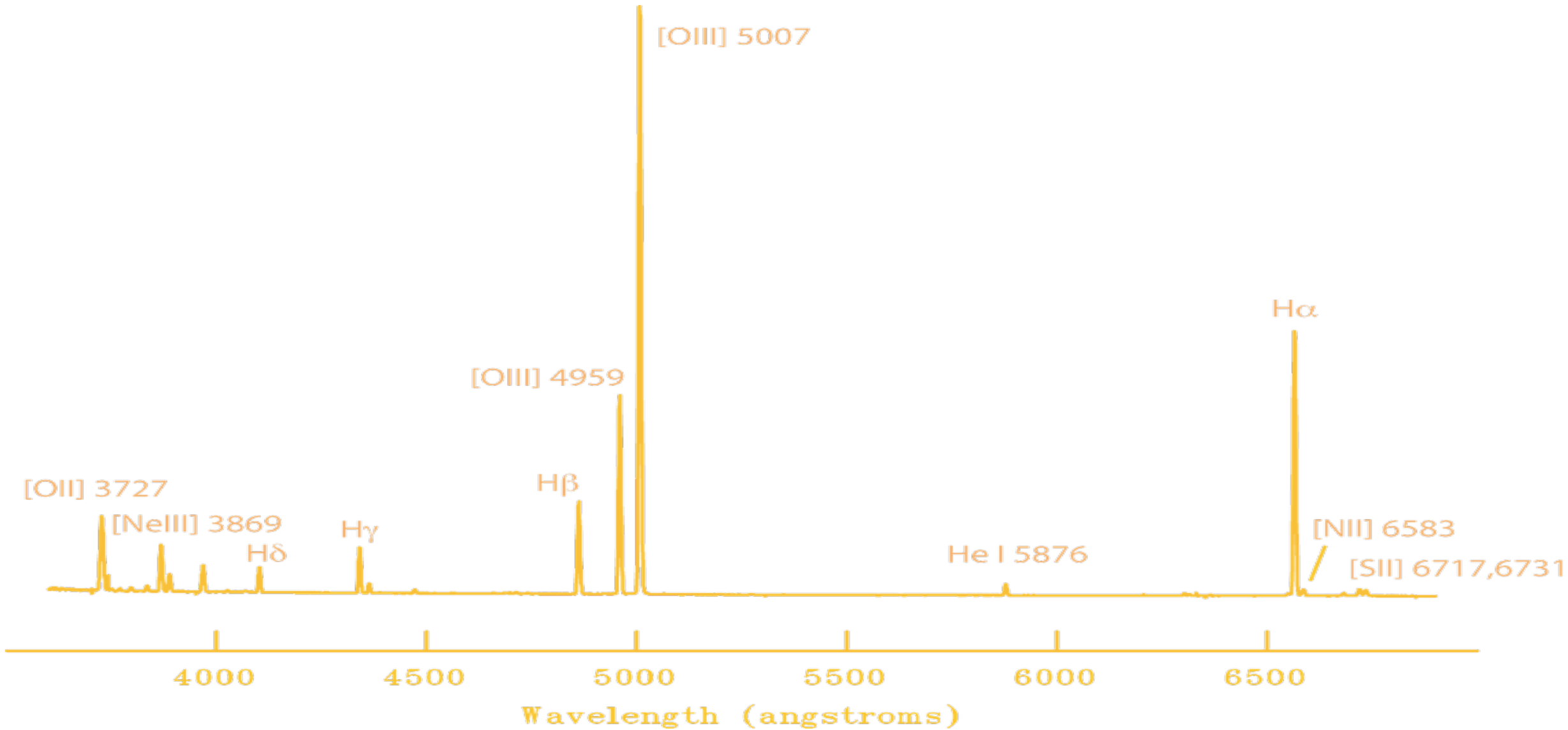
good image quality seeing ~ 0.5 arcsec

+

large collecting area

TECHNICAL REQUIREMENTS

i) wide wavelength coverage at ~5 Å spectral resolution (1” slit)



TECHNICAL REQUIREMENTS

i) wide wavelength coverage at ~5 Å spectral resolution (1” slit)

GRISMS
300R (2nd order) + 300B

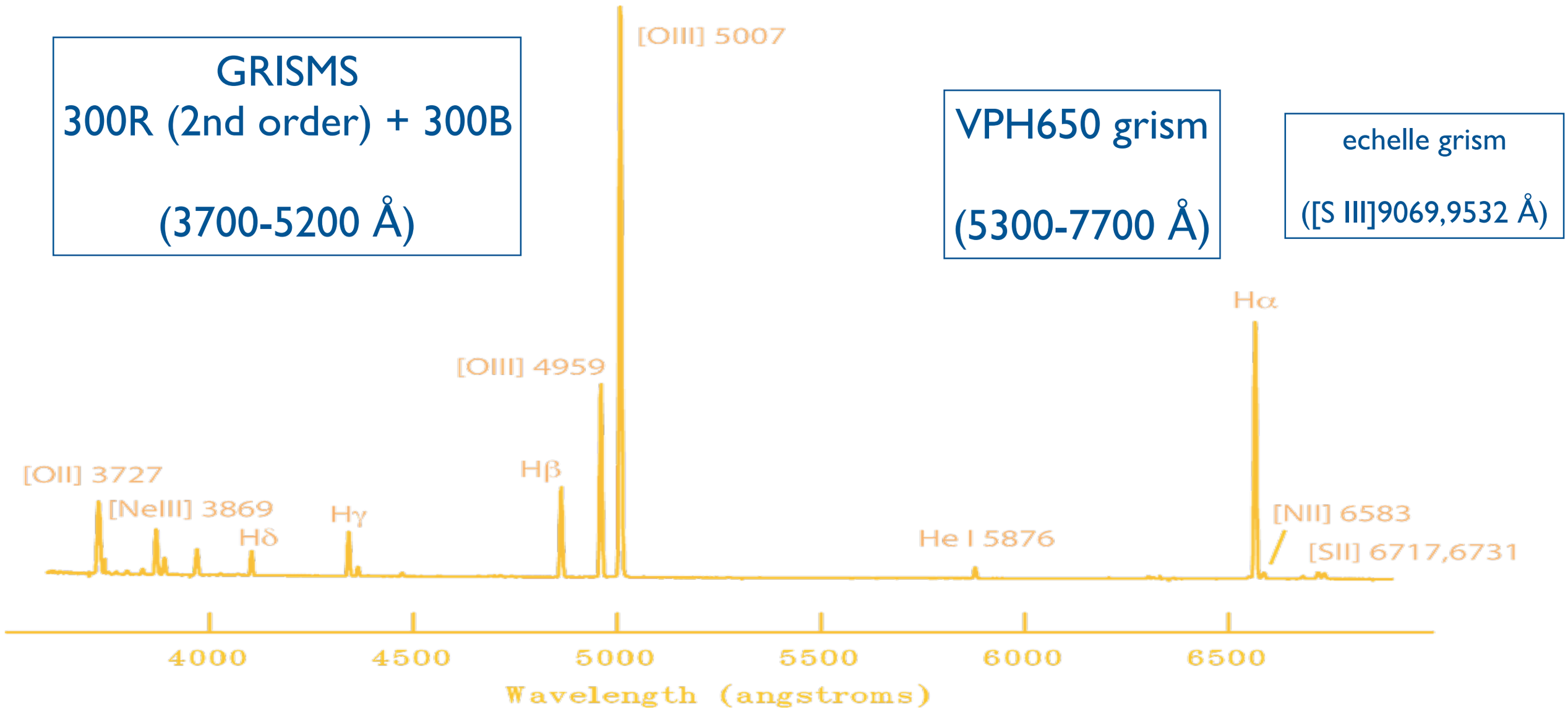
(3700-5200 Å)

VPH650 grism

(5300-7700 Å)

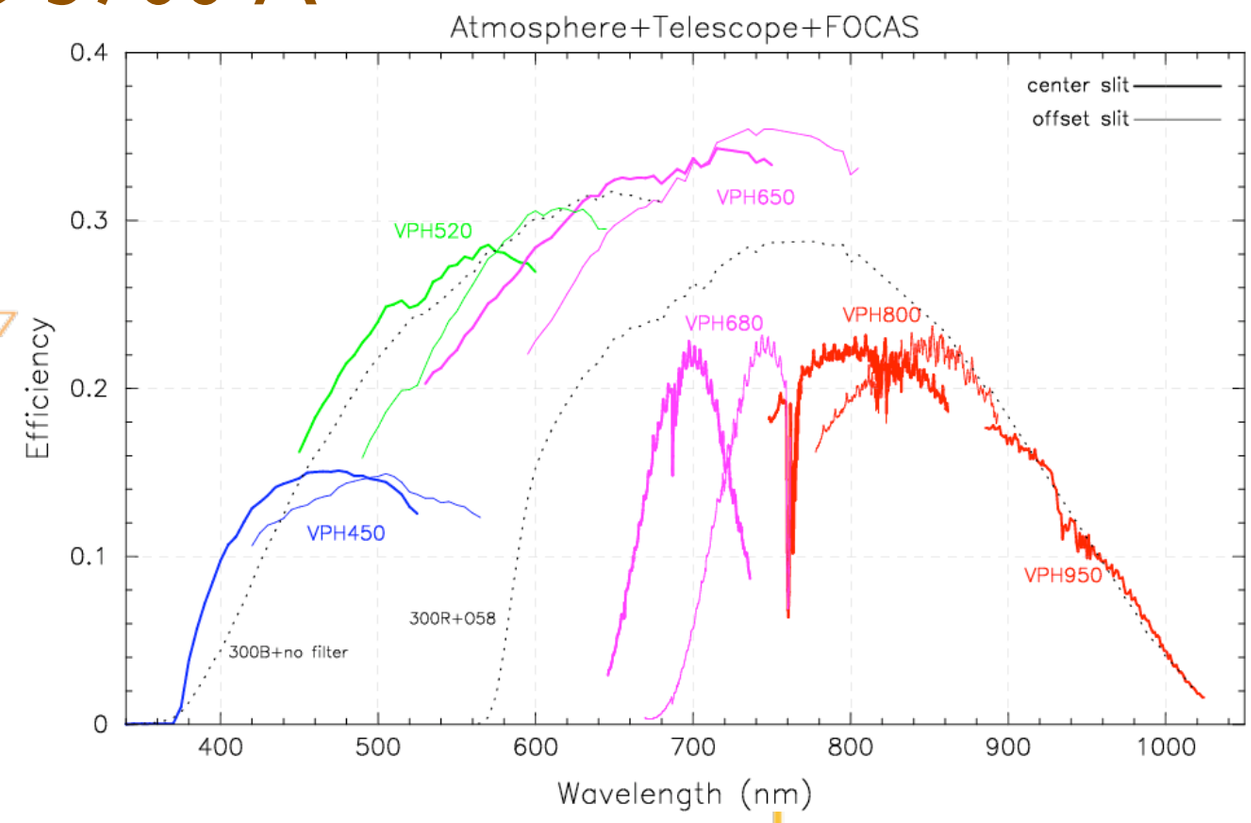
echelle grism

([S III]9069,9532 Å)



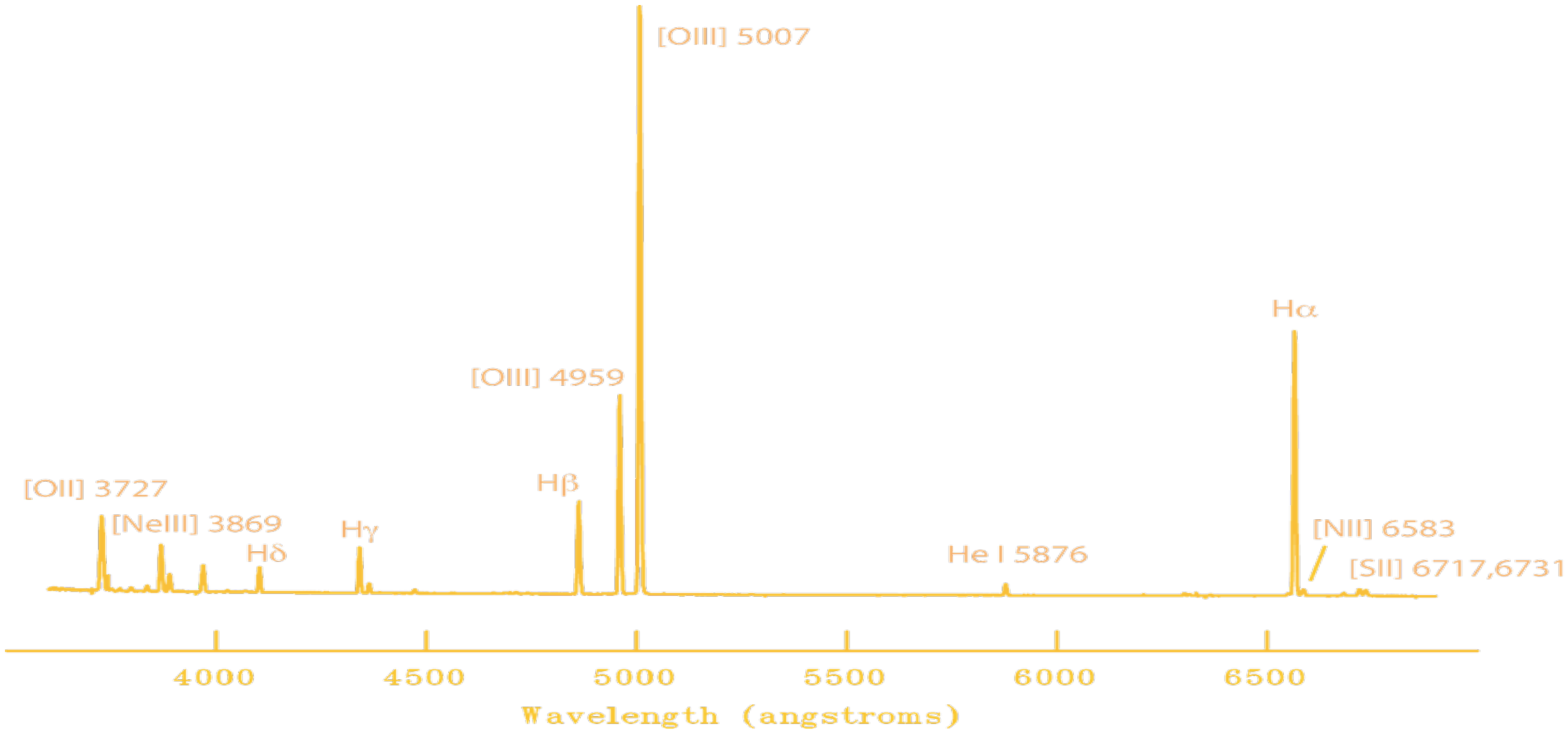
TECHNICAL REQUIREMENTS

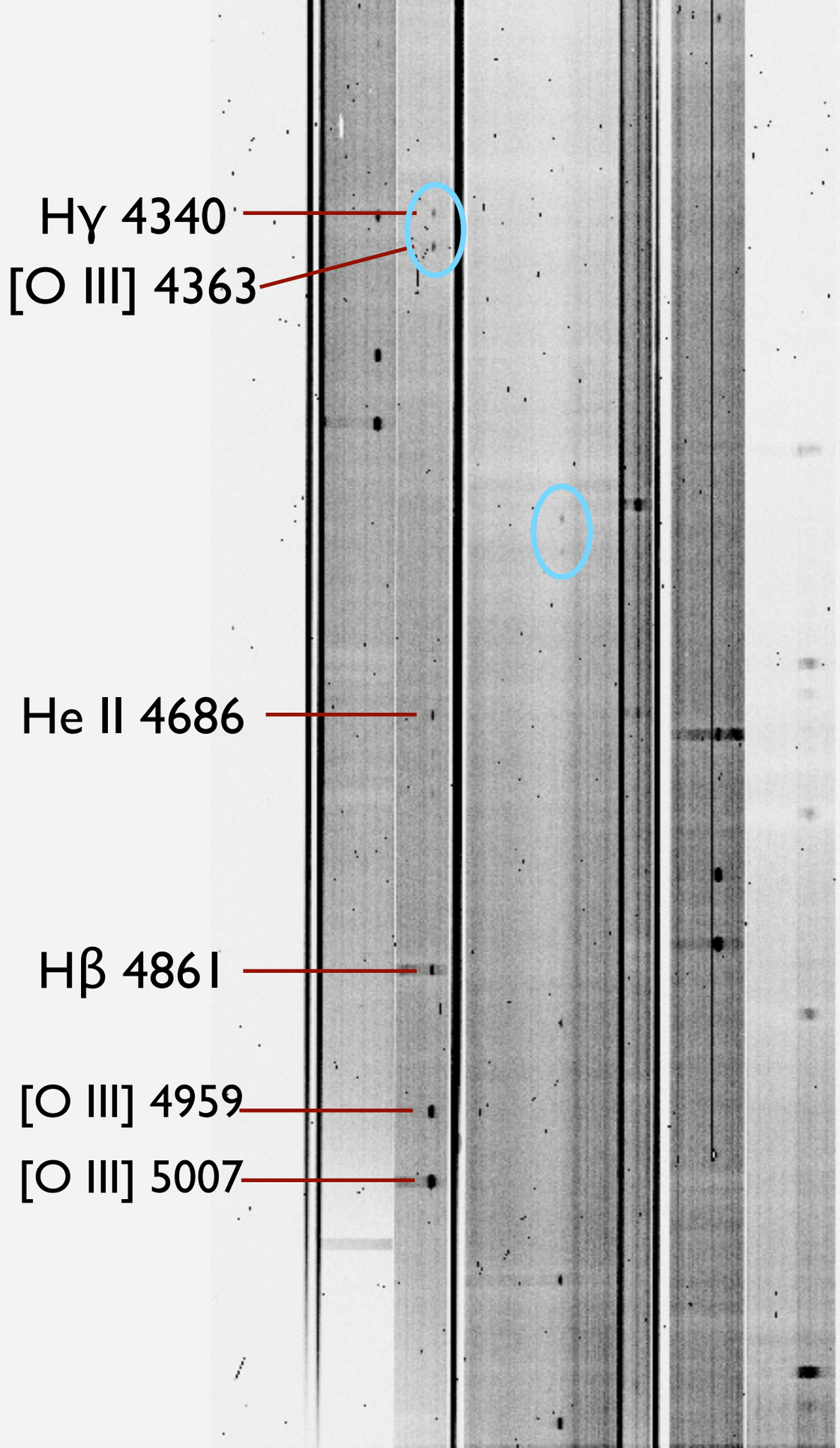
ii) wavelength coverage down to 3700 Å



TECHNICAL REQUIREMENTS

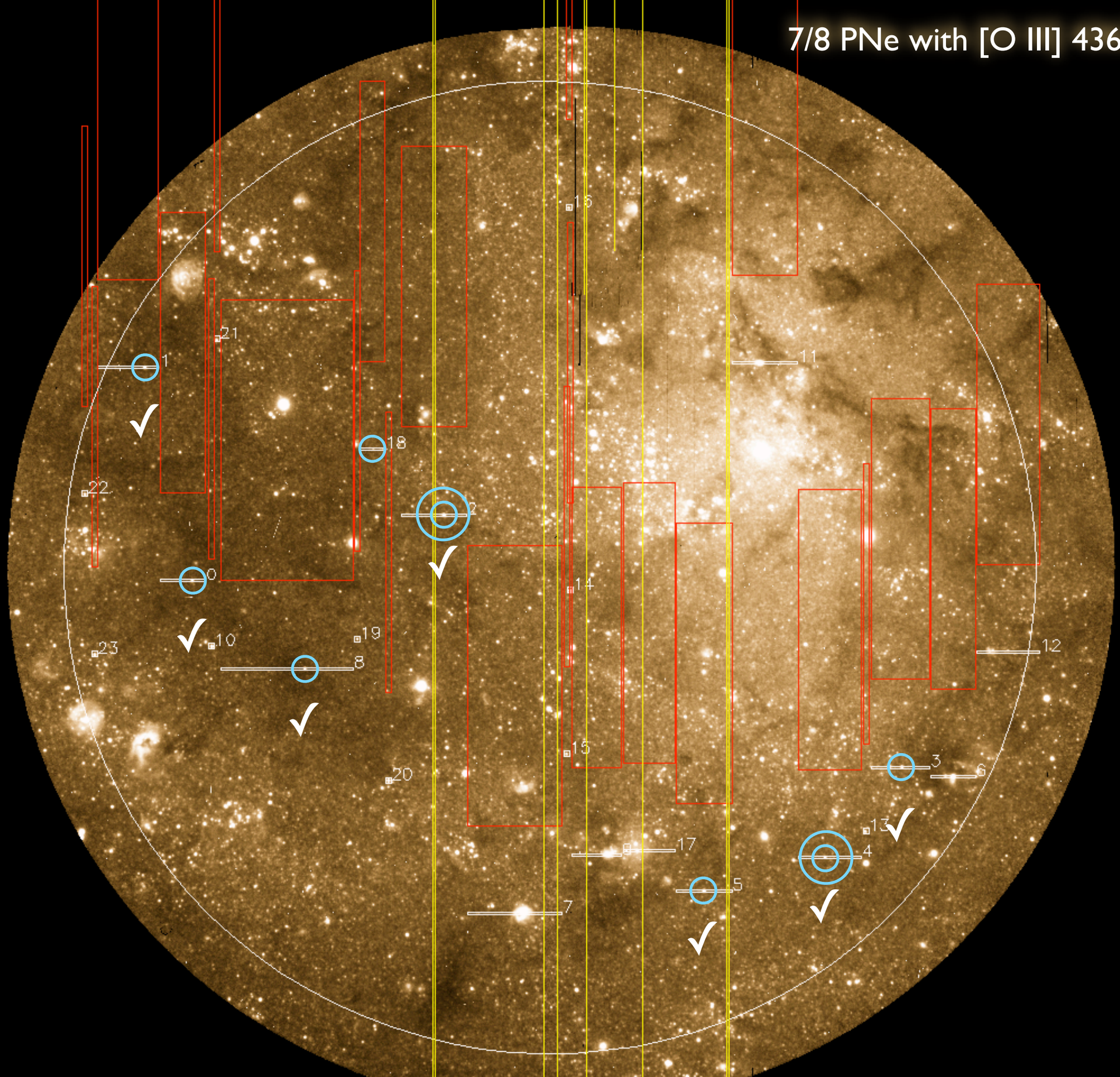
iii) flux calibrated spectra --> atmospheric dispersion corrector



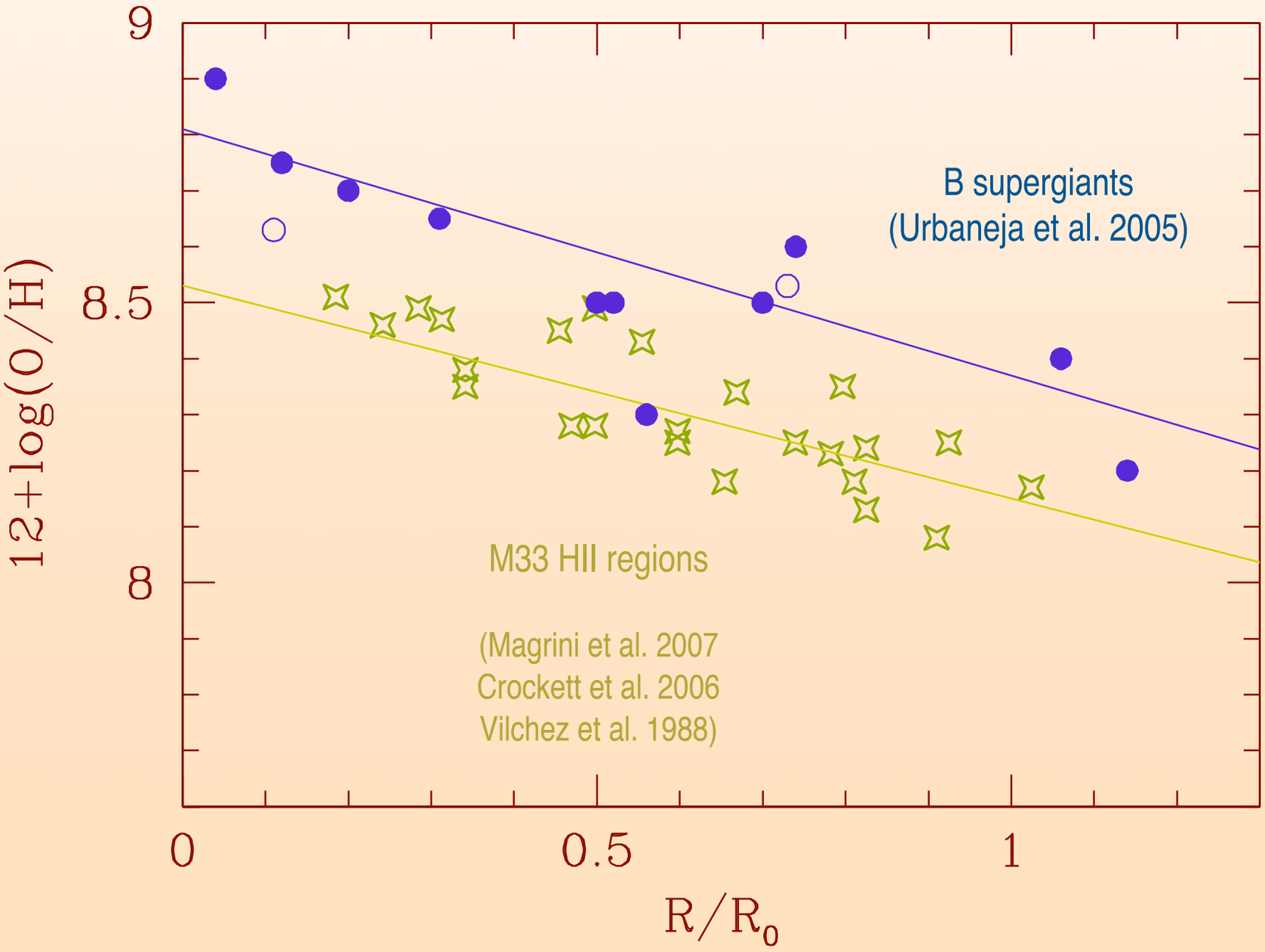


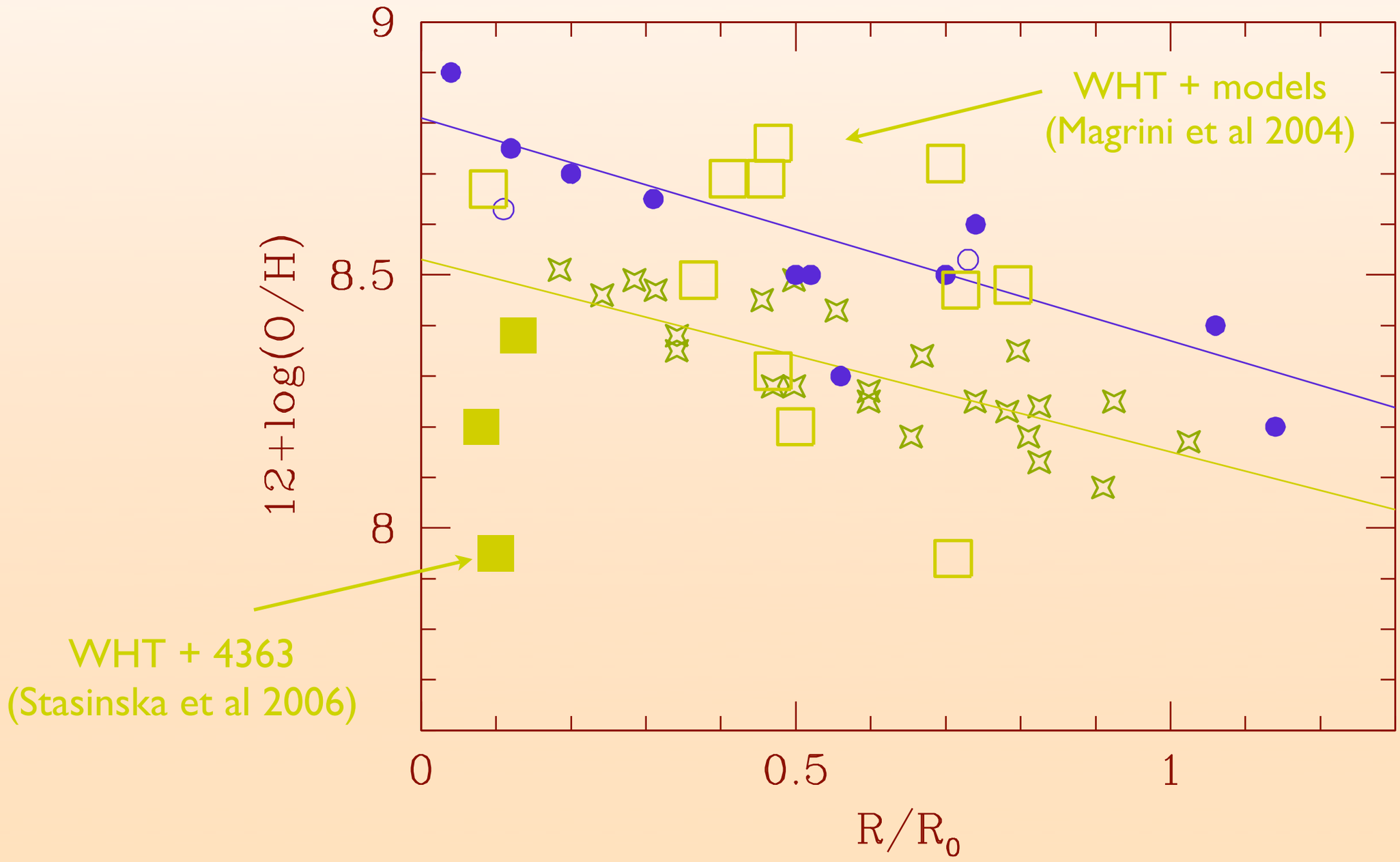
300R (2nd order)
1800 seconds

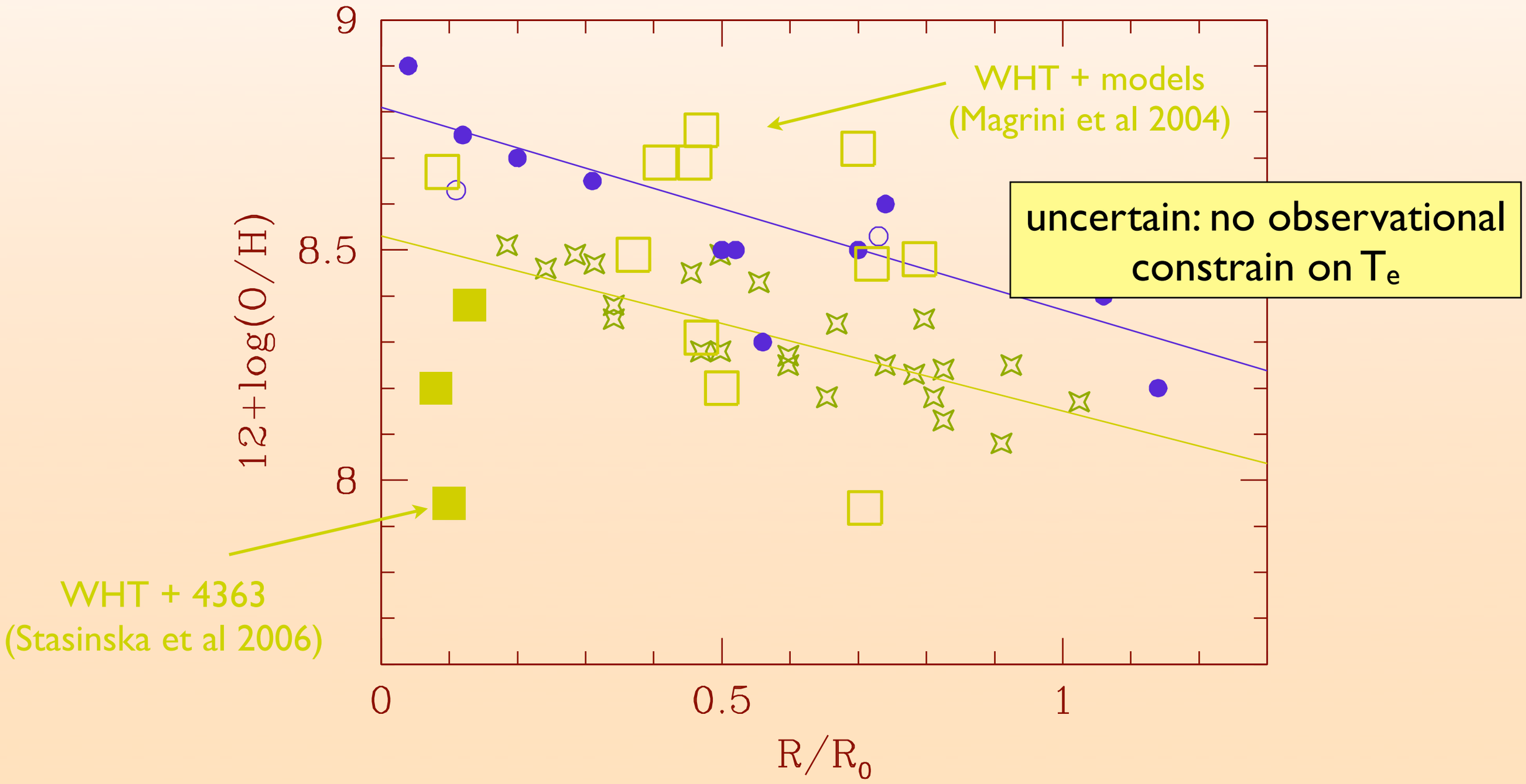
7/8 PNe with [O III] 4363 detected



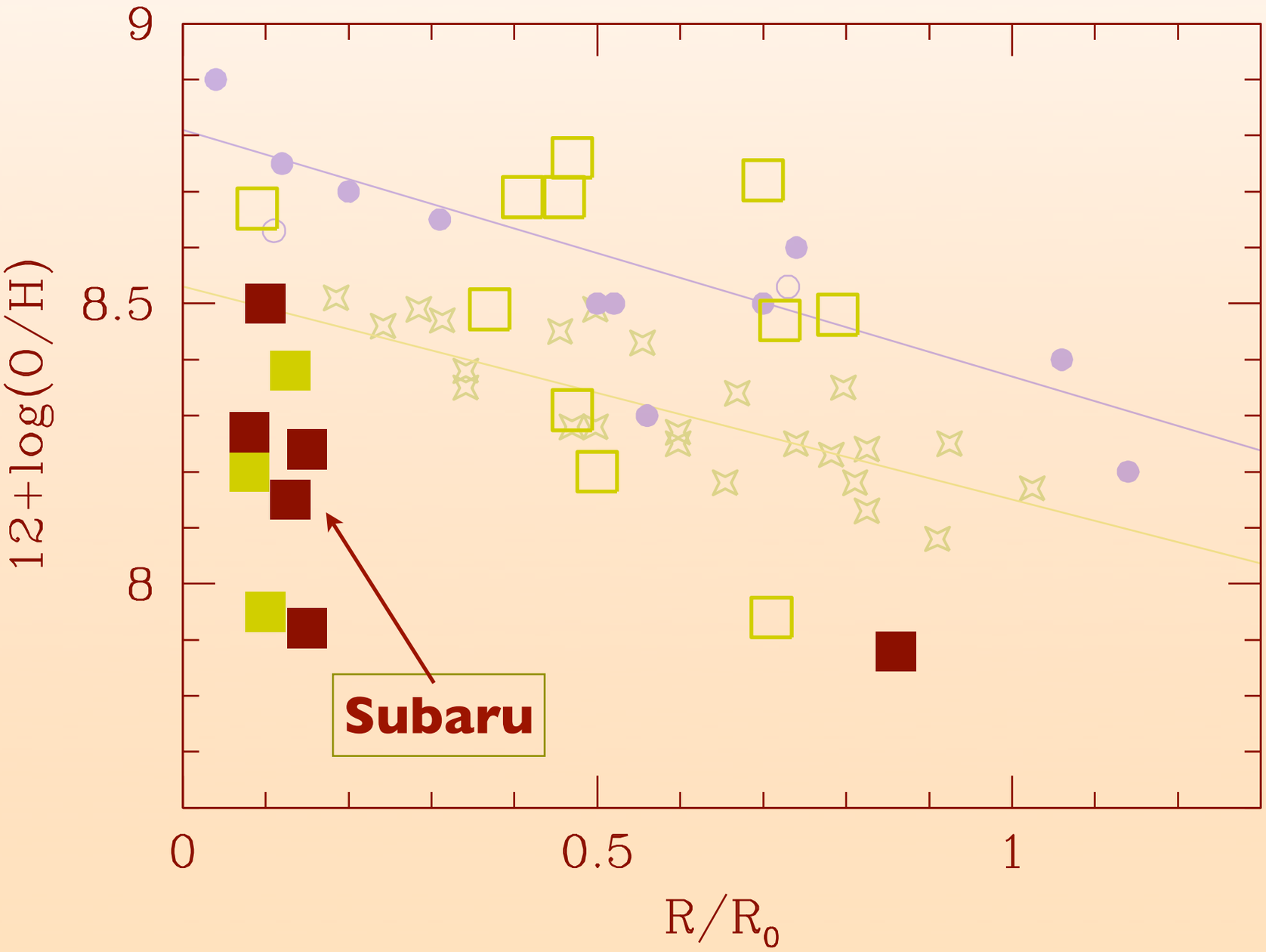
M33 - end of 2007

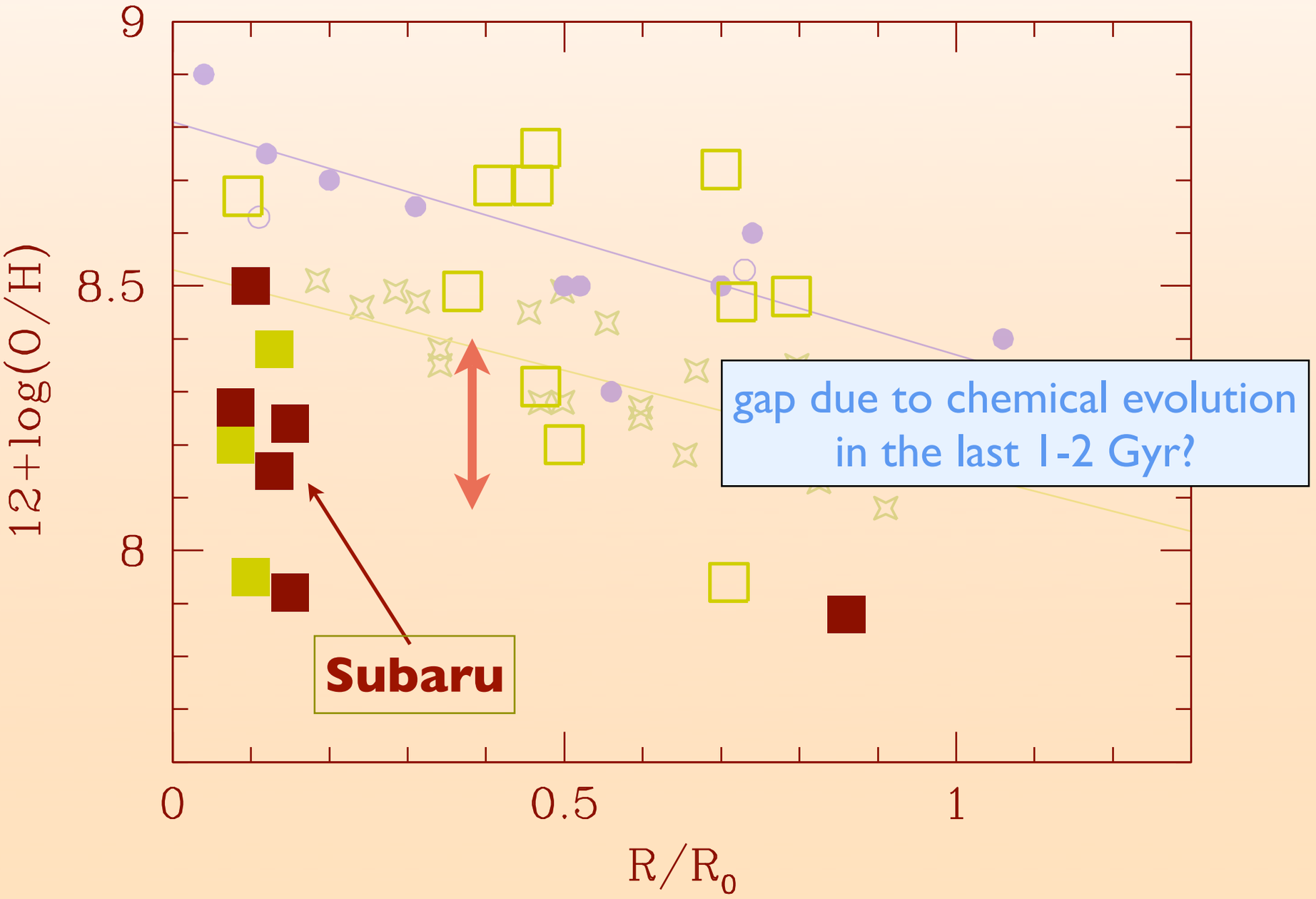



9
8.5
8
12+log(O/H)
0
0.5
1
R/R0
WHT + models
(Magrini et al 2004)
WHT + 4363
(Stasinska et al 2006)


9
8.5
8
12+log(O/H)
0
0.5
1
R/R0
WHT + models
(Magrini et al 2004)
uncertain: no observational constrain on Te
WHT + 4363
(Stasinska et al 2006)

(preliminary!)




9
8.5
8
12+log(O/H)
0
0.5
1
R/R0
gap due to chemical evolution
in the last 1-2 Gyr?
Subaru

Future work

- complete data reduction of whole sample
- obtain not only O/H, but also Ne, Ar, N, He and S abundances

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- study effects of AGB nucleosynthesis and mixing, known to affect He, C and N. What about O? Can the evolution along the AGB change the O abundance? Ar and S should not be affected.

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- study effects of AGB nucleosynthesis and mixing, known to affect He, C and N. What about O? Can the evolution along the AGB change the O abundance? Ar and S should not be affected.
- derive T_{eff} and L of central stars --> progenitor star mass and age
- interpret abundances of PNe and HII regions within a galaxy evolution model (e.g. how is the metallicity built up?)