Uncertainties in Nebular Helium Abundances

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Based, in part, on Aver, Olive, & Skillman, in prep.

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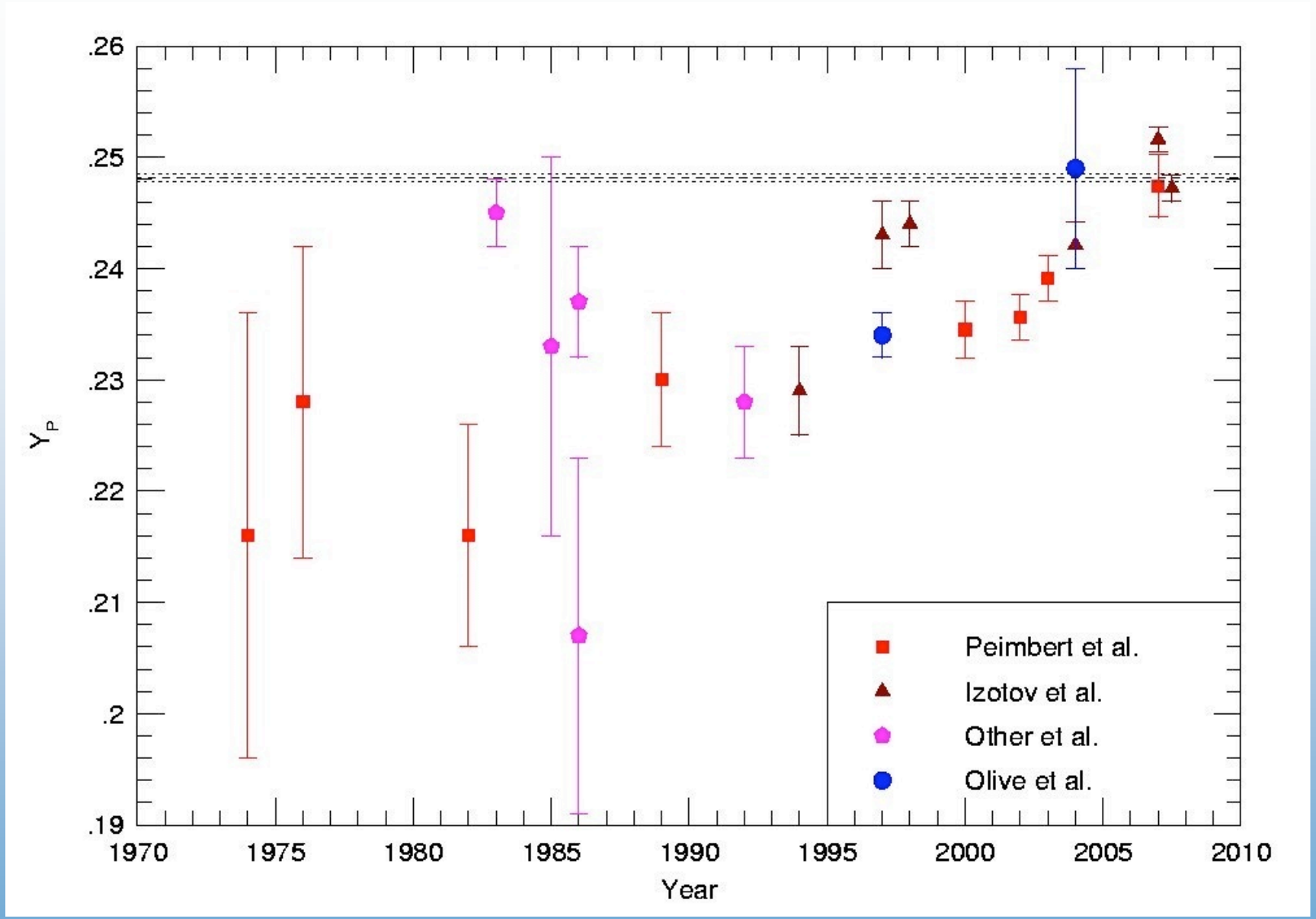


The History of Primordial Helium Measurements

In defense of Olive & Skillman (2004)

Following the notions of:

(1) Adding 7065 as a density indicator
(2) Adding 3889 as an optical depth indicator
(3) Solving for electron temperature from HeI lines
(4) Using 4026 as an indicator of underlying He I absorption

We pursued a "non-parametric" approach based on H and He emission lines only with the result that the uncertainties on the individual points increased.

TABLE 7

ERROR BUDGET IN THE Y_p(SAMPLE) DETERMINATION

Problem	Estimated Error
Collisional excitation of the H I lines	$\pm 0.0015^{a}$
Temperature structure	$\pm 0.0010^{b}$
$O(\Delta Y/\Delta O)$ correction	$\pm 0.0010^{a}$
Recombination coefficients of the He I lines	$\pm 0.0010^{a}$
Collisional excitation of the He I lines	$\pm 0.0007^{b}$
Underlying absorption in the He I lines	$\pm 0.0007^{b}$
Reddening correction	$\pm 0.0007^{a}$
Recombination coefficients of the H I lines	$\pm 0.0005^{a}$
Underlying absorption in the H I lines	$\pm 0.0005^{b}$
Helium ionization correction factor	$\pm 0.0005^{b}$
Density structure	$\pm 0.0005^{b}$
Optical depth of the He I triplet lines	$\pm 0.0005^{b}$
He I and H I line intensities	$\pm 0.0005^{b}$

[a] Systematic error.

[b] Statistical error.

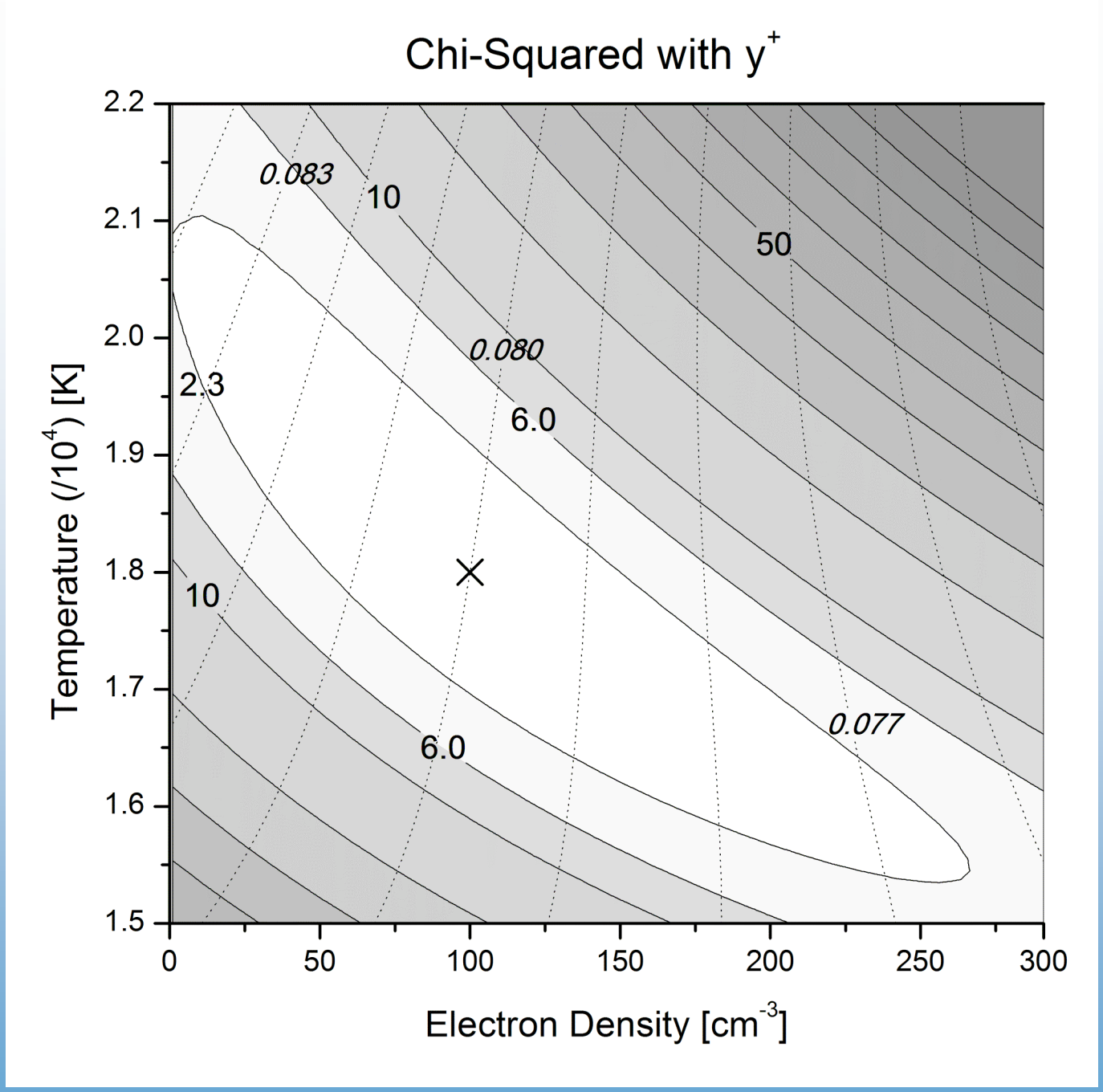
Table 7 from Peimbert, Luridiana, & Peimbert 2007

In defense of Olive & Skillman (2004)

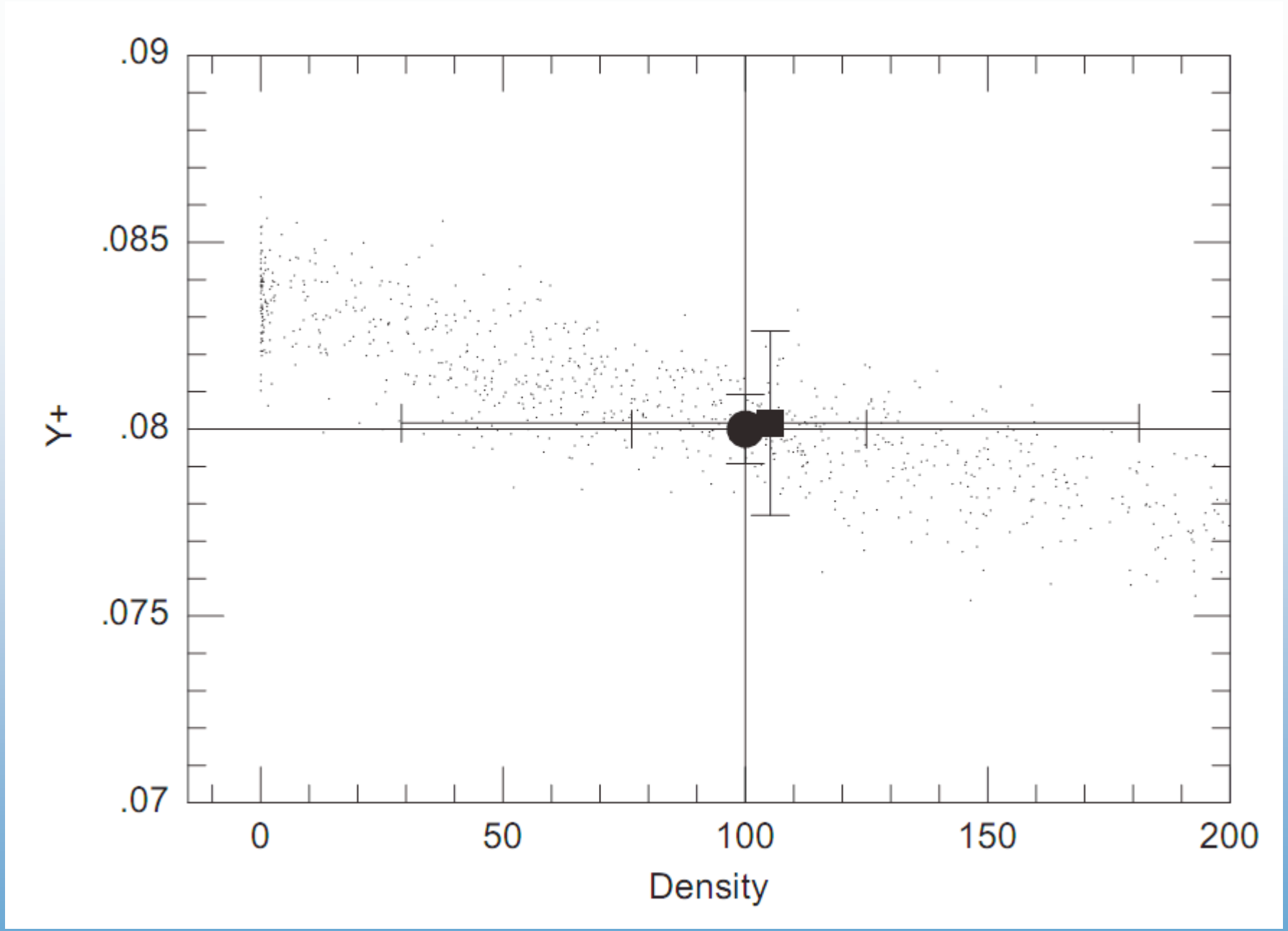
Larger uncertainties on individual points are a result of:

(1) larger estimates of individual terms
(2) including more terms
(3) exploring degeneracies in solutions

Monte Carlo analyses are required to estimate the true uncertainties



The Underlying Degeneracy



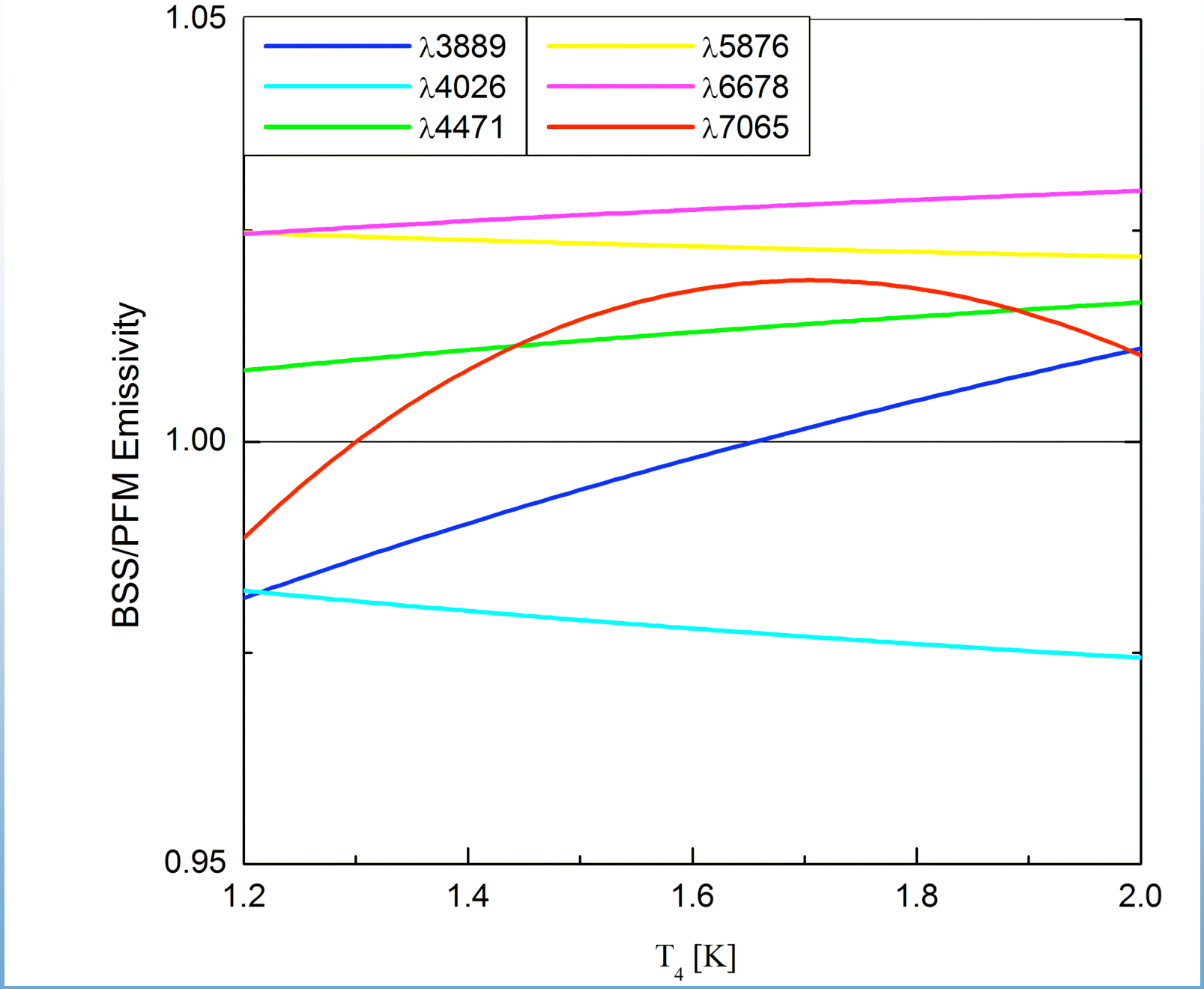
The Underlying Degeneracy

In Aver, Olive, & Skillman (2010)

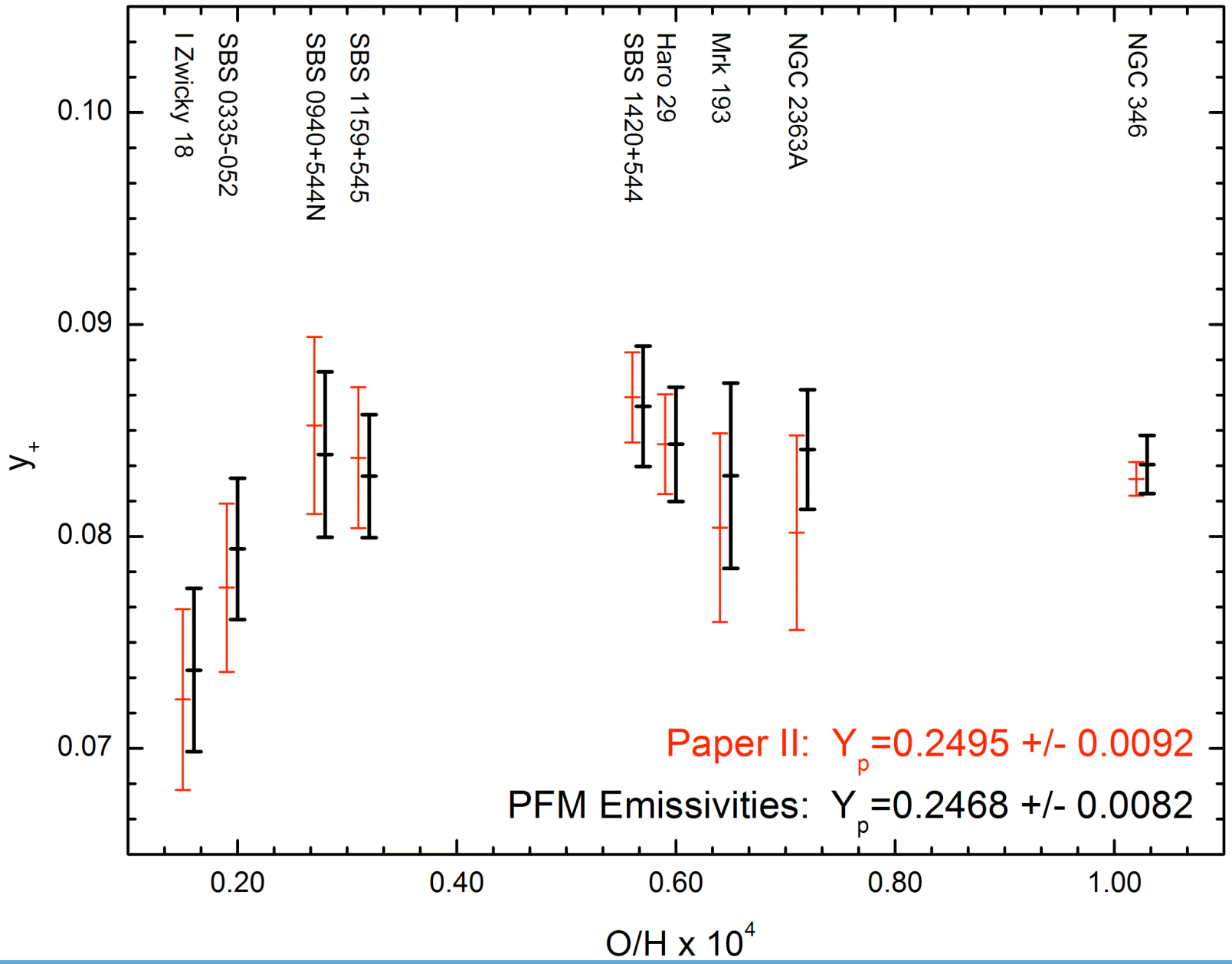
We explore:

(1) new He I emissivities
(2) "integrating" the H I and He I lines in a minimization
(3) better treatment of underlying absorption
(4) solving for H I collisional excitation

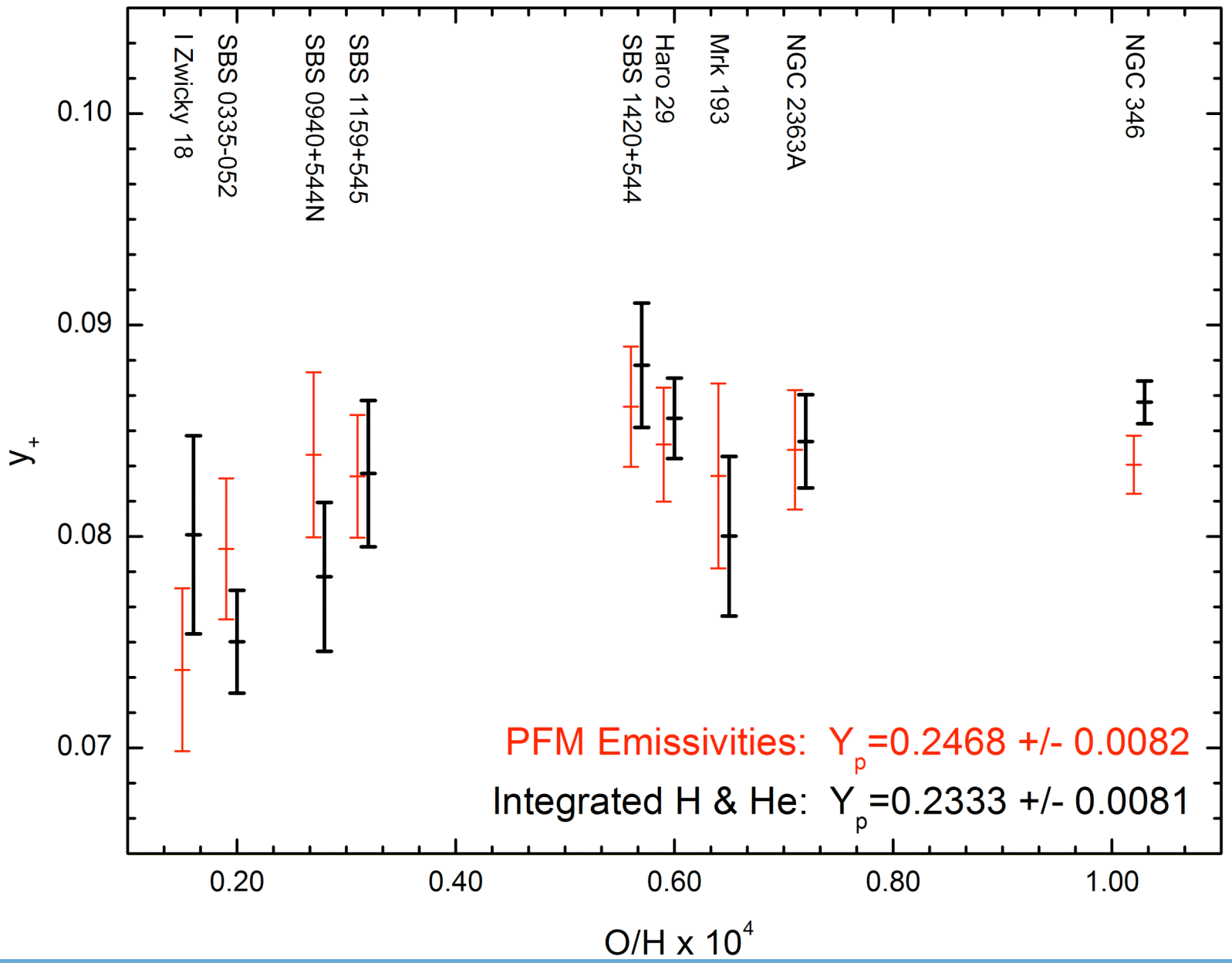
The results have been interesting…



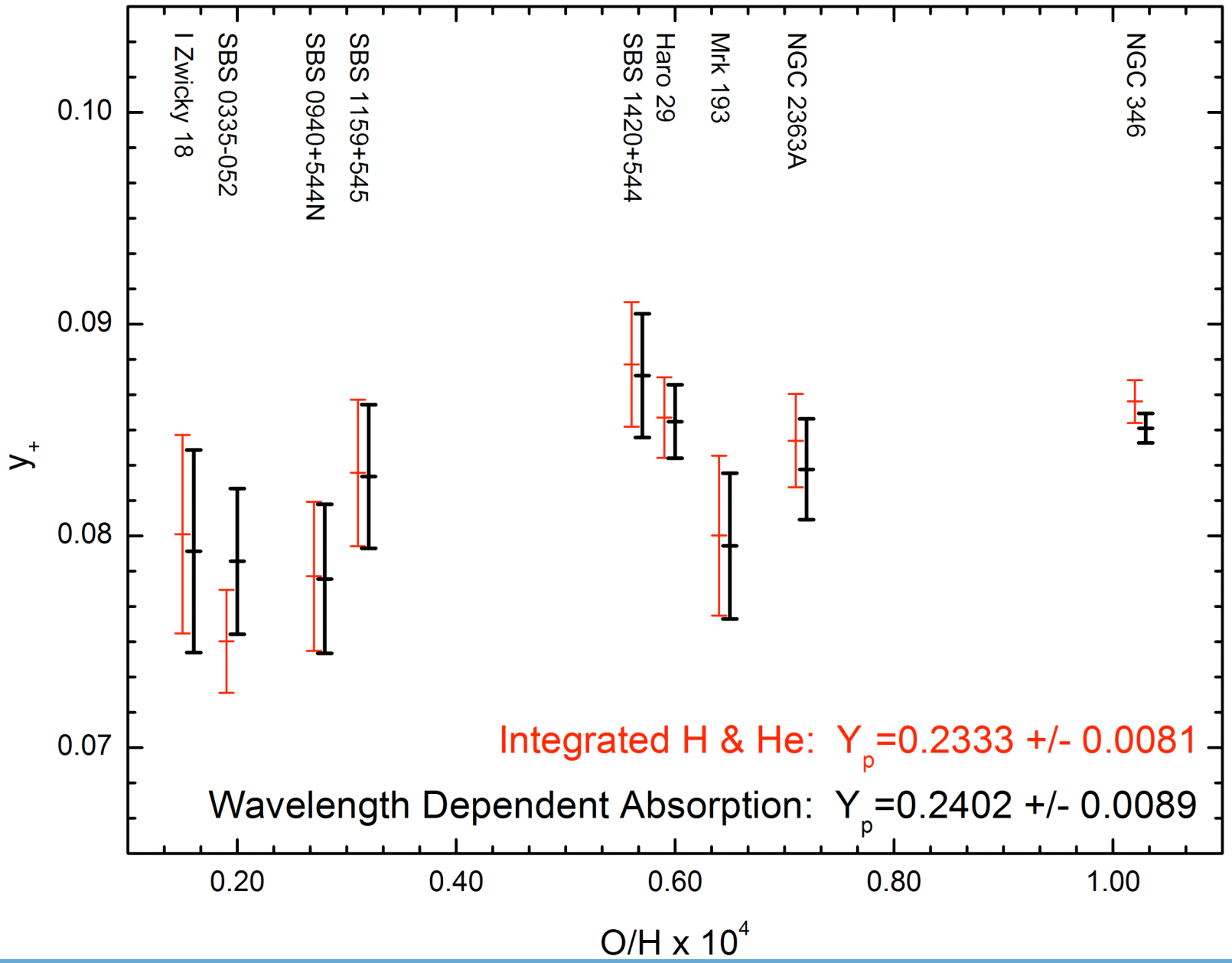
The Effect of New Emissivities



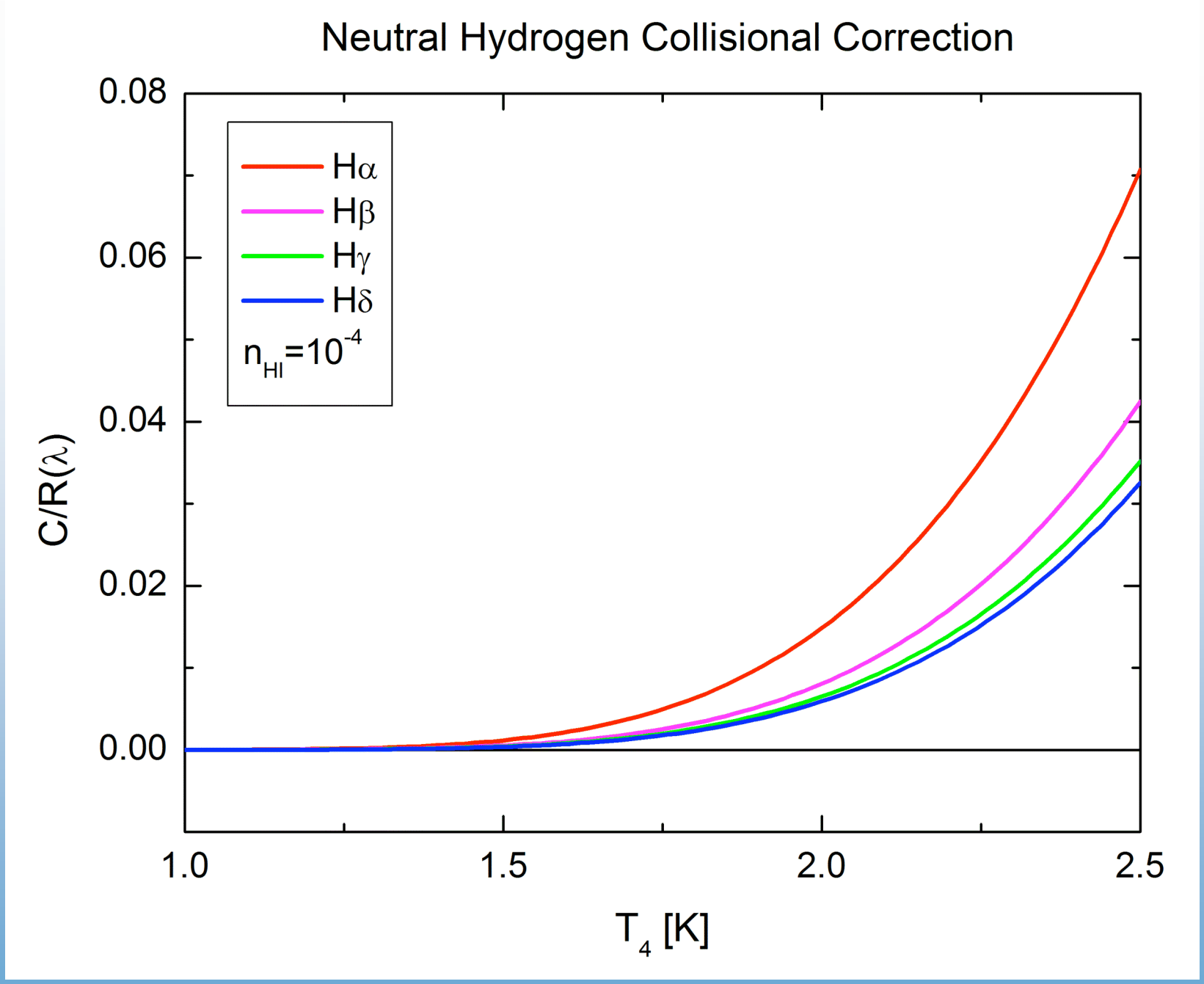
The Effect of New Emissivities



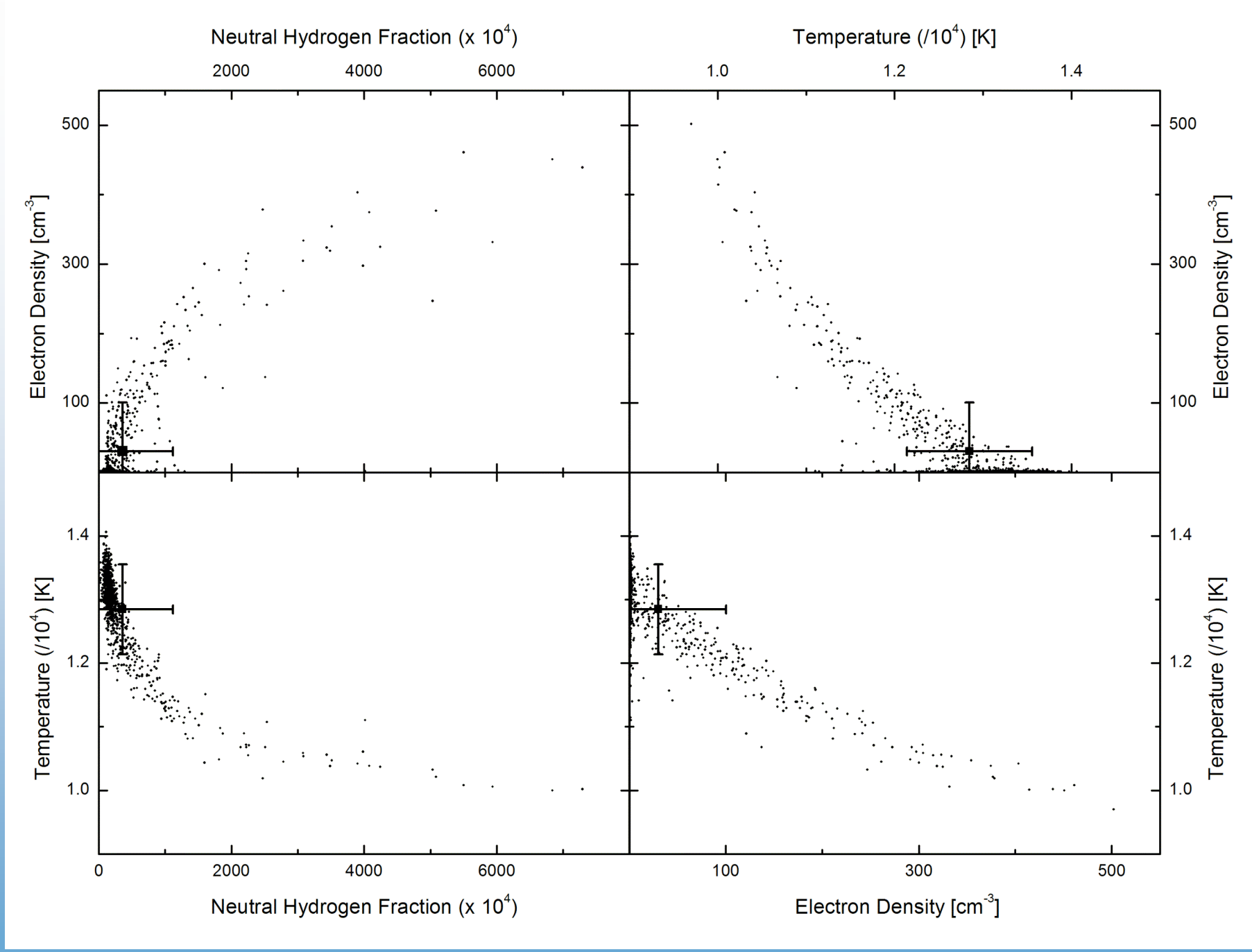
The Effect of "Integrating" the Analysis



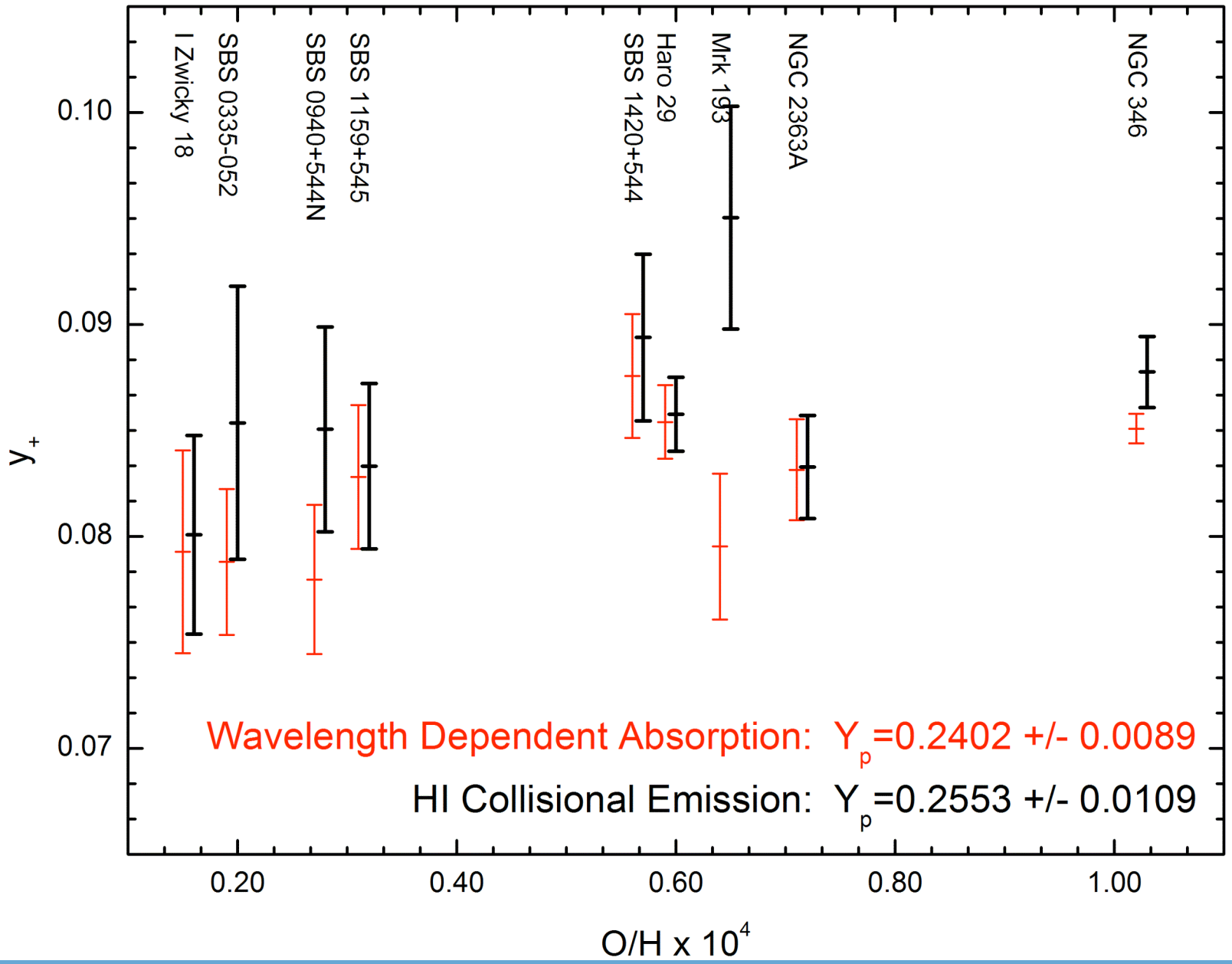
The effect of wavelength dependent underlying absorption



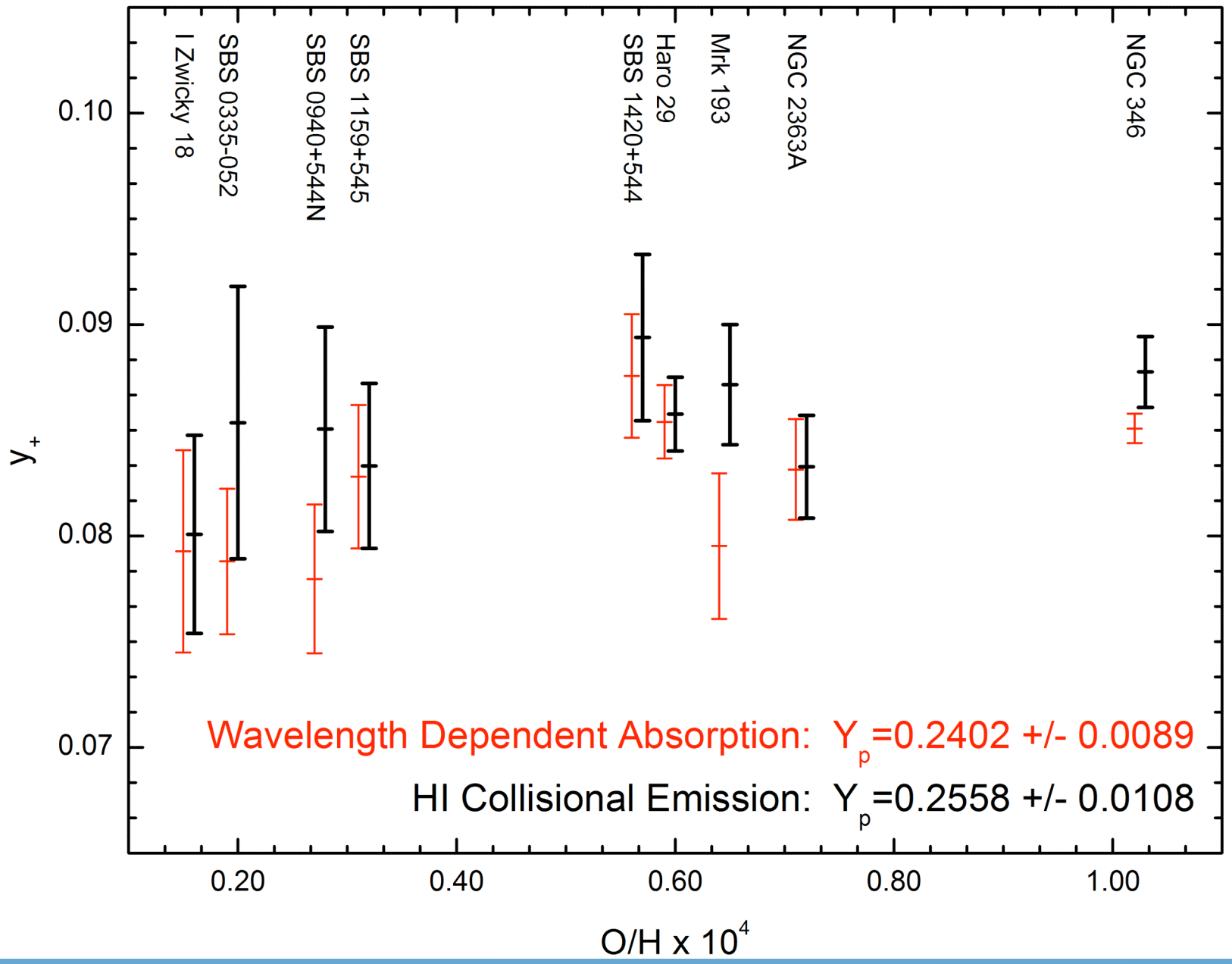
The relative importance of collisional excitation of H



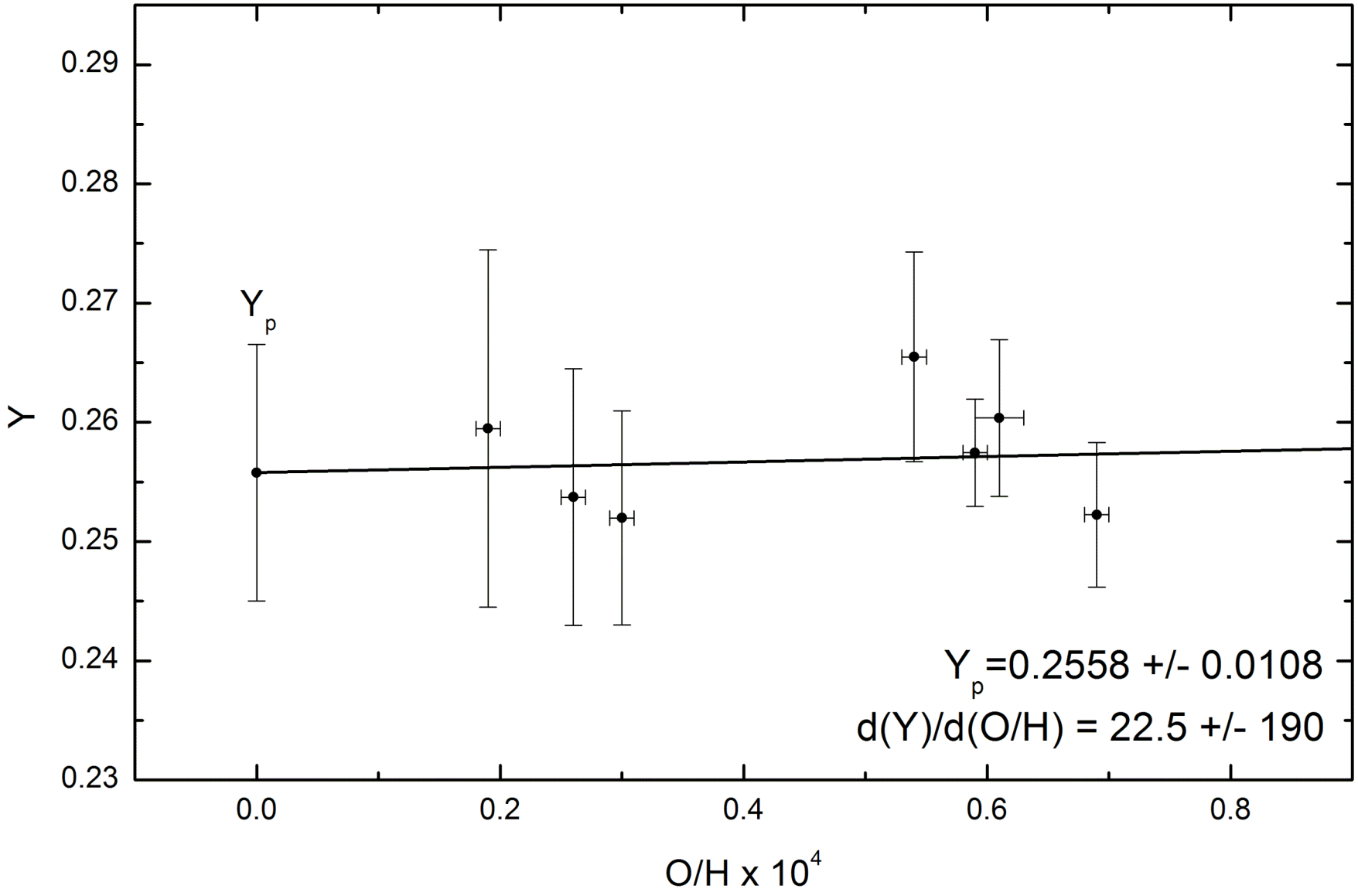
The underlying degeneracies revealed (NGC 346)



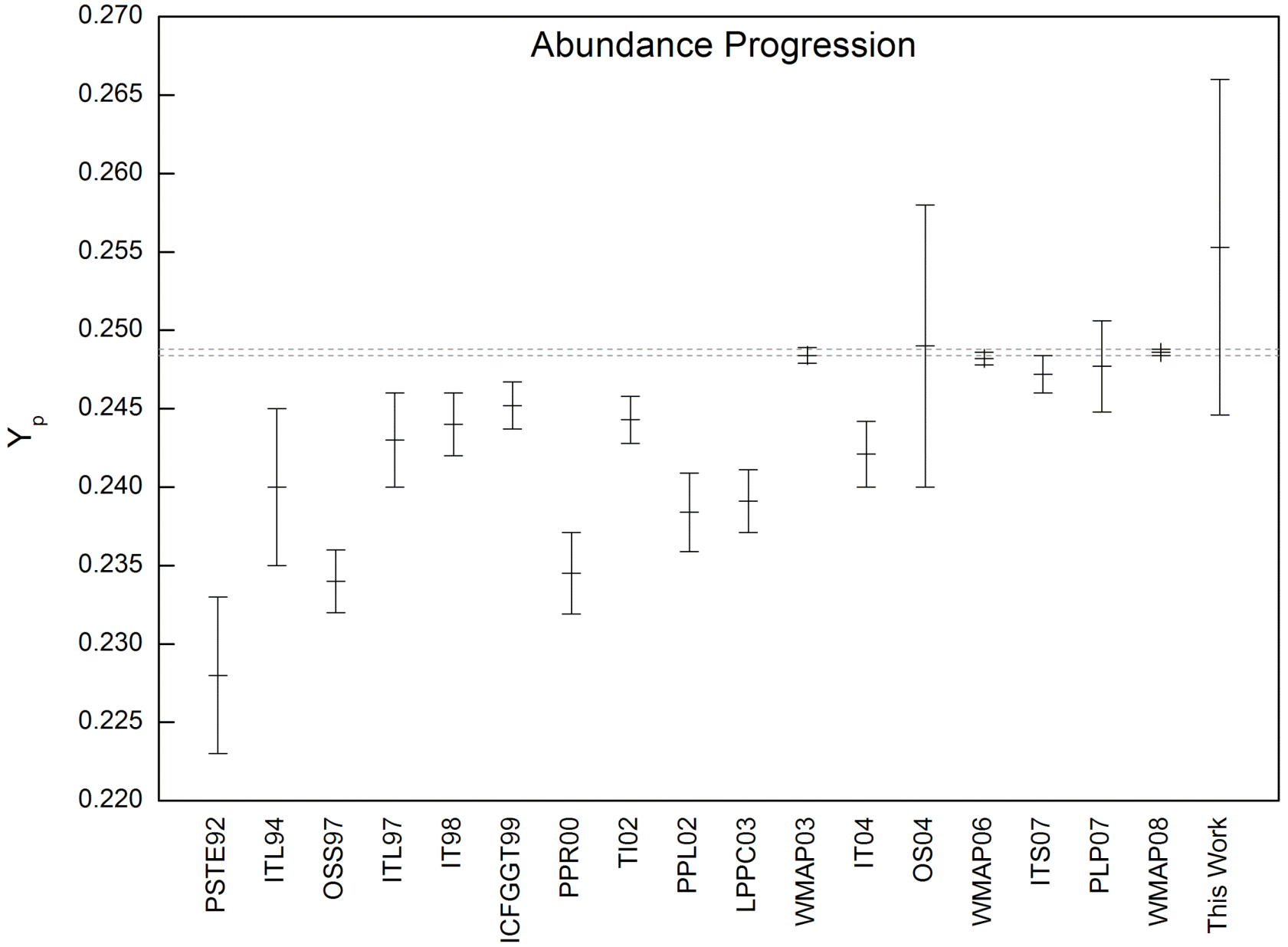
The effect of correcting for collisional excitation of H



The effect of correcting for collisional excitation of H



A Representative Regression



The History of Primordial Helium Measurements

In Aver, Olive, & Skillman (2010)

We explore future improvements:

(1) Higher quality spectra are needed for smaller uncertainties on individual objects
(2) Specifically, higher resolution spectra remove underlying absorption as a free parameter
(3) High S/N in the higher Balmer lines allow a better constraint on the collisional excitation of H I

Summary

- Only a few objects are suitably high quality for non-parametric analysis
- Uncertainties for individual objects have typically been underestimated
- The situation with regard to observations can be improved
- Primordial He is primarily a consistency check as opposed to a BBN constraint