Metallicity estimation using N2 method with OSIRIS

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Abstract The OTELO (OSIRIS Tunable Emission Line Object Survey project) is an emission line survey using the OSIRIS Tunable Filters on the GTC 10.4m telescope (Cepa et al. 2008). Observing in selected atmospheric windows relatively free of sky emission lines, and with a total survey area of 0.1 square degree distributed in different fields, it is expected to reach 5 sigma depth of 10^{-18} erg/cm^2/s, detecting objects with EW < 0.2. OTELO will be the deepest emission line survey to date. As part of the preparatory activities, we have selected from the simulation of OTELO spectra, including errors, the best combination of tunable filters bandwidth (FWHM) and sampling, that will allow deblending Hα from [N II]λ6583 lines with a flux error lower than 20%. With the selected instrumental configuration will be possible to estimate the objects chemical abundances using the N2 method in very low metallicity systems. We estimate that OTELO will allow to estimate the metallicities of more than 3000 Hα star forming emitters up to a redshift 0.4.

1 Hα & [N II] Simulations

We generated synthetic spectra based on data from real HII regions, with Hα and [N II] λ6583 lines in emission centered on 6563 and 6583 Å respectively (zero redshift), and FWHM(Hα)=4.7, and [N II]λ6583 /Hα=0.43.

As a first step, we redshifted the spectrum to z=0.24 and z=0.4, the two redshifts where are located the atmospheric windows of our observations with OSIRIS. To

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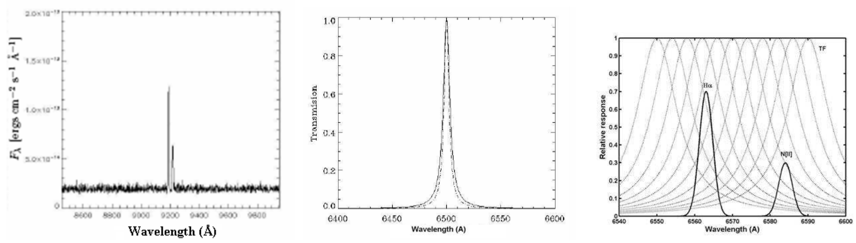

Fig. 1 Left: Example of a simulated spectrum, middle: Airy function of 9 (dot-dash line) and 12 Å (solid line), and right: Convolution of a synthetic spectrum with an Airy function.

add a continuum, we used different equivalent widths with EW(Hα) of 5, 10, 20, 30, 40 and 50 Å. Finally, we add a Poisson noise of 5 to all spectra (see Figure 1).

2 Convolutions

To simulate the expected OTELO spectra, we use the instrumental response of the red tunable filter of OSIRIS, which consists of two plane parallel transparent plates which are coated with films of high reflectivity and low absorption, the transmission function of a tunable filter (an Airy function) is given by the next ecuation:

$$\tau_r(\lambda) = \left(\frac{T}{1-R}\right)^2 \left[1 + \frac{4R}{(1+R)^2} sin^2 \left(\frac{2\pi\mu d cos\theta}{\lambda}\right)\right]^{-1} \quad (1)$$

where T is the transmission coefficient of each coating of the tunnable filter, R is the reflection coefficient, d is the plate separation, μ is the refractive index of the medium in the cavity, and θ is the angle of incident light (Bland & Tully 1989).

We generate Airy functions with a FWHM of 9 & 12 Å, as shown in Figure 1 (middle), then we convolved this function with the generated spectrum as shown in Figure 1 (right).

As a result of this convolutions, and using different combinations of FWHM of the Airy Function with different samplings (1, 2, 3, 4, 5 and 6), we obtained a pseudo-spectra, one for every combination of FWHM, sampling, and spectrum. In total, we obtained 72 pseudo-spectra.

3 Continuum subtracted

As a first aproximation to subtract the continuum, we fit a line to the pseudospectra to subtract the continuum and we estimate fluxes, obtaining quite high errors.

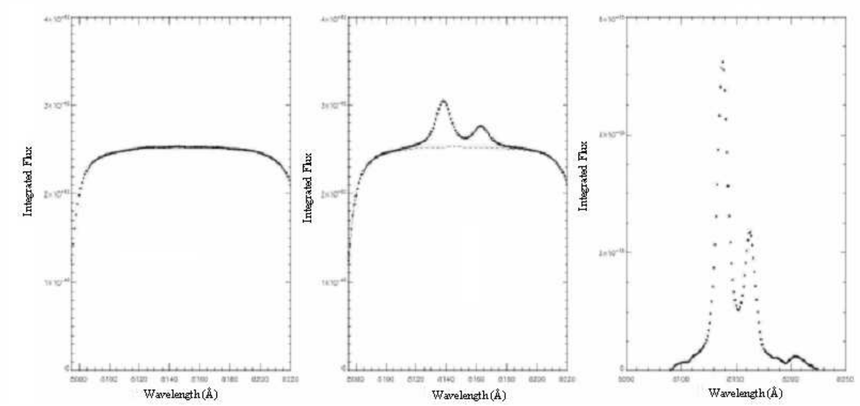

Fig. 2 From left to right, simulated continuum of a spectrum, result of the convolution of a spectrum with an Airy function and the overplot with the simulated continuum, and the difference of both functions.

We find that a better method is to adjust a function to every pseudo-spectrum as shown in Figure 2. From the continuum subtracted pseudo-spectrum, we estimate the Hα and [N II]λ6583 flux.

It is important to notice that the best method to subtract the continuum is fitting a function, due to the form of the entire pseudospectrum.

4 Errors estimate

In order to obtain the best combination of tunable filters bandwidth (FWHM) and sampling, that will allow deblending Hα from [N II]λ6583 lines with a flux error lower than 20%, we obtained relative errors from the continuum subtracted pseudo-spectra for all the combinations of FWHM, sampling, and redshift, as an example see Table 1.

5 Conclusions

We conclude that the observational strategy of our survey recommends that the best combination of tunable filters, FWHM and sampling, is a FWHM of 12 Å and a sampling of 5 Å, that will result in a flux measurement error less than 20%.

FWHM de 12 Å, z=0.24						
Sampling step: 3 Å						
EW Å	Hα Error	σ	[N II] Error	σ	[N II]/Hα Error	σ
50	9	0.7	0.8	0.2	10	0.6
40	11	0.7	4	0.7	7	0.7
30	11	0.7	1	0.7	13	1
20	13	0.8	0.7	0.4	15	0.1
10	10	1	6	0.7	17	1
5	11	1.4	4	0.6	17	2
Sampling step: 4 Å						
50	10	2	1.3	0.8	11	1
40	12	2	5.5	1.8	8	0.7
30	12	2	1.4	0.5	14	1.5
20	14	1.8	1.5	1.5	15	0.1
10	10	1.8	5	1.7	17	1
5	11	1.5	3	1.8	16	3
Sampling step: 5 Å						
50	11	2.4	2.5	2	11	2.6
40	13	2.5	6.4	2.4	8	2.4
30	13	2.6	2.4	2	13	2
20	15	2.4	2.5	2	15	3.7
10	11	2.6	4	2	18	4.6
5	12	2.8	3	2	18	6
Sampling step: 6 Å						
50	12	4	3	3	11	1.5
40	14	4	7	4	8	1
30	14	4	3	2.5	14	2.5
20	16	3	3	3.5	15	0.5
10	12	3	4	2.5	18	2
5	13	3	3	2	18	6.5

Table 1 Relative errors with sampling 3, 4, 5 y 6 Å using an Airy function with FWHM of 12 Å, and a spectrum at z=0.24

References

1. Cepa et al. 2008, A&A, in press
2. Bland, J., & Tully, B., 1989, AJ, 98, 723