Stellar population in active galactic nuclei

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1st workshop
Astrophysical winds and disks-similar phenomena in stars and quasars

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Differences in AGN spectra

QSO spectrum

LINER spectrum

z=5.0

Ly a

SiIv

CIV

wavelength

Flux

Wavelength (in A)
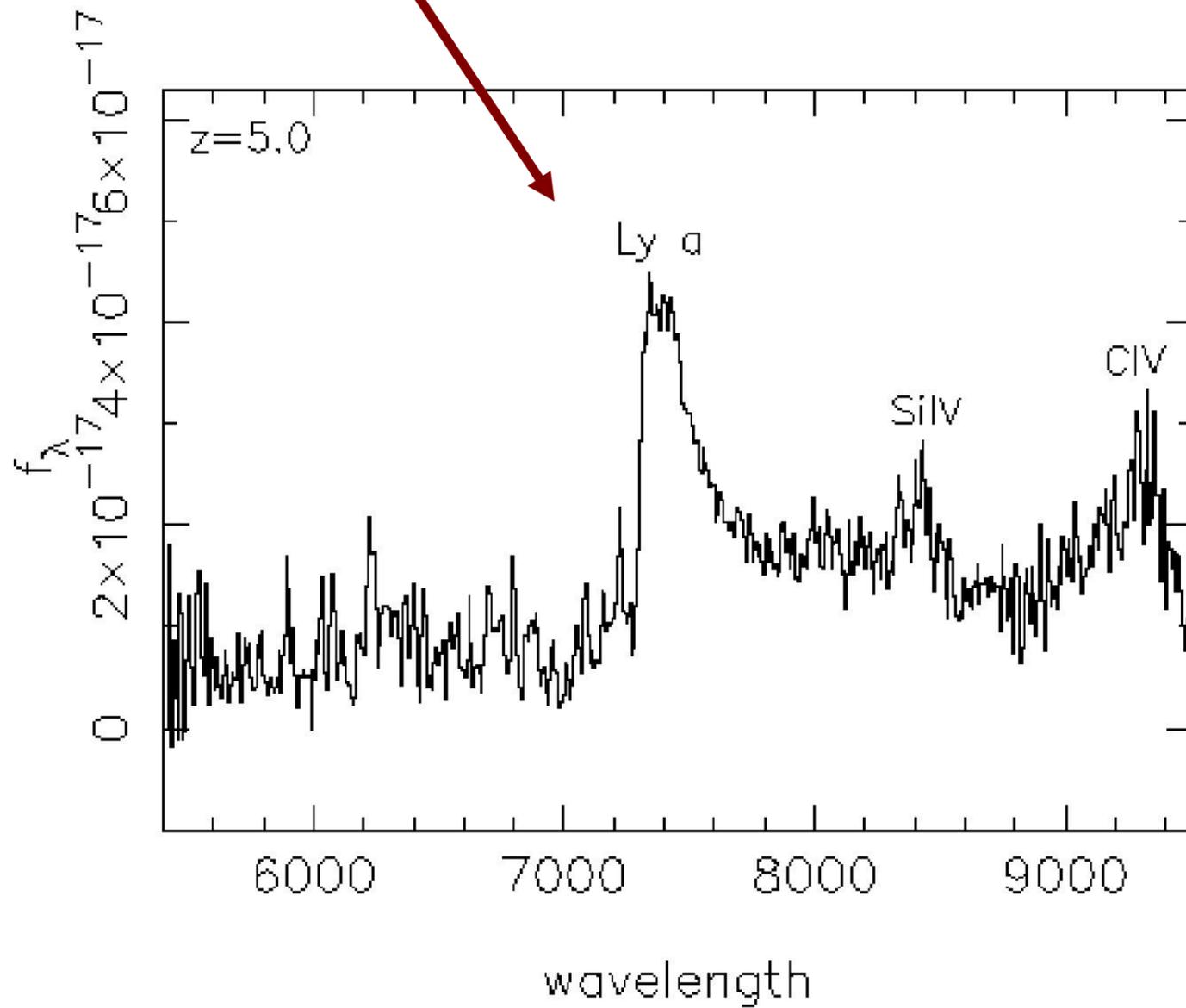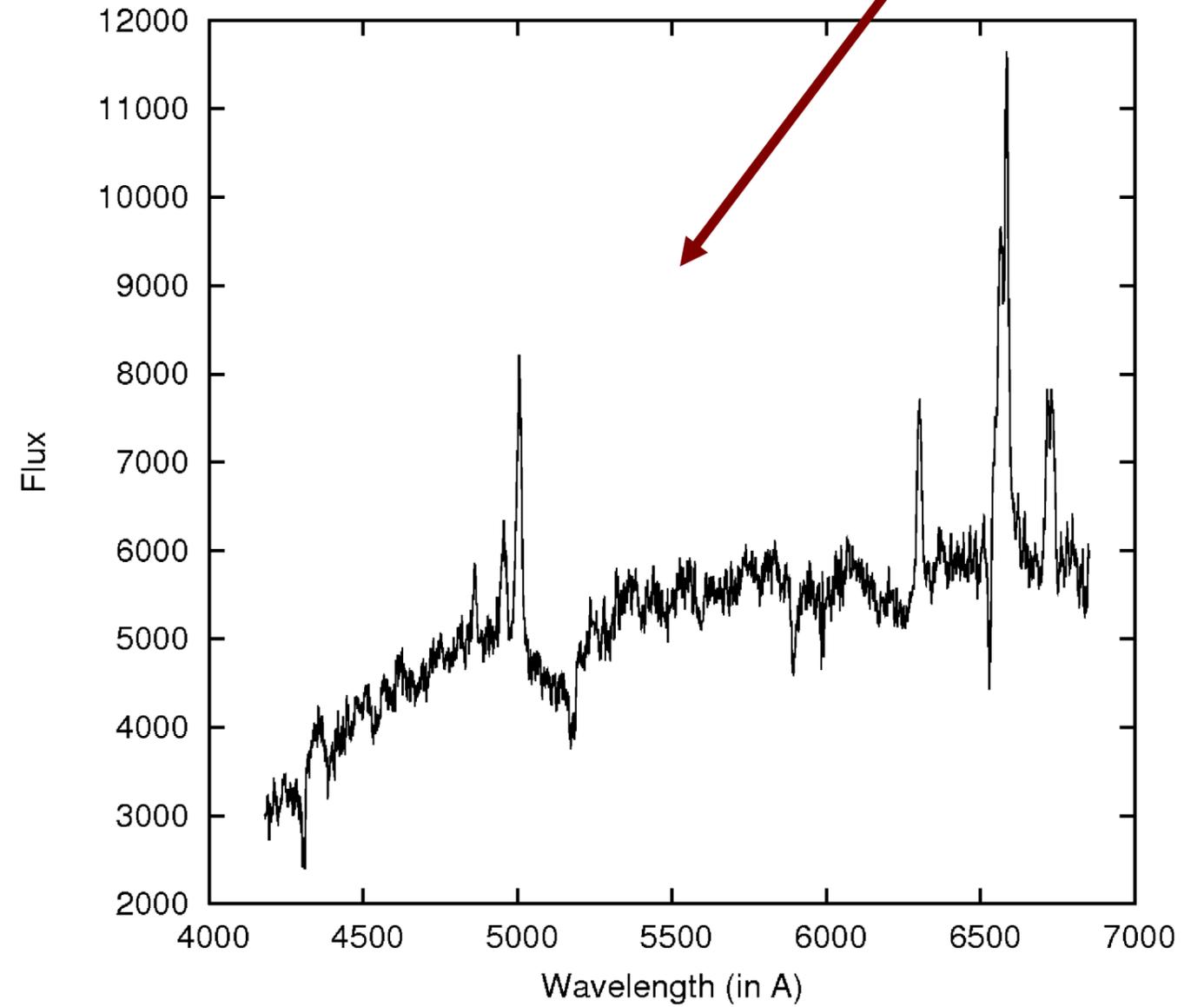
Program and model

- We developed the full-spectrum fitting package - ULYSS to fit spectro-scopic observations against a linear combination of non-linear model components convolved with a parametric line-of-sight velocity distribution. The minimization can be either local or global, and determines all the parameters in a single fit. We use χ2 maps, convergence maps and Monte-Carlo simulations to study the degeneracies, local minima and to estimate the errors.

- Application – determination of:
  - stellar population characteristics (fraction, age, metallicity, kinematics)
  - AGN characteristics (of continuum and emission lines)

$$M(x) = P(x)([T\,(x) \otimes G(x)] + C(x) + \sum S(x))$$

Simulation I
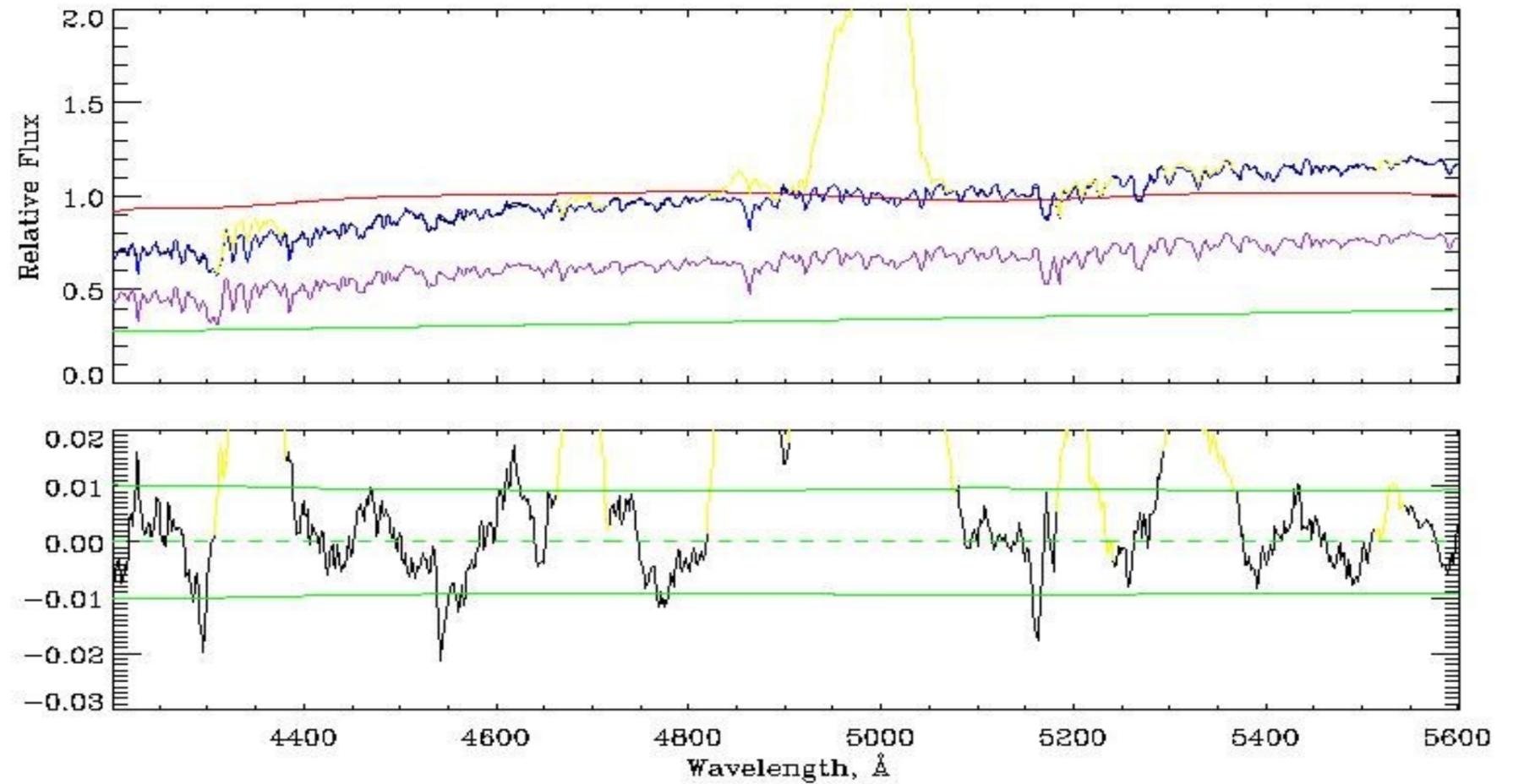
Table 1. lists fit results of the simulated spectra with 0%, 25% and 50% of the AGN continuum contribution. Analysed parameters in the fit are mean stellar velocity (v), stellar velocity dispersion (σ), age and metallicity (z) of stellar population, AGN fraction and spectral index of the power law AGN continuum. The second column represents the initial values in the simulated spectra. Table 2. represents fit results of the simulated spectrum with 75%, 85% and 90% of the AGN continuum contribution.

experiment	init. values	AGN 0%	AGN 25%	AGN 50%
v (km/s)		-0.003 ± 0.816	-0.563 ± 1.471	-1.701 ± 2.219
$\sigma(km/s)$	100	99.996 ± 0.882	101.258 ± 1.799	104.052 ± 2.820
age (Myr)	5000	4998.55 ± 242.07	5156.04 ± 735.29	5610.45 ± 1233.77
z (dex)	0	5.95e-5 ± 0.015	-0.026 ± 0.031	-0.051 ± 0.048
f(%)		0.003 ± 0.054	23.140 ± 2.112	47.071 ± 2.269
sp_index	1.519 ± 0.005		1.415 ± 0.336	1.499 ± 0.228

experiment	init. val.	AGN 75%	AGN 85%	AGN 90%
v (km/s)		-2.679 ± 4.575	-4.99 ± 7.622	-8.489 ± 11.406
σ (km/s)	100	105.639 ± 5.487	111.662 ± 9.173	120.632 ± 13.933
age (Myr)	5000	5822 ± 2606	5616 ± 3893	5947 ± 5290
z (dex)	0	-0.022 ± 0.095	-0.014 ± 0.157	0.023 ± 0.205
f(%)		73.54 ± 0.38	82.93 ± 0.39	87.86 ± 0.37
sp_index	1.519 ± 0.005	1.509 ± 0.06	1.49 ± 0.14	1.467 ± 0.148

Simulation II
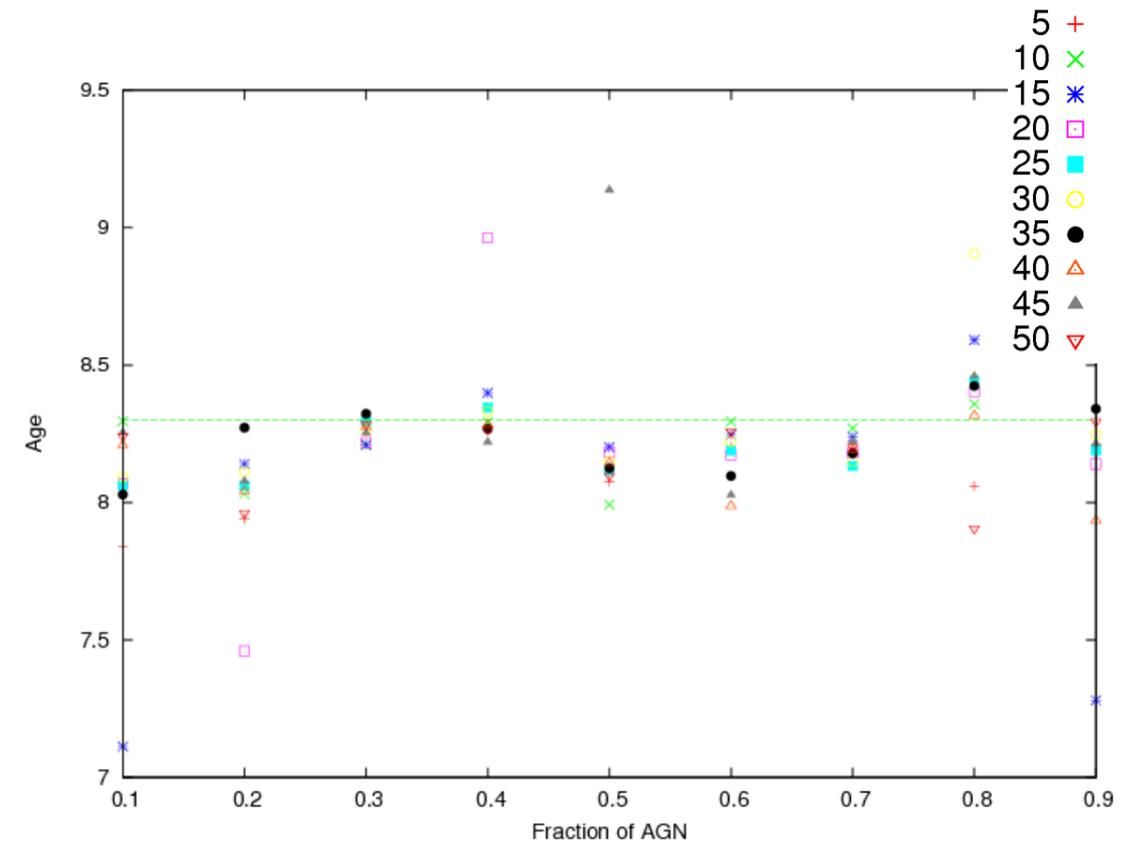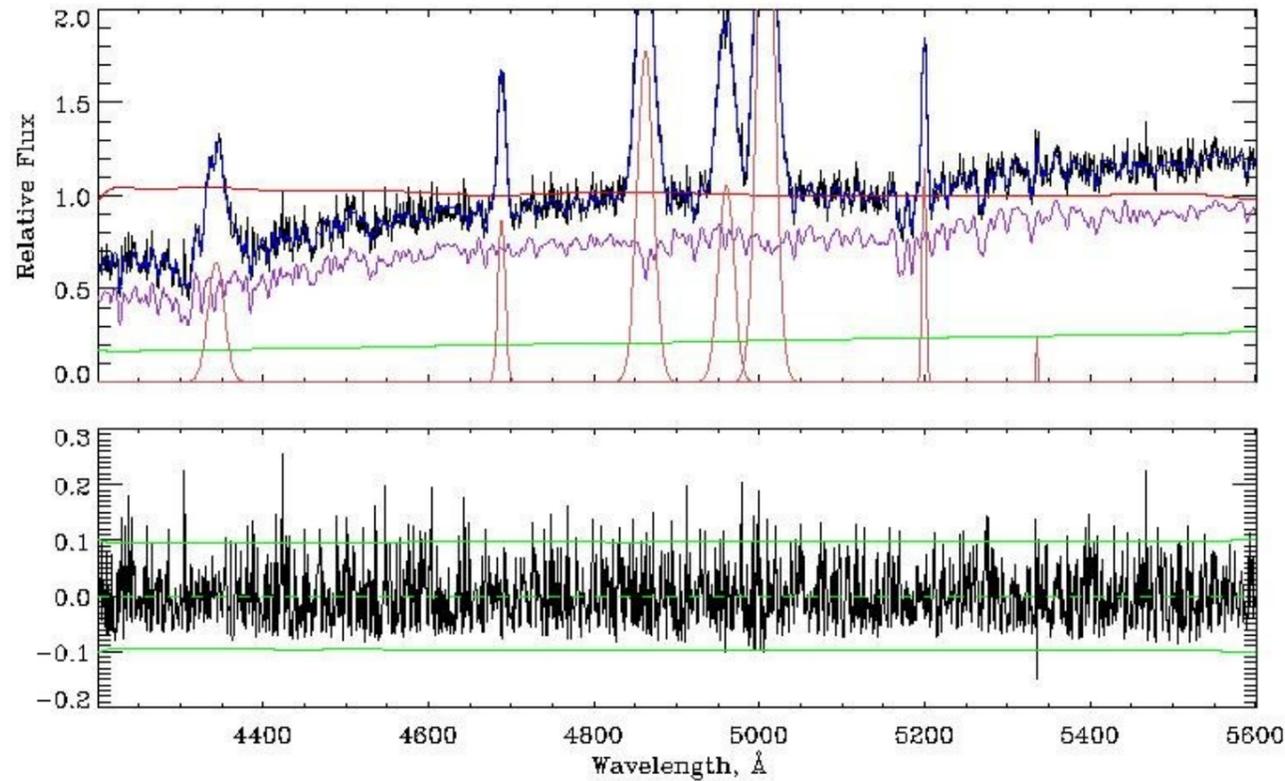
Affection of the age and metallicity by the signal to noise level and by the AGN contribution to the spectrum. Green line show the expected value of the age. Legend: plus represent the SNR=5, cross-SNR=10, star-SNR=15, square-SNR=20, filled square-SNR=25, circle-SNR=30, filled circle-SNR=35, triangle-SNR=40, filled triangle-SNR=45 and unversed triangle-SNR=50.

Grid of 7200 composed AGN spectra:

• AGN power-law continuum (we used spectral index α=-1.5,-0.5,0.5,1.5,2.5) in various fractions (0.1-0.9% of the total spectrum)

• single stellar population spectrum produced by PEGASE-HR code with age of 4000 Myr and metallicity of -0.4 dex

• We create [OIII] 4959 emission line with five different intensities and widths and corresponding [OIII] 5007 line, Hβ and Hγ, where we linked the intensities of [OIII] lines, as well as widths and shifts of all lines in the spectrum

• We vary the signal-to-noise (SNR) ratio between 5 and 50, with the step of 5.

FIT OF SDSS SPECTRA AND COMPARISON WITH STARLIGHT RESULTS

Since STARLIGHT is providing their results only for SDSS objects, we present here the sample of 5 low-luminous active galactic nuclei, with S/N higher then 12. This SNR value is determined by STARLIGHT around the $\lambda = 4020$ Å. The analysed wavelength range was [3900, 6800] Å, which includes the strongest Balmer emission lines.

Fig. 4. show the example of the fit, while Table 3. lists the main results of our fit and results obtained by STARLIGHT.
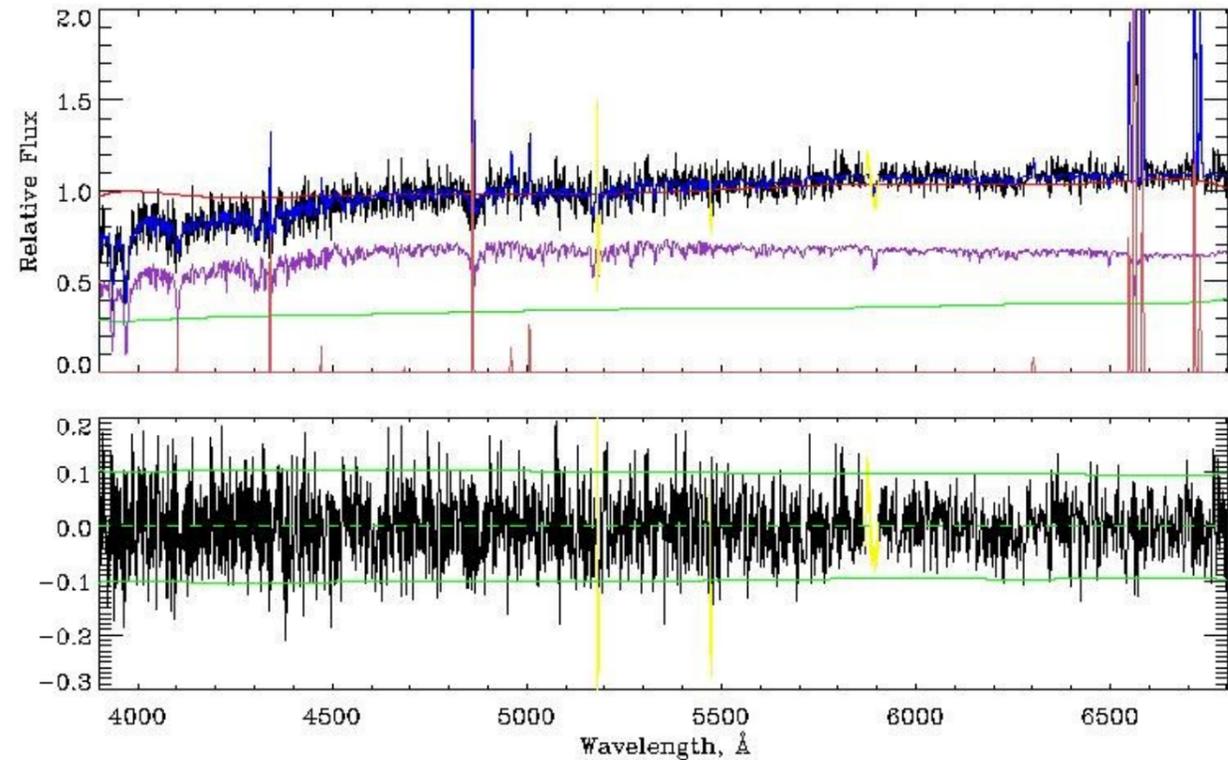
The fit of SDSS J114730.11+042409.2. 1.

GALAXY	v(km/s)	σ(km/s)	Age (Myr)	z (dex)
SDSS J164543.31+642024.3	-12.01 ± 8.17	58.73 ± 9.18	198 ± 86	0.16 ± 0.22
	-42.8	66.9	364	-0.26
SDSS J114730.11+042409.2	-22.32 ± 4.97	66.13 ± 6.2	1167 ± 173	-0.67 ± 0.15
	3	58.1	629	-0.147 Worthey 1999
SDSS J114730.11+042409.2	0.7 ± 8.8	57.13 ± 8.5	198 ± 75	0.02 ± 0.21
	-36.8	66.8	110	-0.06
SDSS J083431.87+425457.7	-6.1 ± 6.3	43.99 ± 7.4	545 ± 111	0.007 ± 0.22
	-17.3	78.1	167	-0.123
SDSS J115003.44+534456.7	-7.3 ± 8.2	54.27 ± 10.94	434 ± 271	-0.25 ± 0.67
	-22.3	36.9	131	-0.44

Fit results of sample of SDSS galaxies. Upper value for each parameter represents our result, while the value bellow represent the result of STARLIGHT.

THANK YOU FOR YOUR ATTENTION!