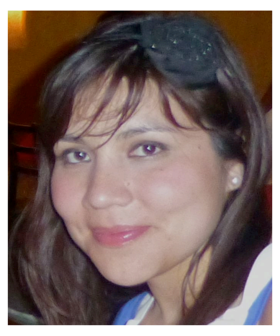
Integral Field Spectroscopy SINFONI observation of AGN at z~1.5



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Abstract

The aim of the study is to obtain properties of distant low luminosity active galactic nuclei (AGN). In terms of galaxy evolution, nuclear activity seems to play an important role. AGN feedback processes may have impacts on the evolution of galaxies, as these processes are thought to affect the efficiency of star formation [3]. Therefore it becomes interesting to study the AGN host galaxy. SINFONI is an adaptive optics assisted near infrared integral field spectrometer mounted to the ESO VLT. The integral field spectroscopy allows us to explore spatially extended sources, to resolve properties of high redshift galaxies. We present the observation of two low luminosity AGNs from which we want to disentangle the properties of it's host galaxy. The selected galaxies to be studied J0959+0243 @z=1.31 and J022529-044044 @z=1.55 were observed with SINFONI from VLT in the H band during a total of 6 hours each. We present here our ongoing work. We obtain the reduced data-cube corresponding to the observation with J0959+0243 and J022529-044044 IR spectrum. The broad Hα emission line is clearly observed in both cases, with some important differences. Improving reduction steps and the deconvolution in the AGN and host galaxy components is the next step in this study.

Galaxies and their SMBH

Observations of the Hubble Space Telescope showed that most of galaxies harbour a supermassive black hole SMBH in it's center. There is a correlation between the mass of the SMBH and the luminosity of it's galactic bulge.

There is general agreement on the hierarchical model of evolution but observation showed something different. Observations shows an anti-hierarchical formation process.

Two models to find the key: co-evolution and paralel formation. The paralel formation model implie that galaxies evolve independently, as a result of an statistical process. Co-evolution model implie that galaxies interaction with their SMBH affects efficience of star formation process.

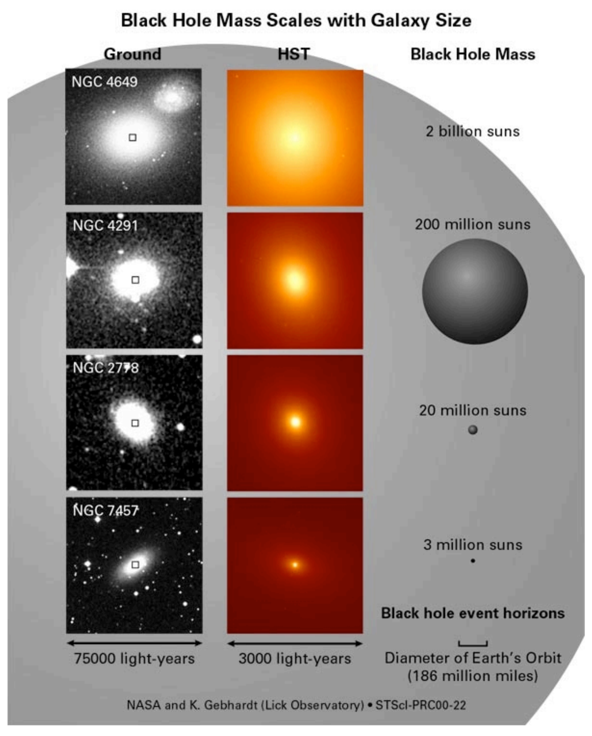


Figure3:

Integral Field Spectroscopy [1]

The integral field spectroscopy (IFS) objective is to gather spectra from sky in a two dimensional field of view. The final product is a data-cube with axis x and y (spatial coordinates) and wavelength. The integral field spectrograph has two component: the spectrograph and the integral field unit (IFU). SINFONI is a near infrared (1.1-2.45 μm) integral field spectrograph fed by an adaptive optic module. It uses image slicer: the image is formed on a mirror that is segmented on 32 thin horizontal sections. A second segmented mirror is arranged to reformat the slices and redirect the light to the spectrograph. The advantage of using IFU is the better use of incident light when the object is extended, exploring spatially extended sources in a spatially extended way.

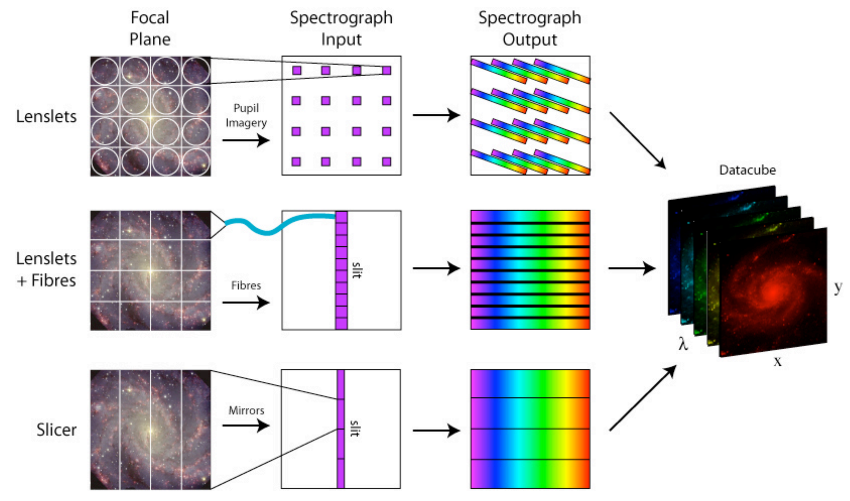


Figure2: Sketch representing the 3 types of IFS instrument. Image credit: M. Westmoquette, adapted from Allington-Smith et al. 1998

Target Selection

We select a sample of z~1.1-1.8 AGNs from to spectroscopic survey: the Sloan Digital Sky Survey (SDSS) and the VIMOS VLT Deep Survey applying the following criterium:

1.- the object had to be observed with HST/NICMOS

2.- it was possible to derivate the BH mass estimate based on the MgII broad emission line,

3.- the redshifted wavelength of Hα is away from the OH sky emission line, 4.- the expected Hα luminosity, estimated from the OII flux, is sufficient to probe the galaxy kinematics,

5.- a star bright enough for the adaptive optic tip-tilt correction is available within 40 arcsec of the target galaxy.

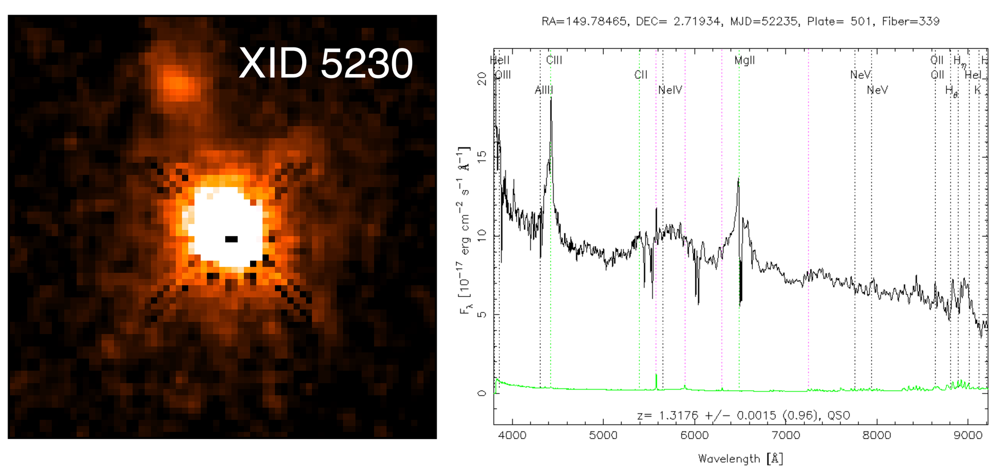
Data reduction and data analysis

The data reduction was performed with the ESO-SINFONI pipeline. In complement, we wrote some specific Python routines to improve some reduction steps. In particular we generate a mask to identify wavelengths intervals affected by sky line residuals.

After calibration procedure, we perform the broad line fitting and deconvolution process (J0959+024325.1). First a 15 pixels region was integrated. The broad line was fitted into a gaussian ignoring the central part of the broad line. Considering as constant the AGN emission, a normalization factor was applied to the fitting in order to use it in each spaxel. Subtracting the normalized fitting to the spectrum we get a residual. This residual would represent the host galaxy.

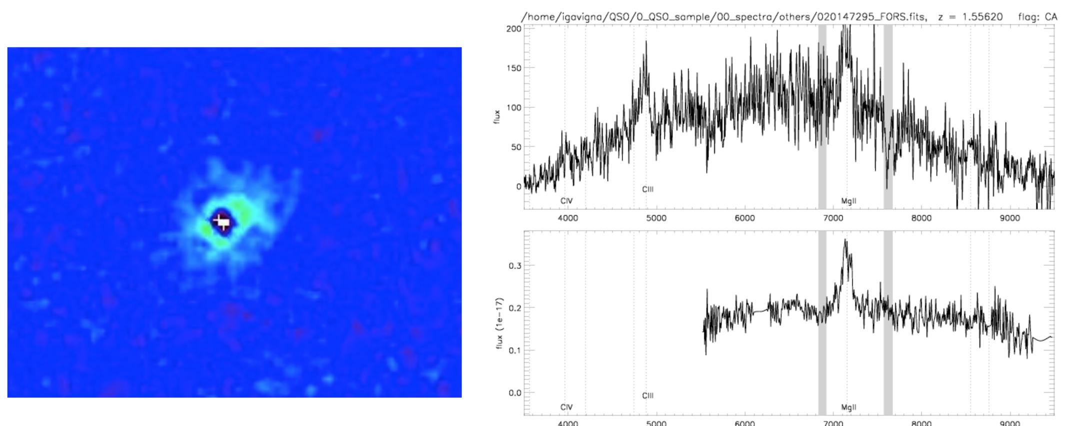
Our targets

- J0959+024325.1



Eddington rate	0.63
M_{BH} (MgII)	$1.7\times10^{8} M_{sol}$
I_{AB}	18.43 (I band from SDSS)

- J022529-044044



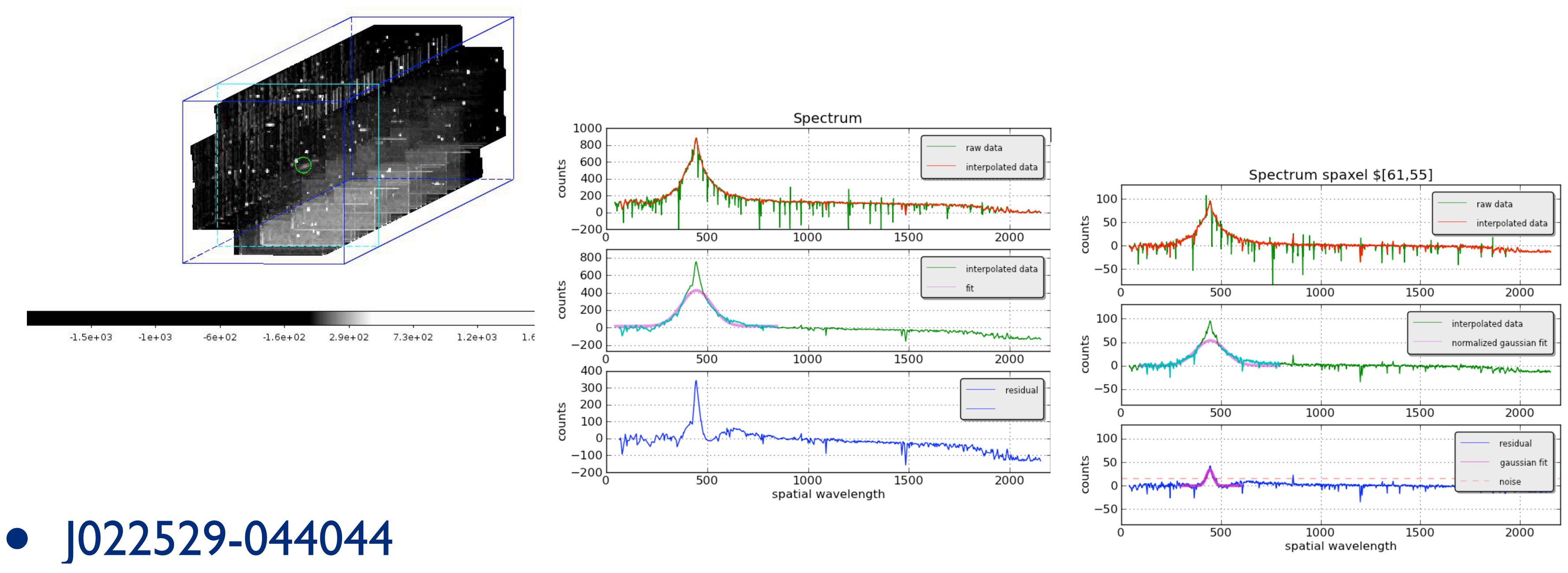
Eddington rate	0.06
M_{BH} (MgII)	$1.9\times10^{8} M_{sol}$
I_{AB}	22.6

Figure4-7: HST/NICMOS image and calibrated spectrum of our targets.

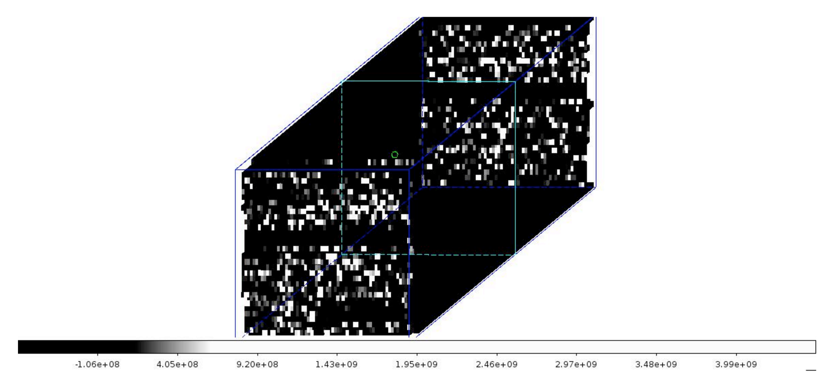
We target two AGN of similar mass and redshift but with very different Eddington ratios.

Reduced data

- J0959+024325.1



- J022529-044044



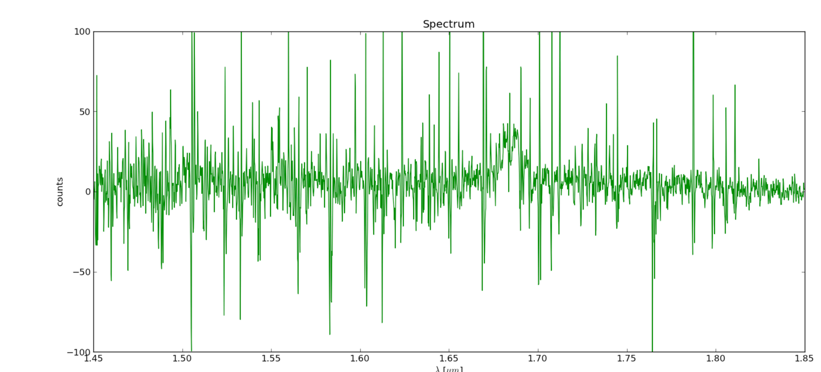


Figure9-10 (up-down right): Final data cube obtained after combining 15 and 11 exposures of 300 seconds respectively . Note that the remaining bright spots are skyline residuals. Our targets are figured with a green circle.

Figure11-13 (up-down left): IR spectrum of J0959+0243 and J022529-044044. For J0959+0243 we present the integrated spectrum and the spectrum of one spaxel.

Future Work

Improving reduction steps for both objects J0959+0243 and J022529-044044 is the next step in this study. Also the deconvolution in the AGN and host galaxy components. Different methods of deconvolution will be applied. We aim then at deriving the physical and dynamical properties of J0959+0243 and J022529-044044 host galaxy.

Bibliography

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[2] Peterson, B.M., 1997, An Introduction to active galactic nuclei (Cambridge U. Press),
[3] AGN Feedback in Galaxy Formation, Edited by Antonuccio-Delogu, V., Silk, J., 2011,
[4] Eisenhauer, F. et al. 2003, SPIE 4841, 1548,
[5] http://astronomyonline.org/Cosmology/Galaxies.asp