

# The Procedure of AGN Spectra Elaboration by Using IRAF: The case of H $\alpha$ of III Zw2

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## 1. Introduction

The study of the shape and behavior of the Active Galactic Nuclei (AGNs) broad lines brings information about structure and dynamics of the emitting gas (see e.g. Osterbrock 1990). Concerning that these objects are very faint their CCD images have been obtained by using long exposition regime. That is reason that these images are very noisy and full of cosmic rays.

In order to obtain the true shape of the AGNs emission lines the CCD spectral line images should be processed by special programs. One of the procedures that could be used for extracting spectra is Image Reduction and Analysis Facility (IRAF). Here we present our experience with using the IRAF for calibrating spectra of III Zw2. The H $\alpha$  and H $\beta$  lines, have been observed at Isaac Newton Telescope (INT) at Instituto de Astrofisica de Canarias (IAC).

## 2. III Zw2

III Zw2 is an object classified as Syfert 1 galaxy or as a quasar, with variable central source in all wavelength, from radio to X-rays; variations of factor 2 in a few months occurs. The central part of the nucleus contain a black hole with mass of  $5 \cdot 10^7 M_{\odot}$ . The central engine is powered by accretion flow of 2 solar mass per year. Total accretion disk mass is of the same order as the mass of the central black hole (Kaastra, de Korte 1987).

### 3. Method of elaboration

The IRAF has been developed by the National Optical Astronomical Observatory (NOAO) Kit Peak, and has been adopted by the Space Telescope Science Institute in Baltimore as a principal data analysis environment for Hubble Space Telescope (HST) data. The IRAF contains general image processing and graphic applications, plus programs for reduction and analyses of optical astronomical data. It is developed, and runs under UNIX operating system, and similar operating systems (VMS, LINUX, SOLARIS, etc.).

Also, for calibrating spectra under IRAF, we needed several small packages DATAIO, NOAO, IMRED, CCDRED, TWODSPEC, LONGSLIT, BIAS ...

Procedure of spectra elaboration start with import procedure. The spectra should be imported in a format which is compatible with the IRAF image standard. One of the standards for CCD image data is FITS. The observed spectra of III Zw2 H $\alpha$  and H $\beta$  have been given in FITS format, and have been imported by using DATAIO package. There were two spectra of III Zw2, and several types of calibrating spectra. It is very important to remove the "additive" effects: electronic pedestal level (measured from the over scan region on each of CCD image frame), pre-flash level or underlying bias structure, and dark current. The flat-field data (dome or projector flats and twilight sky exposures) will remove the multiplicative gain and illumination variation across the CCD chip. Also it is important to remove all bad pixels and cosmic ray additive effects (Massey et al. 1992). With those procedures we have calibrated CCD images, and this procedure is standard for all CCD images in general. In Fig. 1. we present a set of CCD images for calibration of CCD spectra.

After removing additive effects and normalizing CCD image, we proceed with finding the spectrum on CCD image by dividing it on several pixel rows, where the location of the spectrum position is being done. Next we define the extraction window, and we trace the center of spatial profile as a function of the dispersion axis. Last step is summing the spectrum within the extraction window. This part of extraction of the spectra gives, as a result, one-dimensional spectra. For these steps we used packet APALL. The same procedure, with the same parameters should be done on a lamp comparison spectrum, so the wavelength calibration could be done. The last step is flux calibration.

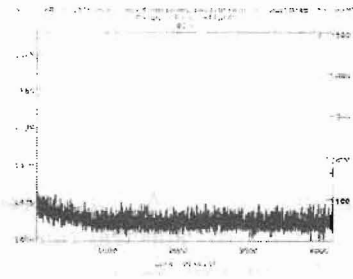


Fig.1a) The bias.

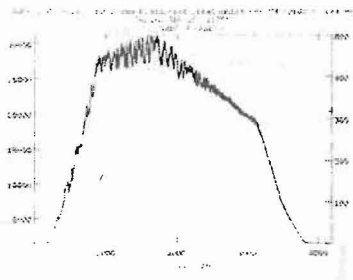


Fig. 1b) The flat field.

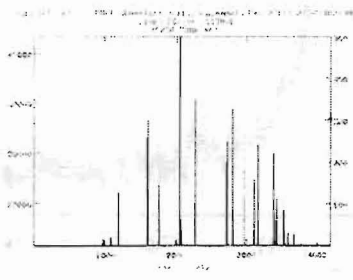


Fig. 1c) The spectrum of CuNe comparison lamp

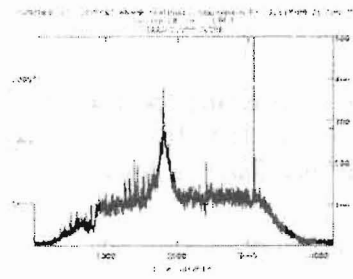


Fig. 1d) One of the spectra of the object III Zw 2

Figure 1. Representation of CCD images

Using the IRAF we have elaborated the III Zw2 spectra observed of IAC. The observations were performed in two spectral range  $\lambda = 6500$  to  $\lambda = 7600$  ( $H\alpha$  spectral range) and  $\lambda = 5000$  to  $\lambda = 6100$  ( $H\beta$  spectral range). In the Fig. 2. one can see an example of calibrated spectrum.

As we can see from Fig. 2. the shape of III Zw2 is very complex. After, here described procedure of elaboration, next step is analysis of the shape of the lines. Detailed discussion of the shape of III Zw2  $H\alpha$  and  $H\beta$  lines will be published elsewhere (Popović et al. 1999)

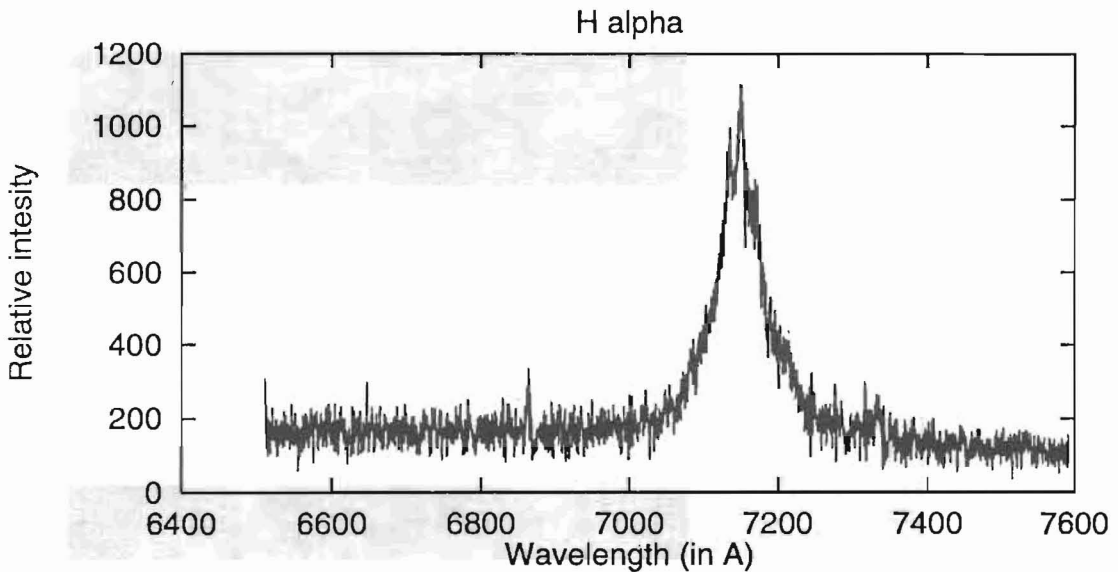


Fig. 2. The profile of  $H\alpha$  of III Zw2  $H\alpha$  line.

## References

- Massey P., Valdes F., Barnes J. : 1992, *A User's Guide to Reducing Spectra with IRAF*.  
 Kaastra J. S. and de Korte P. A. J. : 1987, *Astron. Astrophys.* **198**, 16.  
 Osterbrock D. E. : 1976, *Astrophysics of Gaseous Nebulae and Galactic Nuclei*, University Science Books, California.  
 L. Č. Popović, A. Kubičela, N. Stanić and E. Bon, (in preparation).