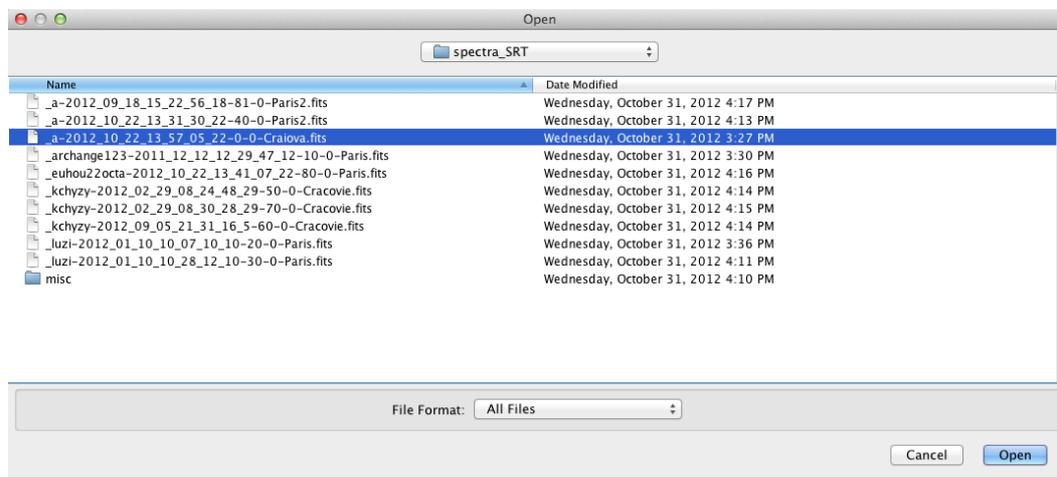
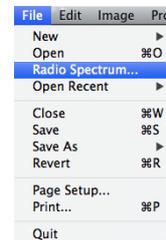


# Exploration of the Hydrogen gas detected in the Milky Way with the EU-HOUMW SRT

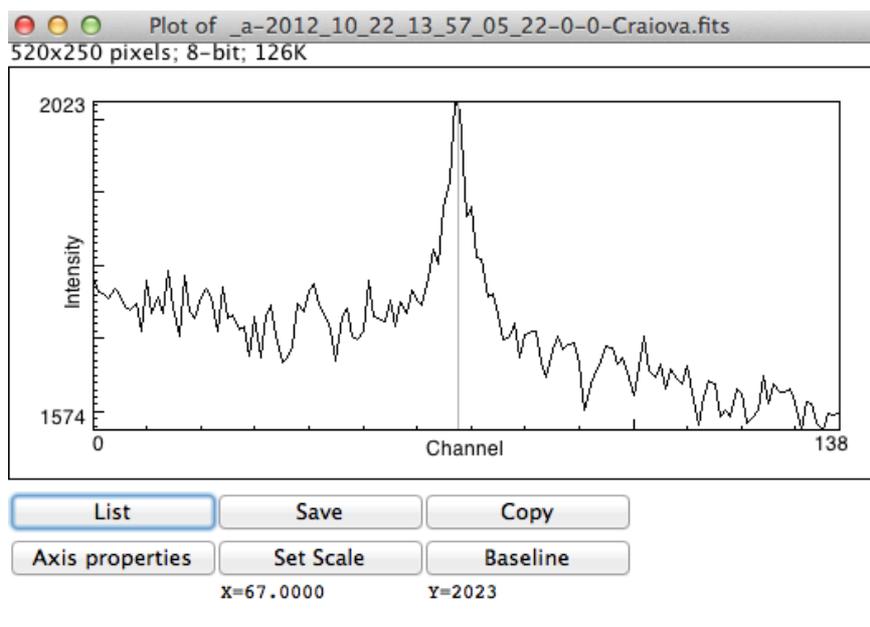
## A SalsaJ tutorial

A few preliminary spectra are stored in **spectra\_SRT** taken every 10 degrees in the Galactic plane. Let consider the spectra taken for the Galactic coordinates  $l=0, b=0$ .

Open **SalsaJ**, and go in **File/Radio Spectrum...** Select the spectra named **\_a-2012\_10\_22\_13\_57\_05\_22-0-0-Craiova.fits**. It has been taken by the user "a" on the 22<sup>nd</sup> October 2012 at 12h57m05s (UTC) for  $l=0, b=0$  in Craiova.

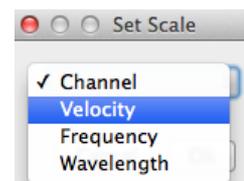


A spectra window appears displaying the abscissa in Channels, the instrument unit. One channel corresponds to the resolution of the instrument (here in frequencies).



In this spectrum the size of one channel is 7kHz.

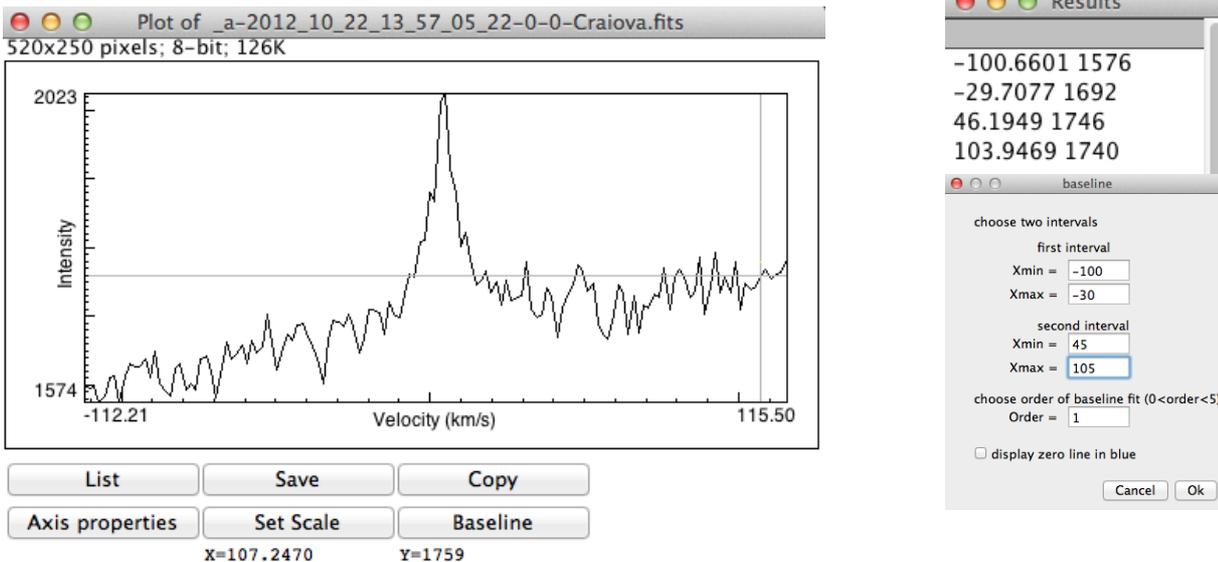
Scrolling the cursor on the graph enables to displays **X,Y** of each point of the spectra. Clicking with the cursor enables to write the values in the **Results window**.



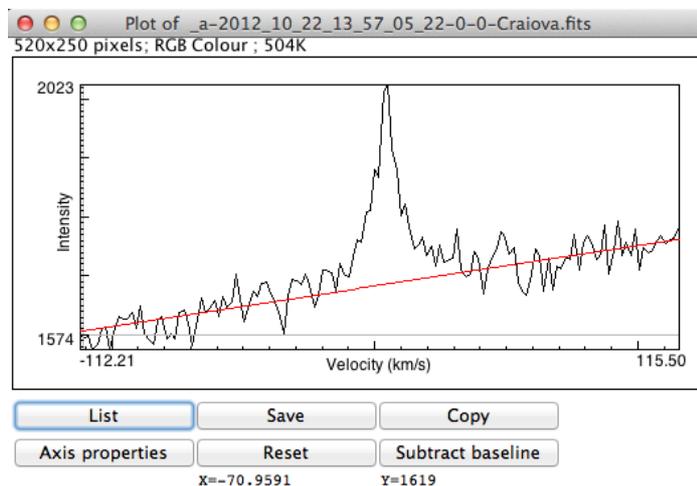
It is more practical to work in physical units, which is possible with the button **Set Scale**. We can switch from frequencies (or wavelengths) into velocities with the formula:

$$V_{radio} = c \frac{f_0 - f}{f_0}, \text{ where } f_0 = 1421\text{MHz.}$$

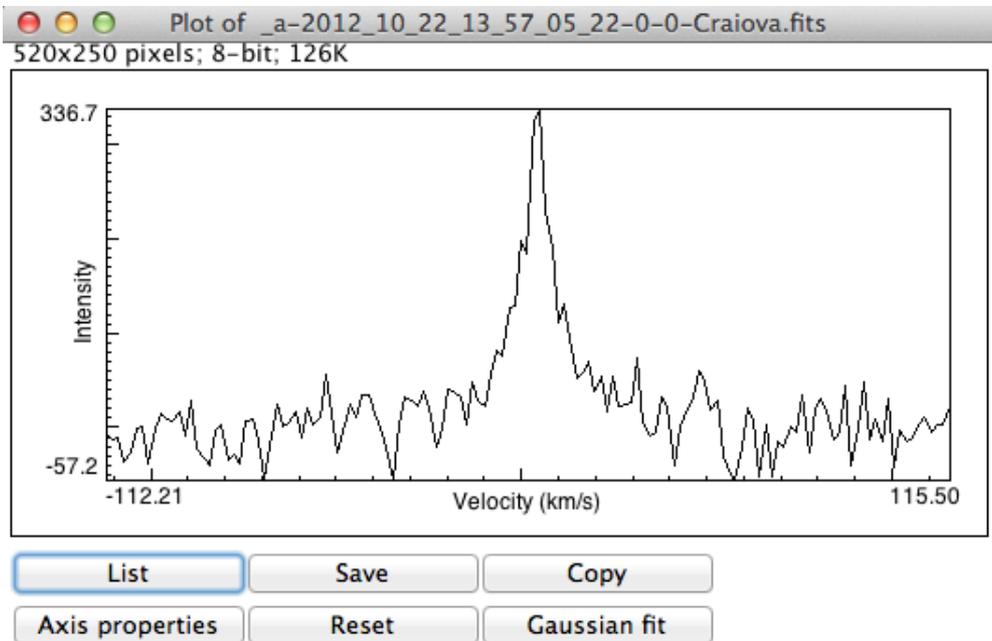
The spectrum is thus inverted is displayed in velocities. We thus directly measure the velocity of the hydrogen clouds detected. There is a peak and some background, which corresponds to the continuum including mainly the sky background. It is customary to remove this continuum with the fit of a baseline. We need to define 2 widows on both side of the signal in order to adjust a polynomial. Hence, you need to click four times: and your values are printed in the **Results window**.



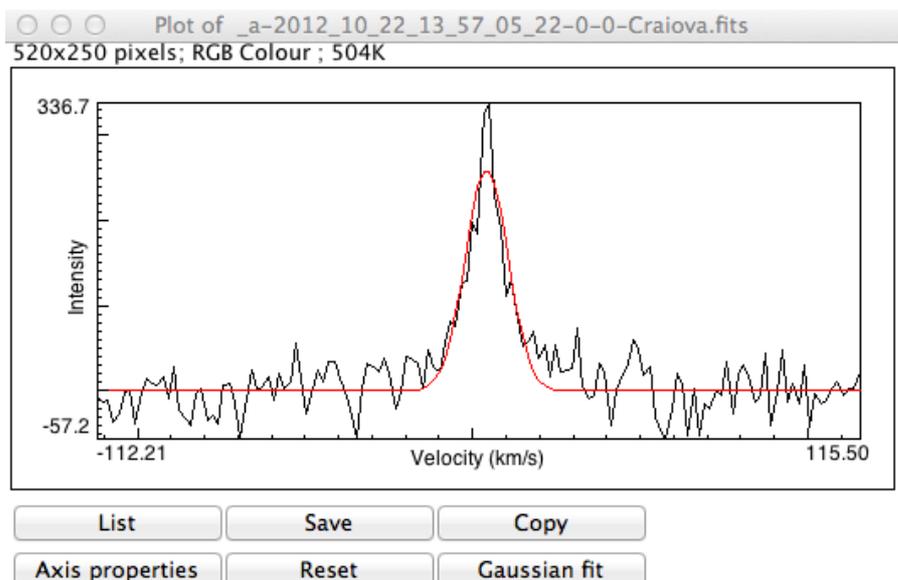
Click on **Baseline** and enter the 4 abscissa values you just measured. An adjusted polynomial is then superimposed in red on the spectrum. You can then click on **Subtract baseline** to subtract it.



The background level is then set at 0 and we can study the line. It is interesting to note that the intensity of the HI line corresponds to about 20% of the value of the continuum. At this stage it is possible to use the cursor to measure the position of the peak. It is possible to improve a bit the accuracy of the measure by zooming on the peak with **Axis properties**.



We will now go a bit further. We will adjust a Gaussian profile on this peak and extract more information from this data, following the research methods used on this type of data. For this, we need to define in which window the fit will be performed, and first guesses of the values of the maximum, the width of the line and the central values. It is best to click first on the key positions in order to store the values in the **Results window**. Click then on **Gaussian fit**, and fill the window as displayed here. A Gaussian function is then superimposed on the spectra. The parameter of this Gaussian function can be retrieved from the **Gaussian fit results** window.



Gaussian fit results							
measurements	File	l	b	Velocity (km/s)	Intensity	Width	Area
2	_a-2012_10_22_13_57_05_22-0-0-Craiova.fits	0.00	0.00	4.21	259.79	14.96	4138.04

While the adjustment is quite good, we can note that the signal is probably not exactly Gaussian (discrepancy near the peak), but it is a good approximation and a good way to measure the integral or the area of the line. It also provides a value of the central velocity, which takes into account the whole line.

The area value (in K km/s) is usually used to derive the so-called column density of Hydrogen present along the line of sight observed.

**We have to stress at this stage that in the current stage of EU-HOUMW archived are calibrated on the sky with a diode. It is relatively crude, and researchers usually use a standard quasar or radio-source (with a known intensity). In the following, we will process to get the order of magnitude of the column density of hydrogen, having in mind that our measurement will be affected by an uncertainty due to the calibration.**

Having said that, we can proceed to measure the column density of hydrogen (usually written  $N_H$ ) towards the Galactic centre. We can find in textbook that:

$N_H$  (in atoms/cm<sup>2</sup>) =  $1,823 \times 10^{18} A$ , where  $A$  is the area of the line measured above. We thus find  $N_H = 7,5 \cdot 10^{21}$  atoms/cm<sup>2</sup>, which is a typical value.

It is possible to compare this value with other data (LAB) or values from the literature. Knowing the distance of the Galactic centre (8,5kpc), the beam of the SRT (5degrees), the mass of the Hydrogen atom (proton mass:  $1.67 \times 10^{-27}$  kg), you can derive the mass of gas corresponding at this column density. You thus assume that all the gas is at the centre (part of it could be along the line of sight).

To go further, you can explore the other spectra stored in the spectra\_SRT directory or directly the EU-HOUMW SRT archive [euhou.obspm.fr/public/archive.php](http://euhou.obspm.fr/public/archive.php).