HI line observations using 3-m SRT

1 Introduction

In this section the operation of the 3-m telescope and receiver is described. The initialization procedure for the HI line experiment id given below.

1.1 Initialization of the Telescope

1. Make the connections as instructed and switch ON the power supply. Click on the SRT software icon, The telescope will start moving automatically untill it attains a home position called as 'Stow' position.

2. Familiarize yourself with the concerned option on the command toolbar e.g. Stow, Azel, Offset, freq. and record.

3. Once the Stow is complete, select `Freq` and type in the command line `1420.0 4`. This setting allows you to select the 1420 MHz freq. with total band width of 1.2MHz across 156 channels.

1.2 Experimental Procedure

The experiment involves observations of a few selected points along the Galactic plane with 0 degree Galactic latitude. The list of the points to be observed is given in Table 1. The source position is given in the Equatorial Coordinates (RA,DEC) in 1950 epoch. These coordinated are feed to the software and the objects are visible on the map visible on the software screen.

1. Stow position is (Az=0 Al=10). Click on `AZel` and type `0 30` (This is usually a direction of cold sky).

2. Press `Cal` to calibrate the telescope. Note down the value of T_{sys} shown in the right side table.

3. Click on one of the HI sources visible on the map.

4. Set the antenna offsets as calculated from the Experiment 1. Press `offset` button followed by typing `azoffset eloffset`

5. Click on the source on the sky map. The antenna will start slewing to the source

6. After antenna is pointing to the source, check the spectrum in the spectrum window which should show a strong HI line.

7. If the line is not visible, check if you have followed the procedure correctly, entered the offsets and receiver mode (LO and bandwidth) correctly.

8. If the line is visible, start recording data. Press `record` and type the file in the format below
$wsr\_spec\_sourcename\_batch1\_yymmdd\_hhmmss$. Press `record` again to start recording data.

9. Record data for about a minute and then to stop recording the data. Press `record` again.

10. Repeat the procedure for each of the source in Table 1 recording the data in a separate file.

Source Name	RA	Dec
P01	17h42m26s	-28d55’00
P02	18h43m28s	-02d39’46
P03	19h11m20s	10d38’13
P04	19h41m47s	23d46’10
P05	20h19m02s	36d26’45
P06	21h10m18s	48d07’24
P07	22h28m06s	57d36’13
P08	00h23m01s	62d26’55
P09	02h28m10s	60d16’29
P10	04h00m39s	52d17’01
P11	05h00m42s	41d16’57
P12	05h42m26s	28d55’00
P13	06h14m58s	15d55’24
P14	06h43m28s	02d39’47
P15	07h41m47s	-23d46’10
P16	09h10m18s	-48d07’24
P17	12h23m01s	-62d26’55
P18	16h00m39s	-52d17’00

Table 1: Source coordinates along the Galactic plane in 1950 Epoch

2 Observation Log

1. Source & Data file name :
2. Source & Data file name :
3. Source & Data file name :
4. Source & Data file name :
5. Source & Data file name :
6. Source & Data file name :
7. Source & Data file name :
8. Source & Data file name :
9. Source & Data file name :
10. Source & Data file name :
11. Source & Data file name :
12. Source & Data file name :
13. Source & Data file name :
14. Source & Data file name :
15. Source & Data file name :
16. Source & Data file name :
17. Source & Data file name :
18. Source & Data file name :

3 Analysis Procedure and Log

3.1 Procedure

1. Open the data file in EXCEL spreadsheet format in the laptop.

2. The typical data file has the following format - time, Az, Alt, azimuth offset, altitude offset, RF, freq resolution, receiver mode, number of channels, powers in ch1, ch2, ..., ch N.

3. To get accumalated spectrum, add the powers in all time samples for each channel and store it in the last row of the spreadsheet

4. Export the powers in each channel in the last row to ASCII file using excel export option to write to an ASCII file with similar name but .asc extension.

5. Repeat this for all data files.

6. Copy exported data files to a PEN drive and transfer to MATLAB PC (located in Room No 8 on the first floor) for analysis.

7. Copy data files to MATLAB local working directory and rename to shorter names such as “scan1.data” and so on.

8. load data in MATLAB using “load scan1.dat”

9. Generate X axis using “x=zeros(1,n)” where n is the number of data-point (usually n= 156). “vel=zeros(1,n)” and Y axis by “y=zeros(1,n)”

10. Load Xaxis by (for azimuth) “for i=1:n x(i) = 1420.4 + i*0.0078125”;

11. Load Velocity axis similarly by converting the shift to relative velocity. Also, find out the corrections required for velocity relative to LSR and due to earth spin and revolution around sun and correct the velocity axes for these systematics.

12. Load yaxis by “for i=1:n y(i) = scan1(1,i);end”

13. plot data using “plot(vel,y)” and “plot(x,y)”

14. Copy these data points to two arrays datax, velo and datay

15. Type "cftool" to go to curve fitting tool box
16. select vel and datay as X and Y arrays in DATA tab
17. First select the datapoints away from the line
18. Select "New fit" and "Polynomial" in fit tab and try fits. This will provide a baseline to be subtracted from the data. Depending on the data, a higher order polynomial or a piecewise fit may be required to properly remove the baseline.
19. Use the above fitted model to subtract baseline from datay datapoints.
20. Select "New fit" and "Gaussian fit" in fit tab. Use datapoints near the line. This will fit a Gaussian and display its parameters and errors
21. Subtract the fitted curve from the data and examine the residual curve. If any significant features are noticeable, these need to be removed by fitting additional Gaussian. Depending on the source, you may need a sum of 1 to 4 Gaussians as model.
22. Repeat the fit till residual curve looks like a Gaussian random variable.
23. The parameters of the fitted Gaussian provide the measurable - line position, width and amplitude and number of lines for altitude position in case of Azimuth.
24. Attach fitted plots and write the following log

3.2 Log

1. Source :
   (a) Baseline fit parameters :
   (b) No of Gaussians required :
   (c) Position of Gaussians : km/s $\pm$
   (d) FWHM of Gaussians : km/s $\pm$
   (e) Peak of Gaussians : km/s $\pm$
   (f) Residual Chisq :

2. Source :
    (a) Baseline fit parameters :
    (b) No of Gaussians required :
    (c) Position of Gaussians : km/s ±
    (d) FWHM of Gaussians : km/s ±
    (e) Peak of Gaussians : km/s ±
    (f) Residual Chisq :
3. Source :
    (a) Baseline fit parameters :
    (b) No of Gaussians required :
    (c) Position of Gaussians : km/s ±
    (d) FWHM of Gaussians : km/s ±
    (e) Peak of Gaussians : km/s ±
    (f) Residual Chisq :
4. Source :
    (a) Baseline fit parameters :
    (b) No of Gaussians required :
    (c) Position of Gaussians : km/s ±
    (d) FWHM of Gaussians : km/s ±
    (e) Peak of Gaussians : km/s ±
    (f) Residual Chisq :
5. Source :
    (a) Baseline fit parameters :
    (b) No of Gaussians required :
    (c) Position of Gaussians : km/s ±
    (d) FWHM of Gaussians : km/s ±
    (e) Peak of Gaussians : km/s ±

(f) Residual Chisq :

6. Source :

    (a) Baseline fit parameters :
    (b) No of Gaussians required :
    (c) Position of Gaussians : km/s ±
    (d) FWHM of Gaussians : km/s ±
    (e) Peak of Gaussians : km/s ±
    (f) Residual Chisq :

7. Source :

    (a) Baseline fit parameters :
    (b) No of Gaussians required :
    (c) Position of Gaussians : km/s ±
    (d) FWHM of Gaussians : km/s ±
    (e) Peak of Gaussians : km/s ±
    (f) Residual Chisq :

8. Source :

    (a) Baseline fit parameters :
    (b) No of Gaussians required :
    (c) Position of Gaussians : km/s ±
    (d) FWHM of Gaussians : km/s ±
    (e) Peak of Gaussians : km/s ±
    (f) Residual Chisq :

9. Source :

    (a) Baseline fit parameters :
    (b) No of Gaussians required :
    (c) Position of Gaussians : km/s ±

(d) FWHM of Gaussians : km/s $\pm$

(e) Peak of Gaussians : km/s $\pm$

(f) Residual Chisq :

10. Source :

    (a) Baseline fit parameters :

    (b) No of Gaussians required :

    (c) Position of Gaussians : km/s $\pm$

    (d) FWHM of Gaussians : km/s $\pm$

    (e) Peak of Gaussians : km/s $\pm$

    (f) Residual Chisq :

4 Results and Discussion

Calculate the doppler velocity from the spectrum of the sources observed. Discuss the nature of the spectrum and its features. Comment on the velocity calculated and the location of these sources on the galactic plane. Discuss the factors responsible for the doppler shift of your spectrum. Give the sources of error and explain the results.