



Background Radio emissions observation at 1.42 GHz

Kamal M. Abood, Anmar M. Kitas*

Department of Astronomy and Space, Collage of Science, University of Baghdad, Baghdad, Iraq.

Abstract

In this work, a Radio Emission Background at 1.42 GHz; 21 cm Hydrogen line is carried out by using a 3-meter radio telescope, these telescope is placed on the roof of the building the Astronomy and Space Department at the college of Science, University of Baghdad. Background spectrometry files were received and arranged with a schedule of minimum observation time with span in (GHz). In this work, an observation program was set up to identify some variables related to the telescope and its study, including span, sweep time and central frequency using (MATLAB 2013 software) by reading four files which were selected from the dataset and in different observation times and different span.

Key words: Radio Astronomy, Background radio emissions, 21cm Hydrogen line.

"رصد الانبعاثات الراديوية الخلفية عند تردد 1.42 GHz"

كمال محمد عبود، انمار مرتضى قيطاس*

قسم الفلك والفضاء، كلية العلوم، جامعة بغداد، بغداد، العراق.

الخلاصة

في هذا العمل تم أستلام ملفات خلفية الانبعاثات الراديوية لخط الهيدروجين بطول موجي 21cm بتردد 1.42GHz المستلمة بواسطة تلسكوب راديوي بقطر 3m موضوع على سطح قسم الفلك والفضاء بكلية العلوم جامعة بغداد، تم استلام ملفات خلفية المطياف وترتيبها بجدول الحد الأدنى لزمن الرصد مع الامتداد بوحدة (GHz)، وذلك بتهيئة برنامج للرصد لمعرفة بعض المتغيرات التي تخص التلسكوب ودراستها منها الامتداد للتردد والزمن الممتد والتردد المركزي بأستخدام (برامجيات ماتلاب software2013) وذلك بقراءة أربع فايلات تم أختيارها من تلك الفايلات المستلمة وفيها ازمنة رصد مختلفة وامتداد ترددي مختلف.

1. Introduction

In this study, the frequency in which observations are made is 1.42 GHz, which is probably the most important frequency in radio astronomy. One of the reasons is that the emissions of the radio sky that are observed by radio astronomers are not the light from the stars, but radio waves from the gas and dust clouds that are remnants of supernova or star explosions. The 21cm hydrogen line has been used to chart the structure of our galaxy, known as the Milky Way. The 21cm hydrogen line is in fact one of the most precisely measured physical properties.

Hydrogen is most abundant element in the Universe; About 70 percent of luminous mass is composed of hydrogen. Rest is made up of Helium and other trace elements. One of the most significant spectral lines in radio astronomy is 21 cm hydrogen line. In interstellar space, gas is extremely cold. Therefore, hydrogen atoms in interstellar medium are at such low temperatures (100K) that they are in ground electronic state. This means that the electron is as close to the nucleus

*Email: ahmed33892010@gmail.com

as it can get, and it has the lowest allowed energy. Radio spectral lines arise from changes between one energy level to another [1].

In the fields of communication, signal processing, and in electrical engineering more generally, a signal is any time- varying or spatial- varying quantity. This variable (quantity) changes in time: Speech or audio signal (A sound amplitude that varies in time), Temperature reading at different hours of a day, and Stock price changes over days. Signals can be classified by continuous-time signal and discrete-time signal; a discrete signal or discrete-time signal is a time series, perhaps a signal that has been sampled from a continuous-time signal, a digital signal is a discrete- time signal that takes on only a discrete set of values [2].

2. Spectrometry Theory

The first person to predict this 21-cm line for neutral hydrogen was H.C. van de Hulst in 1944. However, it was not until 1951 that a Harvard team created the necessary equipment and the first detection of this spectral line was made in the hydrogen clouds of our galaxy.

In the Spectrometry, we are able to check all parameters that are explained in the following statements and then test spectrometer for short observation. The spectrum data appears on the Trace Waveform graph and can be saved in the file as well. The main parameters such as resolution bandwidth RBW, video bandwidth VBW, the frequency parameters of the analyzer can be defined from both pages-Spectrometry and Tracking Spectrometry. The analyzer sweeps within a specified frequency range in normal or accuracy precision by "Sweep" selection. "Centre Frequency" can be expressed the frequency range of a channel which is a combination of "Centre Frequency" and "Span" [3, 4]. Figure-1 shown the Spectrometry and listed parameters such that: center frequency, sweep time, span, RBW, VBW respectively

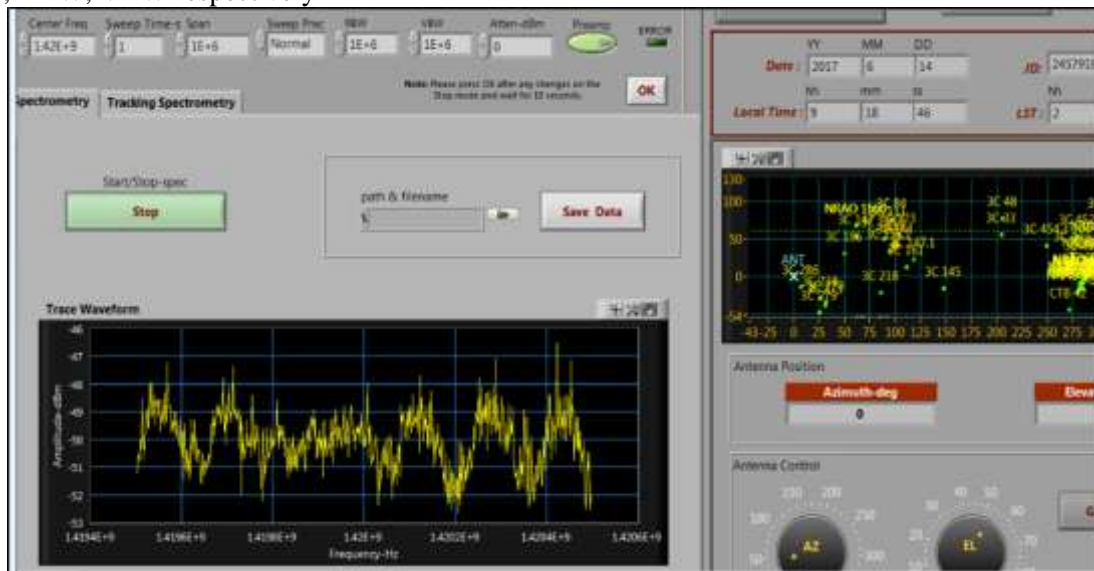


Figure 1-Spectrometry.

A three-meter Diameter Radio Telescope which is set up on the roof of the building of the Department of Astronomy and Space at the University of Baghdad, the radio telescope Software (RTC) is used for control and data acquisition of a professional radio telescope. RTC is able to control the antenna for scanning an area in the sky, track the radio astronomy sources and also show the object positions in the equatorial and Horizon coordinate system. 60 strong radio astronomical sources with their position and intensity are presented by RTC. This software connects to devices such as Radio Telescope Control System (RTCS), and Radio Telescope Receiver System (RTRS) [5].

Calibration of the antenna position is necessary before doing anything with the antenna. Calibration can be done by selecting two recognized sources in the sky such as Sun, Moon, any strong radio sources, or a known satellite with emitting frequency in the range of receiver system and then do many steps like, when the shadow of horn is on the center of dish this mean the antenna is calibrated now and it would be recommended to repeat the calibration every so often [6].

3. Experiment Instrument

In this work the files received from the observatory relating to the radio background emissions received by a radio telescope, with a diameter of 3 meters, any file takes from radio telescope (as in Figure-2 save in the telescope's computer then the data transfer to the excel sheet file shown in Figure-3 for reading and studying.

28/05/2017												
center frequency	Sweep Time(s)	VBW	Span	Sweep Prec	RBW	Atten(dBm)	Preamp-On=					
1.420000E+9	1.000000	1000000.000000	1.000000E+8	0.000000	1000000.000000	0.000000	1.000000					
Frequency-Hz				0.000000	0.000000	2495840.266223	4991680.532446	7487520.798				
6589E+8	2.071547E+8	2.096506E+8	2.121464E+8	2.146423E+8	2.171381E+8	2.196339E+8						
E+8	4.193012E+8	4.217970E+8	4.242928E+8	4.267887E+8	4.292845E+8	4.317804E+8						
6.314476E+8	6.339434E+8	6.364393E+8	6.389351E+8	6.414309E+8	6.439268E+8	6.464226E+8						
5940E+8	8.460899E+8	8.485857E+8	8.510815E+8	8.535774E+8	8.560732E+8	8.585691E+8						
E+9	1.058236E+9	1.060732E+9	1.063228E+9	1.065724E+9	1.068220E+9	1.070715E+9						
1.270383E+9	1.272879E+9	1.275374E+9	1.277870E+9	1.280366E+9	1.282862E+9	1.285358E+9						
2529E+9	1.485025E+9	1.487521E+9	1.490017E+9	1.492512E+9	1.495008E+9	1.497504E+9						
hh	mm	ss	msec	0	Amplitude-dBm(#1 to #600)							
10.000	5.000	23.000	858.821	0.000	-38.719	-41.345	-52.385	-58.192	-57.638	-58.462	-58.381	-5
0	-56.723	-58.770	-57.968	-55.909	-57.232	-58.484	-58.405	-56.096	-55.836	-57.325	-56.720	-5
2	-38.429	-14.932	-21.200	-58.593	-57.646	-59.034	-59.024	-58.420	-58.640	-57.410	-58.952	-5
9	-21.357	-22.327	-19.302	-39.964	-57.448	-54.998	-57.406	-57.462	-56.134	-56.731	-57.258	-5
8	-53.527	-54.261	-53.868	-53.147	-54.689	-53.907	-54.954	-53.777	-53.919	-52.358	-54.262	-5
10.000	5.000	24.000	855.878	0.000	-37.474	-40.986	-49.495	-57.391	-58.360	-58.881	-59.838	-5
7	-57.386	-58.551	-57.033	-56.358	-57.742	-58.501	-56.693	-57.671	-58.377	-57.522	-57.090	-5
6	-37.217	-15.185	-22.797	-58.253	-58.847	-57.972	-58.592	-59.490	-57.007	-58.939	-57.945	-5
9	-20.382	-22.720	-19.034	-33.145	-56.586	-56.870	-55.828	-55.935	-57.336	-57.085	-55.531	-5
6	-53.542	-53.835	-53.398	-54.645	-54.039	-53.714	-52.914	-52.603	-53.831	-53.937	-52.585	-5
10.000	5.000	25.000	860.936	0.000	-39.054	-40.868	-52.999	-58.203	-59.087	-60.275	-58.971	-5

Figure 2- Data received from telescope's computer.

Figure 3- Dataset sample as Excel file (file no. 1)

These files are arranged in table form as previously stated shown in Table-1 this table includes: numbers of files, observation time, span, and observation date.

Table 1- list of observation files

File #	Observation Time (sec)	Span (Hz)	Observation Date
1	16	1×10^8	01/06/2017
2	17	1×10^8	02/06/2017
3	19	5×10^8	24/05/2017
4	20	1×10^8	22/05/2017
5	22	1×10^8	07/06/2017
6	24	1×10^8	06/06/2017

7	27	1×10^8	04/05/2017
8	29	1×10^8	09/06/2017
9	31	1×10^8	01/05/2017
10	38	1×10^8	11/06/2017
11	38	1×10^8	13/06/2017
12	47	1×10^8	14/06/2017
13	82	1×10^6	01/07/2017
14	108	5×10^8	15/05/2017
15	108	1×10^8	19/05/2017
16	112	1×10^8	28/05/2017
17	177	1×10^8	20/05/2017
18	185	1×10^8	15/07/2017
19	788	1×10^8	12/07/2017
20	903	2×10^8	16/07/2017

In the beginning of each file there are some parameters related to spectrum radio telescope such that: sweep time, span, RBW, VBW, and center frequency, instead of these parameters the files contain the 600 columns for amplitude in (dBm) and further parameters like: start, end frequency, center frequency, frequency ticks, and Span as explain in Table-2.

Table 2- List of selected observation data

Span (Hz)	Start freq. (GHz)	Center freq. (GHz)	End freq. (GHz)	Freq.ticks (GHz)
1×10^8	1.37000	1.42058	1.46966	1.660×10^5
1×10^6	1.41950	1.42000	1.42049	0.020×10^5
2×10^8	1.32000	1.41104	1.49940	2.990×10^5

4. Results and Discussion

The observation done by using small radio telescope (3 meters diameter), which complement the study done by Zainab and Kamal [7] and it's done by store the data in excel sheet in computer. Three files from the received files are selected that belong to the radio emissions received and the span is different. The first file with span is equal to 1×10^6 Hz (file no. 13), where the time of observation is equal to 82 sec. The file information entered to computer program (in MATLAB) several variables related to those files are found such; span, sweep time, RBW, VBW, center frequency (these parameters already exist in data file). A Fourier transform converts a signal in the time domain to the frequency domain (spectrum) the Discrete-Time Fourier Transform (DTFT):

$$x(e^{j\omega}) = \sum_{n=-\infty}^{+\infty} X[n] e^{-j\omega n} \tag{1.1}$$

Where the X[n] the frequency domain, j the complex values, w the frequencies. Here in this work have been using the inverse discrete-Time Fourier Transform converts the frequency domain components back into the original time domain signal as the equation [8]:

$$X[n] = \frac{1}{2\pi} \int_{2\pi} x(e^{j\omega}) e^{+j\omega n} d\omega \tag{1.2}$$

As previously stated Data will transform using inverse Fast Fourier transform to convert the signal from frequency domain to time domain. Amplitude will extract from of data (frequency domain), and complex values were obtained for that absolute value equation is used [7]:

$$r = |Z| = \sqrt{X^2 + Y^2} \tag{1.3}$$

Where Z: is complex number.

$$Z = X + Yi \tag{1.4}$$

Where Y_i is the imaginary values, have been getting different information from those data such as: max intensity and min intensity, start frequency, end frequency, starting time, ending time, and interval time. obtaining Thus, Figure-4 illustrates the relationship between Intensity and time as shown that the first file (no.13) where the span is 1×10^6 Hz and the observation time is 82 sec. From Figure-5 as shown that the second file is (no. 9) where the span is 1×10^8 Hz and the observation time is 31 sec. From Figure-6 as shown that the third file is (no. 20), and the observation time is 903 sec

and the span is equal to 2×10^8 Hz. The finding the values of the variables required as shown in these figures.

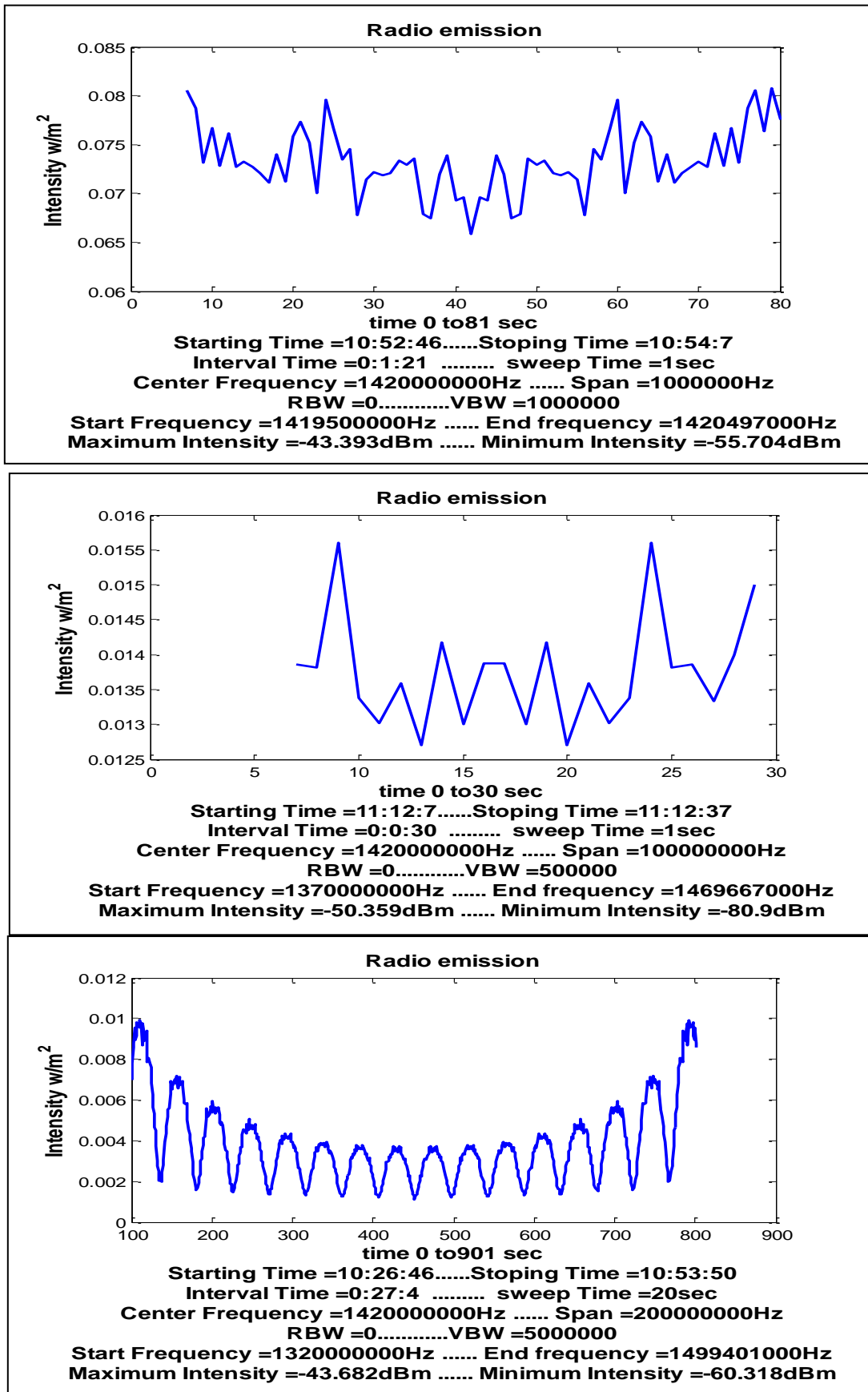


Figure 6- The relationship between Intensity and time (file no. 20).

The previous selection, explain that the span change will change the frequency packet received. In computer program, we facilitate monitoring by obtaining the information required to carry out analyzes and calculations of the signal received by the radio telescope during observation. By receiving the disk from the observing person and at any time through the application of the program, we have prepared the information and variables of the monitored person. Of the time and effort of the monitoring person in order to conduct the calculations required of him as soon as possible.

Conclusions

From reading of observation files received from observer, computer program was built using MATLAB 2013, for obtaining the parameters of radio telescope: sweep time, span, RBW, VBW ,and center frequency,Then these files are re-arranged with respect to observation time and the date of observation with a span. The observation done by using small radio Telescope 3-meters diameter that store the data in excel sheet in computer. Four files from the received files are selected that belong to the radio emissions received and the span is different, several variable related to those files are found such, max intensity, min intensity, start frequency, end frequency, starting time, ending time and interval time.

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