Experiment Radio astronomy

Lab course protocol

Group 3+12

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Contents

1 Introduction

In this experiment, we observe radio emissions from the Sun and the Milky Way using the radio telescope at Sand 1, Tübingen. We aim to detect the Sun as a point source, since the resolution of our telescope isn't high enough to detect it as an extended source. We also aim to observe the 21 cm Hydrogen line to derive the galactic rotation curve and to also create a radio map of the milky way.

In section 2 we discuss the theory of the solar and milky way radio emissions and how to obtain the rotation curve. In section 3 we describe the radio telescope used for the observations and how the observations were made in section 3.2. Finally in section 3.3 we display our results and describe the data analysis steps used to obtain them.

2 Theory

2.1 The Sun

2.2 The Milky Way

2.2.1 Doppler Effect

2.2.2 Milkay Way Rotation

2.2.3 Mass Estimate

3 Experiment

3.1 The Telescope

The radio telescope at Sand 1, Tübingen is a parabolic antenna with a diameter of 2.3 m. At the 21 cm Hydrogen line, it has a resolution of 5°. The telescope is controlled using the qradio software on a computer attached to it.
The telescope can either be operated as a bolometer (measuring the total power of radio signal) or as a spectrometer. For the first case, the measured signal is compared to the calibration source ('noise diode') located in the middle of the dish. For spectrometry, the power is measured together for the source and the background such that radio noise from human sources, sky emissions and the continuum emission of the source can be subtracted.

Figure 1: Radio telescope at Sand 1, Tübingen

The telescope is on a Alt-Az mount. Using the computer, the telescope can be moved by specifying galactic, equatorial and other coordinate systems.

3.2 Observations

To start the observations, first a restart of the computer is required. The program qradio is started with the following configurations:2

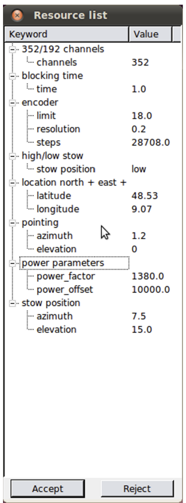

Figure 2: qradio configuration. All the shown values much match

Now using the GUI, different parameters are set for the observations of the sun and the Milky Way.

Figure 3: the qradio GUI

3.2.1 Observation of the Sun

3.2.2 Observation of the Milky Way Disk

To observe the Milky Way, the following parameters were set:

1. In the *receiver* box, *Mode* is set as 'switched' with *Switching* set to 'frequency'.
2. In the *Frequency/Gain* box, $dB * 10$ is adjusted such that both signal and reference levels are about 30%. We set the it to 30.
3. We set the coordinates in the *Telescope* box by first setting the coordinate system as 'Galactic'. The coordinates are then entered in degrees.
4. By clicking on *Track* the telescope will move to the required position and will track that coordinate over time.
5. The spectrum is observed by setting an *integration time* of 10 seconds and by clicking *observe*. The spectrum can then be inspected in the *Control* tab and can be saved.
6. Next we track and get the spectrum for several sets of coordinates.

To choose the coordinates to observe, we first start with part of the disk that is closest to setting in the west anc continue eastward. Spectrums are obtained for $l = 25°, 30°, 40° \dots 80°, 89°$ as b is kept constant at $b = 0°$ since we are observing the centre of the disk.

Background measurements are taken at $l = 30°, 50°, 80°$ and $b = 30°$ to be subtracted from the previous set of observations.

3.3 Data Analysis

4 Conclusions

A Appendix