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# Small Radio Telescope Research

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# The Small Radio Telescope

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## Abstract

Radio astronomy is the study of the universe through the analysis of radio waves detected from space. Radio telescopes gather radio frequencies that celestial bodies emit or reflect and translate them into a signal that can be analyzed. Clark Universities' very own small radio telescope is located on top of the Sackler Science building and has been a source of study and academic advancement for many years now.

## How it works

The two main components of the SRT are the receiver and controller boxes. The receiver box sits at the focal point of the 3-meter parabolic mesh satellite dish. Here, a select frequency range (band) of radio signal is collected and transmitted to the controller box in the SRT office via coaxial cable and USB-serial connection. From there, the computer software Java program written by the MIT Haystack team takes the radio frequency (RF) signal and develops a plot of the amplitude versus frequency, as shown in figure 2. The controller also directs two DC motors that aim the telescope in the azimuth (full 360 degrees) and elevation (90 degrees) directions.

**Fig 1:** Images of the inside of the telescope (left) and controller (right).

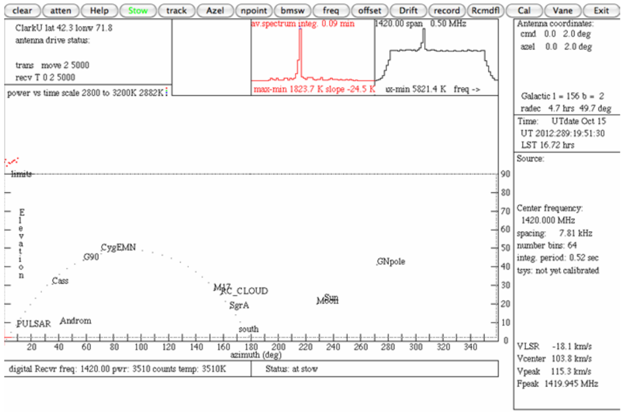


**Fig 2:** Interface through which the telescope is controlled. The graph on the left shows the instantaneous RF, and the graph on the right is integrated over time. Image taken by Eric Gustafson in 2012.

## Measurements

The hydrogen line, also known as the 21cm line, is an electromagnetic radiation spectral line that is at the wavelength at of the hyperfine transition in hydrogen atoms. This transition, which has a frequency of 1420.406 MHz, can easily penetrate the Earth's atmosphere for observation with little to no interference. This line is so important to our research because it is used to determine relative velocities and the rotation curve of our galaxy. Assuming the hydrogen in our galaxy is evenly distributed and taking into consideration the Doppler effect of each plane of sight, we can determine the distance to any point in our galaxy and the velocity relative to us at that point.

## Results

Using the software developed by the MIT Haystack team, scans can be made that show the spectrum and corresponding intensity plot for a chosen source. In Figure 3, the chosen sources are Orion's belt (left) and Sun (right). These plots use data collected from the radio telescope over the course of the Summer of 2022.

## Summer 2022

This summer was mostly spent troubleshooting different errors that were being sent back from the telescope. The communications error was fixed by installing a new coaxial cable that is used to transfer data (RF) to the controller. A persisting error currently is due to a faulty reed switch in the telescope that is now prohibiting the telescope from moving in the azimuth direction.

A big accomplishment made this summer was the development of a new Java program that parses output data files from command line files. The command line files give the telescope directional commands to scan areas of the sky and develop a data file. It is now possible to recreate the graphs constructed by the software in a new format to be further analyzed.

## Conclusions and the Future

The SRT will be an ongoing project and area of exploration. At this time, there are still some areas of functionality and hardware that need to be fixed. Once that is taken care of, the collection and analysis of RF data will resume. At that time, new regions of the sky will be examined, and longer scans should be possible.

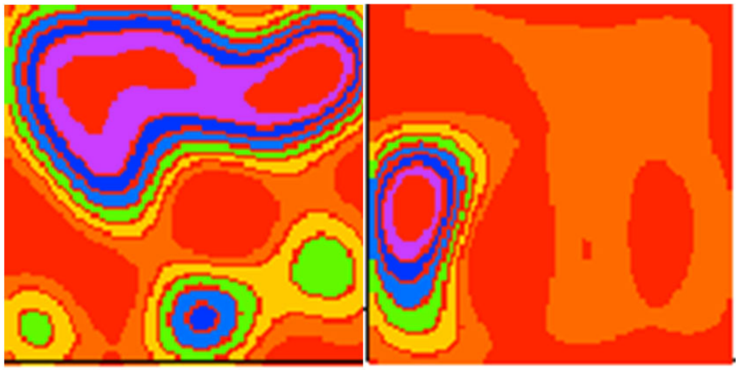

**Fig 3:** The image on the left is an n-point scan of Orion's belt, and the image on the right is an n-point scan of the Sun.