

UnCHARTed: Measuring Beyond the Inner Galaxy

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Abstract

My goal in conducting my research was to measure the speed of matter in the Milky Way galaxy using CHART -- the Completely Hackable Amateur Radio Telescope is an inexpensive, constructable telescope used to detect radio frequency waves in the galaxy. Using these waves and the doppler shift equation, I was able to measure the velocity of hydrogen gas in the inner galaxy. In doing this successfully, I was able to graph the relationship between the velocity and radius which is the rotational curve of the inner galaxy. I then collected and used additional data to calculate the rotational curve of the outer galaxy.



CHART set up to observe the galaxy.

CHART

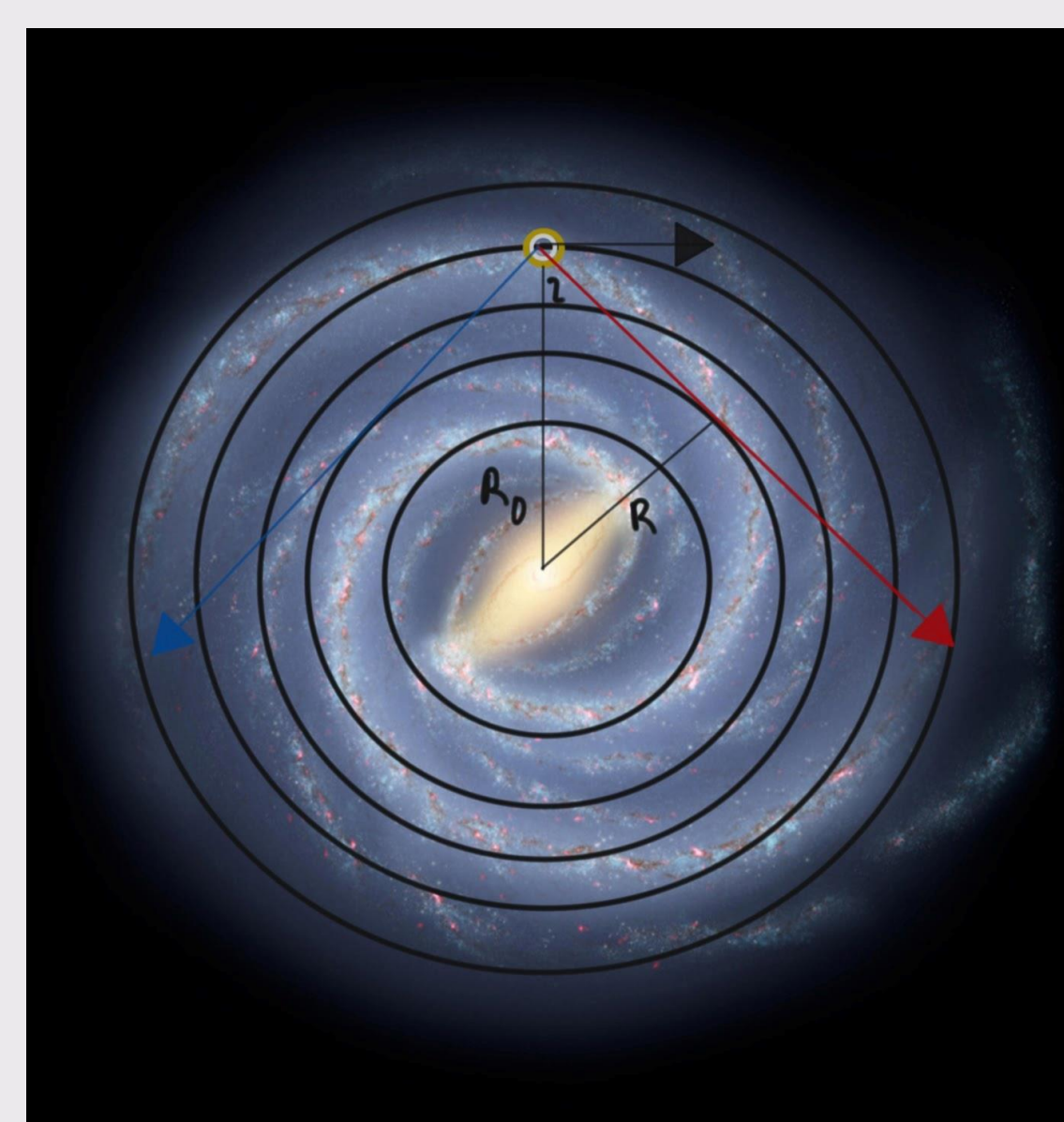
CHART is an affordable radio telescope, designed by undergraduate students. Made using a raspberry pi and a software defined radio, it is easy to build and use. It's used to measure radio wave frequencies in the galaxy.

Our galaxy, the milky way, is made up of a lot of hydrogen gas, stars, dark matter etc. The hydrogen gas emits a light wave frequency at around 1.420 [GHz] that we can pick up with CHART. Measuring the speed of the galaxy can help us show the existence of dark matter.

Milky Way

Galaxy Velocity

To calculate the velocity, I started with the measured doppler shift from hydrogen gas. Accounting for the speed of the solar system, I used the Tangent point method. When calculated the result is the velocity that the gas is rotating and the distance from the center of the galaxy.

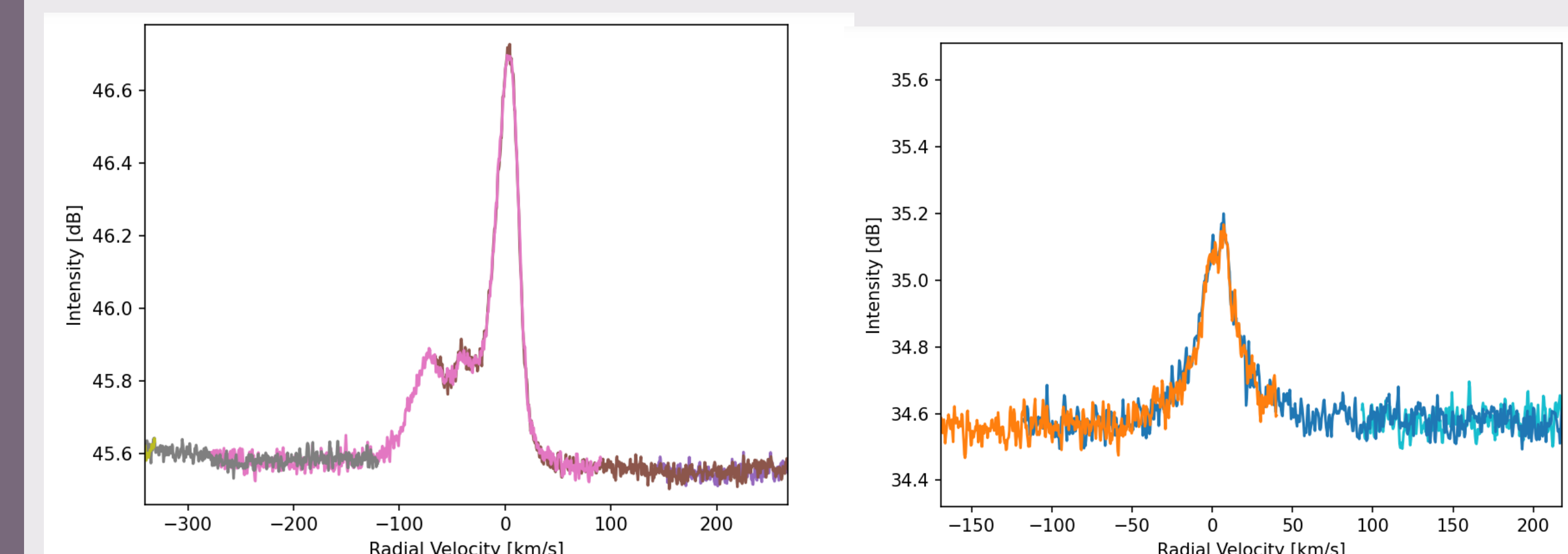


https://science.nasa.gov/wp-content/uploads/2023/09/Milky_Way_illustration-1.jpeg?w=1536&format=webp

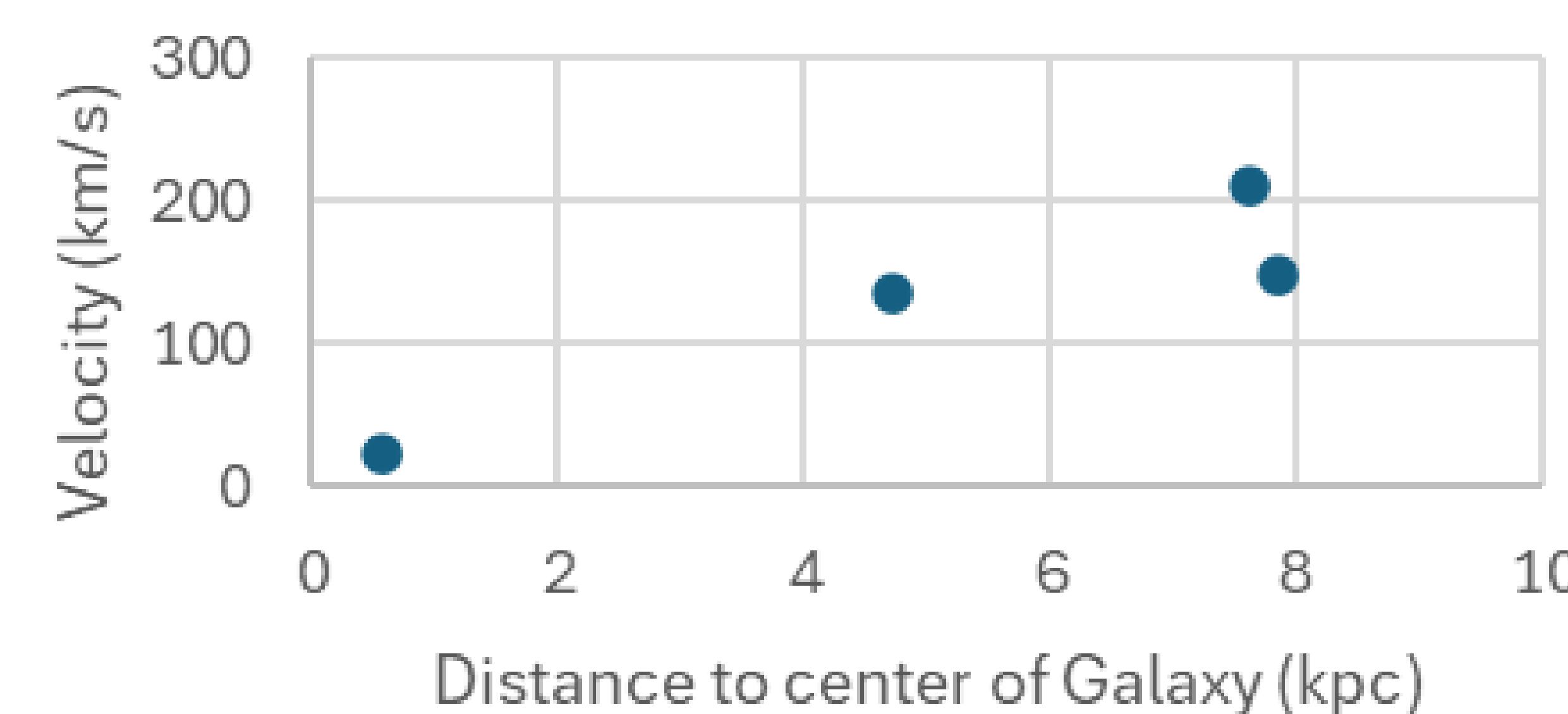
When looking in a specific direction the largest velocity seen comes from a point tangent to the gas's orbit. Now we can use simple geometry for our calculations.

Tangent Point

Data



Here are a couple examples of data measured. The left is at angle 84.2° and the right is at 4.18°



Here is the measured rotational curve of our data.

Rotational Curve

- We hope to fill in more data points for the rotational curve
- Develop a method to measure the velocity in the outer galaxy, because the tangent point method only works inside the solar radius.

Future Work