Name _____ Date _____

Velocity Curve Activity Part 2: Quadrant I Observations

Introduction

We previously made some observations of quadrants II and III of the Milky Way Galaxy (MWG) using the horn radio telescope. From this we learned that the MWG is rotating. In this activity we will take further measurements using a horn telescope to determine the velocity of points in the galaxy at different distances from its center. This is typically referred to as a velocity curve.

Pre-Observation Reflection: Milky Way Galaxy Models

Model Assumptions

- the galaxy is comprised of lots of material - stars, neutral hydrogen atoms, and other interstellar matter.
- The galaxy exists in a 3-dimensional region of space.

1. **Static Model:** The matter in the galaxy is stationary. Apply what you know about gravitational forces to explain why a static model probably does not accurately describe the Milky Way Galaxy.

   [Hint: Assume the galaxy is a large spherical volume of mass. Pick an arbitrary point in this volume, draw a force diagram on a particle at this point, and apply Newton's 2nd Law to illustrate what this model would imply about the motions of the particles in the galaxy.]

2. **Non-static Models:** Continue the analysis in #1 above to determine what type of motion the particles are most likely undergoing. [Think about the motions of the planets around the sun. What would happen if the planets stopped moving?] Incorporate what we have learned about the red and blue shifts of the different quadrants of galaxy to support your explanation.

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Velocity Curve Activity Part 2: Quadrant I Observation

Pre-Observation Prep

1. Assigned galactic coordinates: $galactic\ latitude\ =$ _____; $galactic\ latitude\ = 0^o$
2. Use *Stellarium* to look up the horizontal coordinates (azimuth and altitude) that correspond to your galactic coordinates on the date and time we will be making the observations.

   Note: You may want to prepare a range of pointings at 5 minute intervals over a 20 minute period of time, or so, in case we get off schedule.

Date	Time	Azimuth	Altitude

Data Collection

Actual terrestrial coordinates at time of data collection:

Azimuth = _____; Elevation = _____

Exact time when the data was saved to a file: _____

Name of your data file: _____

Graphing the Spectrum

1. Open your .csv data file in a spreadsheet program, either Google sheets or Excel. (If any screens pop up regarding the format of the data, just hit enter to select the defaults.)
2. Graphing the Data
   a. In the spreadsheet, insert a row above the first row.
   b. In the first row of Column A type “Frequency (MHz)”, and in the first row of Column B label it “Signal”.
   c. Click on the column labels A and B to highlight these columns.
   d. Insert Chart. Choose Smoothed Line. In Google Sheets, under Data Range, select “use row 1 as headers” and “use column A as labels”.
   e. Add axis titles with units. Add a graph title.
   f. Change the x-axis scale to range from 1419.5 to1421.5 MHz, and the y-axis to fit the spectrum accordingly.
   g. Add grid lines so that the minor gridlines are in increments of 0.01 MHz.

Analyze the peaks

1. Use the graph to determine the frequency, to the nearest 0.01 MHz, of the ***most red-shifted*** portion of the peaks. Estimate an uncertainty in this value.

   Most red-shifted frequency: _____ ± _____

2. **Velocity Calculation:** Use the Doppler shift formula to calculate the velocity from this frequency and an uncertainty in this velocity. Show your work, and record the results below.

   velocity = _____ ± _____

3. **Distance Calculation:** Refer to ***The Tangent Method*** document. Calculate the closest distance to the galactic center along the direction of observation. The earth is approximately 8.0 kpc to the GC. Show your work, and record the results in the table below.

Frequency (MHz)	**Velocity (km/s)**	**Galactic Longitude (degrees)**	**distance from GC (kpc)**