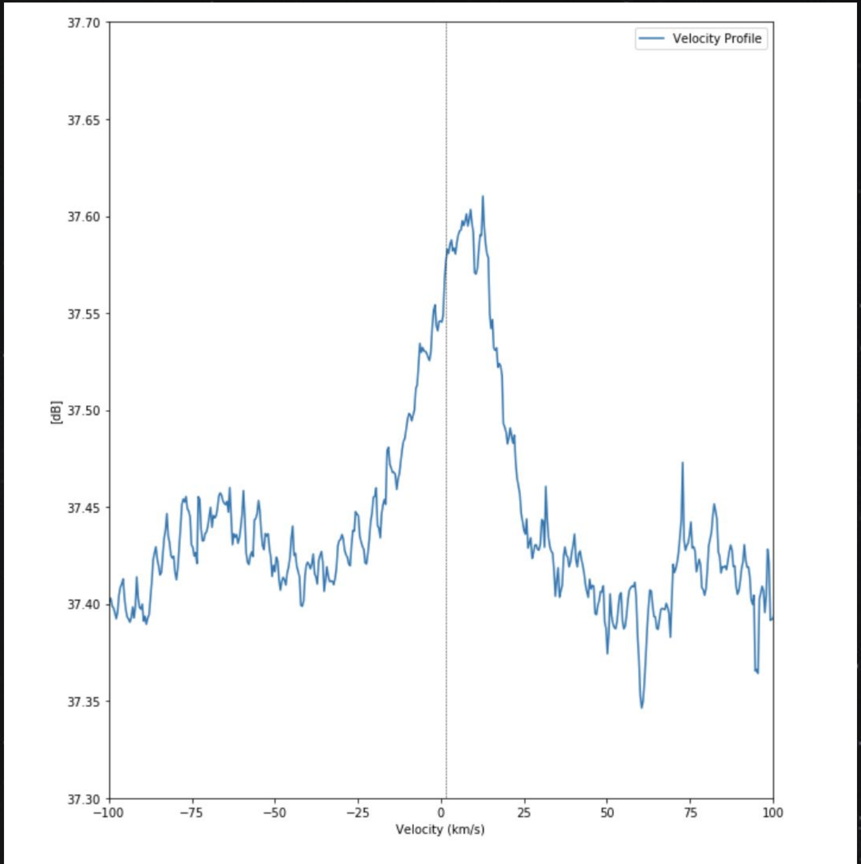
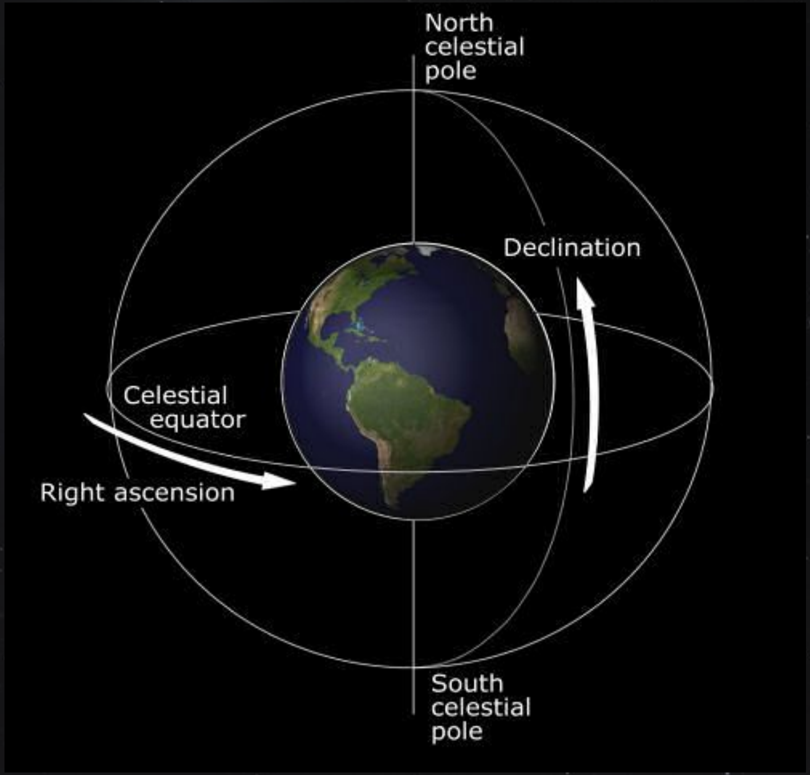
Science Time!

RA 2023 Bootcamp Day 4

Last we left our intrepid heroes....

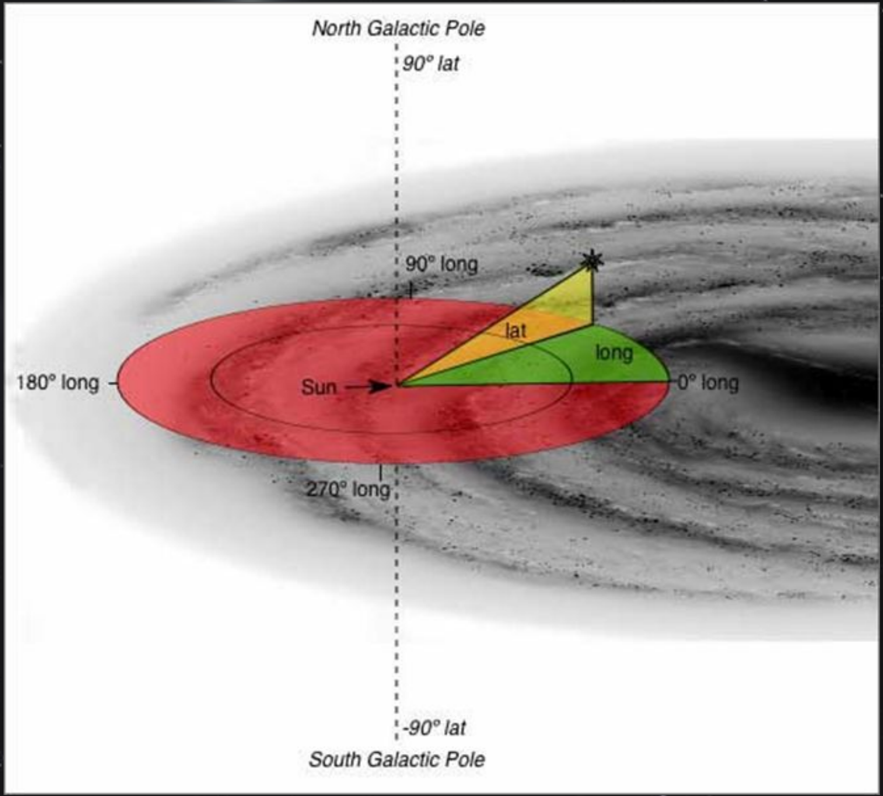


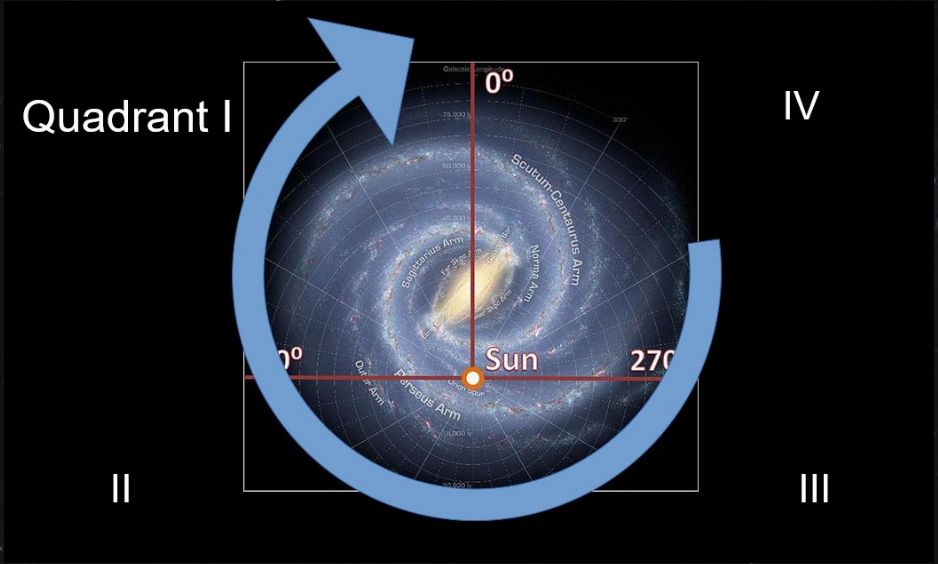
Coordinate Systems (RA/DEC)



- Declination (DEC) is the celestial sphere's equivalent of latitude. The celestial equator is 0° DEC, and the poles are +90° and -90°.
- Right ascension (RA) is the celestial equivalent of longitude.

Coordinate Systems (Galactic)





Where were we pointed?

Visit https://stellarium-web.org/ and capture the approximate Right Ascension and Declination for the center of these pointings:

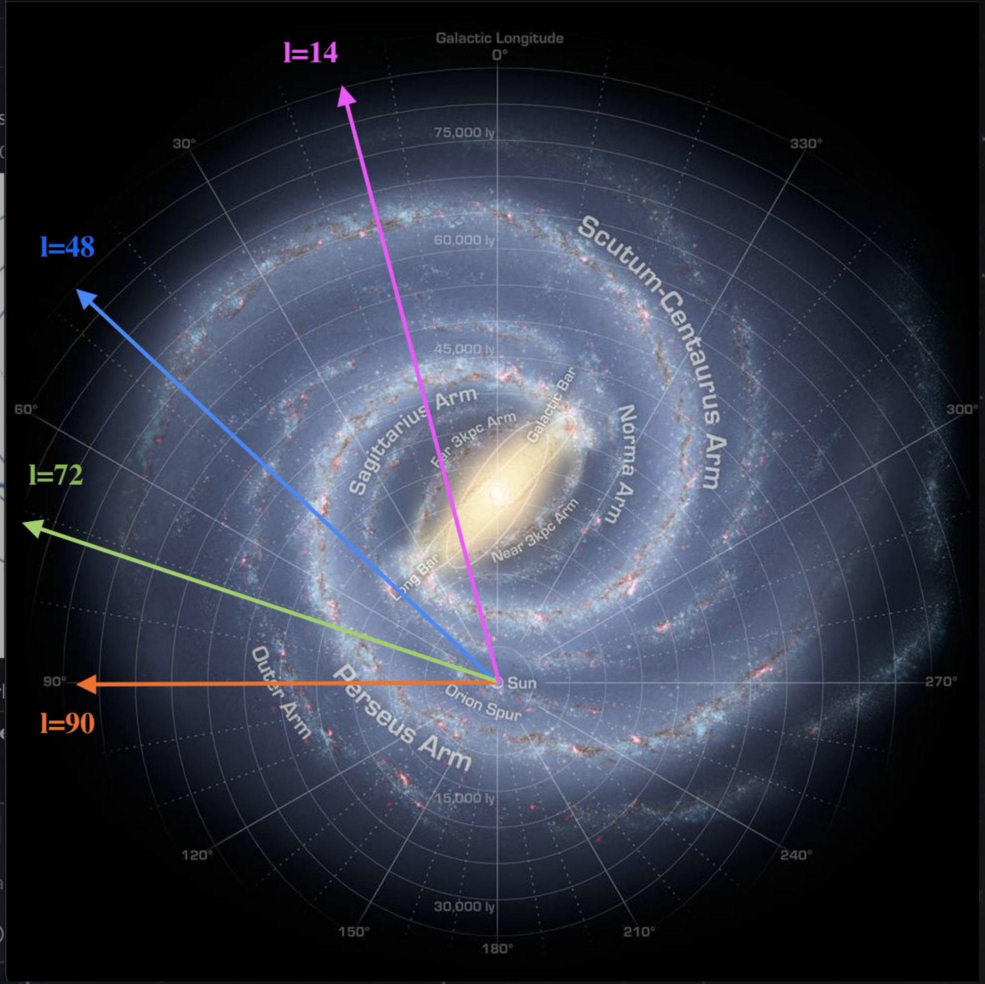
Location: Winona, Minnesota Date: October 10th, 2022

Pointing 1: Laying down toward S, elevation=17deg Started 6:30pm

Pointing 2: 37 deg S of vertical, Started 6:25pm

Pointing 3: pointed 0 deg N-S (Zenith), Started 6:12pm

Convert these pointings to Galactic Coordinates. What part of the galaxy are we looking at? Draw your sight lines on your milky way.

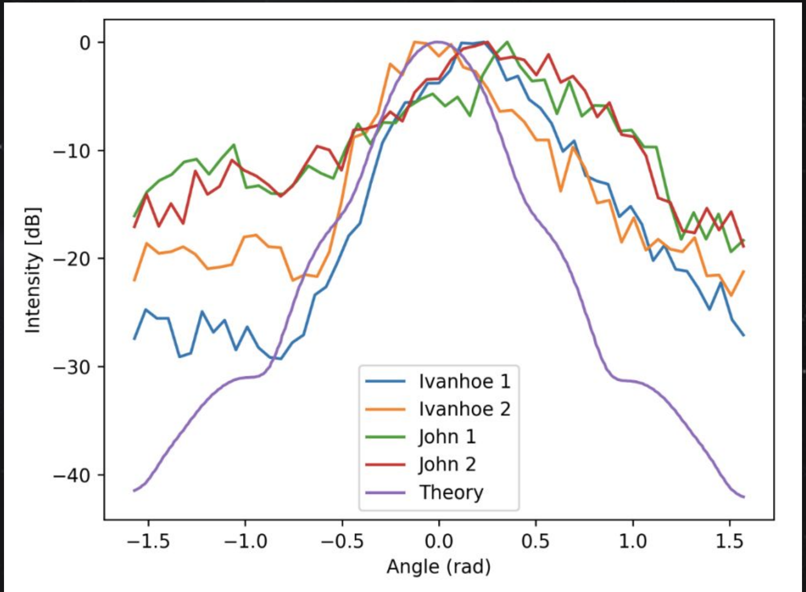


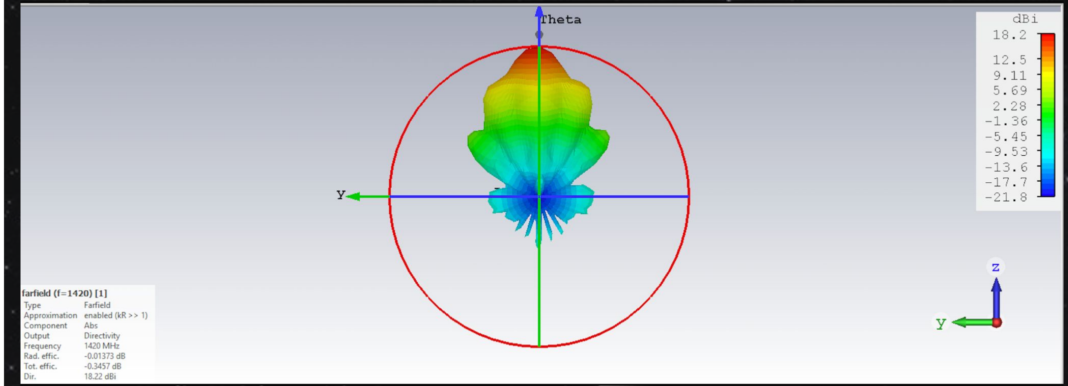
Pointing 1: 20h04m02s, -27d38m51s
l = 14, b = -27

Pointing 2: 19h47m20s, 10d40m12s
l = 48, b = -7

Pointing 3: 19h45m41s, 45d11m16s
l = 90, b= 0

Where were we pointed (FOV)?





FWHM: 20 degrees. How big is this on the sky?

Log into enterprise.sese.asu.edu/jupyter

Uname: locouser#

Pass: bootcamp2023

Open the notebook at
/data/ra_bootcamp_day4.ipynb

Plot the Profiles

Run all the cells in the data preprocessing section

How do we know whether our data makes sense?

Visit
https://www.astro.uni-bonn.de/hisurvey/euhou/LABprofile/index.php

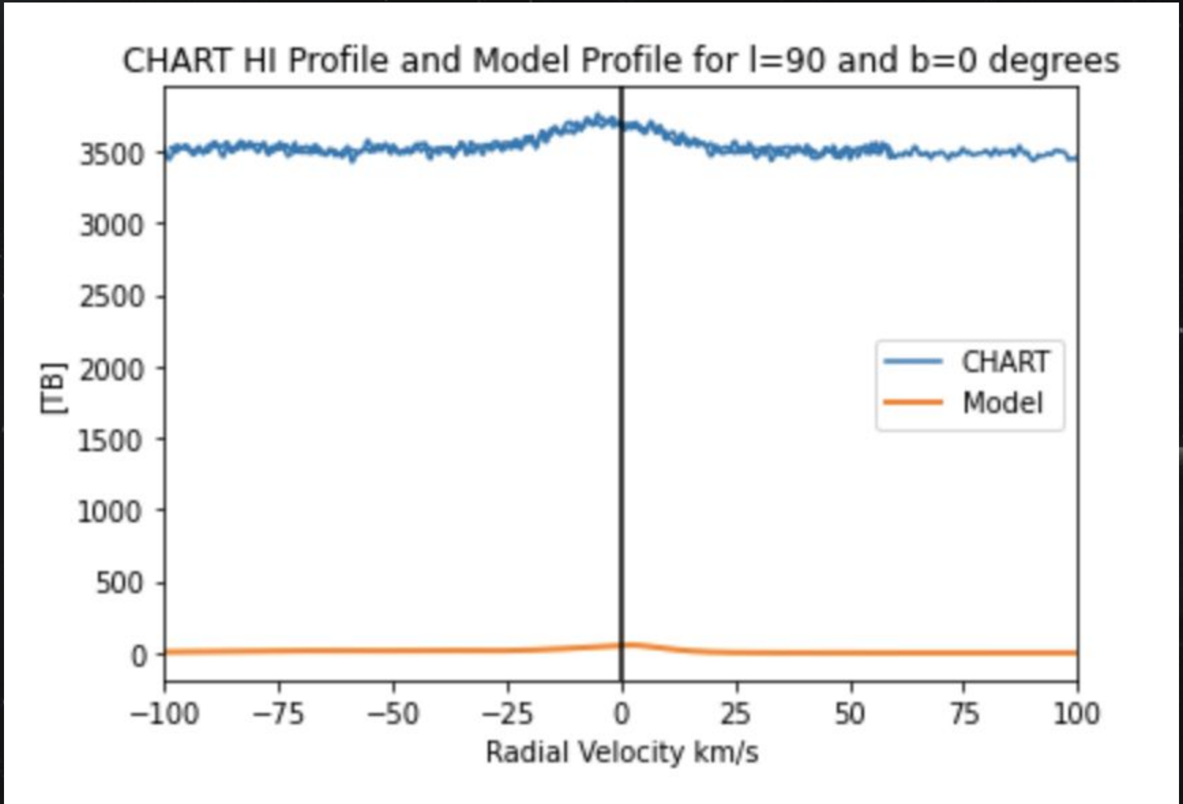
Input your galactic coordinates and beam size, look at your recovered velocity profile. Save as a .txt file and upload to JupyterHub, in the folder called HI_profiles_comparison

Fill the name of your file in under each pointing, where it says sh_comp=

Insert name of your file where it says (input)

```
sh_comp = pd.read_table('HI_profiles_comparison/(input)',skiprows=[0,1,2,3],names=['v_lsr', 'T_B', 'freq', 'wavel'], de
```

Why Doesn't Our Data look like our Model?



Noise and Gain cal

Data = model*gain + noise

Under each pointing, comment out the lines noise = 0 and gain = 1.
Uncomment the noise and gain variables underneath.
Click the kernel tab at the top of the notebook, restart & run all

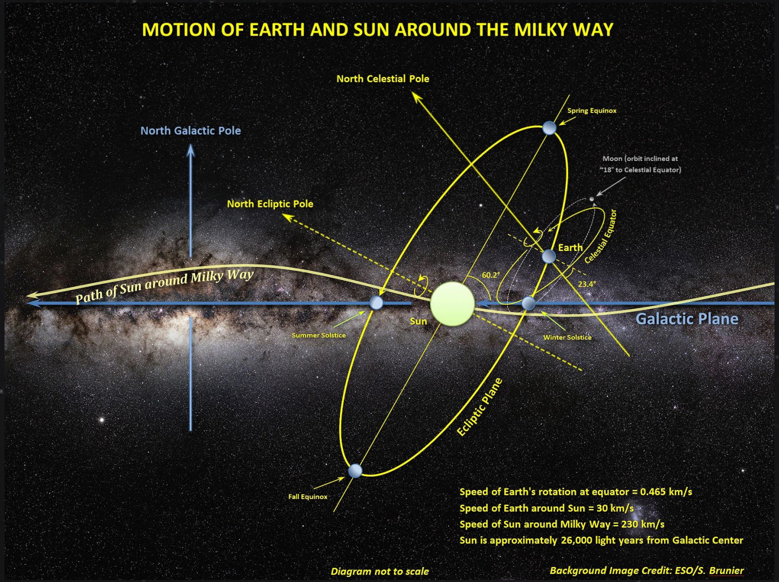
```
noise=0
gain=1

#noise = 2315
#gain = max(10**(spectra[j][11]/10)-2315)/(max(compTB))
```

How good is your fit?

OBSERVING REFERENCE FRAMES

- Velocities for local objects are sometimes reported with respect to the local standard of rest (LSR) – the average local motion of material in the galaxy – instead of the Sun's rest frame.



https://bigthink.com/starts-with-a-bang/earth-move-universe/

LSR

Uncomment all the lines in the block under the pointing header.
Input your coordinates to the Jupyter notebook where it says pointing_45deg.
'ra' = your ra in h, m, d i.e '19h5m3s'
'dec' = your dec in deg, m, s i.e '1d10m3s'
Keep the quotations around your ra/dec
Restart kernel and run all cells.
How good is your fit now? What might be reasons for an imperfect fit? What questions do you have that you could investigate further?

Pointing 1

```
16]: #location = EarthLocation.from_geodetic(-91.64, 44.048708, 200*u.m) #Winona Lon, Lat, elevation
     #location = location.get_itrs(obstime=Time('2022-10-08T18:30:00')) #To ITRS frame, makes Earth stationary with Sun
     #pointing_45deg = SkyCoord('ra','dec', frame='icrs') #Center of CHART pointing
     #frequency = SpectralCoord(1.420405751768e9 * u.Hz, observer=location, target=pointing_45deg) #Shift expected from just
     #f0_shifted = frequency.with_observer_stationary_relative_to('lsrk') #correct for kinematic local standard of rest
     #f0_shifted = f0_shifted.to(u.GHz)
     #v = doppler(f0_shifted,f0)
     #v_adjustment = v.to(u.km/u.second)
     #print(v_adjustment)
     v_adjustment = 0
```

What does this tell us?

What is a velocity curve, really?

Point #1: Are we just looking at one “clump” of gas?

Point #2: What does “Radial Velocity” mean? What motion are we actually measuring?

Estimate your highest velocity cloud

Draw your Vectors!

$Vtp/gc = Vtp/s + Vs/gc = Vobs + Vsun*\cos(90 - \Theta) = Vobs + Vsun*\sin(\Theta)$

$d = Ro*\sin(\Theta)$

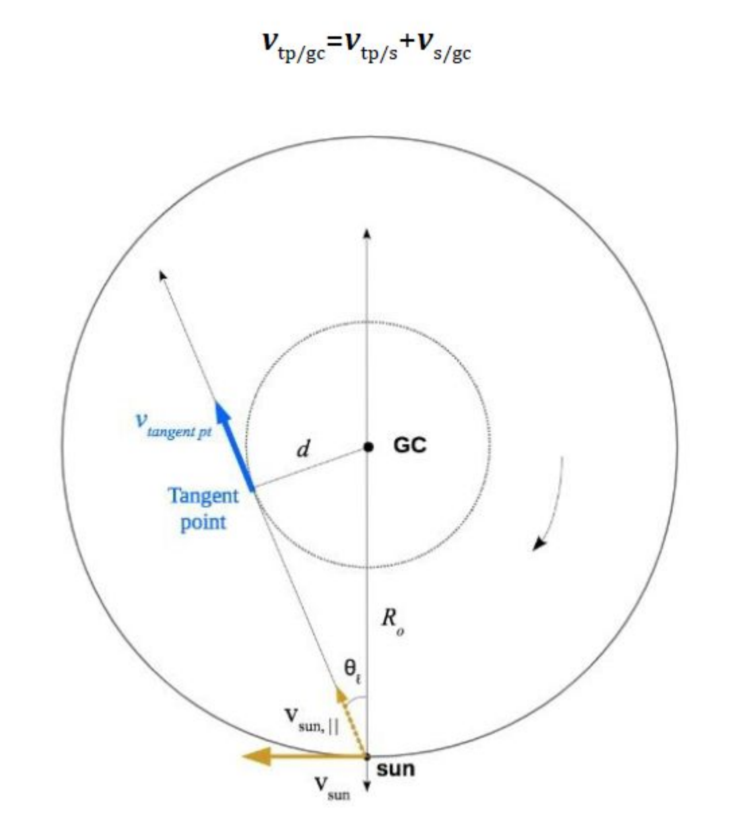
Where :

Vsun = 220 Km/s

Ro = 7.6 Kpc **or 8 kpc?**

Θ = galactic longitude angle

Vobs = speed calculated from measurements with the radio telescope



Calculate Vtp and d for your 3 profiles.
You can do this by hand, or code it up!

https://physicsopenlab.org/2020/09/08/measurement-of-the-milky-way-rotation/

Rotation curve

You should now have 3 distance vs velocity points
Make a scatter plot.
Compare to the rotation curve at
http://astro.unl.edu/classaction/animations/milkyway/milkywayrotationalvelocity.html

Does it look similar?

What now.....

Go get your own data! astrochart.github.io