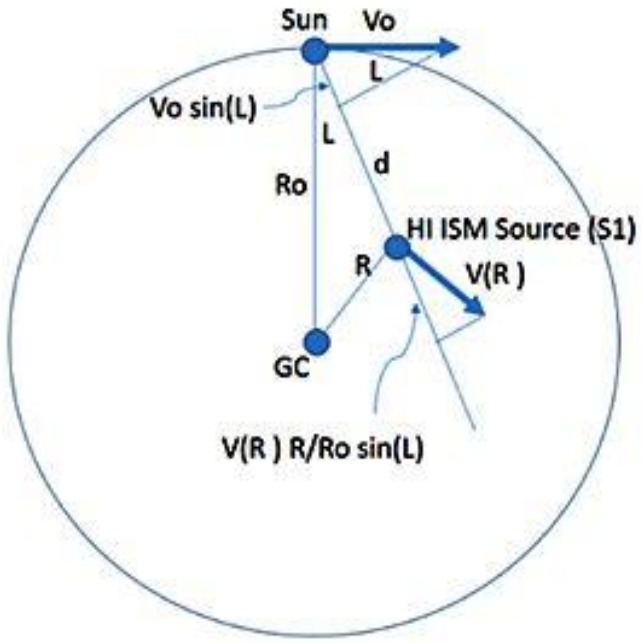
Deep Space Exploration Society
Science Meeting

Getting Ready for HI



October 26, 2020

Dr. Richard Russel

DrRichRussel@netscape.net

DSES.science

Information

- 9 ft Dish – serial port issue
- SuperSID – Down again – no signal
- Radio Jupiter – still need to get a new receiver and setup at site
- Pulsar – 1296 MHz pulsar effort
  - 1st attempt feed down
  - 2nd attempt – ran out of time for long observation run
  - Need 100 MHz bandwidth system to makeup for low S(1400) signal strength
- Fast Radio Bursts:
  - Observe FRB 121102 located at: RA: 05h31m58s DEC: +33d08m04s
    - No attempts yet
- Hydrogen
  - Plan for 1420 feed after Nov moonbounce

2020/21 Observation/ Feed Schedule

- November
  - Week 1-3: 1296 MHz – Pulsar Observations
  - Week 4: Moonbounce (1296 MHz)
  - Nov 28-29 Moonbounce (1296 MHz): http://www.arrl.org/contest-calendar
- December
  - Week 1-4 1420 MHz – Pulsar/ HI/ FRB observations

- January 2021
  - Week 1-4 408 MHz Pulsar Observations
  - (Note: the feeds can be varied based on science interests from 408/ 1296/1420 MHz)
  - 4 GHz Calibration feed

10/24/20 Site Trip

- Ray & Rich traveled to site on Saturday 10/24/20
- Problem indication was that there was no feed signal in the trailer
  - 1st problem found – power supply problem in 1296 amplifier
  - 2nd problem – primary feed cable – disconnect at 150 + feet (around the swivel joint)
    - Shifted feed to 2nd cable –
  - 1296 MHz (receive only) is currently available on dish
    - Check with Ray before you try to use – different power supply and switch lineup required
- Pointing calibration
  - Indication was that feed was centered on tower at 314.5 degrees
  - Used Ray's calibration transmitter (he drove to directly North of dish)
  - Found that peak was at 0.2637 degrees (encoder 1953)
    - Note that current 000 degrees encoder is 1956
- Pulsar system
  - Problem with gnu software – troubleshooting indicated that the laptop was continuously running for a week) – rebooting the computer seemed to fix the problem

Moon Bounce Update

Next Event: Nov 28-29 Moonbounce (1296 MHz): http://www.arrl.org/contest-calendar

CW 10/10/2020 750 K0PRT 559 DL0SHF 559 Germany
CW 10/10/2020 756 K0PRT 559 OH2DG 579 Finland
CW 10/10/2020 805 K0PRT 559 G3LTF 579 England
CW 10/10/2020 814 K0PRT 549 I5MPK 569 Italy
CW 10/10/2020 846 K0PRT 569 SP6JLW 589 Poland
CW 10/10/2020 900 K0PRT 559 DL4DTU 559 Germany
CW 10/10/2020 912 K0PRT 579 SM4IVE 589 Sweden
CW 10/10/2020 919 K0PRT 549 DG5CST 569 Germany
CW 10/10/2020 934 K0PRT 559 VE6BGT 579 Alberta, Canada
PH 10/10/2020 947 K0PRT 57 VE6BGT 56 Alberta, Canada
PH 10/10/2020 947 K0PRT 55 W4OP 57 North Carolina, USA
CW 10/10/2020 1034 K0PRT 549 OK1KKD 569 Czech Republic
CW 10/10/2020 1043 K0PRT 599 OE5JFL 599 Austria
CW 10/10/2020 1049 K0PRT 579 W6YX 589 California, USA
CW 10/10/2020 1103 K0PRT 569 IK2MMB 569 Italy
CW 10/10/2020 1111 K0PRT 579 OZ4MM 599 Denmark
CW 10/10/2020 1149 K0PRT 549 OK1CS 579 Czech Republic
CW 10/10/2020 1153 K0PRT 569 OK2DL 479 Czech Republic
CW 10/10/2020 1201 K0PRT 559 VE6TA 579 Alberta, Canada
CW 10/10/2020 1503 K0PRT 559 JH1KRC 569 Japan
CW 10/10/2020 1526 K0PRT 549 AA4MD 559 Florida, USA
CW 10/10/2020 1533 K0PRT 569 WA9FWD 559 Wisconsin, USA
CW 10/10/2020 1540 K0PRT 569 W5LUA 579 Texas, USA
PH 10/10/2020 1547 K0PRT 569 W5LUA 579 Texas, USA
CW 10/10/2020 1652 K0PRT 539 VA7MM 559 British Columbia, Canada
CW 10/10/2020 1703 K0PRT 559 XE1XA 559 Mexico
PH 10/10/2020 1731 K0PRT 55 VE6TA 55 Alberta, Canada
CW 10/10/2020 1740 K0PRT 569 K2UYH 559 New Jersey, USA
CW 10/10/2020 1806 K0PRT 549 JA6AHB 569 Japan
PH 10/10/2020 1826 K0PRT 54 W6YX 55 California, USA

Astronomy Hydrogen @ 1420.406 MHz

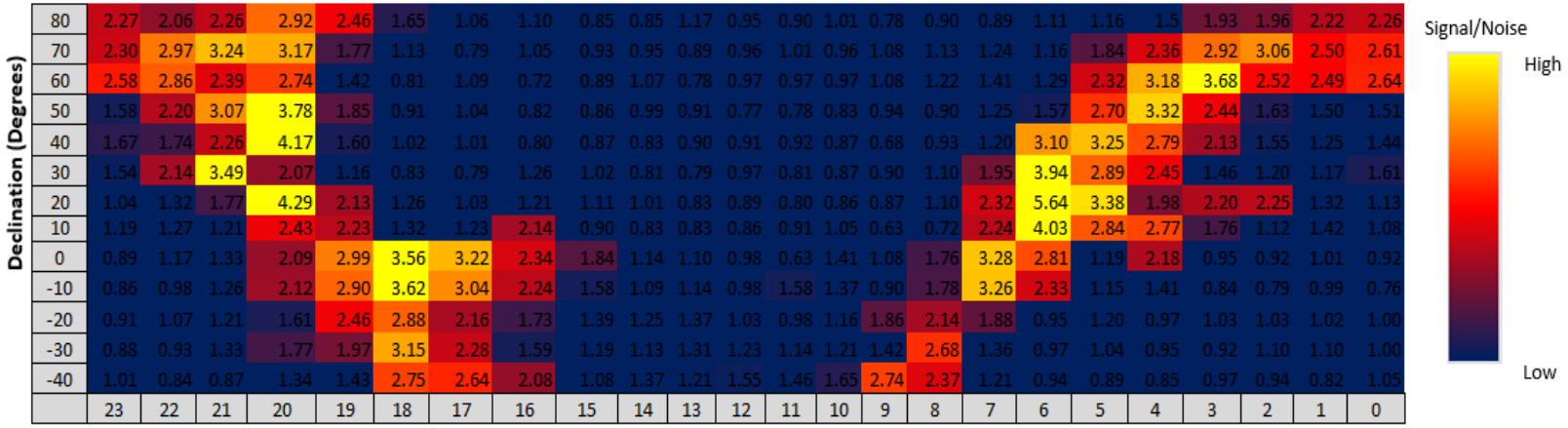
- Mapping the Milky Way
- Velocity vs Galactic Longitude Model

- Movement of the Earth around the Milky Way
- Mass of the Milky Way (inside the Sun's orbit
- Location of the Earth around the Sun

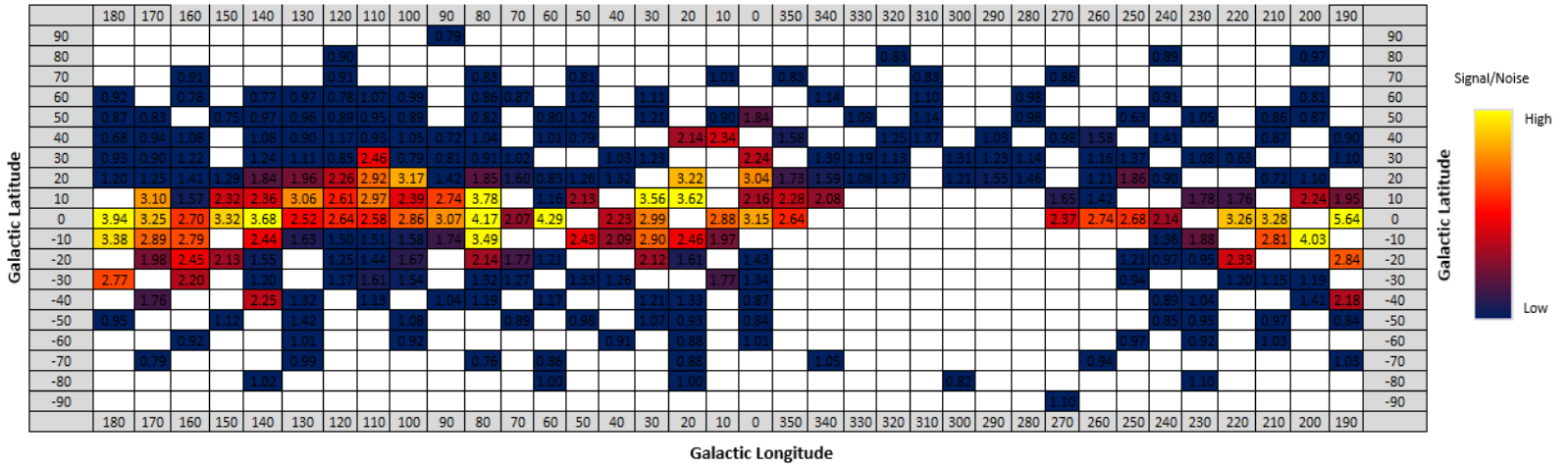
- See http://dses.science/dses-publications

HI Drift Scan using 9-ft Dish at Russel Observatory September 2019

Russel Observatory
HI Spectrum Peak Map Survey



Russel Observatory
HI Spectrum Peak Map Survey

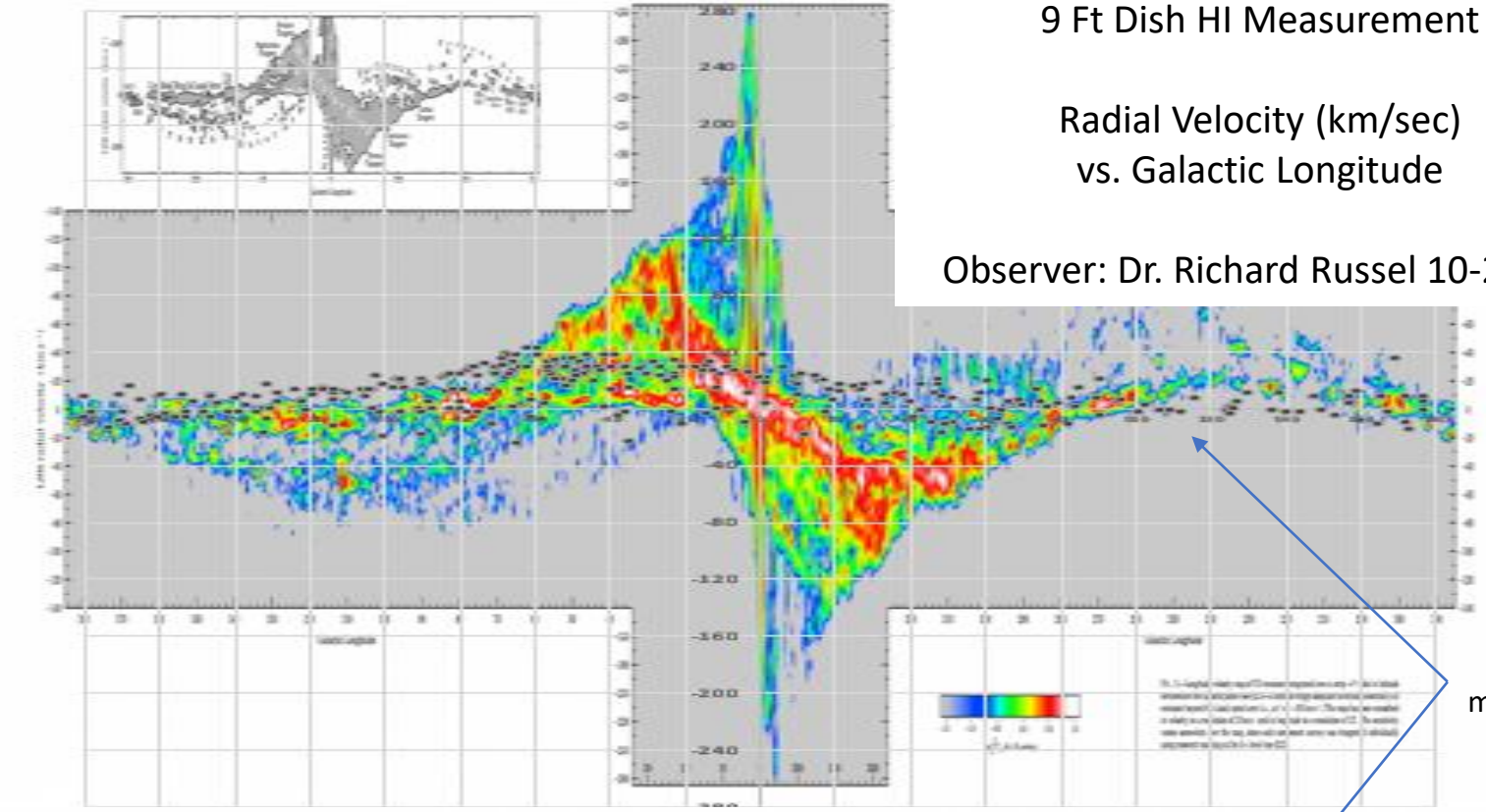


Dr. Richard Russel Observer and Analyst (DrRichRussel@Netscape.net)

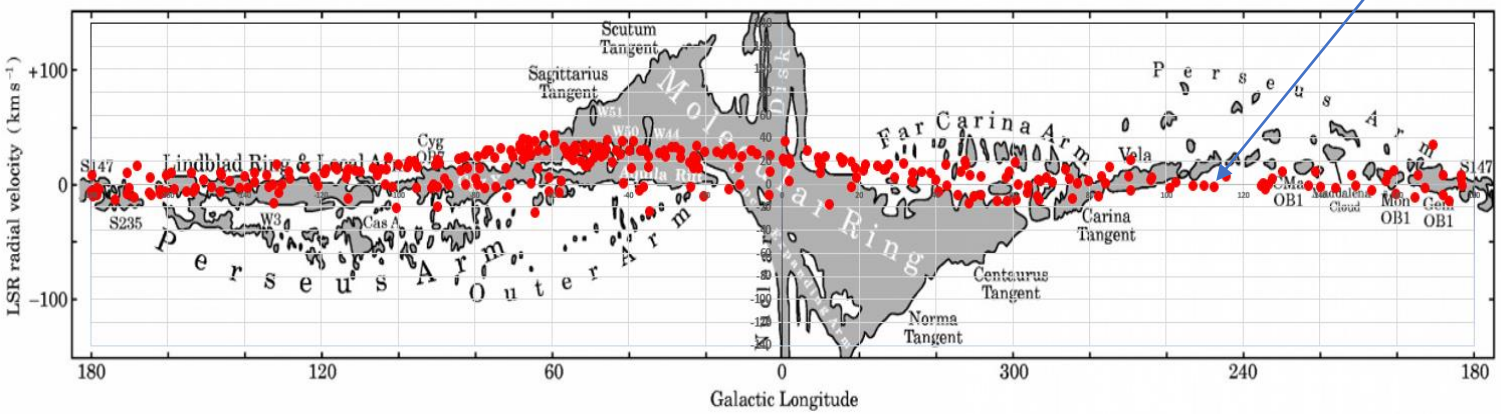
9 Ft Dish HI Measurement

Radial Velocity (km/sec)
vs. Galactic Longitude

Observer: Dr. Richard Russel 10-23-19



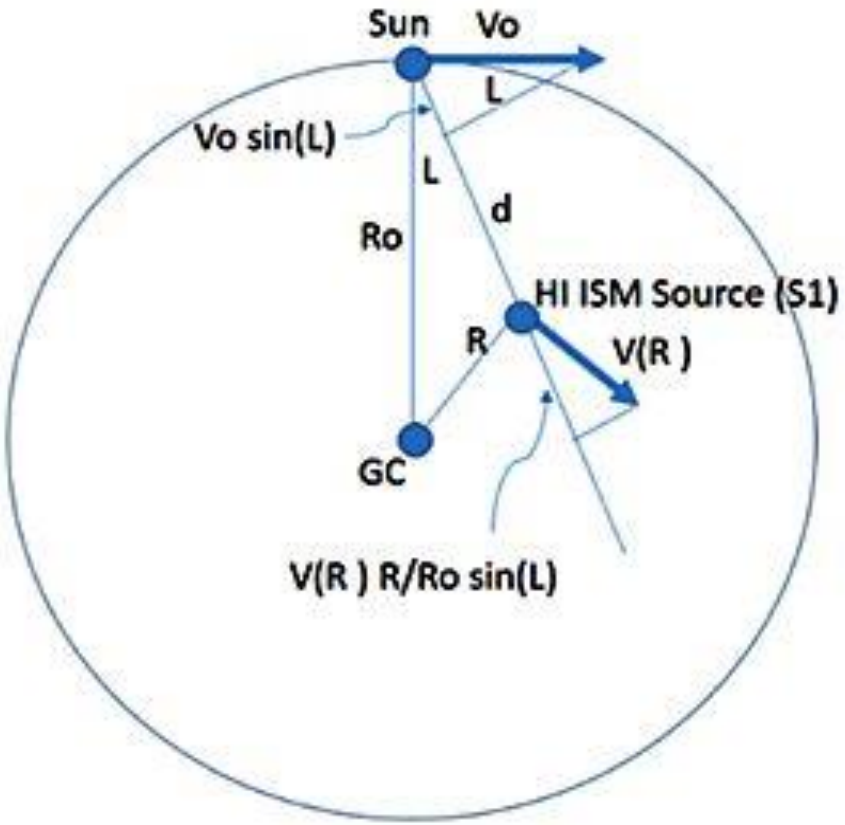
9ft dish HI measurements



Background images obtained at:

https://www.britannica.com/place/Milky-Way-Galaxy/The-structure-and-dynamics-of-the-Milky-Way-Galaxy

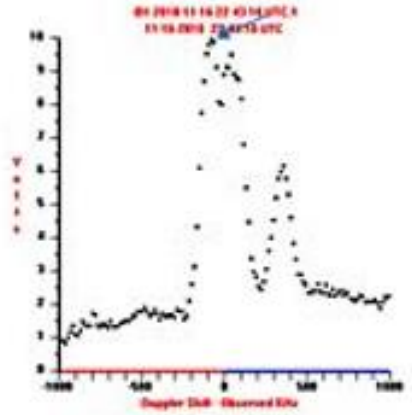
Hydrogen Analysis Geometry



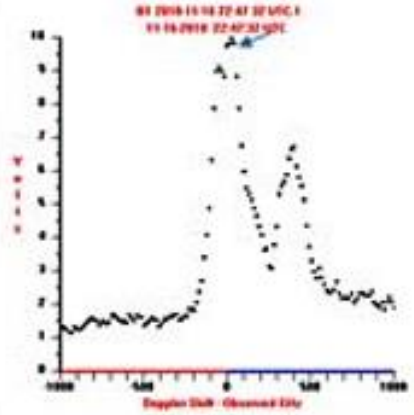
Hydrogen Observations

Galactic Rotation Data (11-17-18 Observations)

GLat 0 Glong 55



GLat 0 Glong 60



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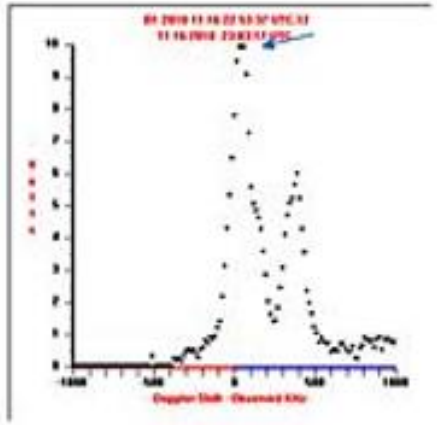

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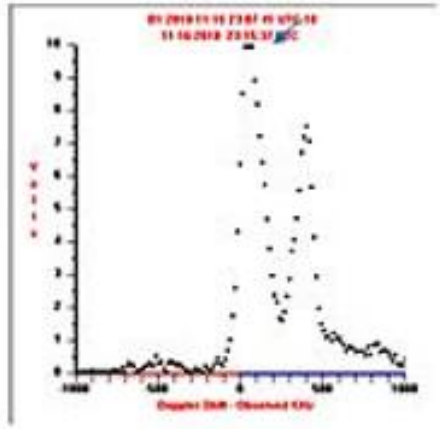

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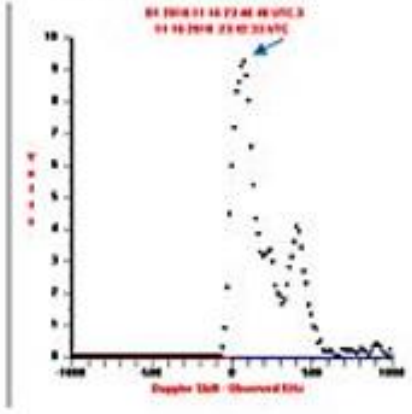

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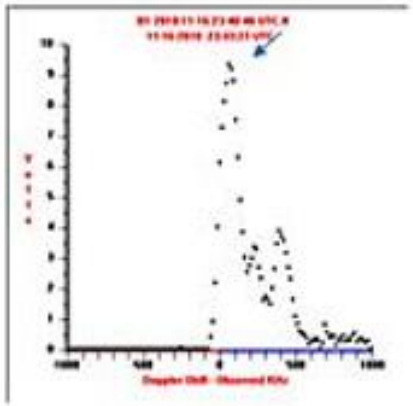
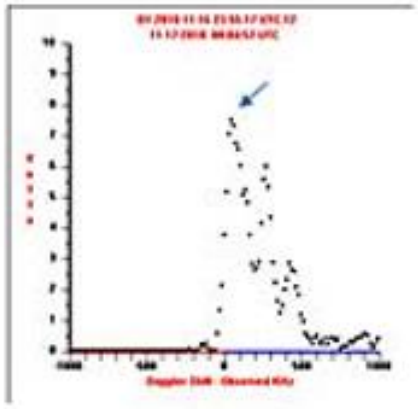
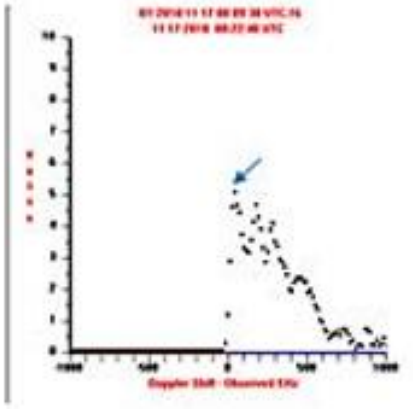


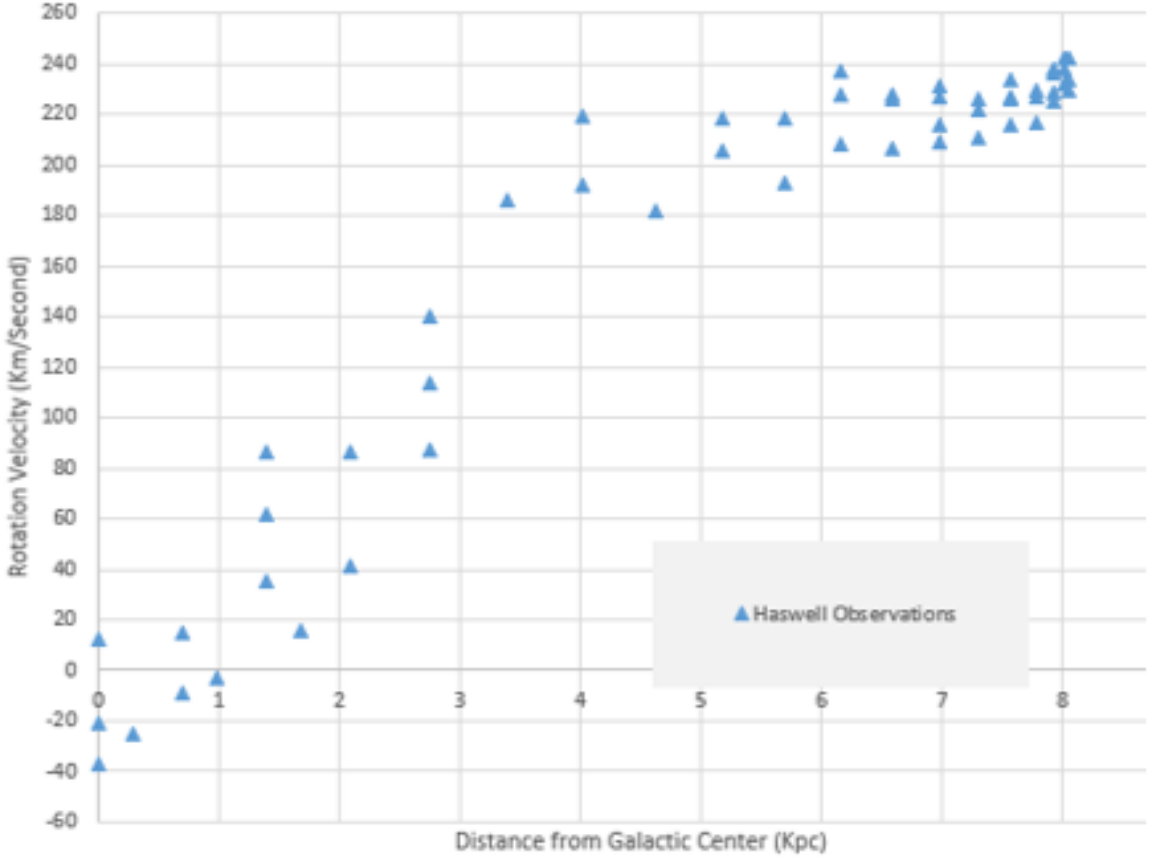
GLat 0 Glong 85



GLat 0 Glong 90



Galactic Rotation



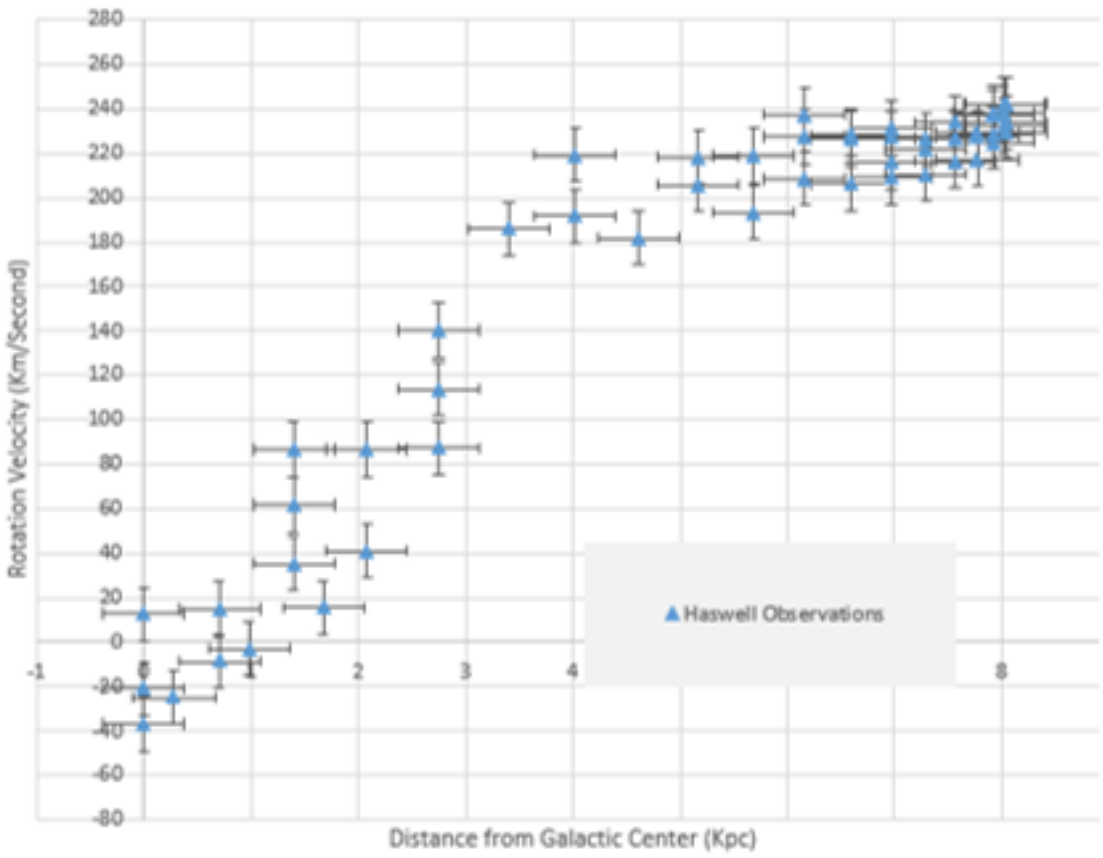


Figure 5: Galactic Rotation Plot

Calculating Mass of Milky Way

The mass of the galaxy can be calculated using the formula:

$$M = \frac{V^2 R}{G} \quad (5)$$

M: Mass of galaxy (kg)
V: Velocity of the galaxy at distance R (km/second)
R: distance from galactic center (m)
G: Gravitation constant $6.67x10^{-11}m^3kg^{-1}s^{-2}$

From the measured results in table 3, the calculated velocity of the galaxy at 8.05±0.46 kpc is 243.3±16.2 km/s. Entering these values into equation 5 with the appropriate conversions:

$$M = \frac{\left(243.3\frac{km}{s}x\frac{10^3 m}{km}\right)^2 (8.05kpc)\left(\frac{3.09x10^{19}m}{1kpc}\right)}{(6.67x10^{-11}m^3kg^{-1}s^{-2})} = 2.21x10^{41}kg \quad (6)$$

$$M = (2.21x10^{41}kg)\left(\frac{1\,M_{Sun}}{2x10^{30}kg}\right) = 1.10x10^{11}M_{Sun} \quad (7)$$

The error range was calculated by substituting the Vo and Ro error ranges into the formulas which results in a total error range of:

$$\mathrm{M}= 1.10x10^{11} \pm 0.22x10^{11}M_{Sun} \quad (8)$$

The estimate for the mass of the Milky Way has been estimated as (Sofue, 2017):

$$M = (1.0x10^{11})M_{Sun}\left(\frac{R}{Ro}\right) \quad (9)$$

The observed measurements, therefore, encompass the historic values of the Milky Way's mass.

Earth Position Using HI Sources

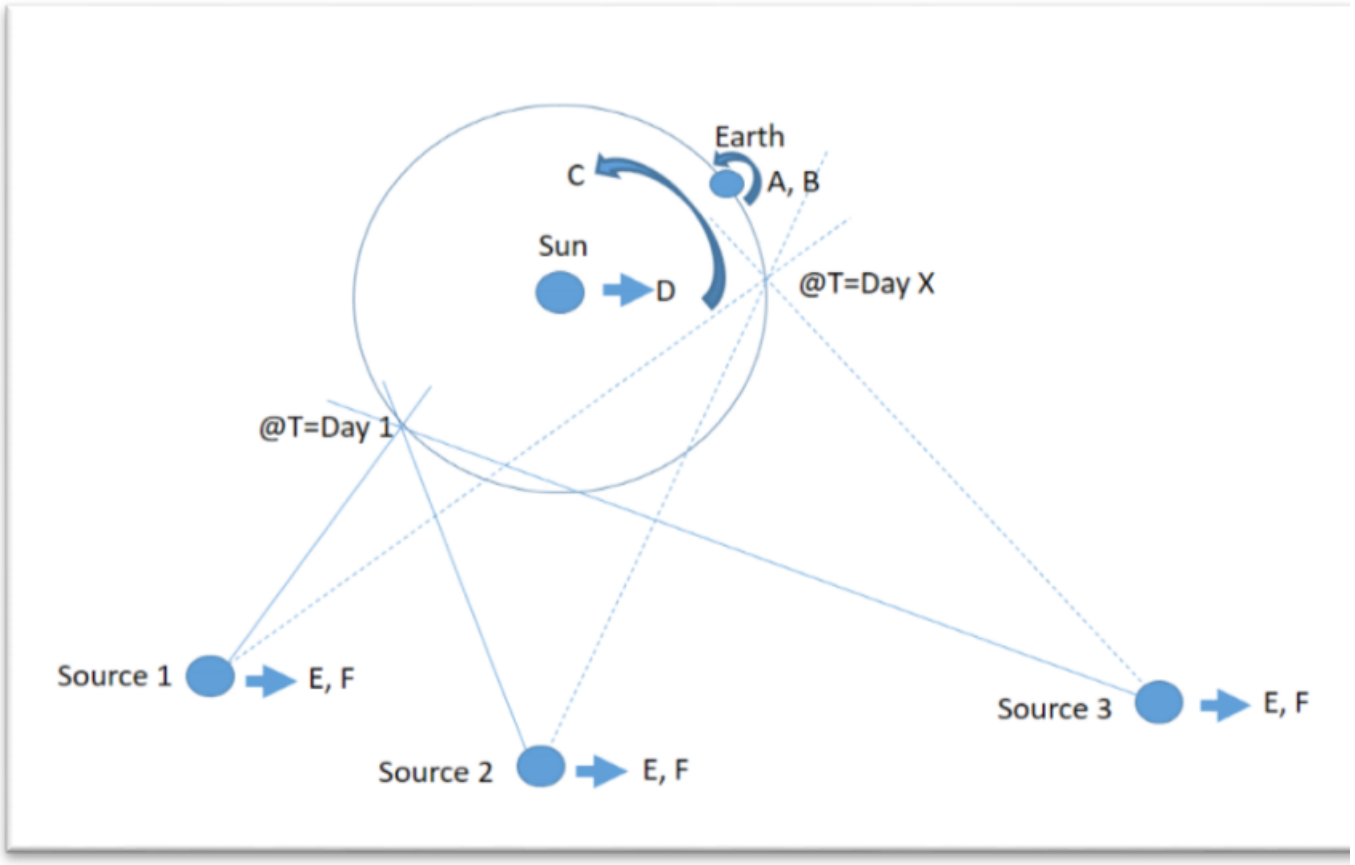


Figure 1: Velocity Contributions of the HI ISM Source Measurements

Inclination Contribution

The inclination of the Earth's orbit to the galactic plane is i=60.2°. (Figure 2)

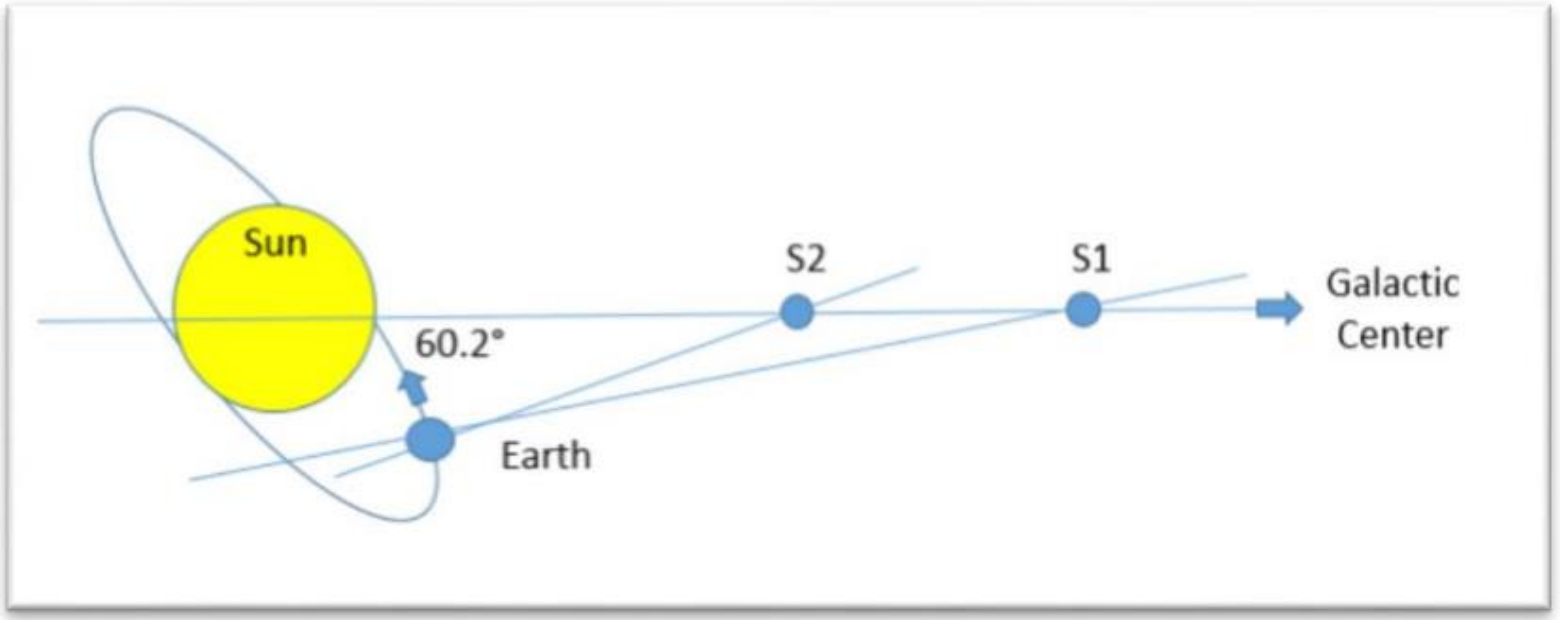


Figure 2: Sun – Galactic Center plane inclination

Earth Position in Milky Way

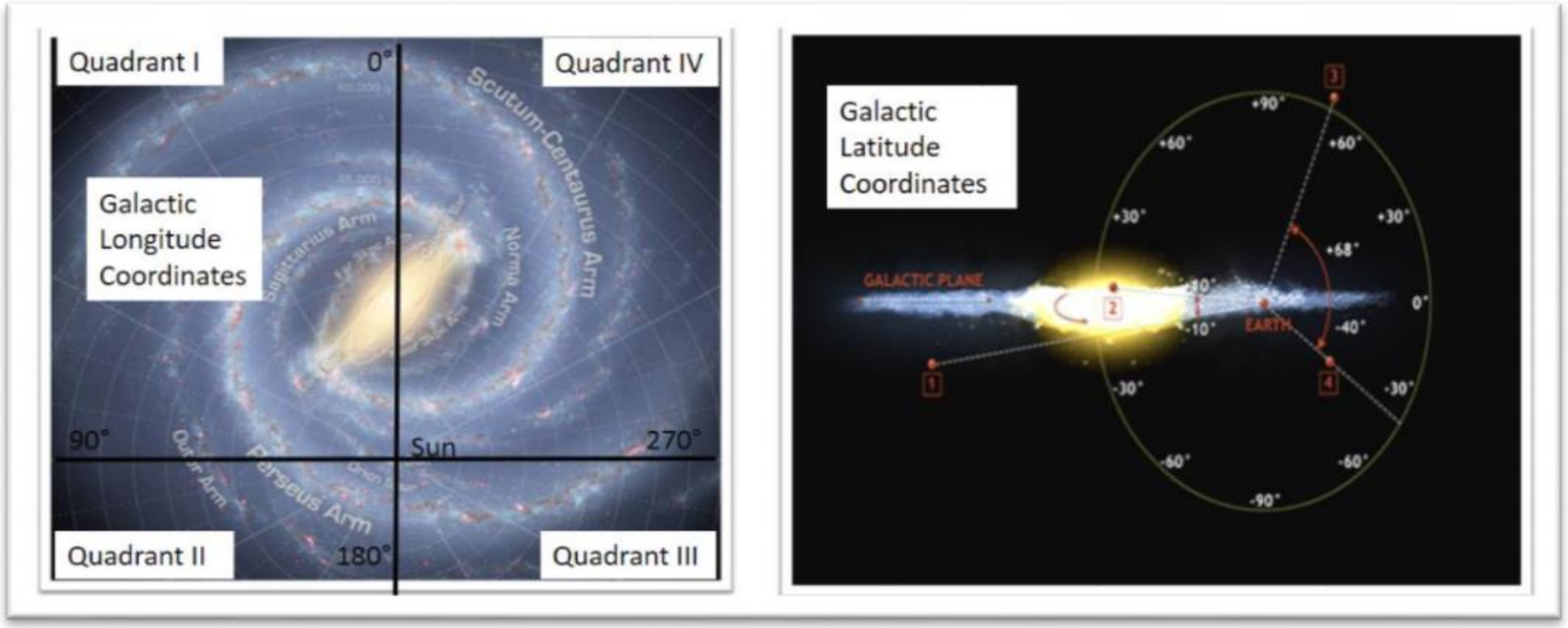
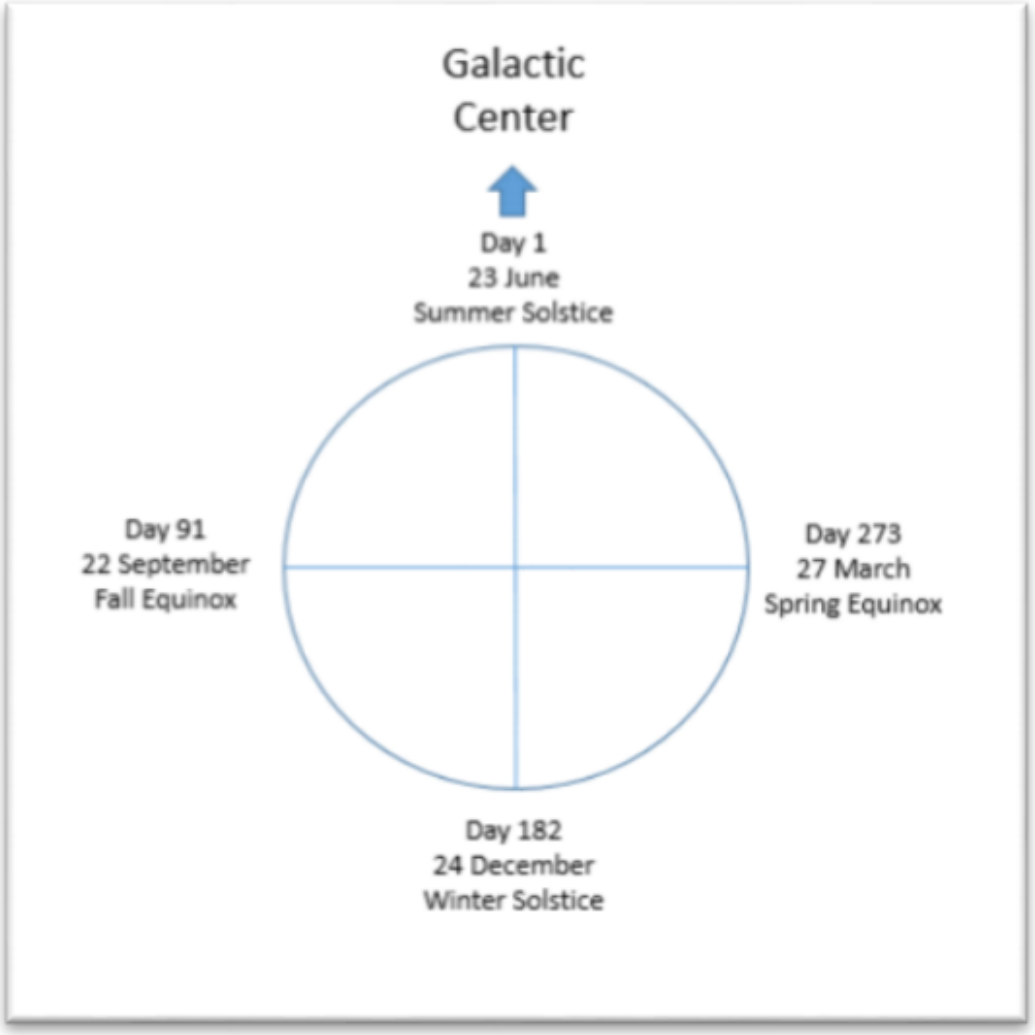


Figure 4: Galactic Coordinates (Charting the Milky Way From the Inside Out, 2015) (Galactic Navigation, n.d.)

Earth Position toward the Galactic Center



Earth Cycle over a Year

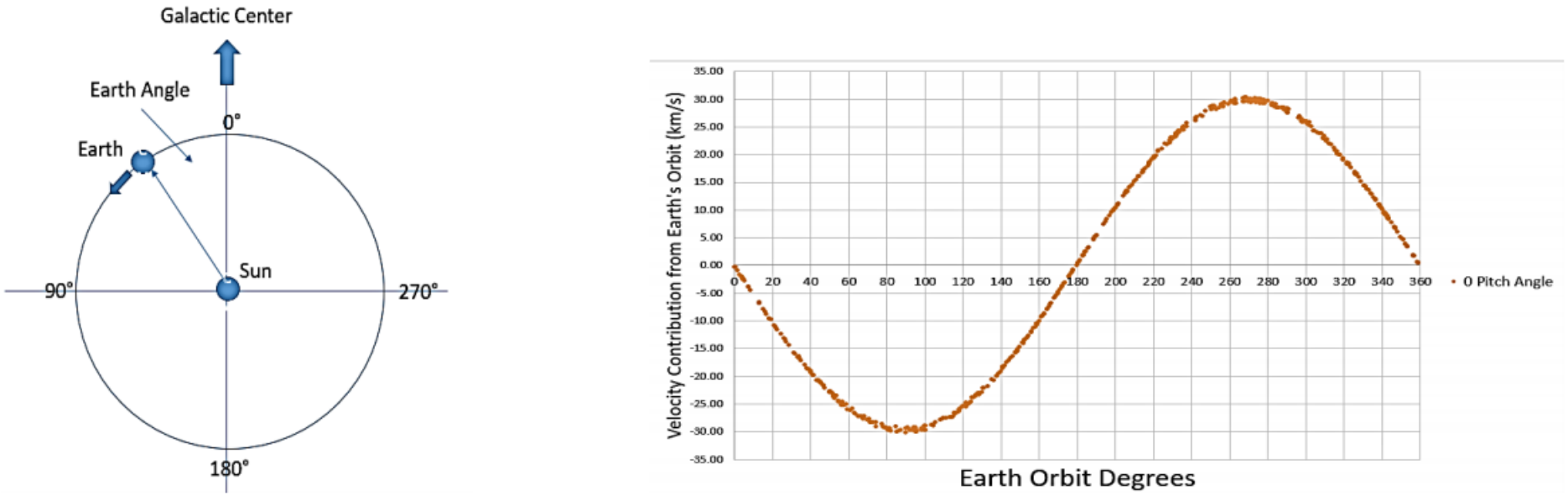
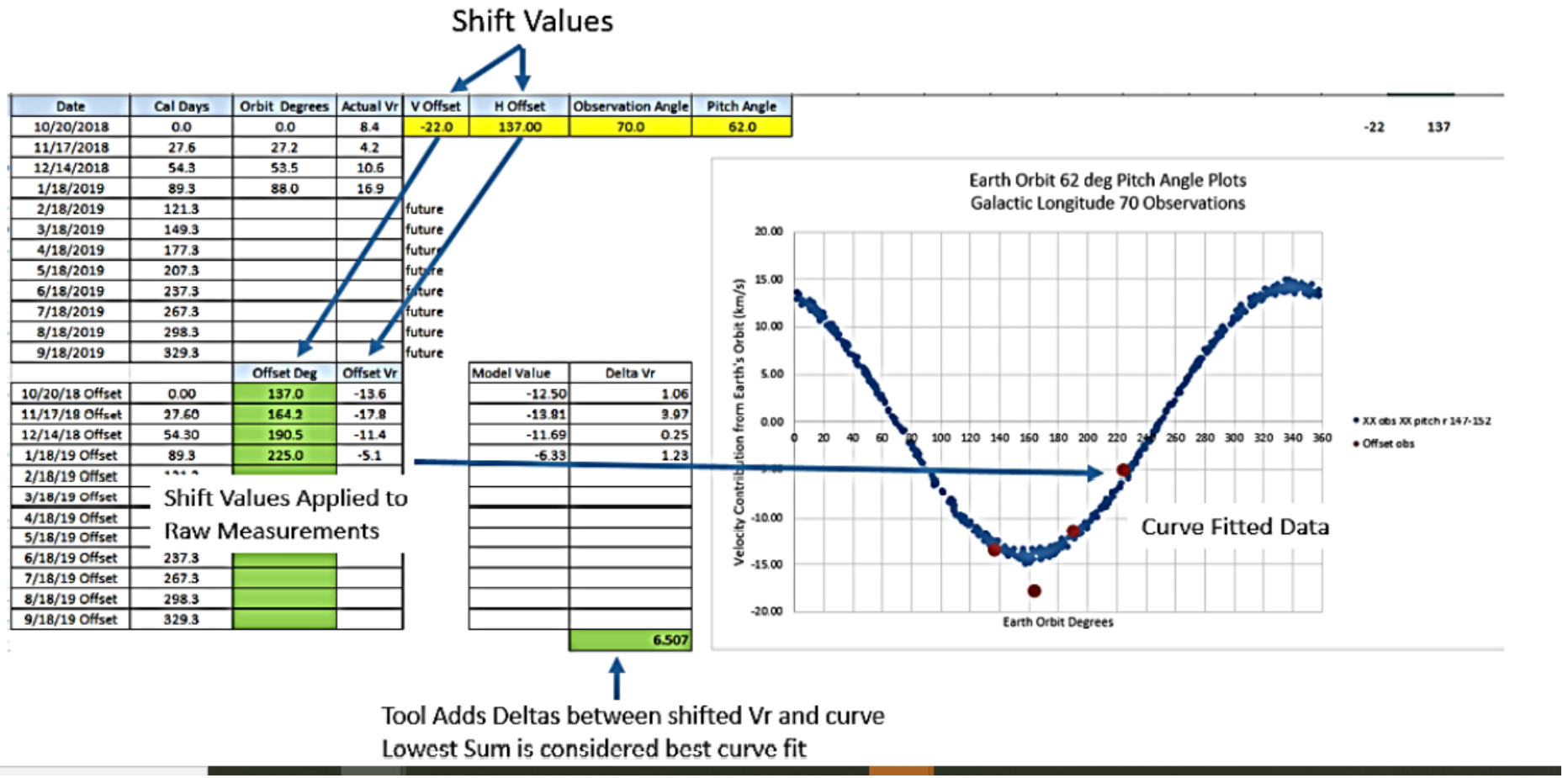


Figure 2 Earth Angle and Velocity Change Relative to the Galactic Center

Earth Position Model



Date	Cal Days	Orbit Degrees	Actual Vr	V Offset	H Offset	Observation Angle	Pitch Angle
10/20/2018	0.0	0.0	8.4	-22.0	137.00	70.0	62.0
11/17/2018	27.6	27.2	4.2				
12/14/2018	54.3	53.5	10.6				
1/18/2019	89.3	88.0	16.9				
2/18/2019	121.3			future			
3/18/2019	149.3			future			
4/18/2019	177.3			future			
5/18/2019	207.3			future			
6/18/2019	237.3			future			
7/18/2019	267.3			future			
8/18/2019	298.3			future			
9/18/2019	329.3			future			

		Offset Deg	Offset Vr	Model Value	Delta Vr
10/20/18 Offset	0.00	137.0	-13.6	-12.50	1.06
11/17/18 Offset	27.60	164.2	-17.8	-13.81	3.97
12/14/18 Offset	54.30	190.5	-11.4	-11.69	0.25
1/18/19 Offset	89.3	225.0	-5.1	-6.33	1.23
2/18/19 Offset					
3/18/19 Offset					
4/18/19 Offset					
5/18/19 Offset					
6/18/19 Offset	237.3				
7/18/19 Offset	267.3				
8/18/19 Offset	298.3				
9/18/19 Offset	329.3				
					6.507

Earth Position Results

10/20/2018		Angle
X1	Y1	135.0
0	0	
-0.70754741	-0.70667	

11/17/2018		Angle
X1	Y1	162.2
0	0	
-0.30617227	-0.95198	

12/14/2018		Angle
X1	Y1	188.5
0	0	
0.14765613	-0.98904	

1/18/2019		Angle
X1	Y1	223.0
0	0	
0.68190598	-0.73144	

2/16/2019		Angle
X1	Y1	252.6
0	0	
0.95406061	-0.29961	

Peihelion		Angle
X1	Y1	207.2
0	0	
0.4575767	-0.88917	

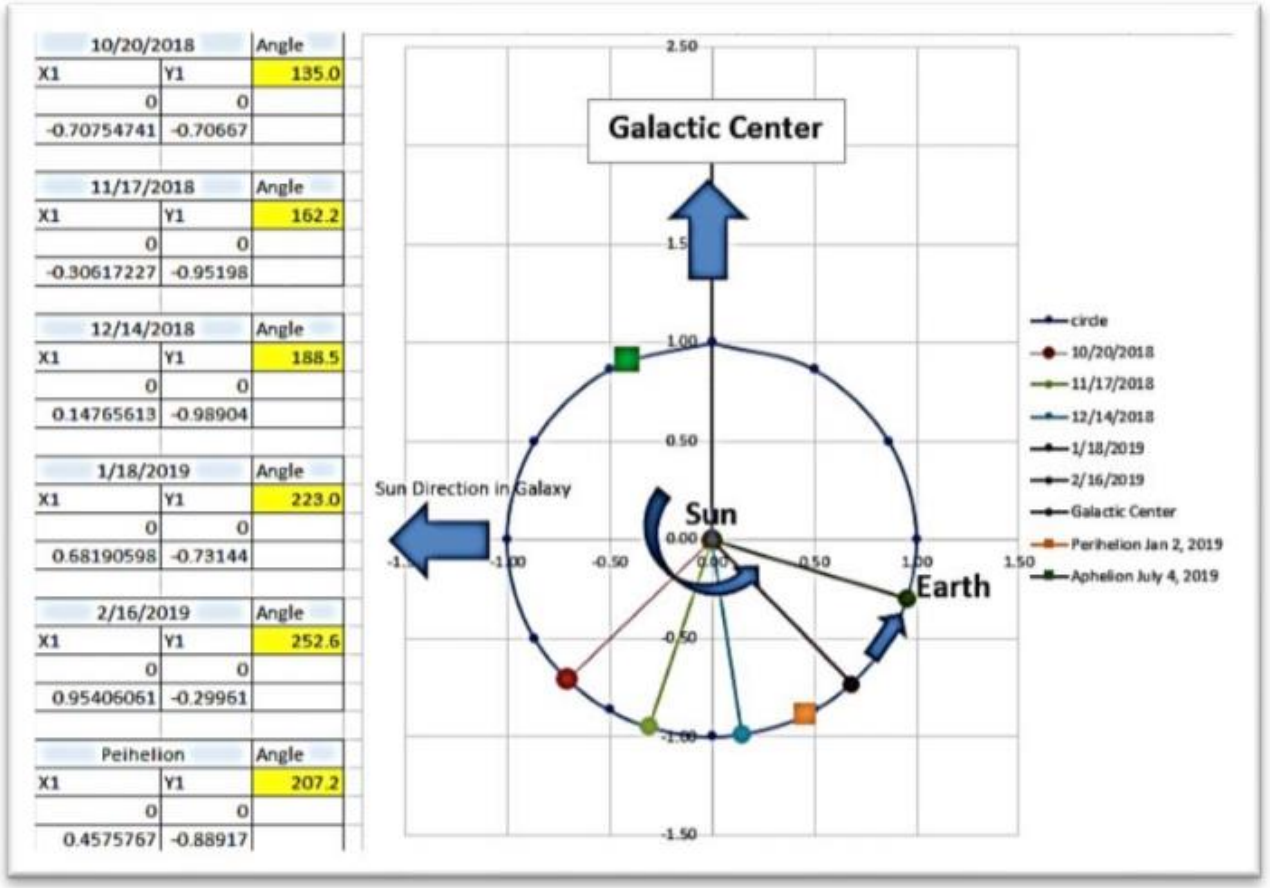
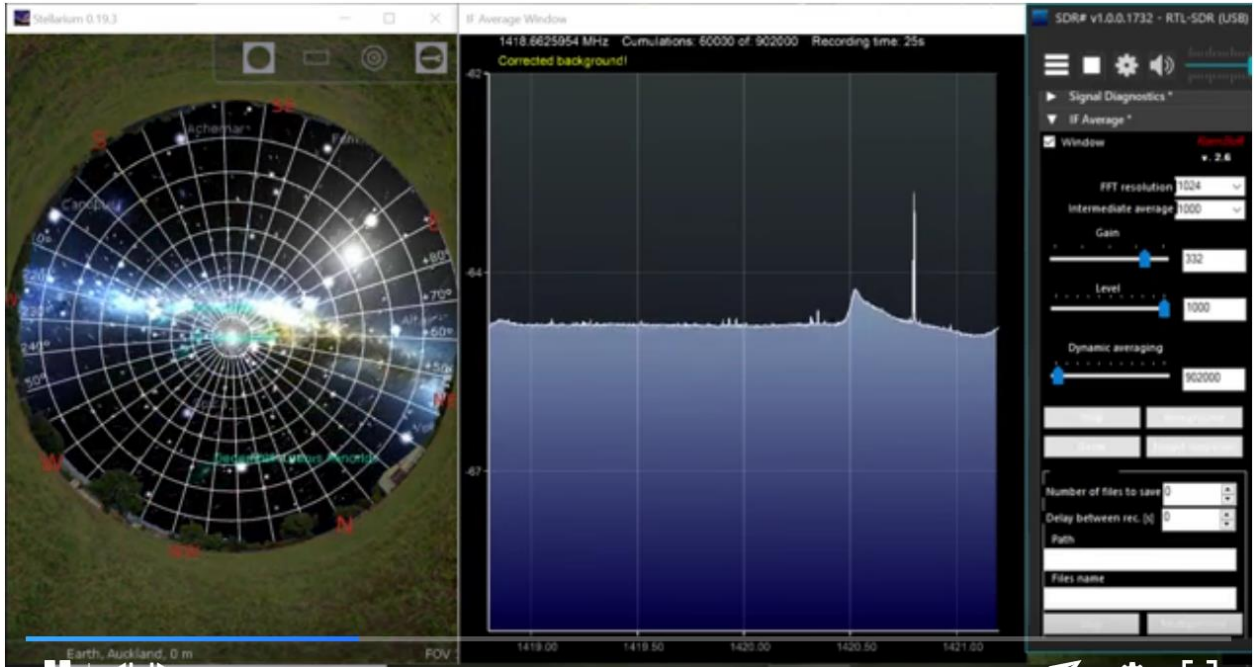


Figure 25: Average Earth Position in Orbit for each Observation Day

SARA Radio Astronomy in a Box



https://www.rtl-sdr.com/cheap-and-easy-hydrogen-line-radio-astronomy-with-a-rtl-sdr-wifi-parabolic-grid-dish-lna-and-sdrsharp/

NOTE: There was a virus on the RTLSharp software download link referenced in this article !!!!!

Plan after November Moon Bounce Event

- Start taking HI Measurements in December on 60 ft dish
- Start pulsar measurements at 1420MHZ
- Assemble SARA HI system
- Take drift scan data on 9-ft dish
- Do 4 GHZ pointing calibration

- Engineering
  - Get Ray's Radio Astronomy receiver hooked to GNU software for pulsars
  - Get the B210 online – this may increase BW to 20 MHz
  - Consider getting an X310 ($5800) – will allow 100MHZ

Questions?