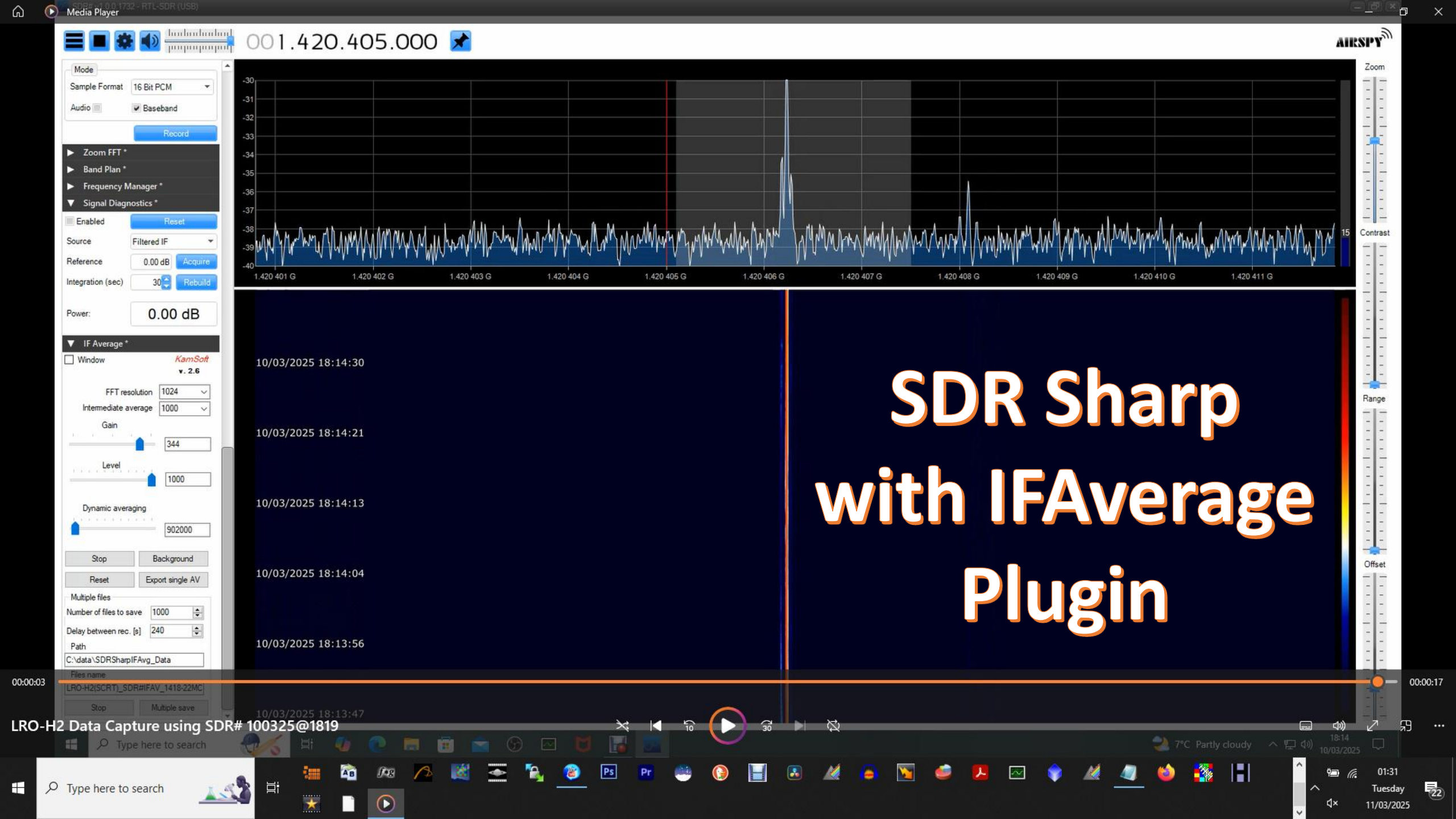
Software options for Hydrogen Line Radio Astronomy

Dr Andrew Thornett

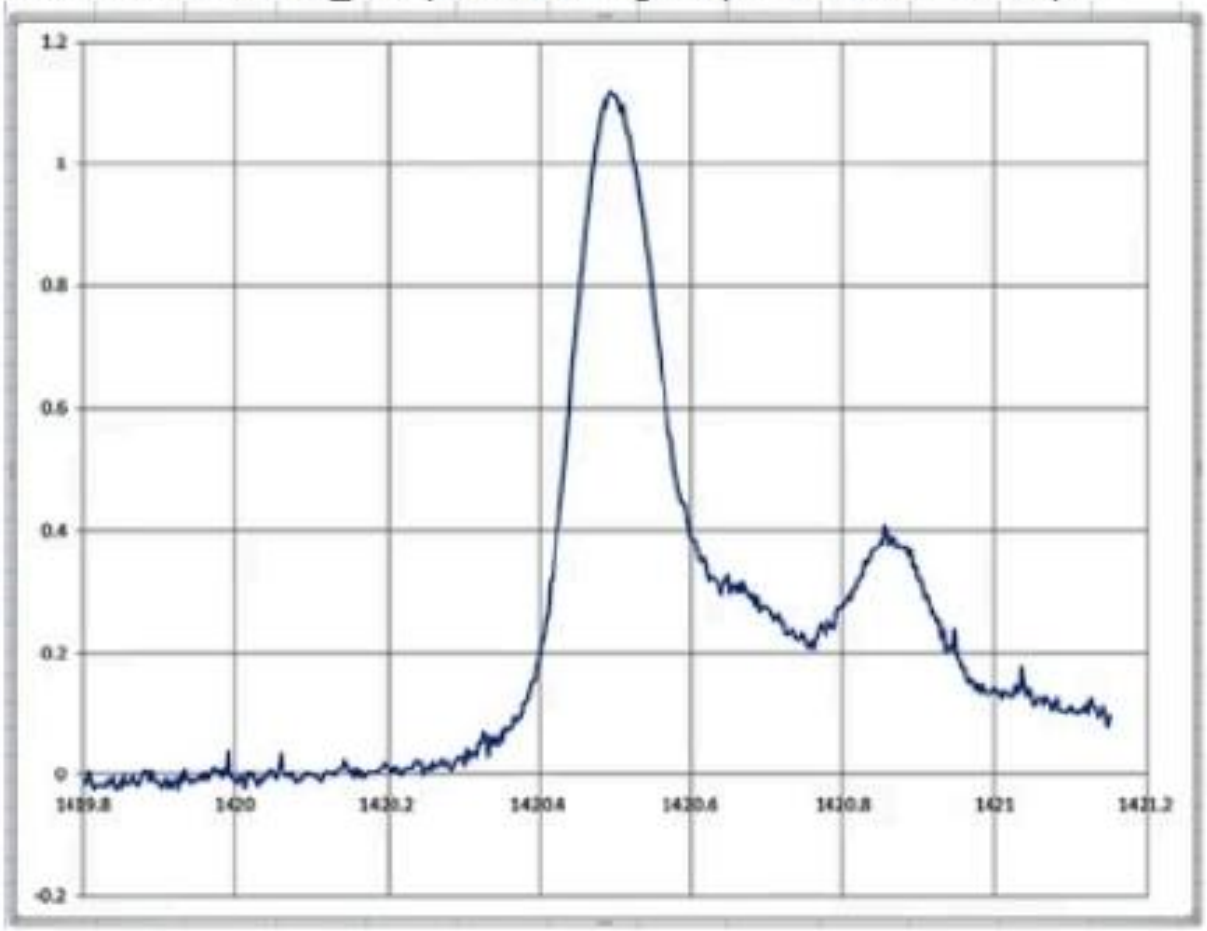
LRO Hydrogen Line Radio Telescopes


Media Player
001.420.405.000
AIRSPY
Mode
Sample Format
16 Bit PCM
Audio
Baseband
Record
Zoom FFT *
Band Plan *
Frequency Manager *
Signal Diagnostics *
Enabled
Reset
Source
Filtered IF
Reference
0.00 dB
Acquire
Integration (sec)
30
Rebuild
Power:
0.00 dB
IF Average *
Window
KamSoft
v. 2.6
FFT resolution
1024
Intermediate average
1000
Gain
344
Level
1000
Dynamic averaging
902000
Stop
Background
Reset
Export single AV
Multiple files
Number of files to save
1000
Delay between rec. [s]
240
Path
C:\data\SDRSharpIFAvg_Data
Files name
LRO-H2(SCRT)_SDR#IFAV_1418-22MC
Stop
Multiple save
-30
-31
-32
-33
-34
-35
-36
-37
-38
-39
-40
15
1.420 401 G
1.420 402 G
1.420 403 G
1.420 404 G
1.420 405 G
1.420 406 G
1.420 407 G
1.420 408 G
1.420 409 G
1.420 410 G
1.420 411 G
Zoom
Contrast
Range
Offset
10/03/2025 18:14:30
10/03/2025 18:14:21
10/03/2025 18:14:13
10/03/2025 18:14:04
10/03/2025 18:13:56
10/03/2025 18:13:47
SDR Sharp
with IFAverage
Plugin
00:00:03
00:00:17
LRO-H2 Data Capture using SDR# 100325@1819
Type here to search
7°C Partly cloudy
18:14
10/03/2025
Type here to search
01:31
Tuesday
11/03/2025

SDR Sharp with IFAverage Plugin

SDR# and IF_Ave Real Time Display
The ' ripple' in the display is from using the Decimation option of the AirSpyMini SDR to improve S/N .. Easily removed via IF_Ave

Saved data from IF_Ave plotted in Log Ampl 1 ea 5 min sample



Download AirSpy SDR# Studio with Kaminski IF_avg pre-installed

HERE

IF_Ave Ver 2.7 & 2.8 PlugIn for SDR# Studio

Full Installation of SDR# & IF_Ave 2.7

https://www.dropbox.com/scl/fi/2f67lyu6qgt2cp98rg9kp/SDR-2.ZIP?rlkey=y82yv6jzjyu7e92sap3x8ewm7&st=tcil7w3s&dl=0

The latest Rev of **IF_Ave allows**

Saving and Recalling named Background Correction Files replace the above with this newer * DLL

IF_Ave Version 2.8

https://www.dropbox.com/scl/fi/aitn8xtookwwxm6mvybkp/SDRSharp.Average.dll?rlkey=667f4a83958krn77ie2862jxf&dl=0

For folks starting to explore radio astronomy,

ezRA - Easy Radio Astronomy

Free 1420 MHz Galactic hydrogen data collection and analysis

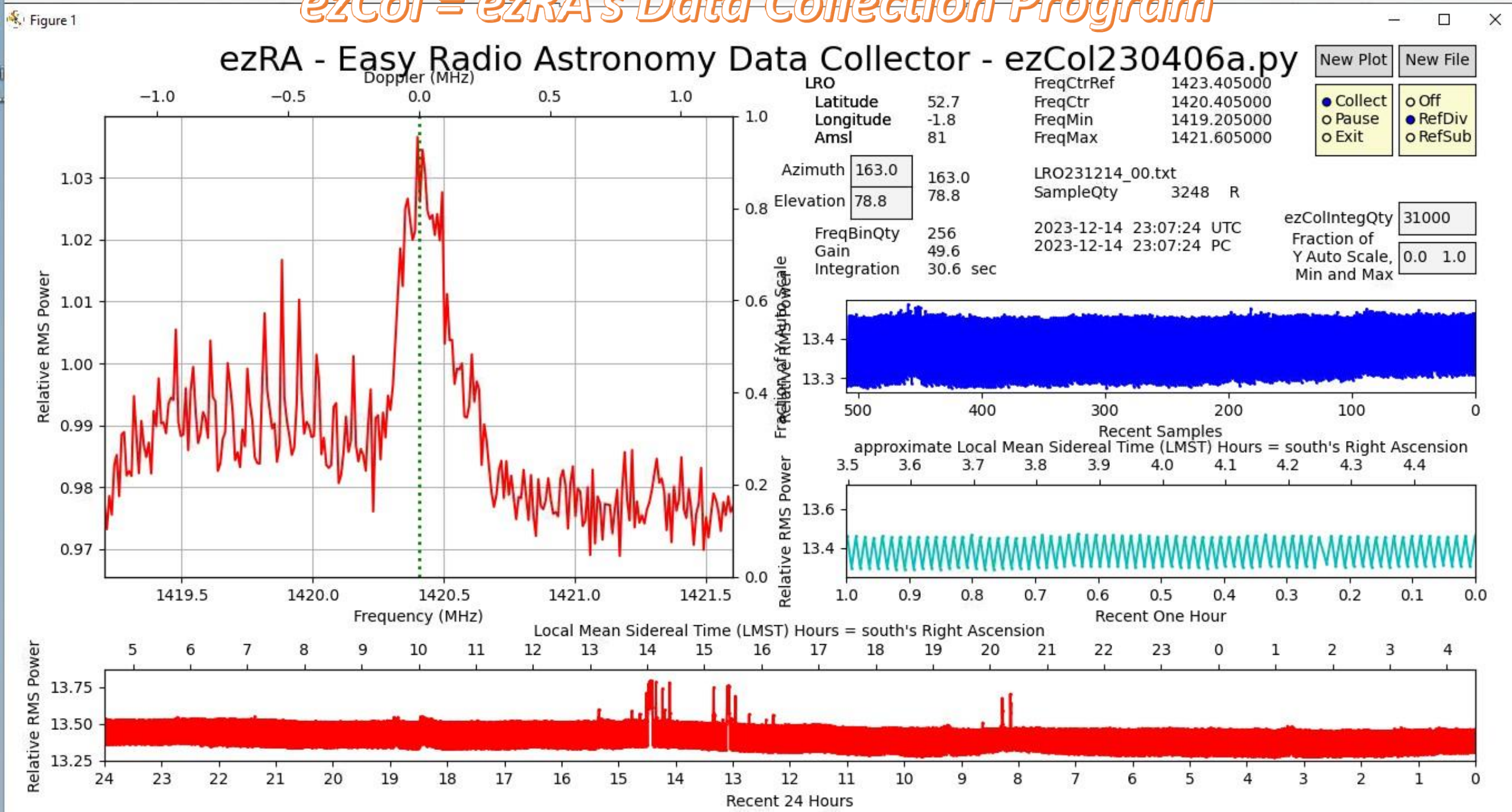
https://github.com/tedcline/ezRA

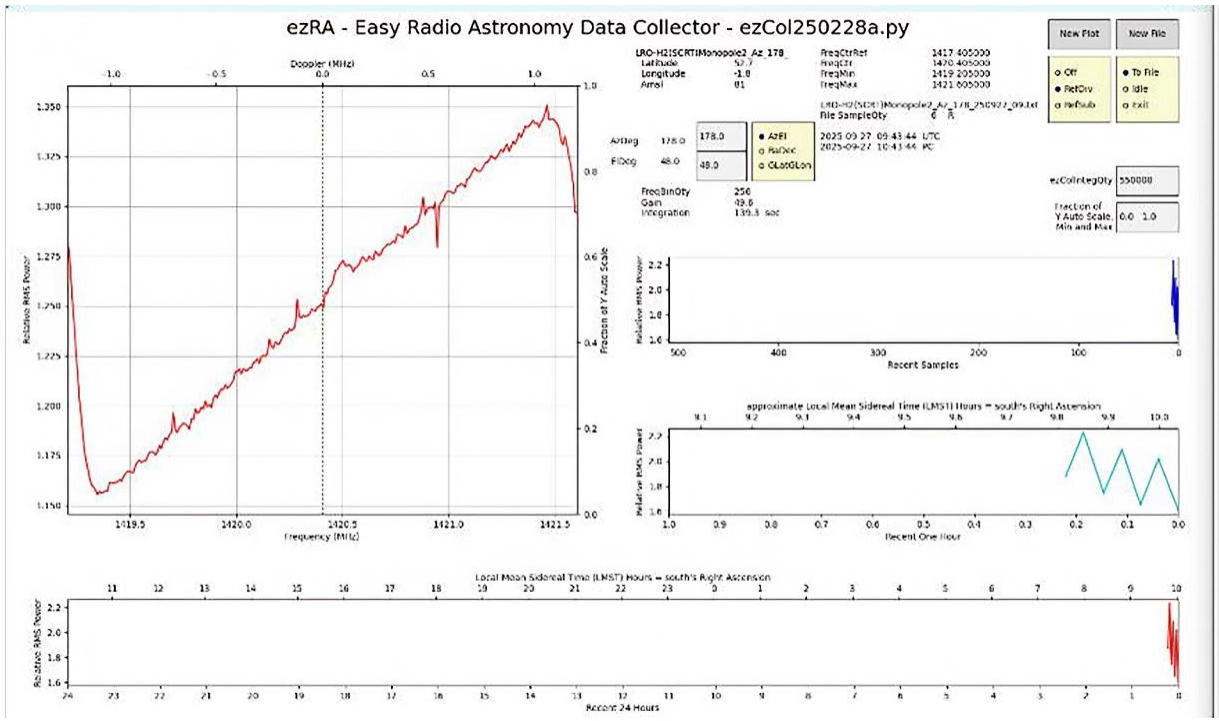
Windows and Linux

LRO-PharmiganArray (LRO-LAP-03) - RealVNC Viewer

ezCol = ezRA's Data Collection Program

Figure 1




ezRA - Easy Radio Astronomy Data Collector - ezCol250228a.py
Doppler (MHz)
Relative RMS Power
Fraction of Y Auto Scale
Frequency (MHz)
Recent Samples
approximate Local Mean Sidereal Time (LMST) Hours = south's Right Ascension
Recent One Hour
Local Mean Sidereal Time (LMST) Hours = south's Right Ascension
Recent 24 Hours
New Plot
New File
LRO-H2(SCRT)Monopole2_Az_178_
Latitude 52.7
Longitude -1.8
Amsl 81
FreqCtrRef 1417.405000
FreqCtr 1420.405000
FreqMin 1419.205000
FreqMax 1421.605000
File SampleQty 6
AzDeg 178.0
ElDeg 48.0
AzEl
RaDec
GLatGLon
2025-09-27 09:43:44 UTC
2025-09-27 10:43:44 PC
FreqBinQty 256
Gain 49.6
Integration 139.3 sec
ezColIntegQty 550000
Fraction of Y Auto Scale, Min and Max 0.0 1.0
Off
RefDiv
RefSub
To File
Idle
Exit

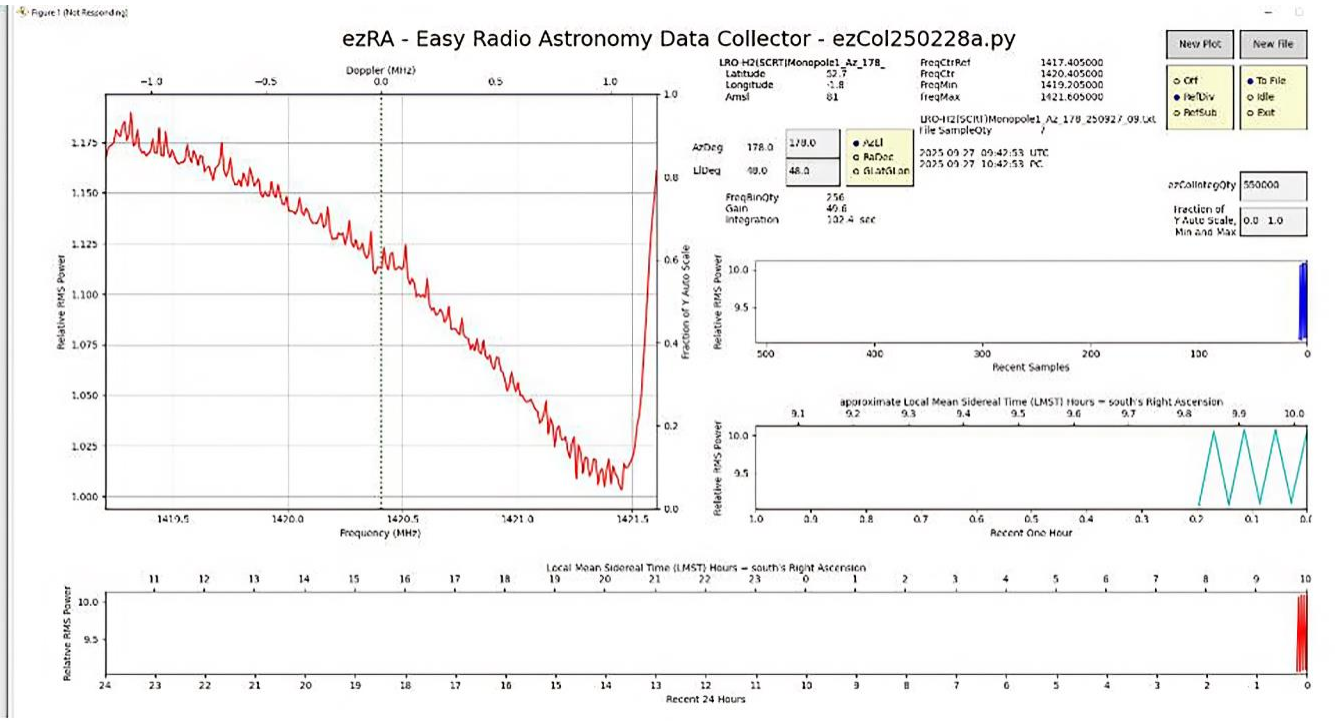
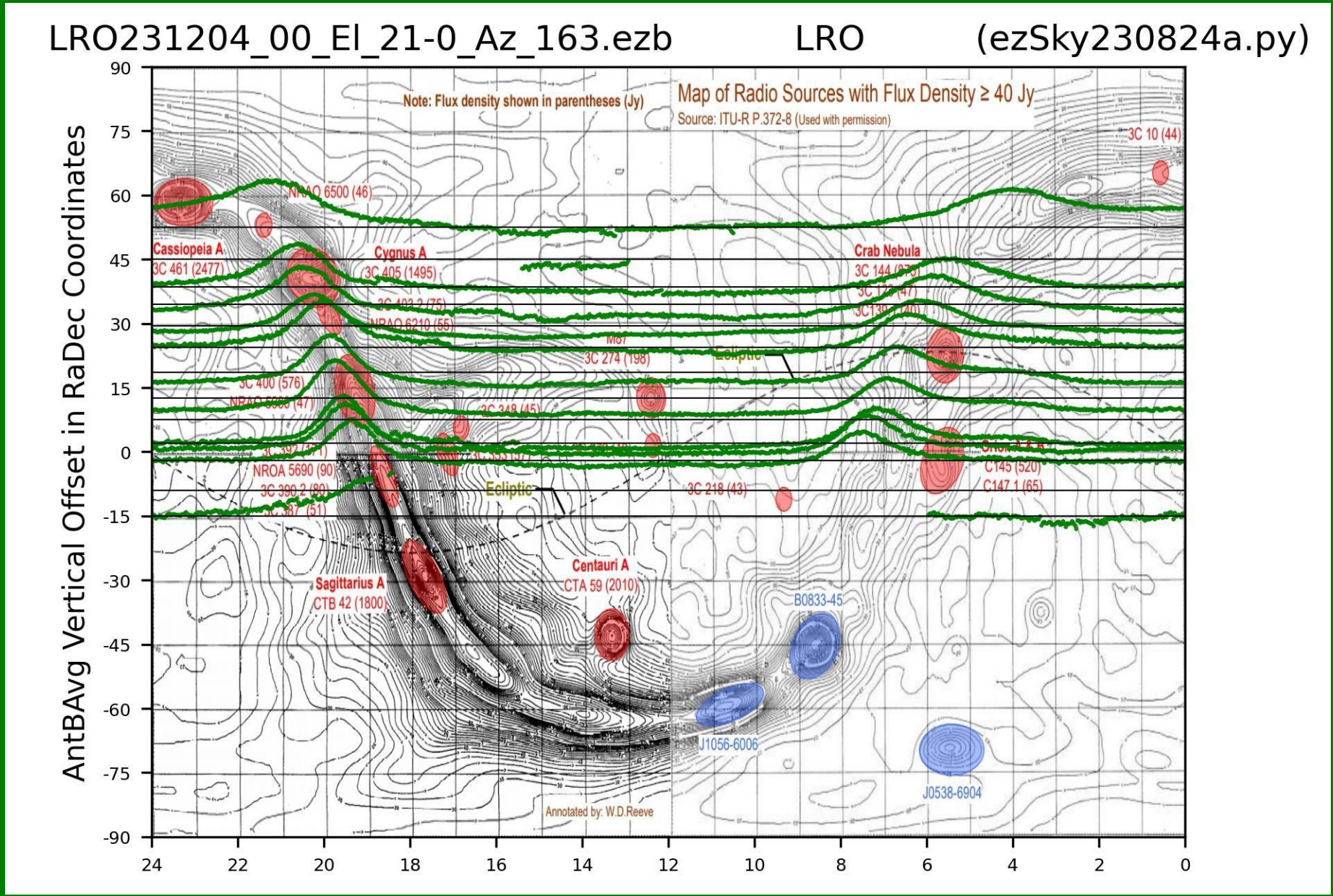
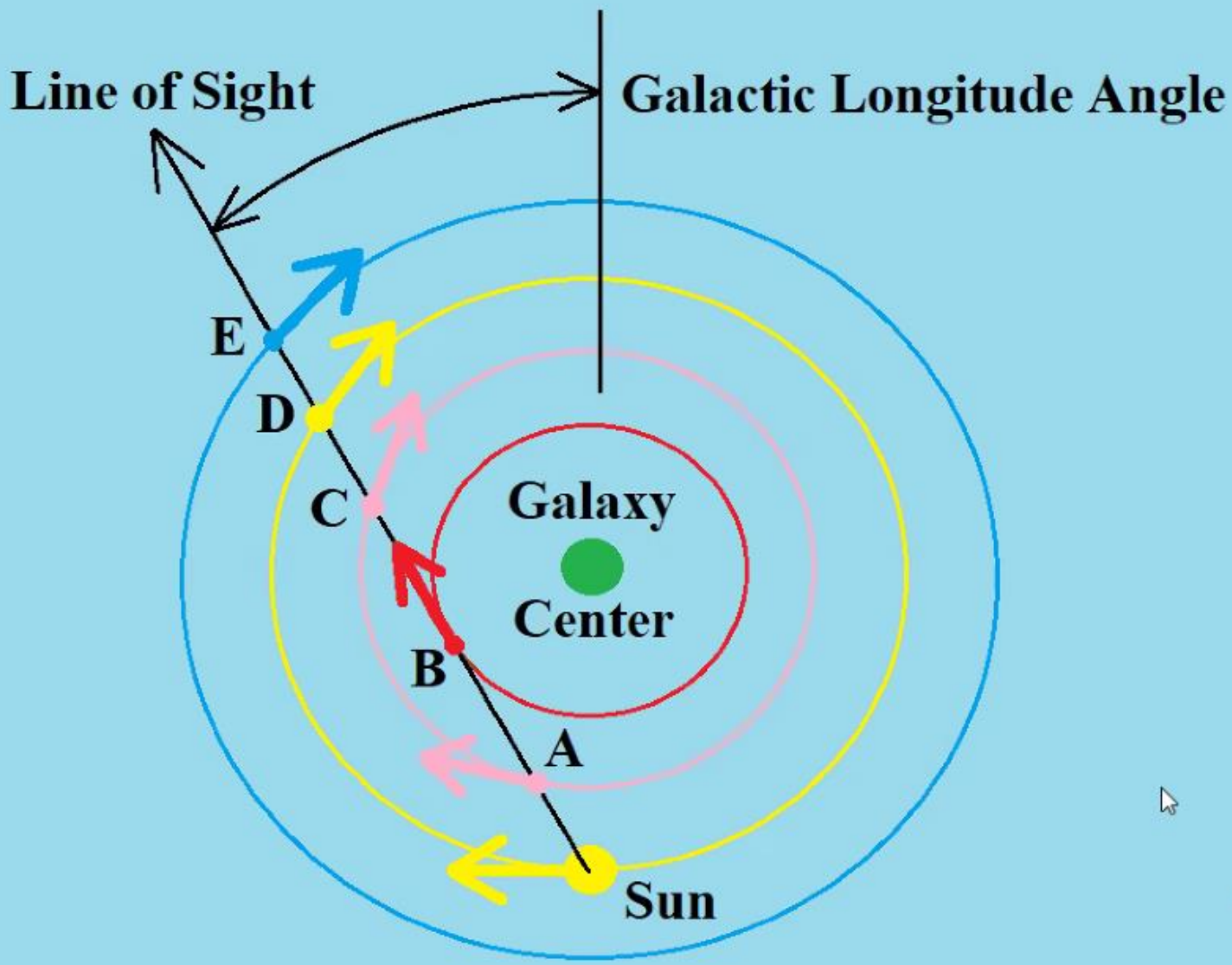


Figure 1 (Not Responding)
ezRA - Easy Radio Astronomy Data Collector - ezCol250228a.py
Doppler (MHz)
Relative RMS Power
Fraction of Y Auto Scale
Frequency (MHz)
Recent Samples
aproximate Local Mean Sidereal Time (LMST) Hours = south's Right Ascension
Recent One Hour
Local Mean Sidereal Time (LMST) Hours = south's Right Ascension
Recent 24 Hours
New Plot
New File
LRO-H2(SCRT)Monopole1_Az_178_
Latitude 52.7
Longitude -1.8
Amsl 81
FreqCtrRef 1417.405000
FreqCtr 1420.405000
FreqMin 1419.205000
FreqMax 1421.605000
File SampleQty 7
AzDeg 178.0
ElDeg 48.0
AzEl
RaDec
GLatGLon
2025-09-27 09:42:53 UTC
2025-09-27 10:42:53 PC
FreqBinQty 256
Gain 49.6
Integration 102.4 sec
ezColIntegQty 550000
Fraction of Y Auto Scale, Min and Max 0.0 1.0
Off
RefDiv
RefSub
To File
Idle
Exit

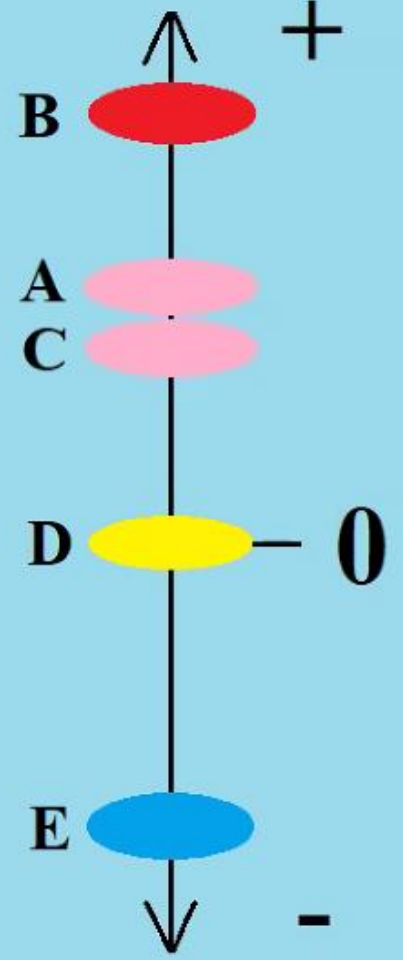
Data collected at LRO with Pharmigan Array plotted by ezRA on background Milky Way radio map



Measure Velocity Difference

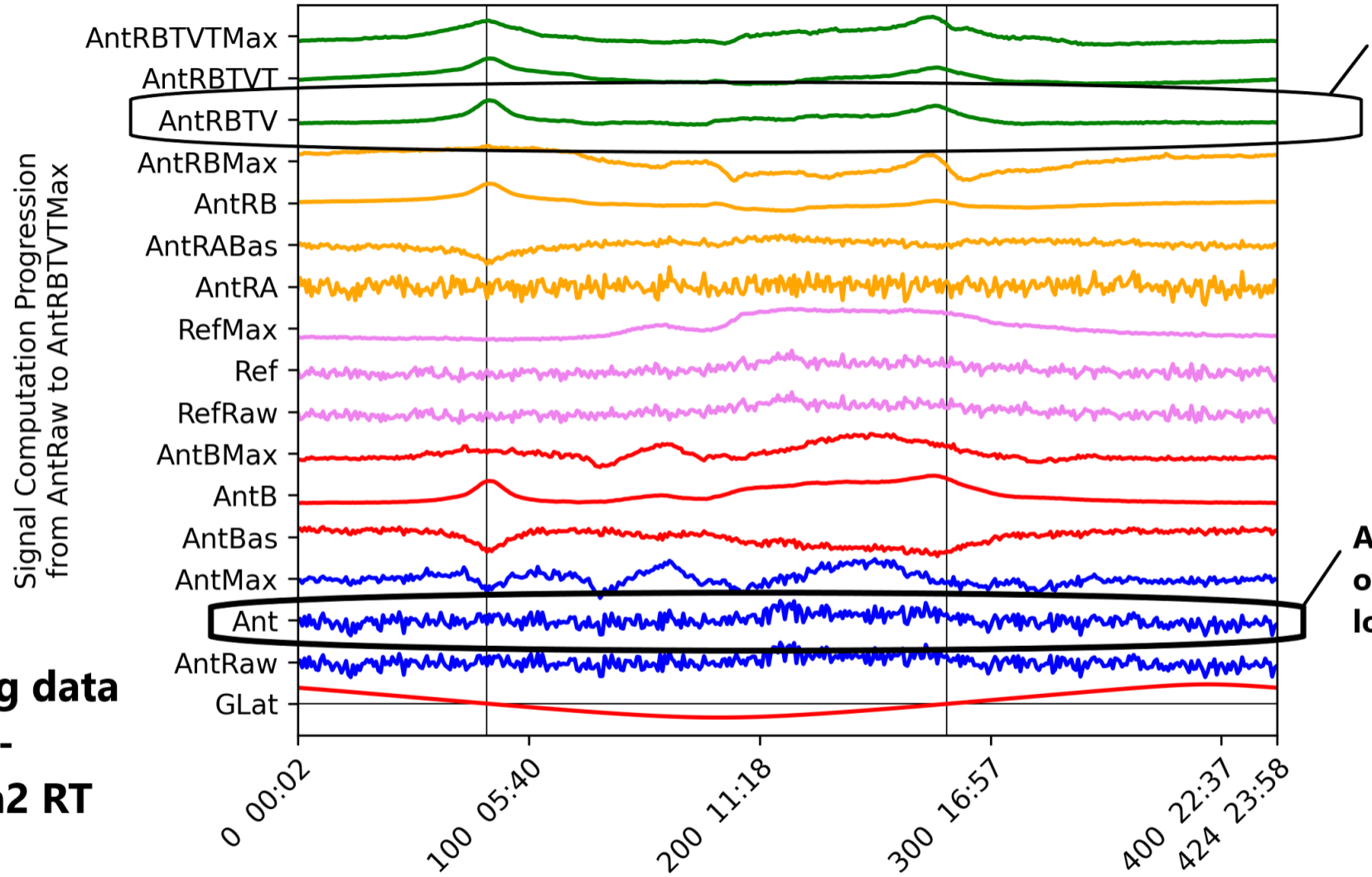


Receding Velocity



Approaching Velocity

LRO-H2(SCRT)_El_48-00_Az_178_250430_00.txt LRO-H2_WoodenCantennaSupports_Az_178_ (ezCon241024a.py)

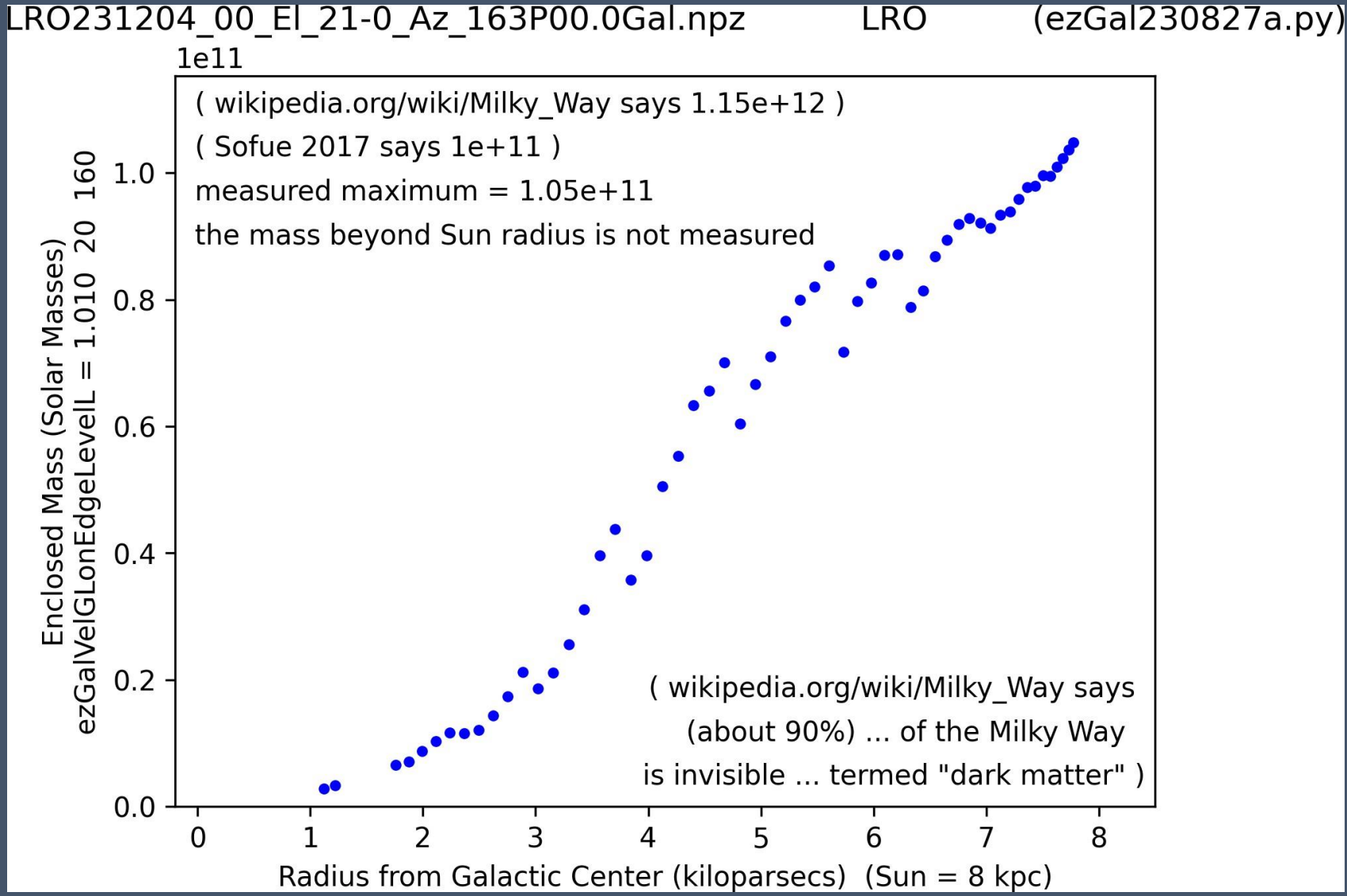


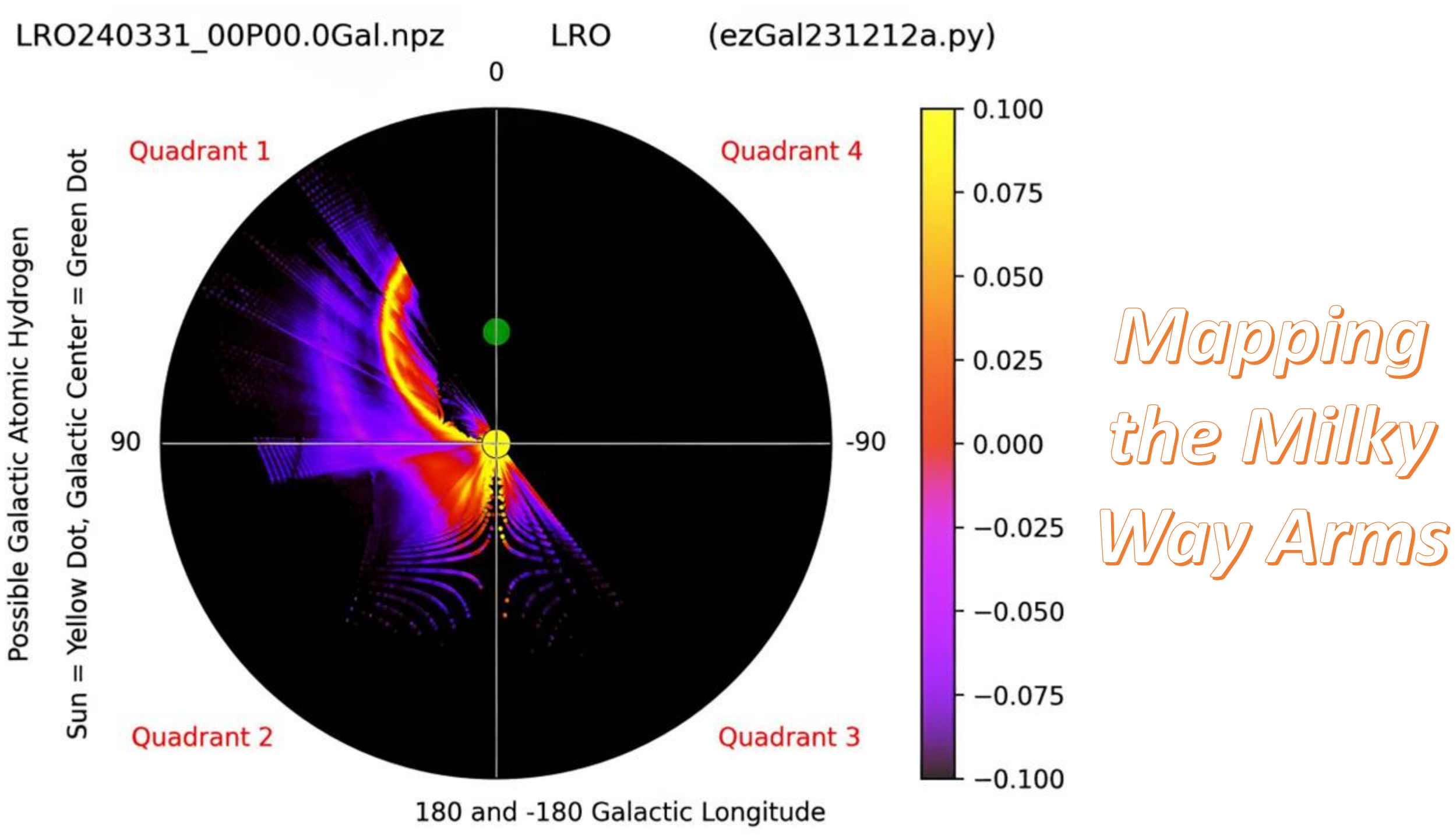
Signal after processing in ezRA including use of reference samples - effectively removes lot of noise to show peaks where aerial/antenna goes through hydrogen clouds of plane of Milky Way Galaxy (black vertical lines)

Antenna reading over 24 hrs showing lots of noise

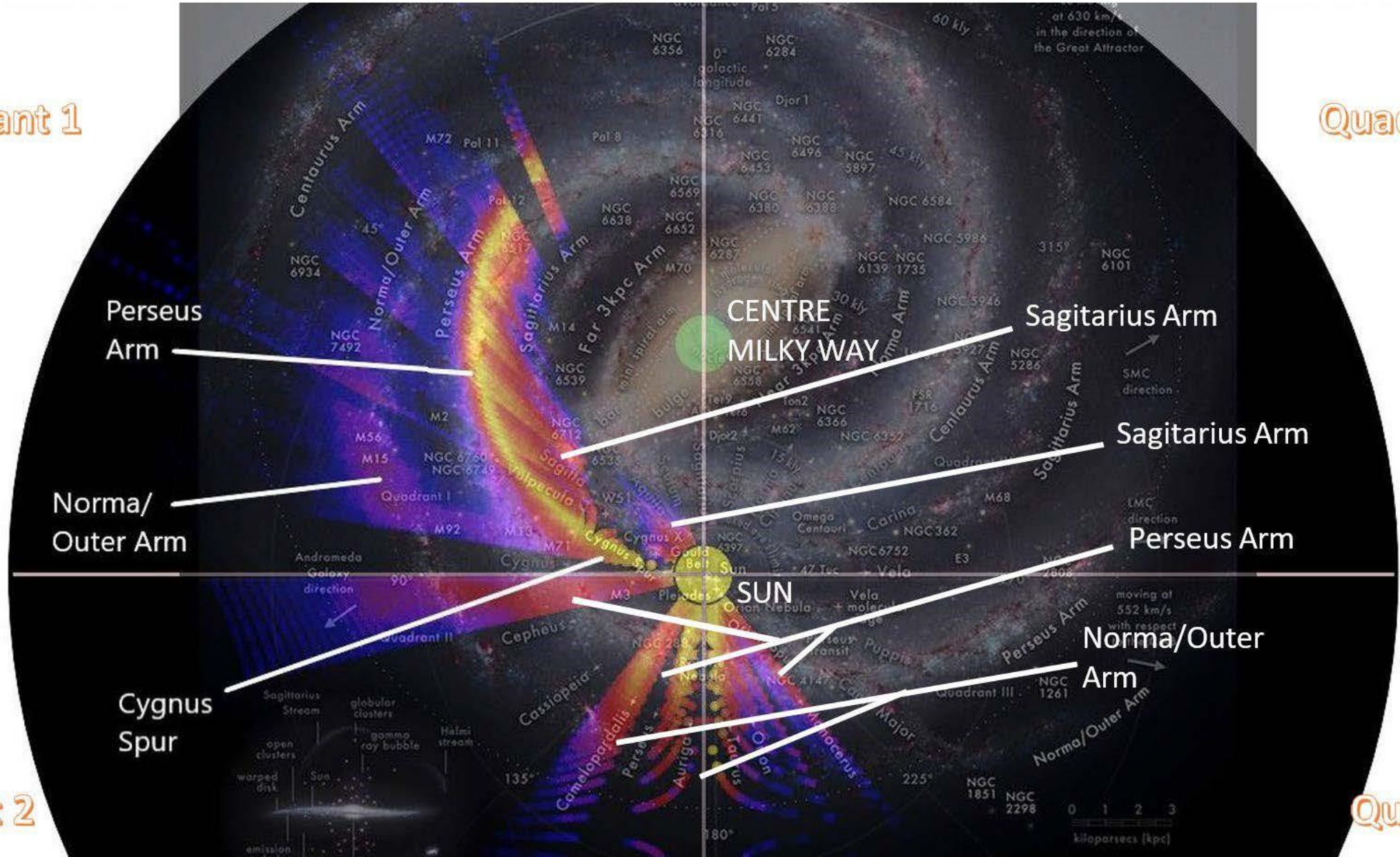
Processing data from LRO-Hydrogen2 RT

Enclosed Milky Way galactic mass

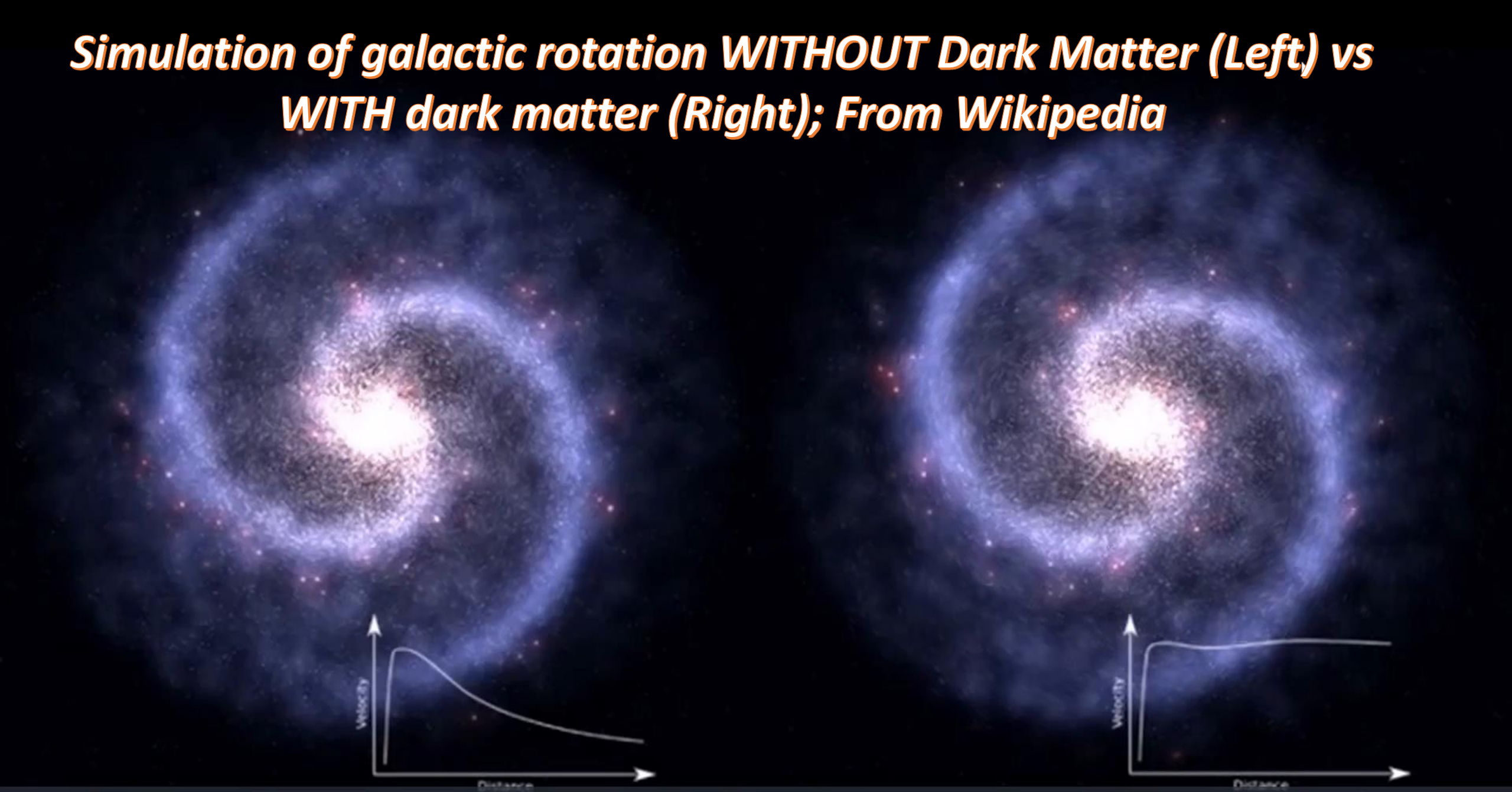



LRO240331_00P00.0Gal.npz
LRO
(ezGal231212a.py)
0
Quadrant 1
Quadrant 4
90
-90
Quadrant 2
Quadrant 3
Possible Galactic Atomic Hydrogen
Sun = Yellow Dot, Galactic Center = Green Dot
180 and -180 Galactic Longitude
0.100
0.075
0.050
0.025
0.000
−0.025
−0.050
−0.075
−0.100
Mapping the Milky Way Arms

Mapping the Milky Way Arms



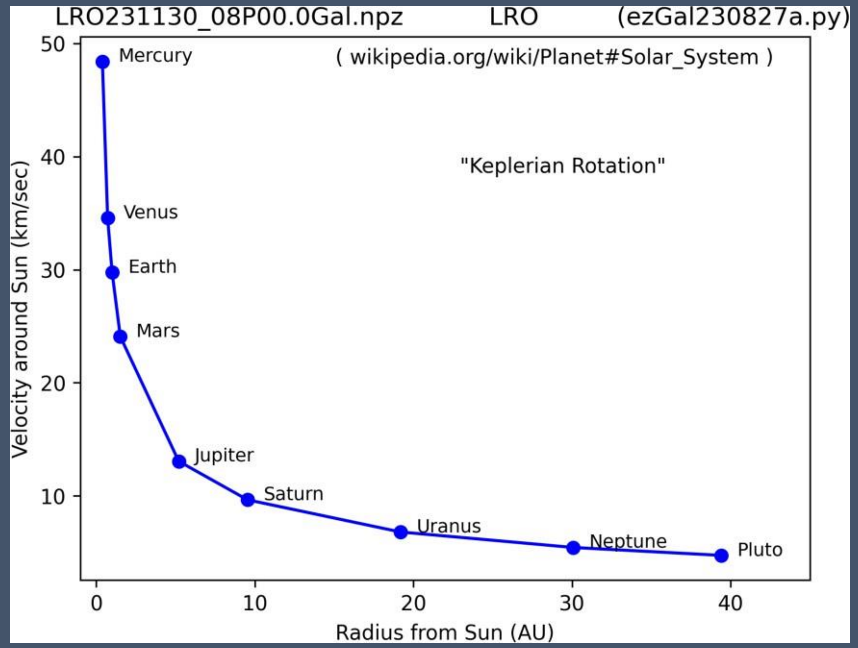
Simulation of galactic rotation WITHOUT Dark Matter (Left) vs WITH dark matter (Right); From Wikipedia

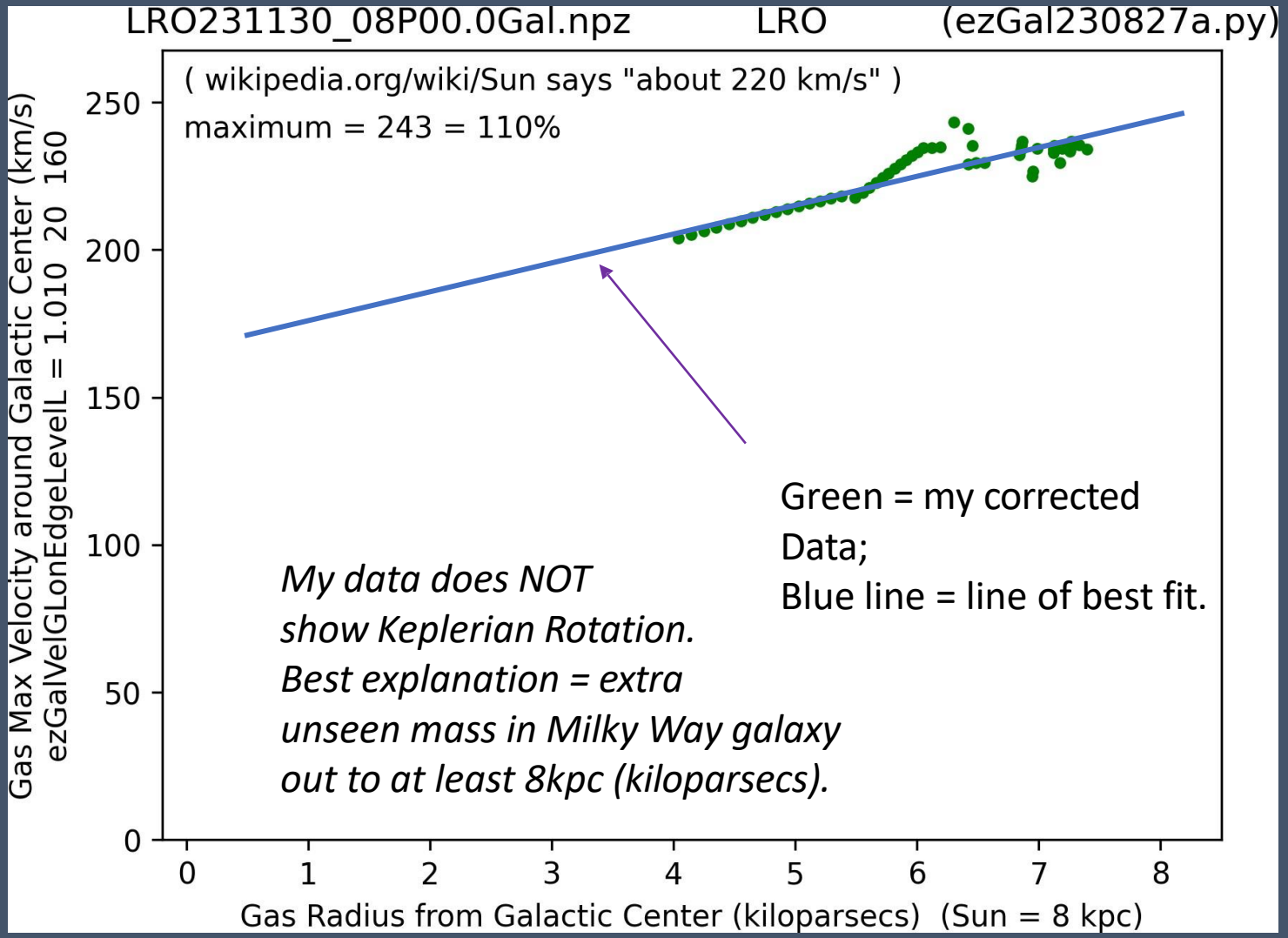


0:00 / 0:15

Dark Matter – galactic rotation curve from my data

Below is typical Keplarian Rotation Curve which would be expected without dark matter, on right my data (ezRA suite/Pharmigan array)





Compare my rotational data (right) to published data (below)

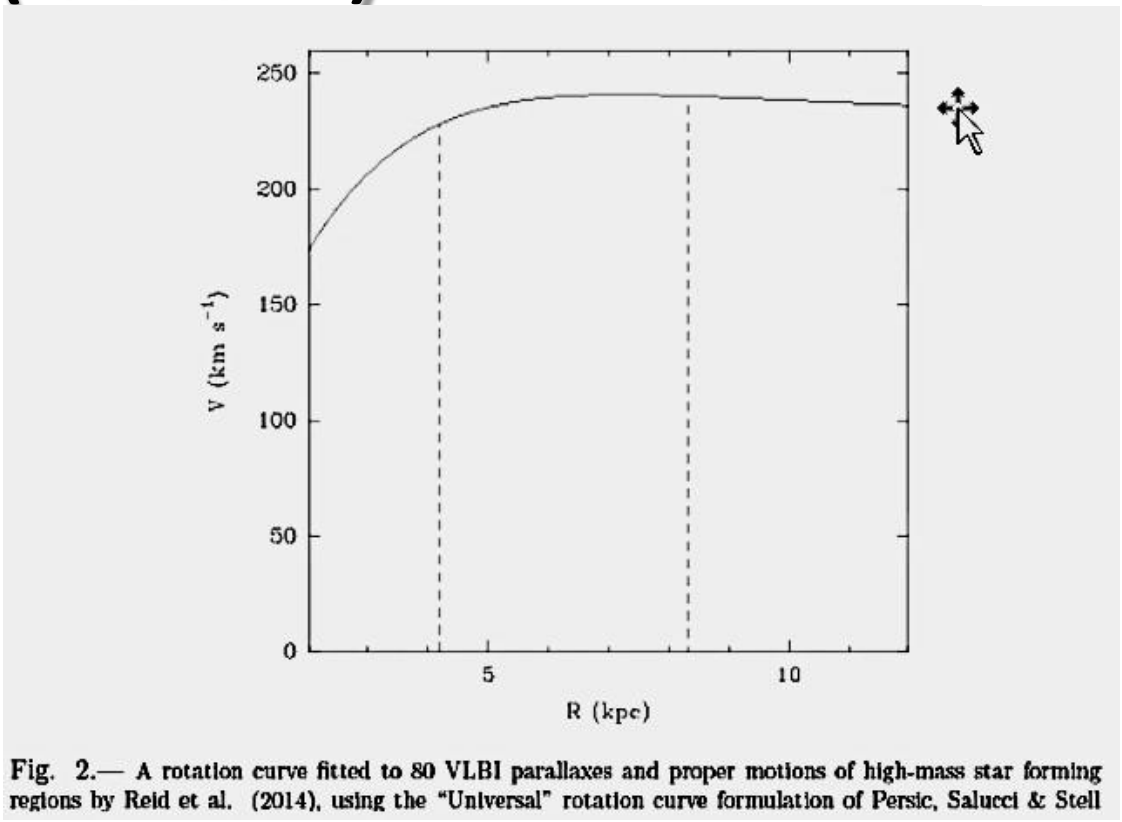
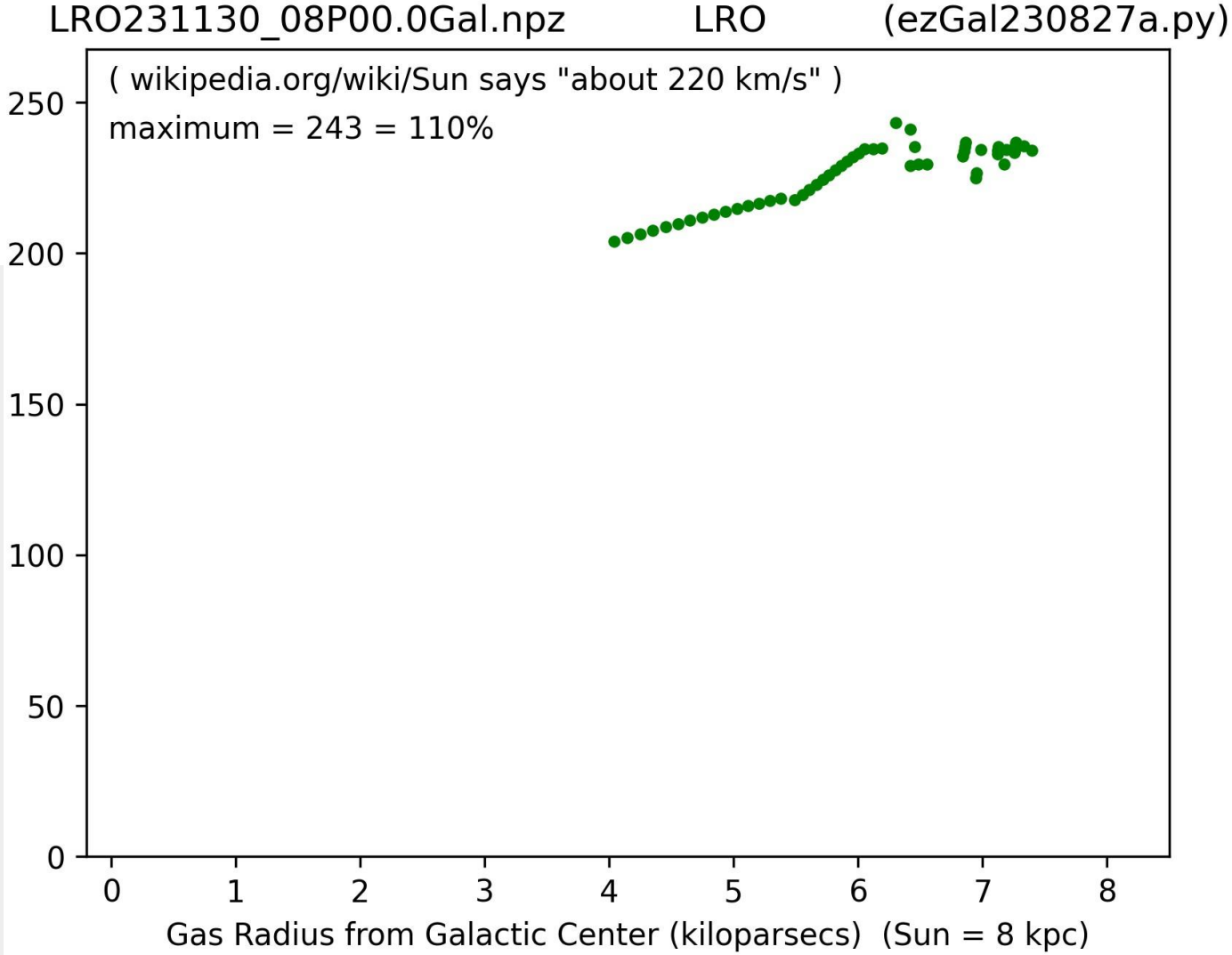
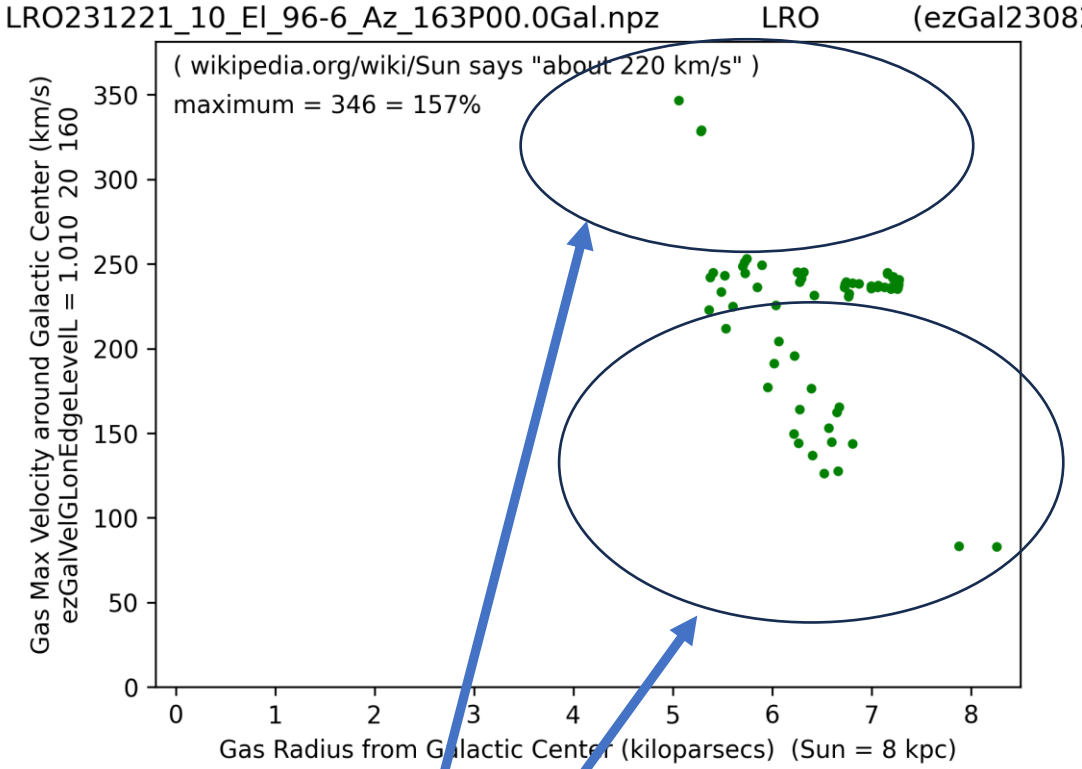
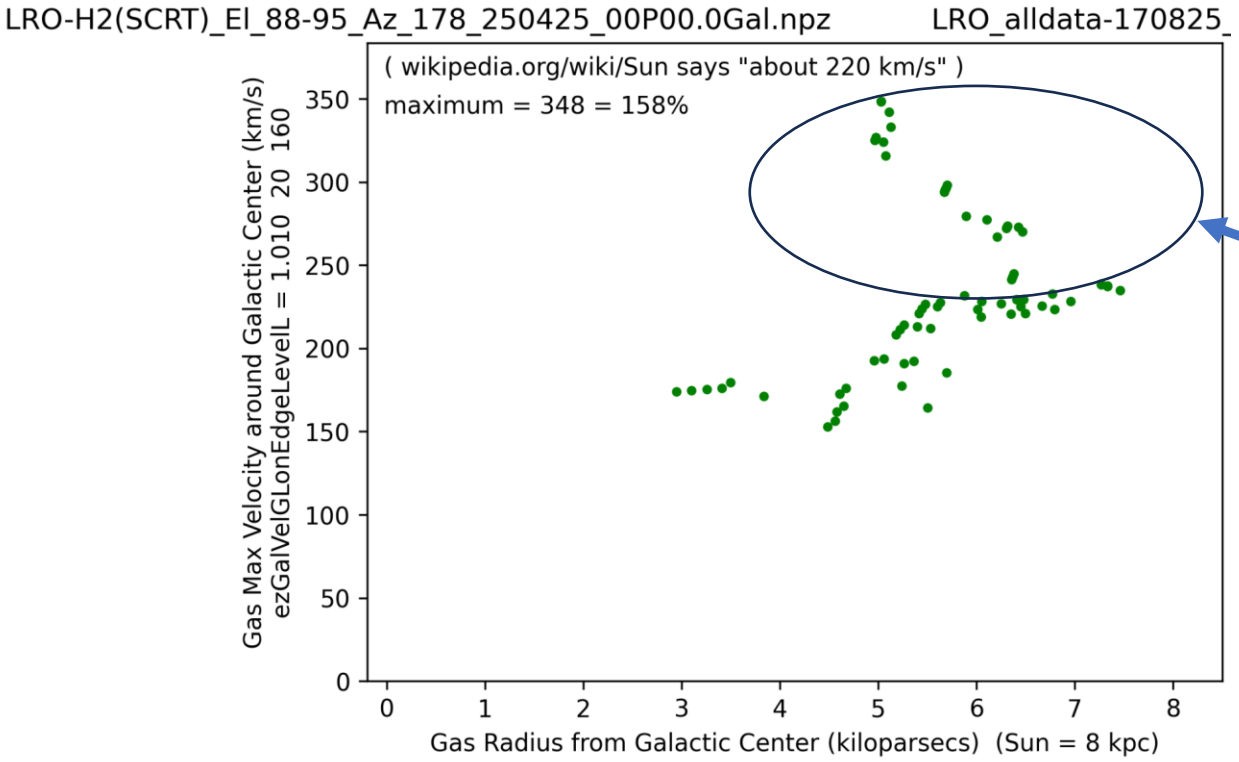


Fig. 2.— A rotation curve fitted to 80 VLBI parallaxes and proper motions of high-mass star forming regions by Reid et al. (2014), using the "Universal" rotation curve formulation of Persic, Salucci & Stell



Cleaning up dark matter data

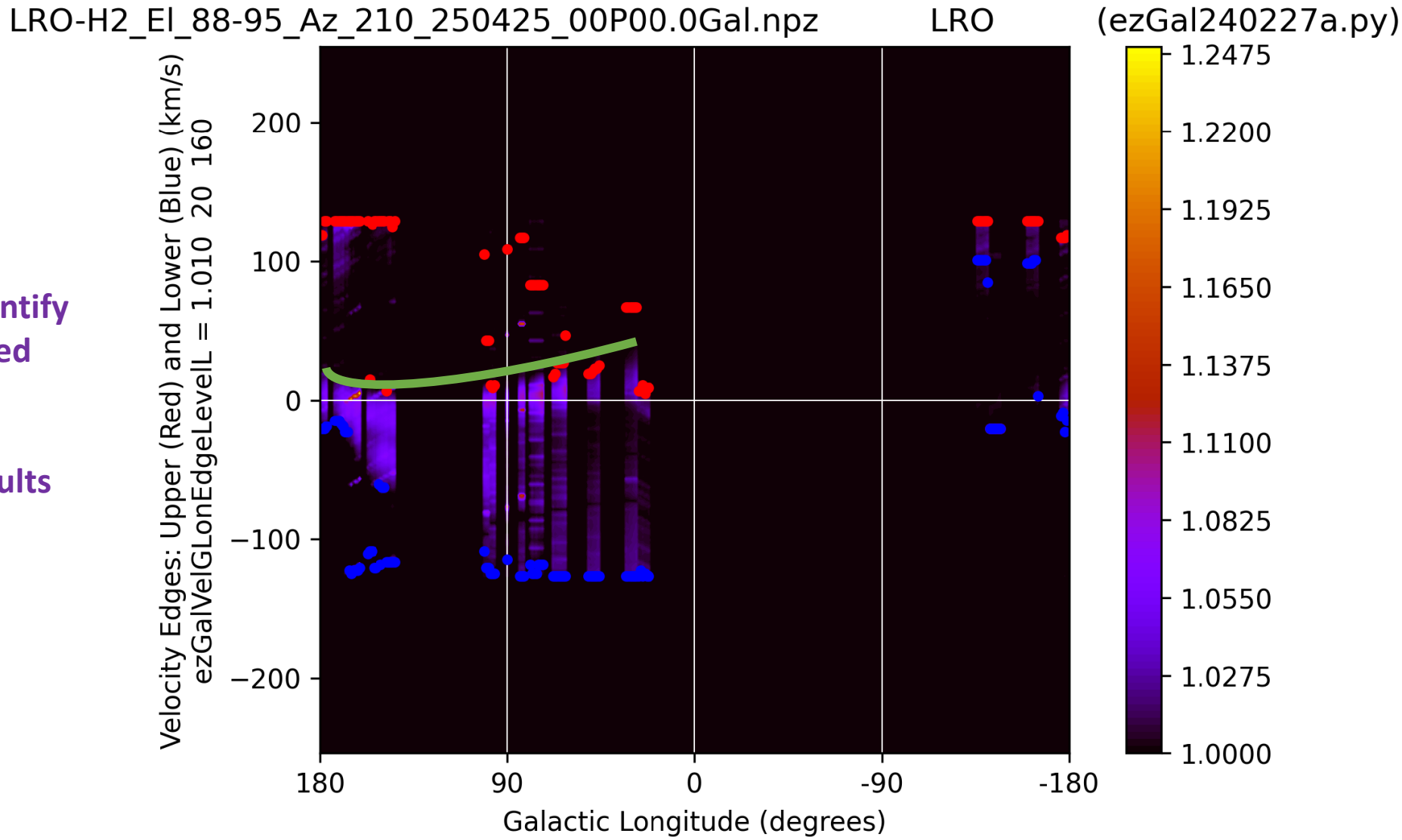




Probable Radio Frequency Interference

Cleaning RFI

ezRA tries to automatically identify peak velocities (red dots) – should be green line.
RFI gives high results which need to be corrected.



What happens when you plot the data from these hydrogen telescopes in 3D?

Project : H Line 3D

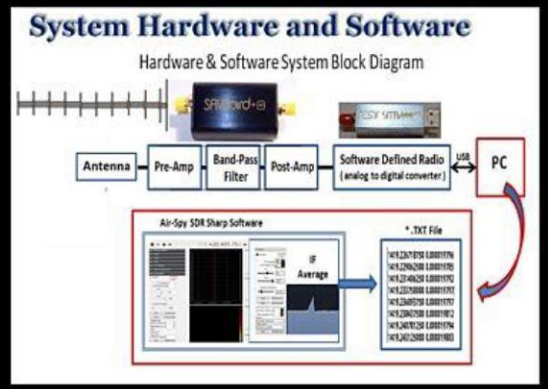
A Beginner's Guide to

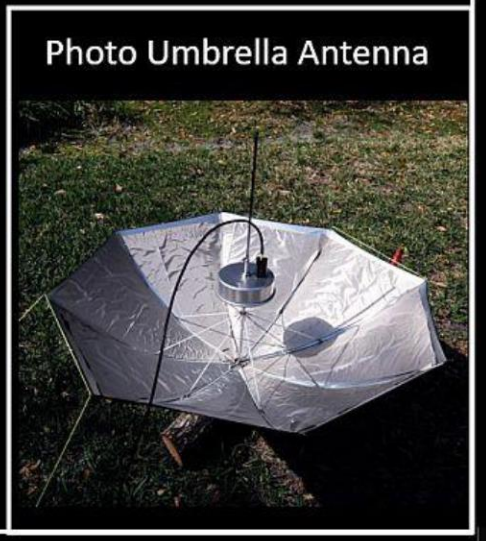
Antenna Fabrication , Reception, Recording, Software Processing , and Graphic Display of the 21cm Wavelength Microwave Electro-Magnetic Emission Spectrum from Neutral Hydrogen Clouds within Our Galaxy : The Milky Way

HARDWARE alex pettit

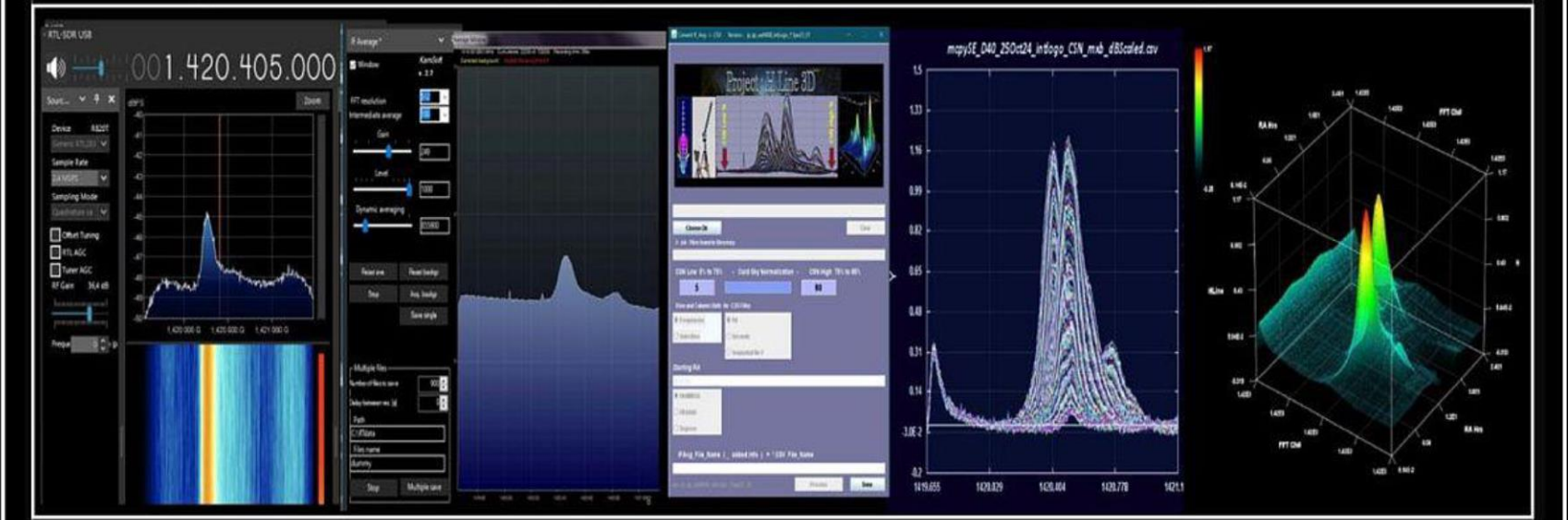
jamison adcock SOFTWARE

Project : H Line 3D





AirSpy SDR# > Kaminski IF_avg Plugin > HLine3D > Rinearn Graphics

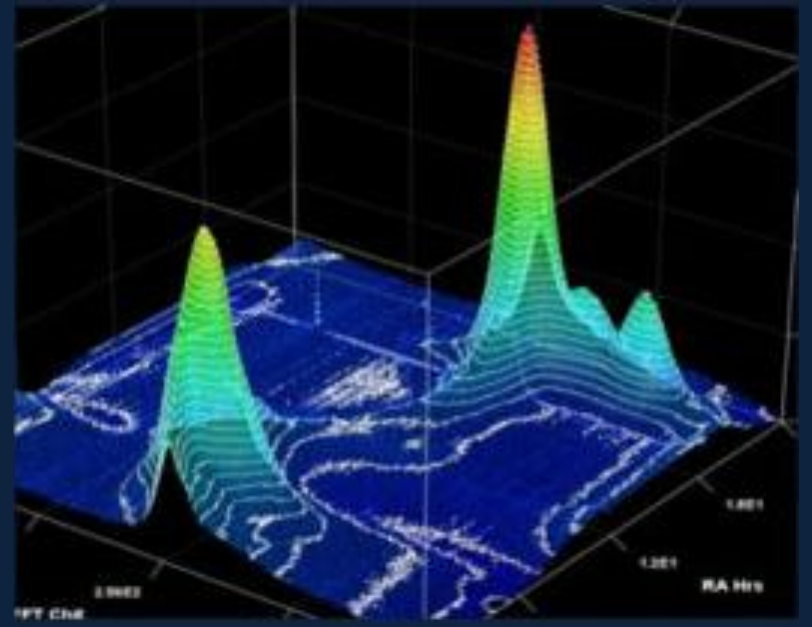


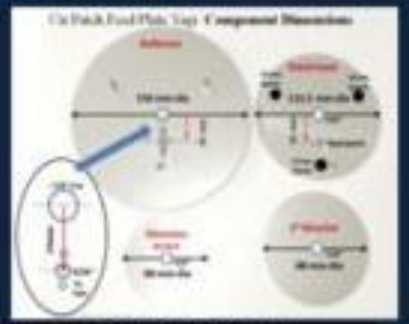
H-Line 3D Processing

Configuration / Operation / Plotting / HLine3D Processing and Rinearn Graphics

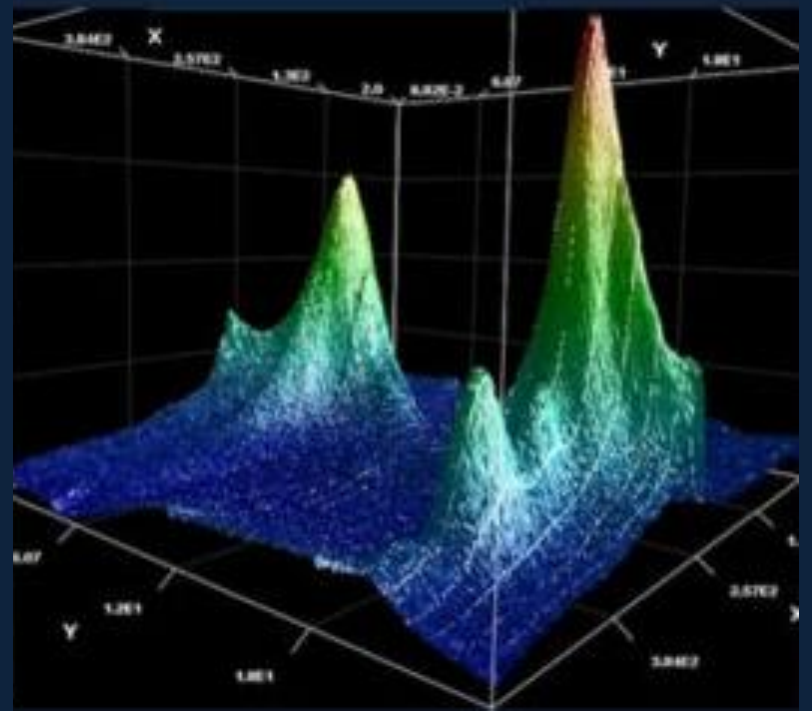
HERE

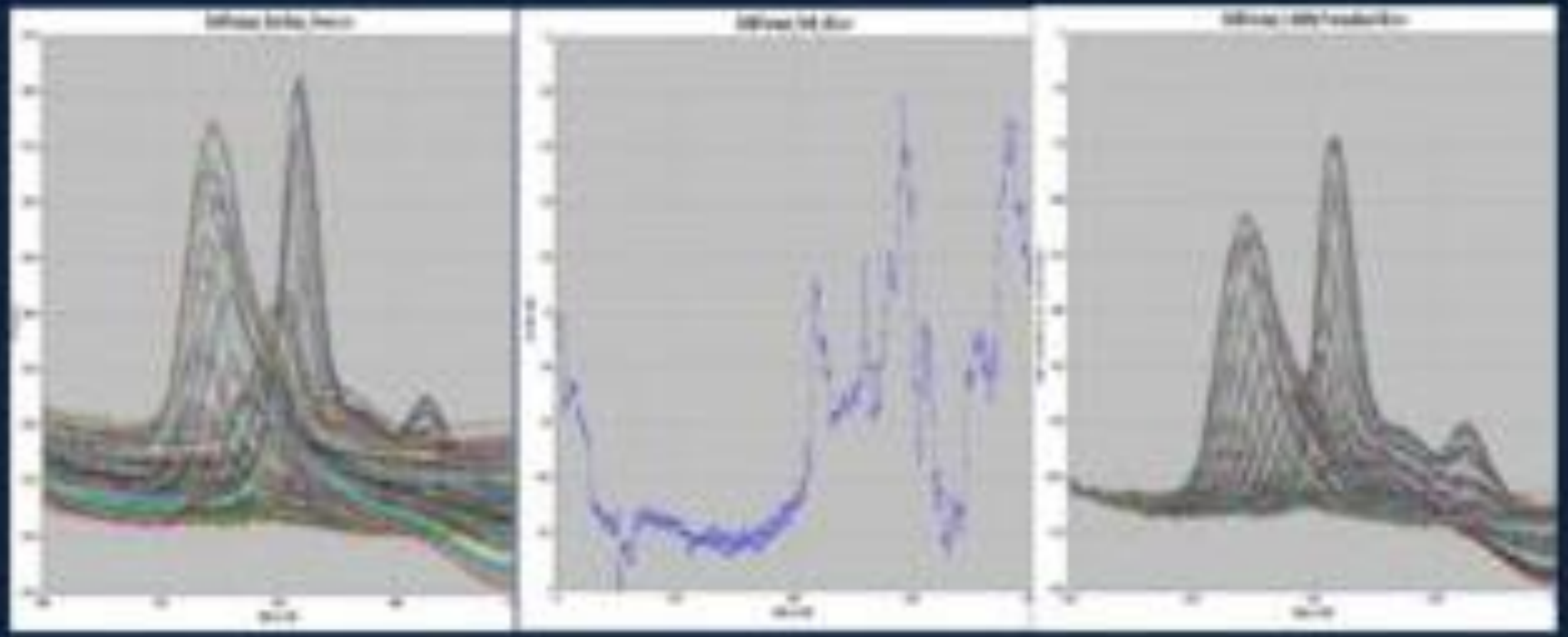
https://github.com/AP-HLine-3D/HLine3D



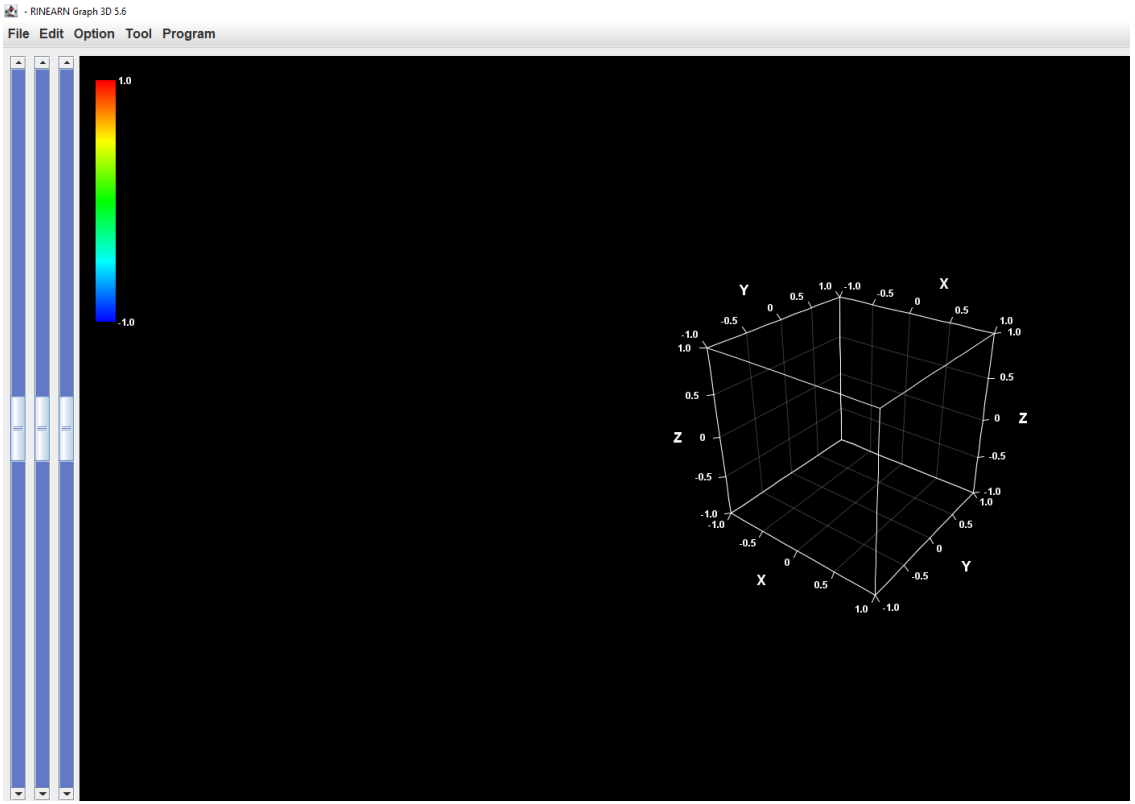



Cir Patch Feed Disk Yagi Dimensions for Student Edition


X
Y
Y



Rinearn3D



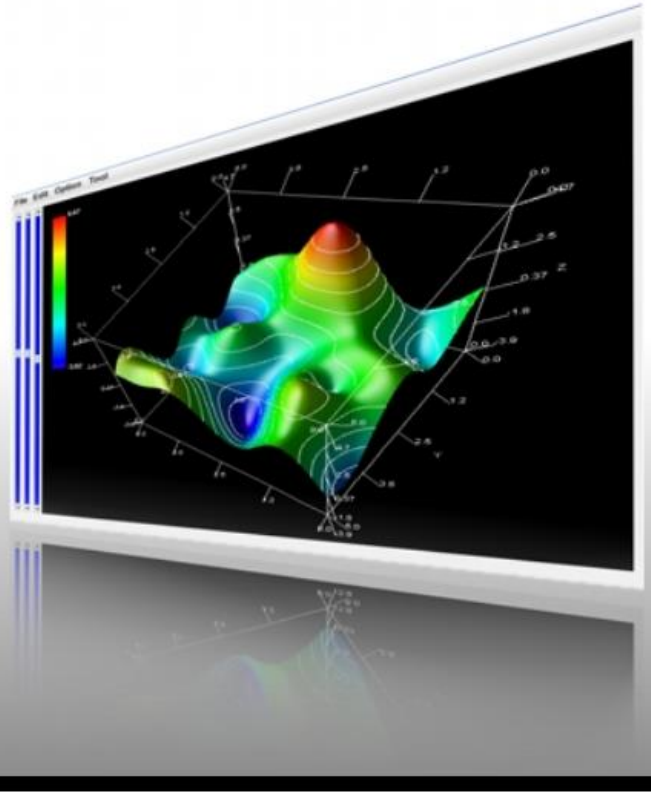
RINEARN
www.rinearn.com

HOME Homepage | INFO Information | SOFT Software | TECH Technology | AI Assistant AI | CONTACT Contact Us

RINEARN Graph3D 5.6

Download Now

» How to use after downloading



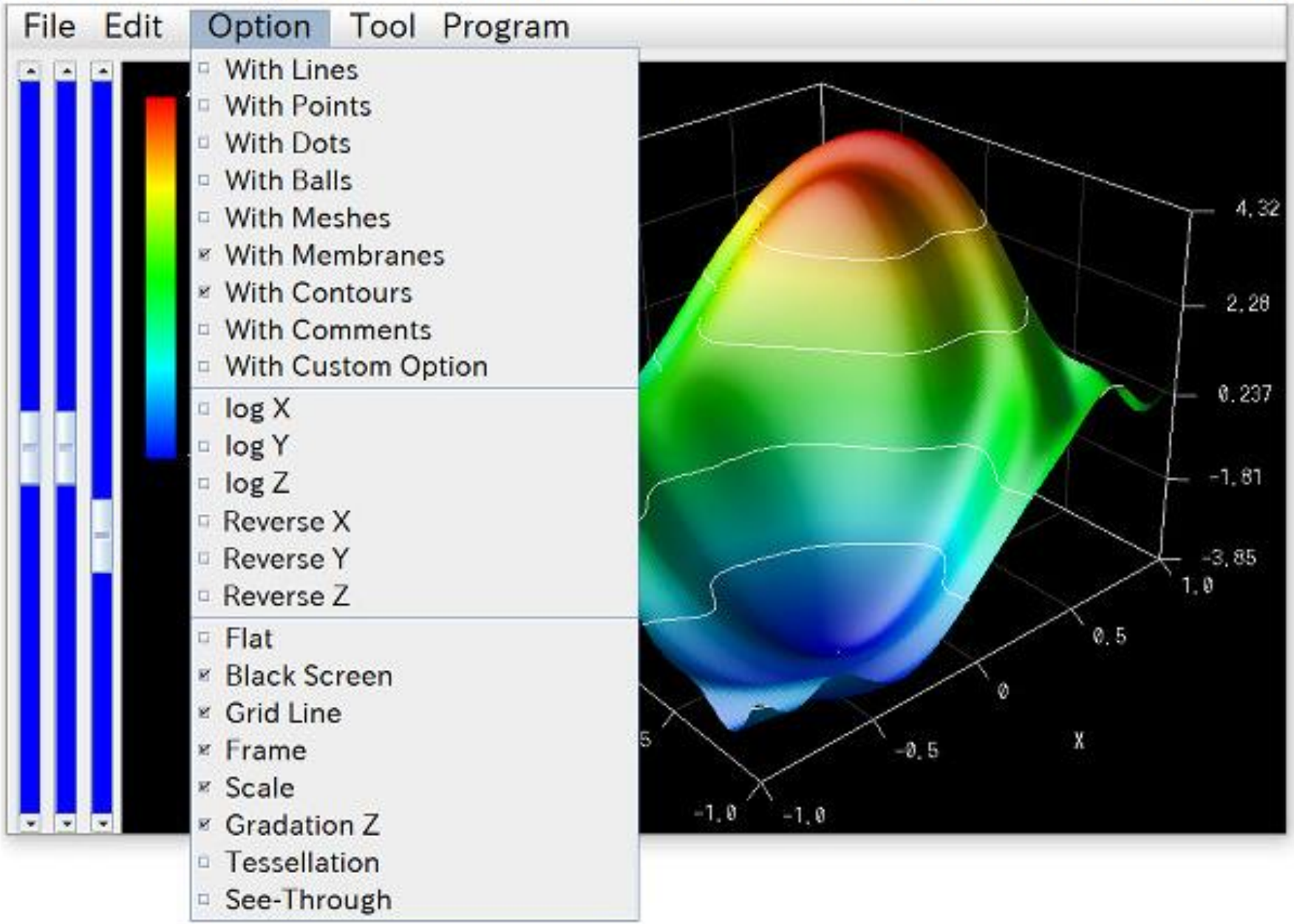
RINEARN > English Top > RINEARN Graph 3D

Japanese 日本語 | US English 英語（米）

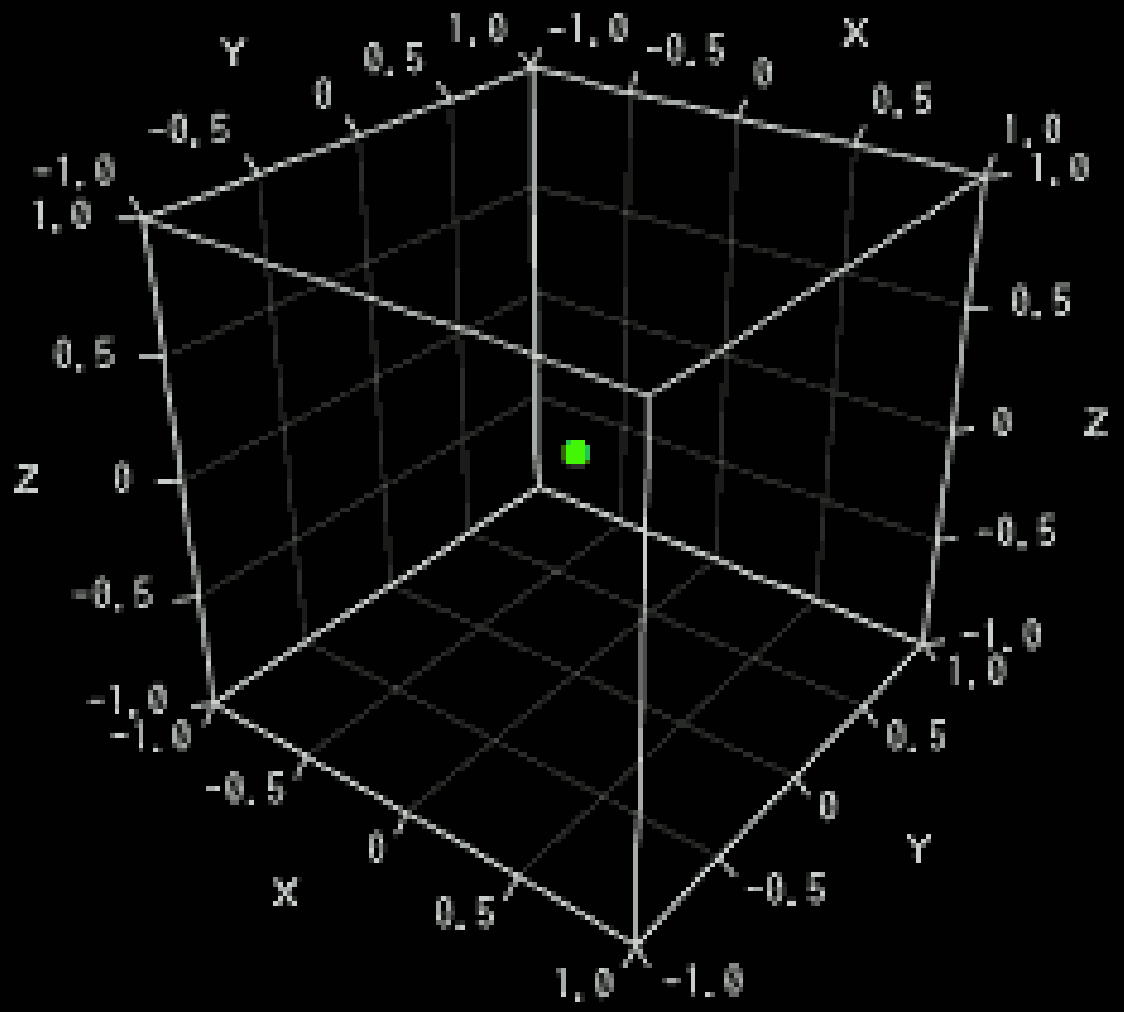
RINEARN Graph 3D

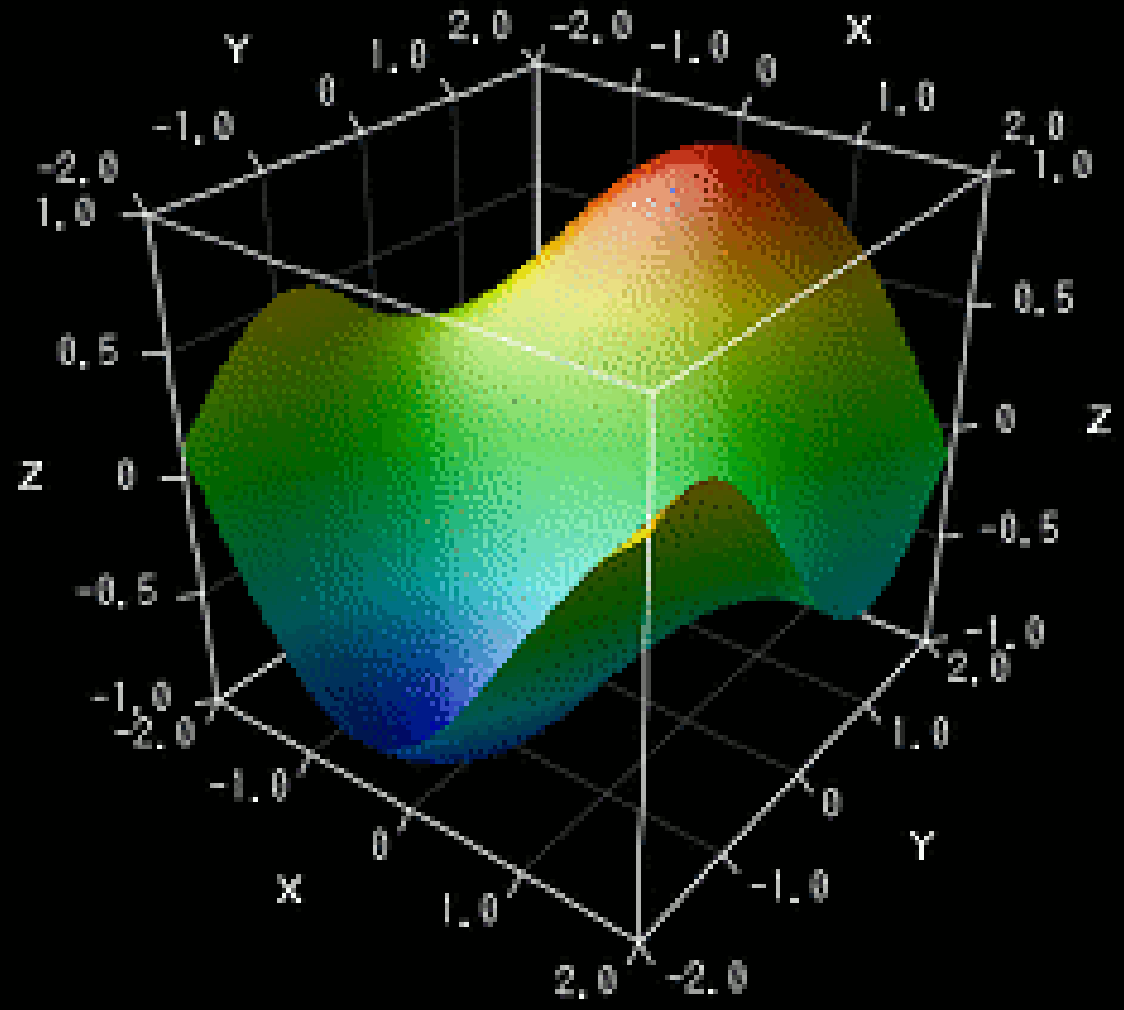
RINEARN Graph 3D is a free 3D graphing software compatible with various operating systems and does not require installation. It allows users to easily create 3D graphs from files generated in spreadsheet software or numerical computing programs.

RINEARN Graph 3D features a simple and intuitive user interface centered around a menu bar and mouse operations.

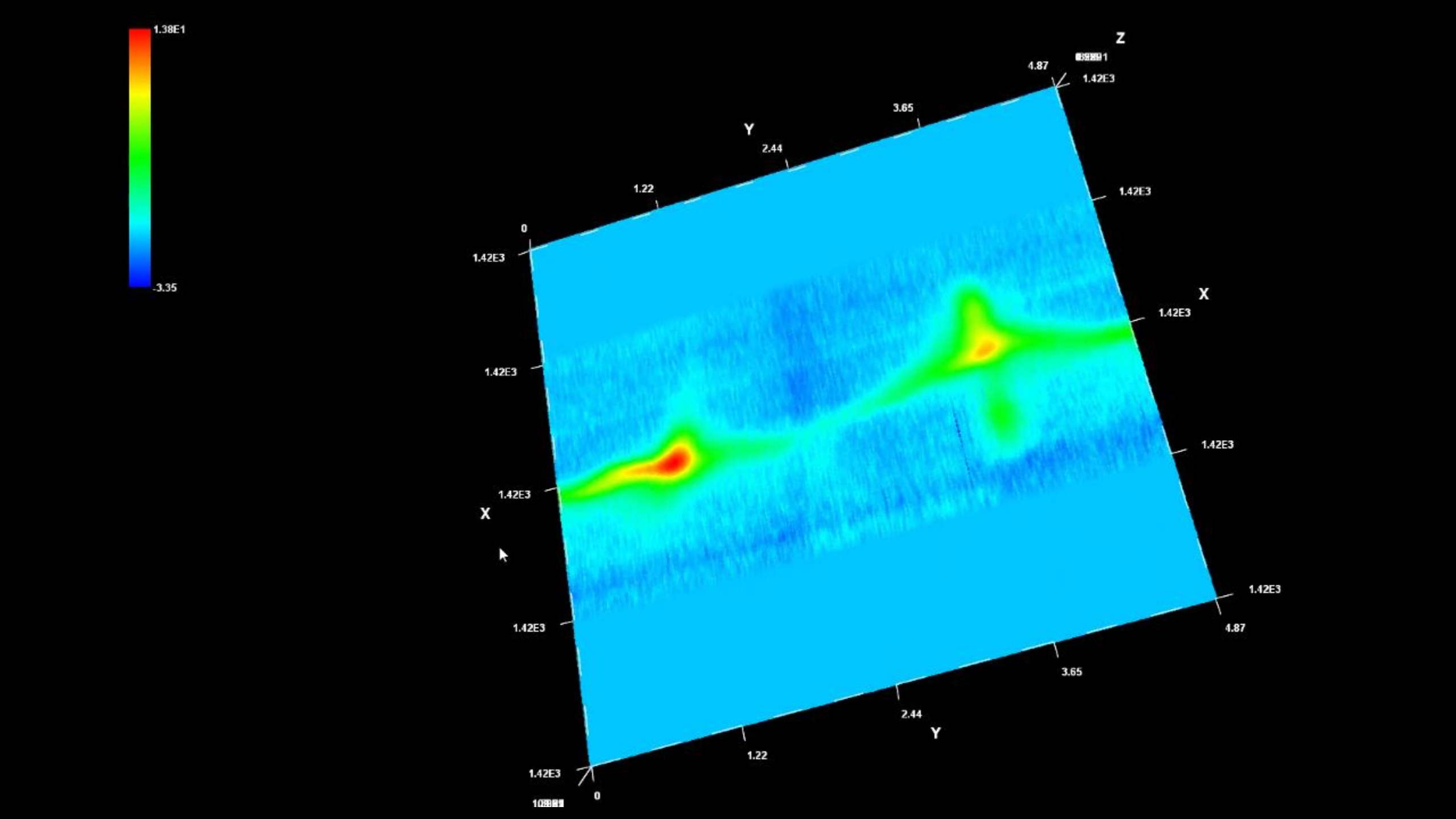


Animation in Rinearn3D

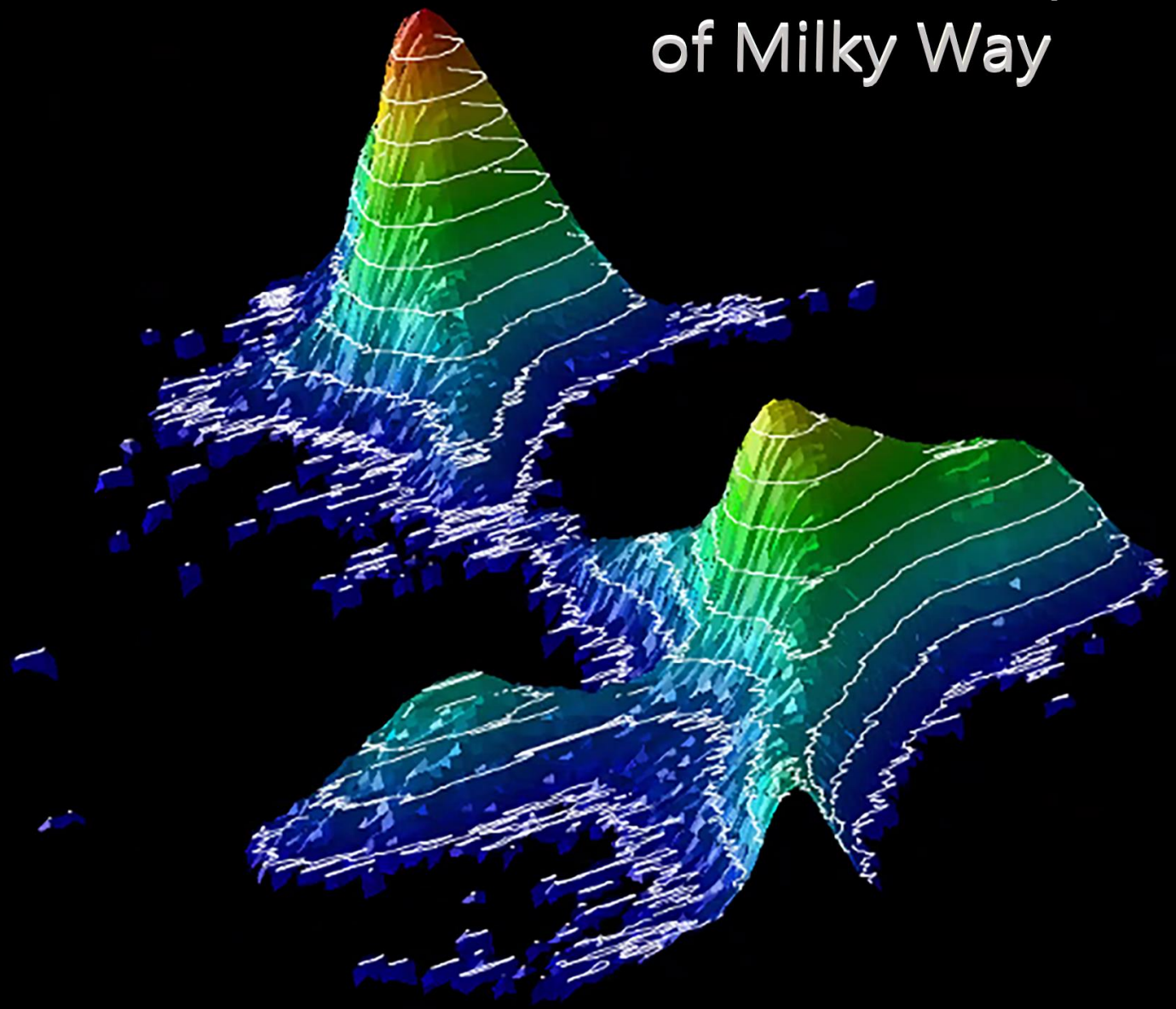


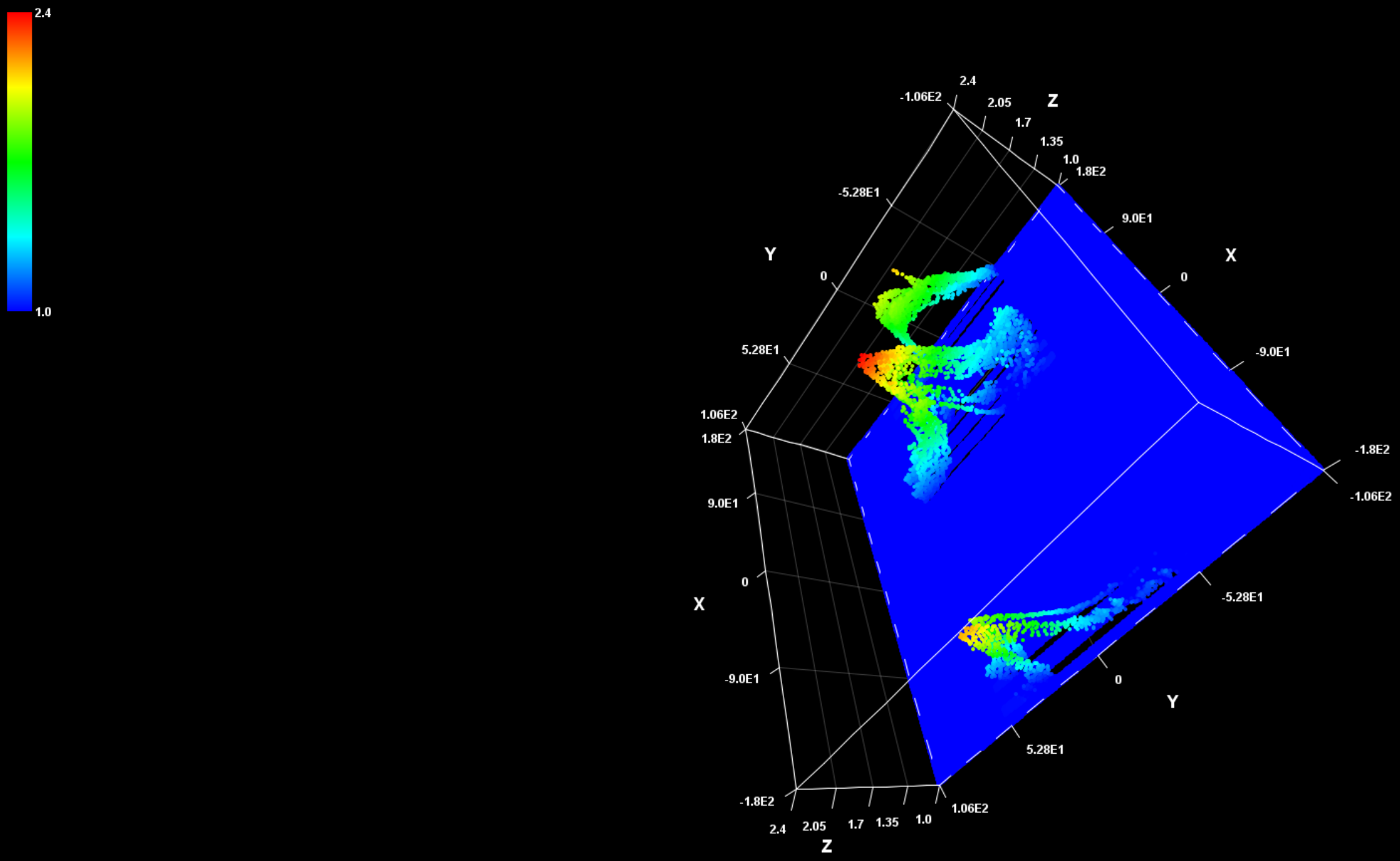


Using Rinearn3D with ezRA Data


1.38E1
-3.35
Z
4.87
1.42E3
3.65
Y
2.44
1.22
0
1.42E3
1.42E3
X
1.42E3
1.42E3
1.42E3
X
1.42E3
1.42E3
4.87
3.65
2.44
Y
1.22
1.42E3
0

3D Relief Map of Milky Way




2.4
1.0
2.4
-1.06E2
2.05
Z
1.7
1.35
1.0
1.8E2
-5.28E1
9.0E1
Y
X
0
0
5.28E1
-9.0E1
1.06E2
1.8E2
-1.8E2
9.0E1
-1.06E2
0
X
-5.28E1
-9.0E1
0
Y
5.28E1
-1.8E2
1.06E2
2.4
2.05
1.7
1.35
1.0
Z

Set Range

- X Axis -

Auto Ranging

X-max: 0

X-min: -150

- Y Axis -

Auto Ranging

Y-max: 200.0

Y-min: 0

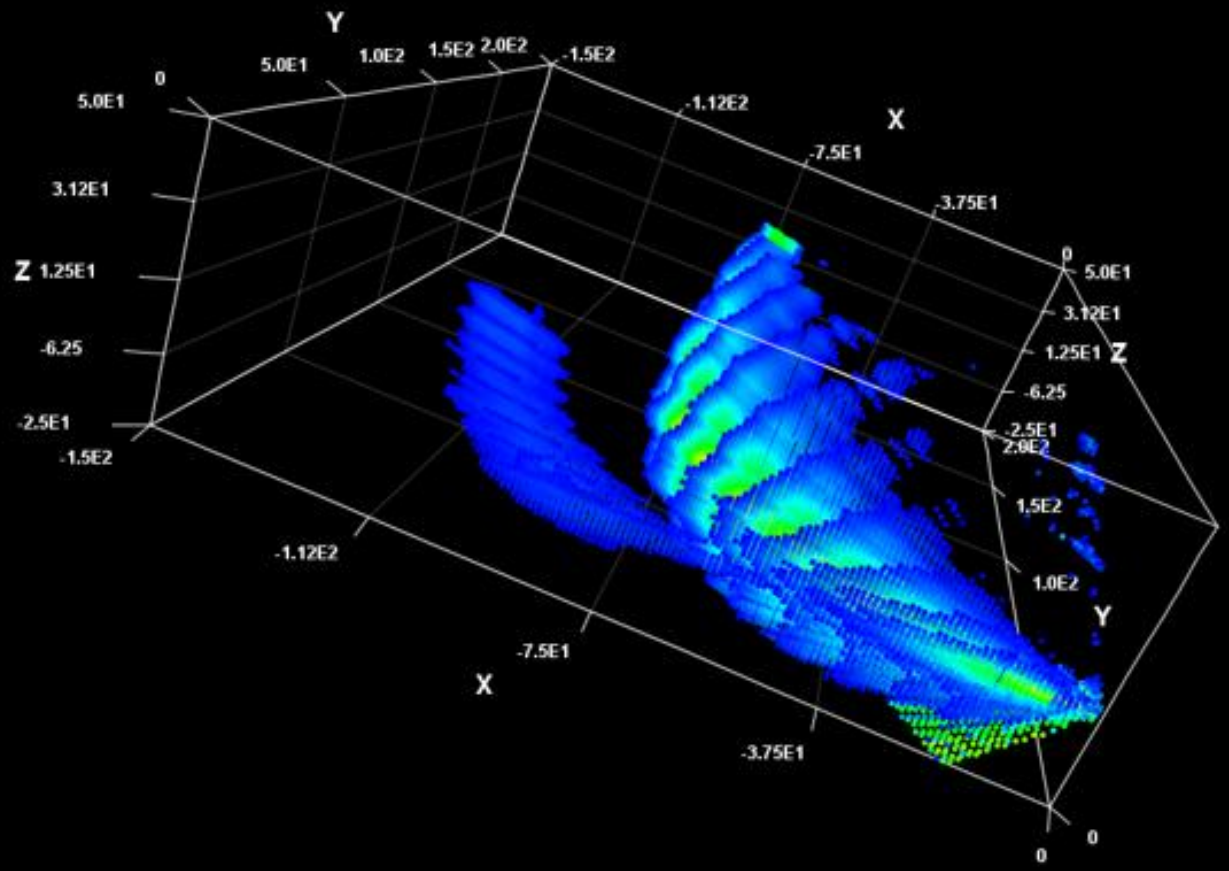
- Z Axis -

Auto Ranging

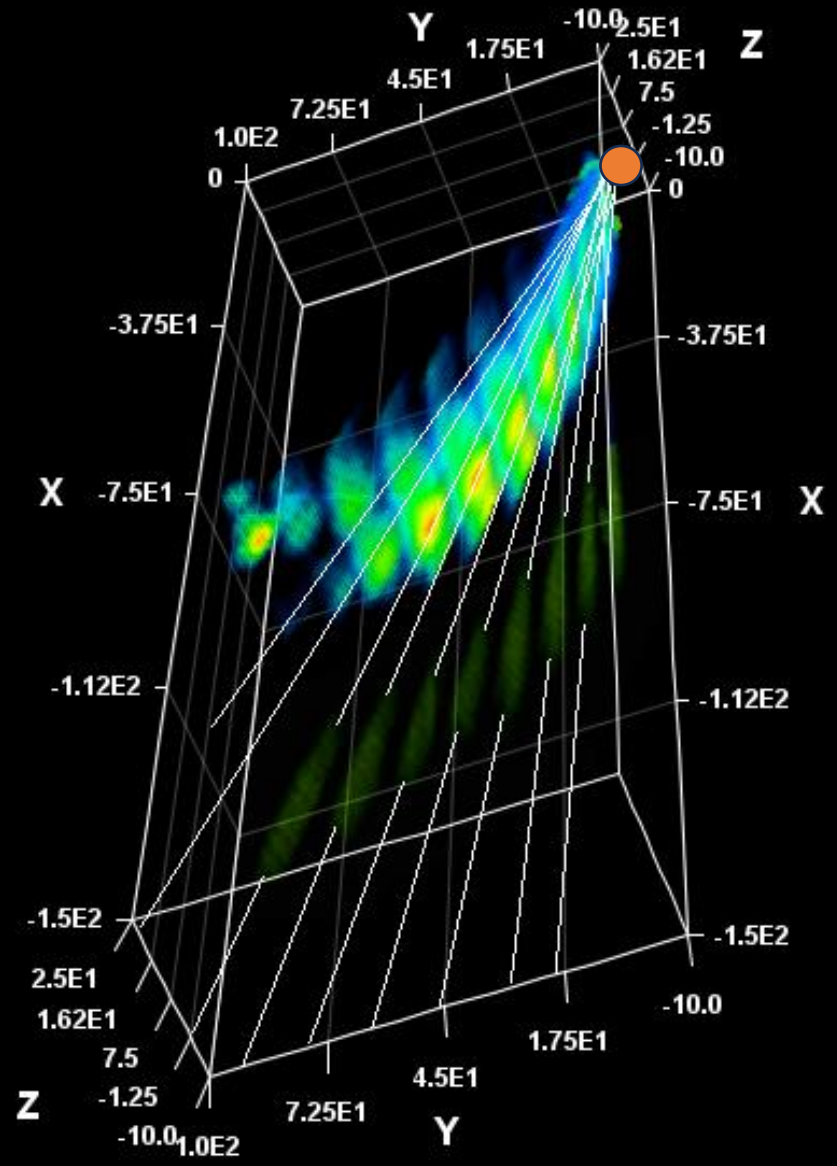
Z-max: 50

Z-min: -25

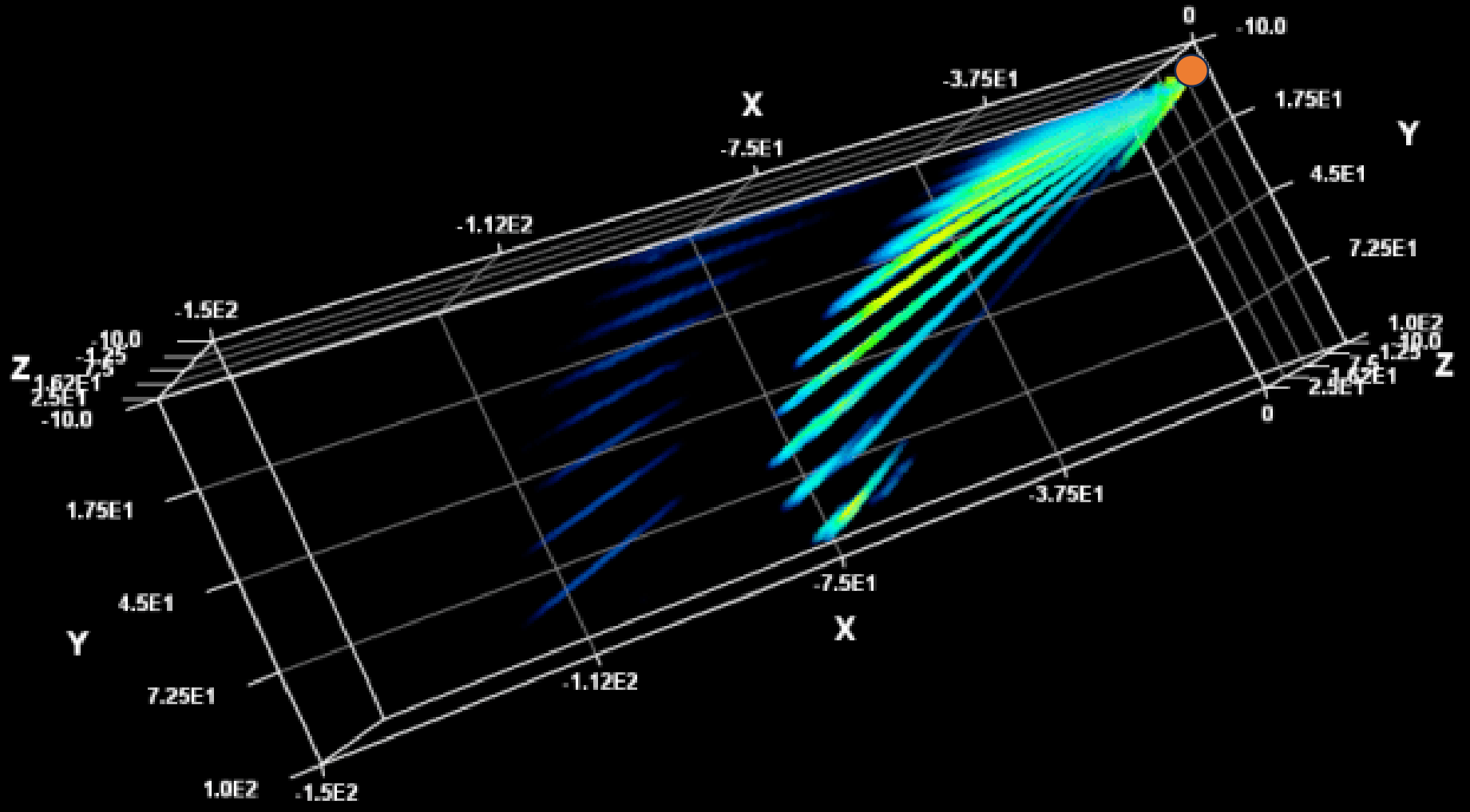
SET

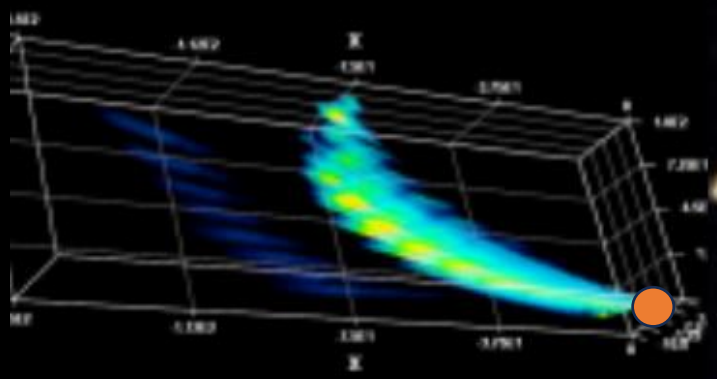


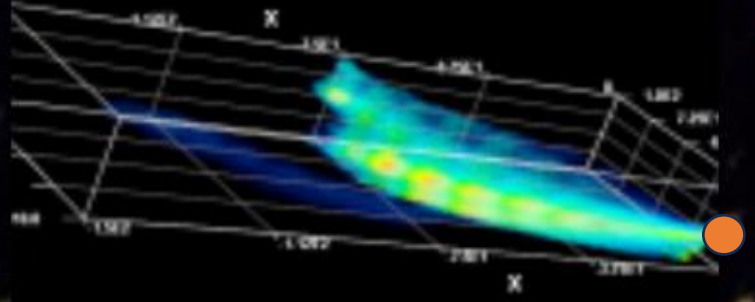
Location of Sun

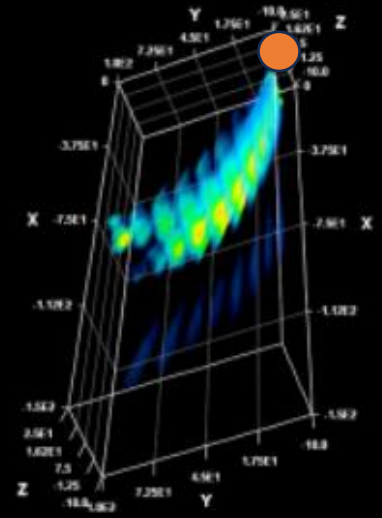


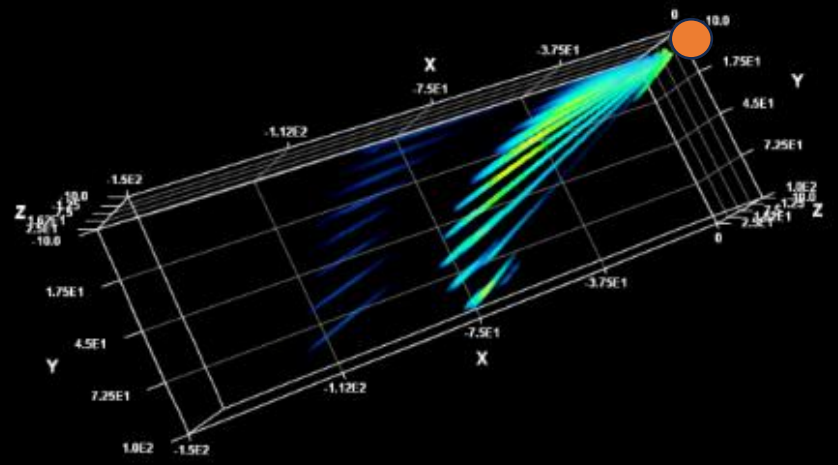
Location of Sun

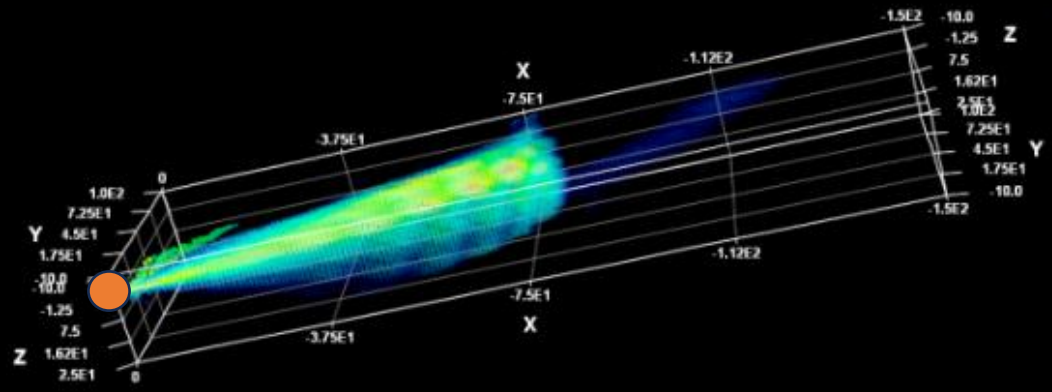


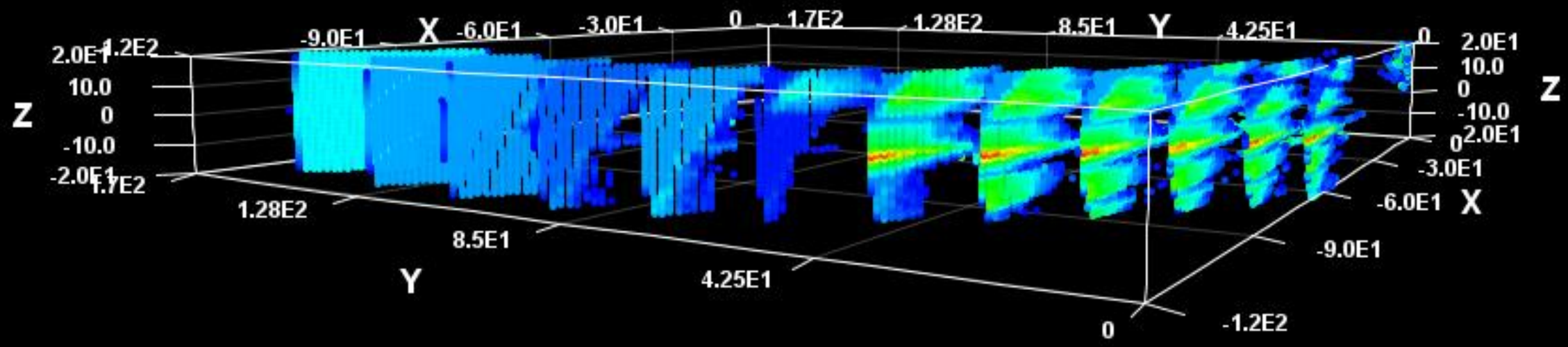

X
X

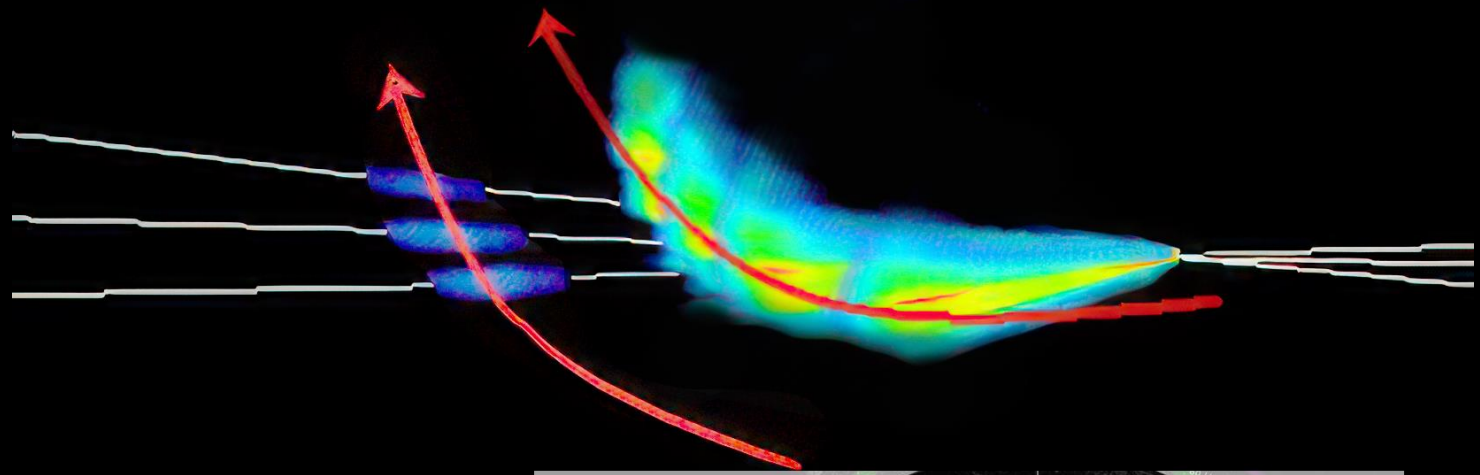

X
X

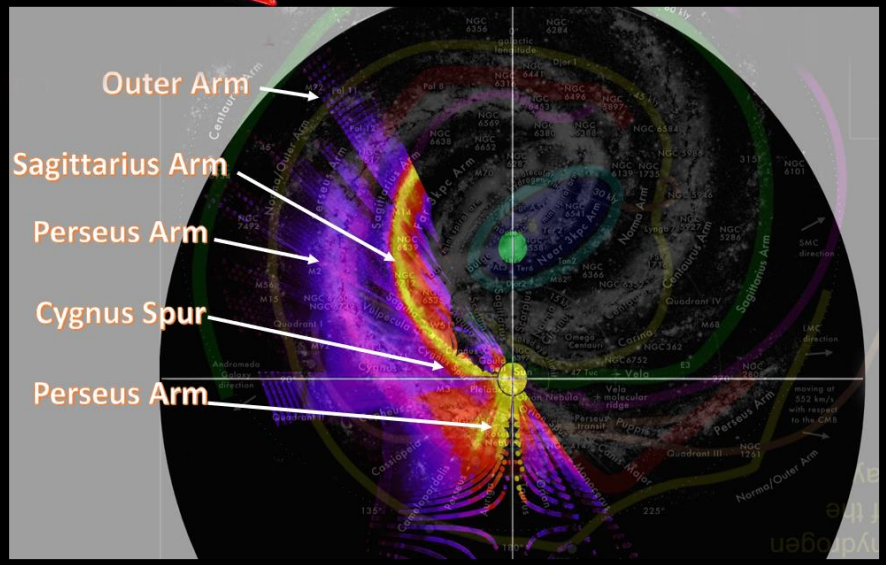

Y
Z
X
X
Z
Y

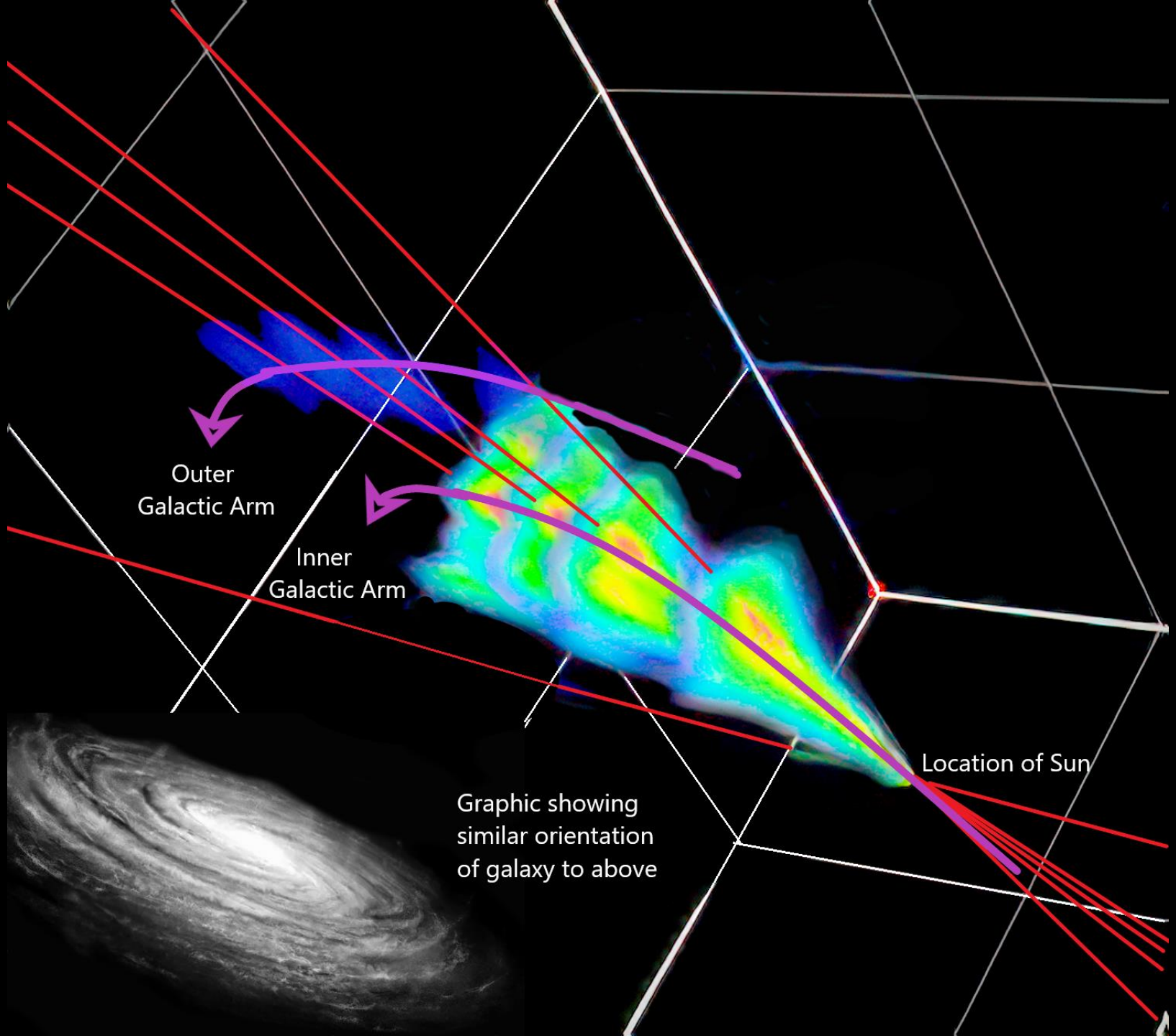

X
-7.5E1
-1.12E2
-1.5E2
-3.75E1
0
10.0
1.75E1
Y
4.5E1
7.25E1
1.0E2
Z
-7.5E1
X
-1.12E2
-3.75E1
Y
4.5E1
7.25E1
1.0E2

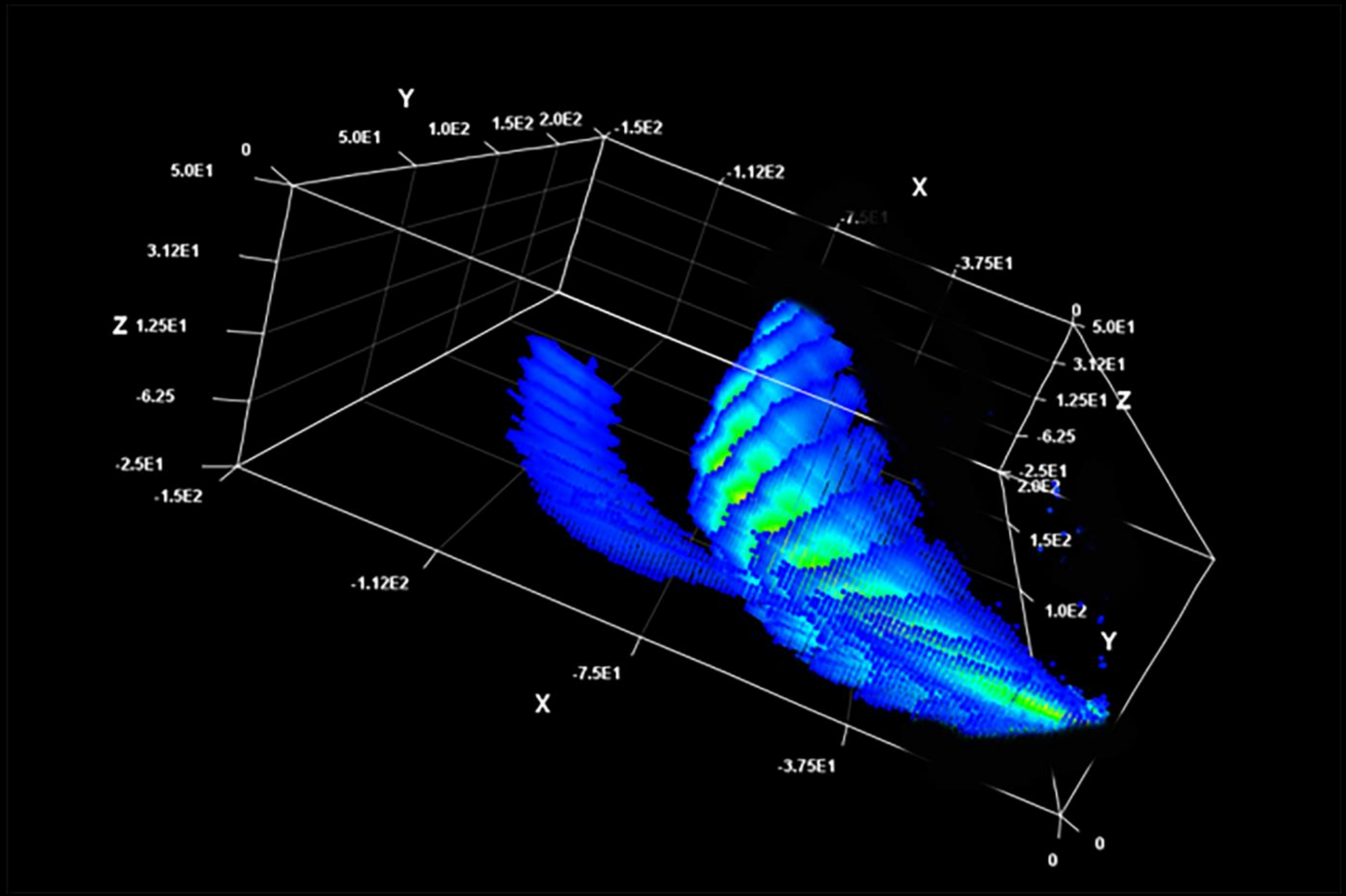

X
-7.5E1
-3.75E1
-1.12E2
-1.5E2
-10.0
-1.25
Z
7.5
1.62E1
2.5E1
7.25E1
4.5E1
1.75E1
Y
-10.0
1.0E2
Y
7.25E1
4.5E1
1.75E1
-10.0
-1.25
7.5
Z
1.62E1
2.5E1
-3.75E1
X
-7.5E1
-1.12E2

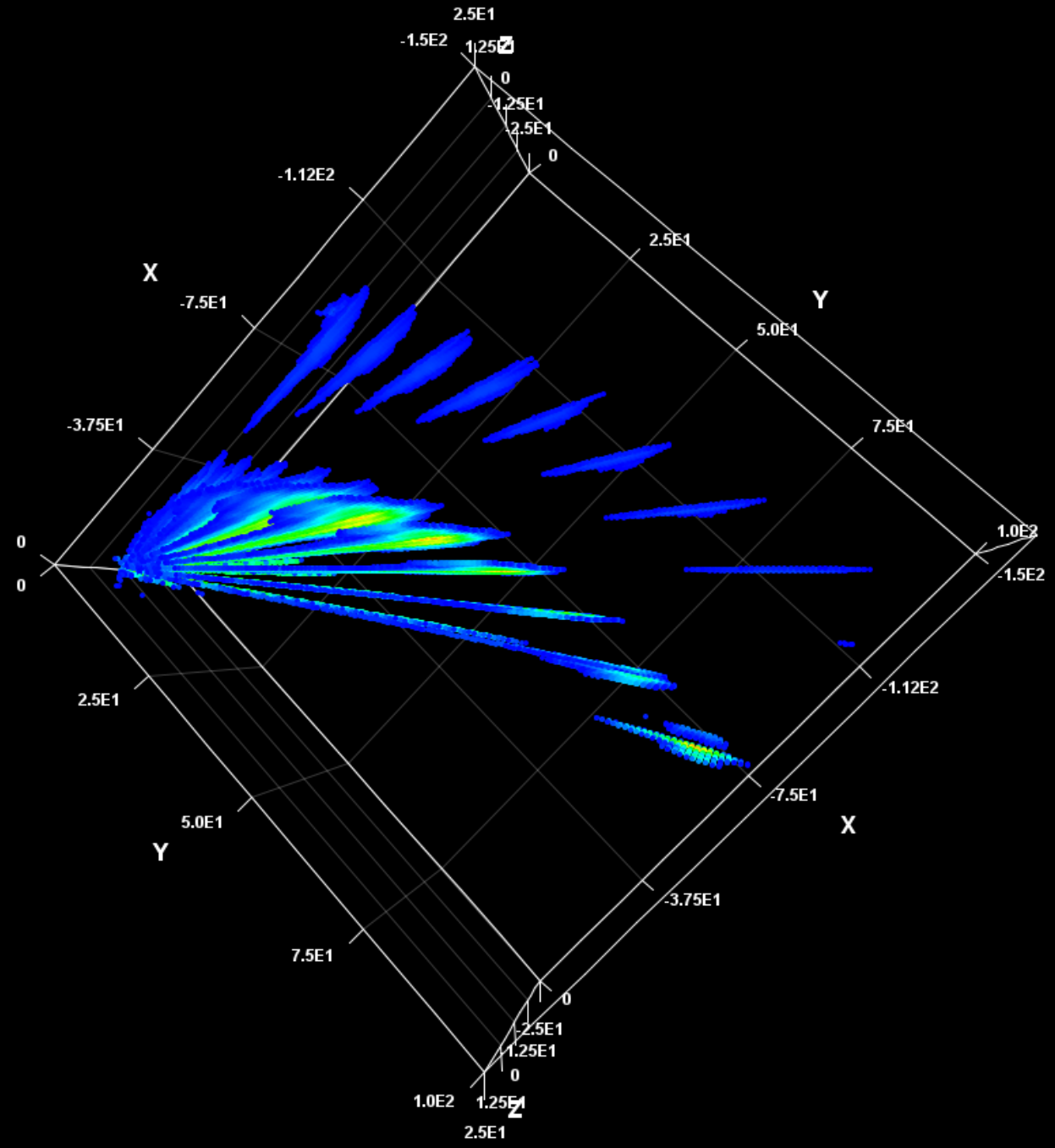

Z
2.0E1
10.0
0
-10.0
-2.0E1
1.7E2
1.28E2
8.5E1
4.25E1
0
-1.2E2
Y
-9.0E1
-6.0E1
-3.0E1
0
1.7E2
1.28E2
8.5E1
4.25E1
0
X
2.0E1
10.0
0
-10.0
-2.0E1
-3.0E1
-6.0E1
-9.0E1
-1.2E2
X
Y
Z

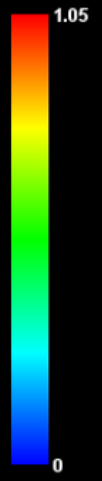



Outer Arm
Sagittarius Arm
Perseus Arm
Cygnus Spur
Perseus Arm

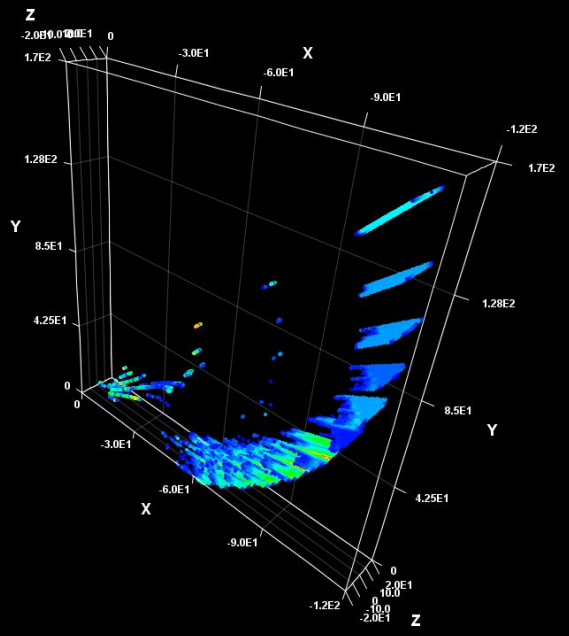

Outer
Galactic Arm
Inner
Galactic Arm
Location of Sun
Graphic showing
similar orientation
of galaxy to above

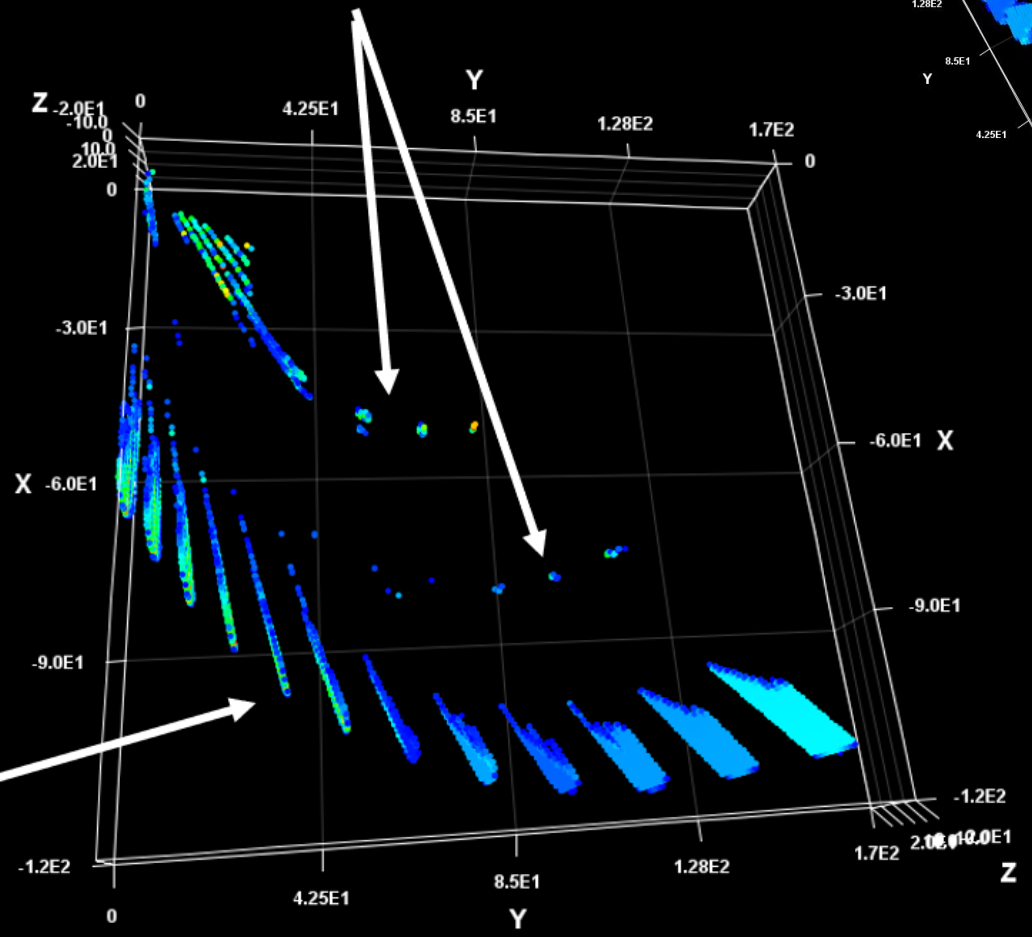

Y
0
5.0E1
1.0E2
1.5E2
2.0E2
-1.5E2
5.0E1
-1.12E2
X
-7.5E1
3.12E1
-3.75E1
Z 1.25E1
-6.25
-2.5E1
-1.5E2
-1.12E2
-7.5E1
X
-3.75E1
0
0
0
5.0E1
3.12E1
1.25E1 Z
-6.25
-2.5E1
2.0E2
1.5E2
1.0E2
Y

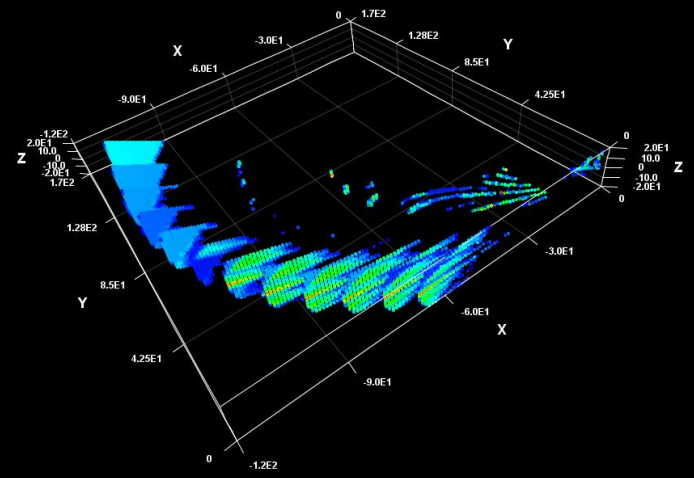

2.5E1
-1.5E2
1.25E1
0
-1.25E1
-2.5E1
0
-1.12E2
2.5E1
X
-7.5E1
Y
5.0E1
-3.75E1
7.5E1
0
0
1.0E2
-1.5E2
2.5E1
-1.12E2
5.0E1
Y
-7.5E1
X
7.5E1
-3.75E1
0
-2.5E1
1.25E1
0
1.0E2
1.25E1
Z
2.5E1



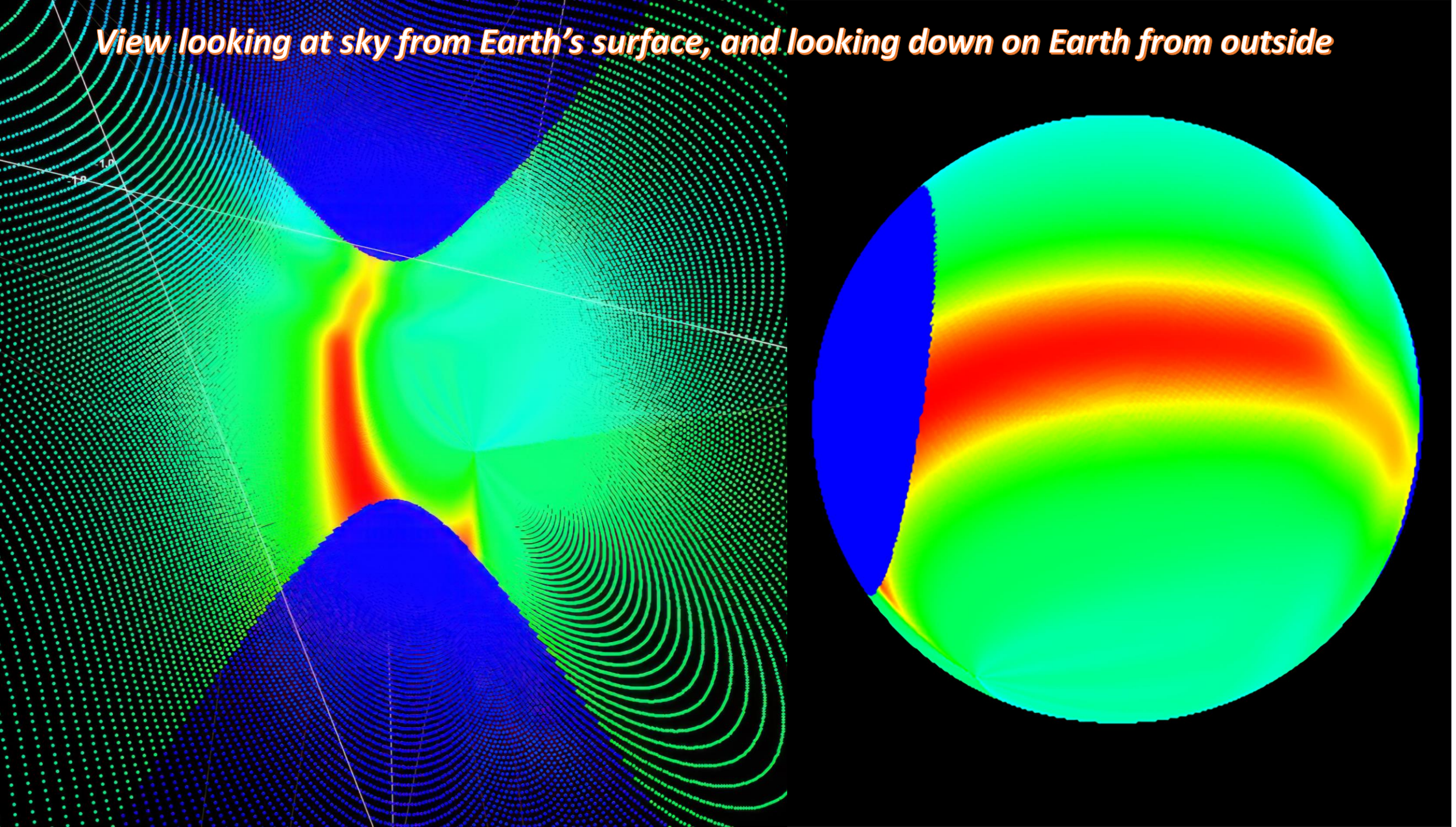
Inner arms/spurs more visible in 3D than in 2D







Sagittarius Arm of Milky Way


View looking at sky from Earth's surface, and looking down on Earth from outside


Contact Details:
Dr Andrew Thornett
M6THO
andrew@thornett.net
www.astronomy.me.uk
www.astronomy.network