Mapping the Milky Way galaxy from the observation of 21-cm spectral line from HI using SRT 4.5m of NARIT

by

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Outline

- Introduction
- Experiments
  - Small radio telescopes (SRT) of NARIT
  - Tangential point method (TPM)
  - Mapping the Milky Way galaxy
- Results & Discussions
- Conclusions

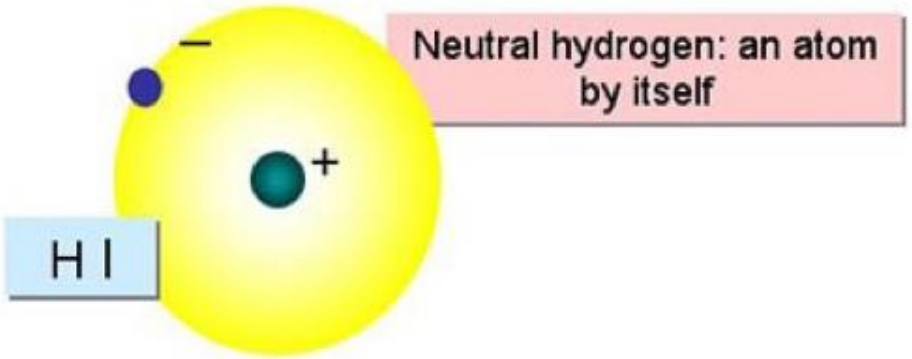
Introduction

Figure 1: Milky way (the Black Rock Desert, Nevada)

Milky Way Galaxy

The astronomers had been studying the kinematics of our galaxy and still finding the right answer due to the limitation as we live inside the galaxy. Therefore, they have to find out other techniques for studying the physical characteristics of our galaxy which one of the techniques for studying of the rotational dynamics and mapping the Milky Way galaxy is tangential point method (TPM).

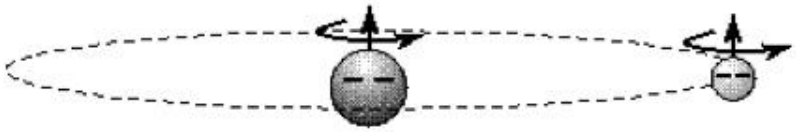
Introduction



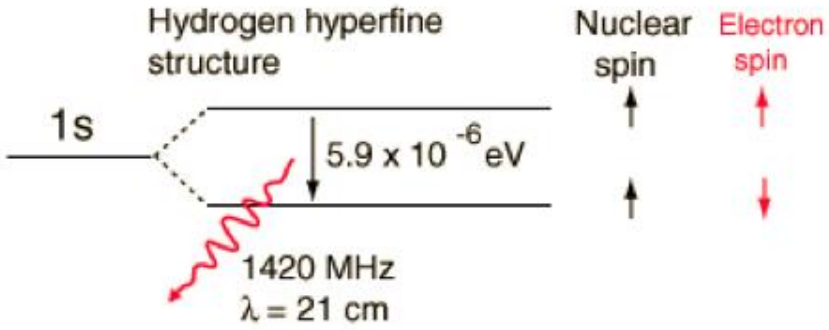
http://astronomy.swin.edu.au/cms/cpg15x/albums/userpics/neutralhydrogen.jpg

Neutral atomic Hydrogen creates 21 cm radiation

Hendrik C. van de Hulst
(1918-2000)



http://www.astronomynotes.com/ismnotes/s3.htm

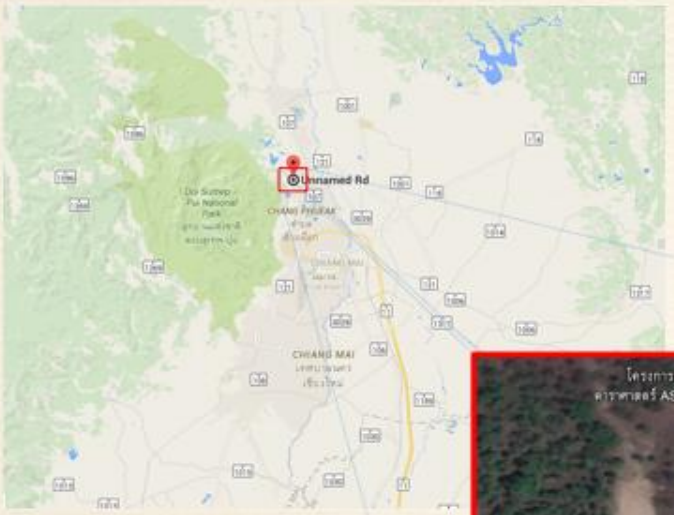


http://hyperphysics.phy-astr.gsu.edu/hbase/quantum/h21.html

$$f = \frac{8}{3} g_i \left(\frac{m_e}{m_p} \right) \alpha^2 \left(R_M c \right) \approx 1420.405751 \ \ MHz$$

Figure 2: property of neutral hydrogen (HI)

Small radio telescope of NARIT



Latitude : 18° 51’ 5.76” N

Longitude : 98° 57’ 11.88” E

Sea level : 331 m

Figure 3: Location of small radio telescope (SRT) of NARIT

Small radio telescope of NARIT

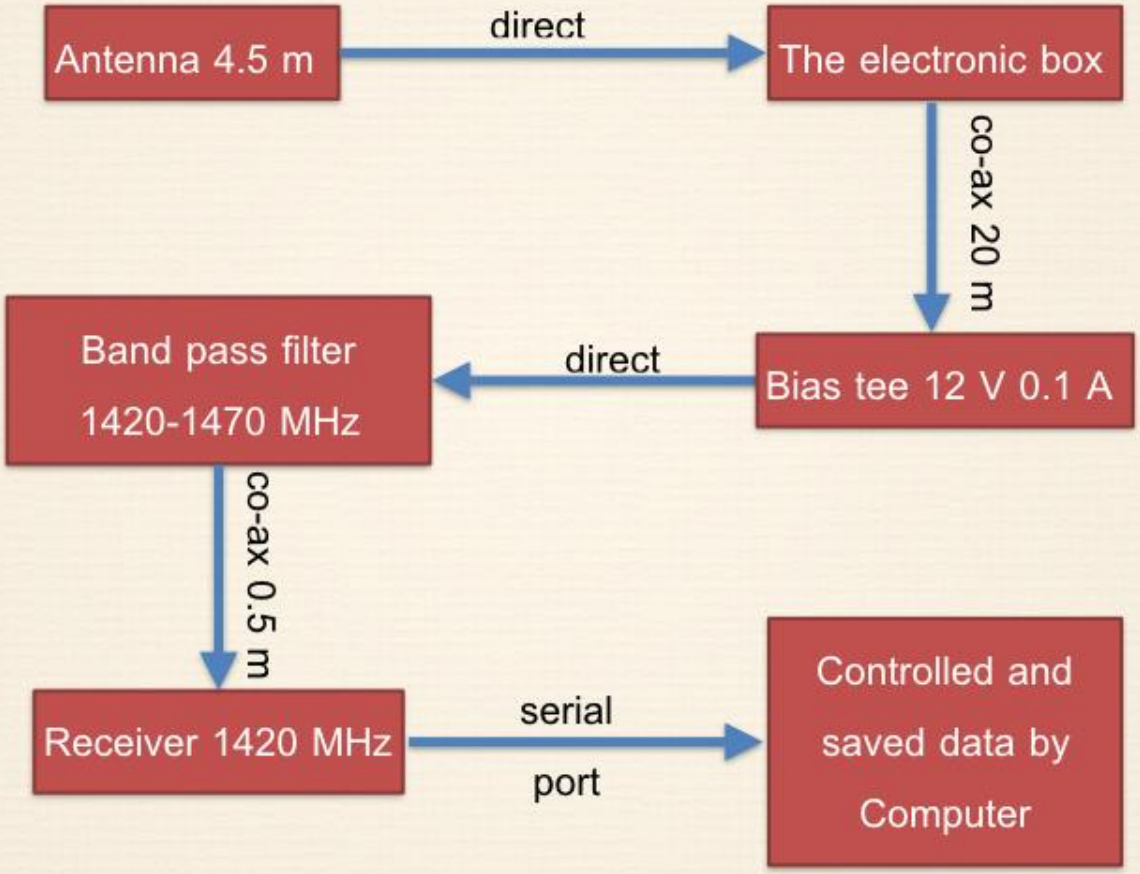


Figure 4 The system of SRT from NARIT, the electronic box are composed of 2 LNA , Bias tee and Band pass filter 1420-1470 MHz

Tangential point method (TPM)

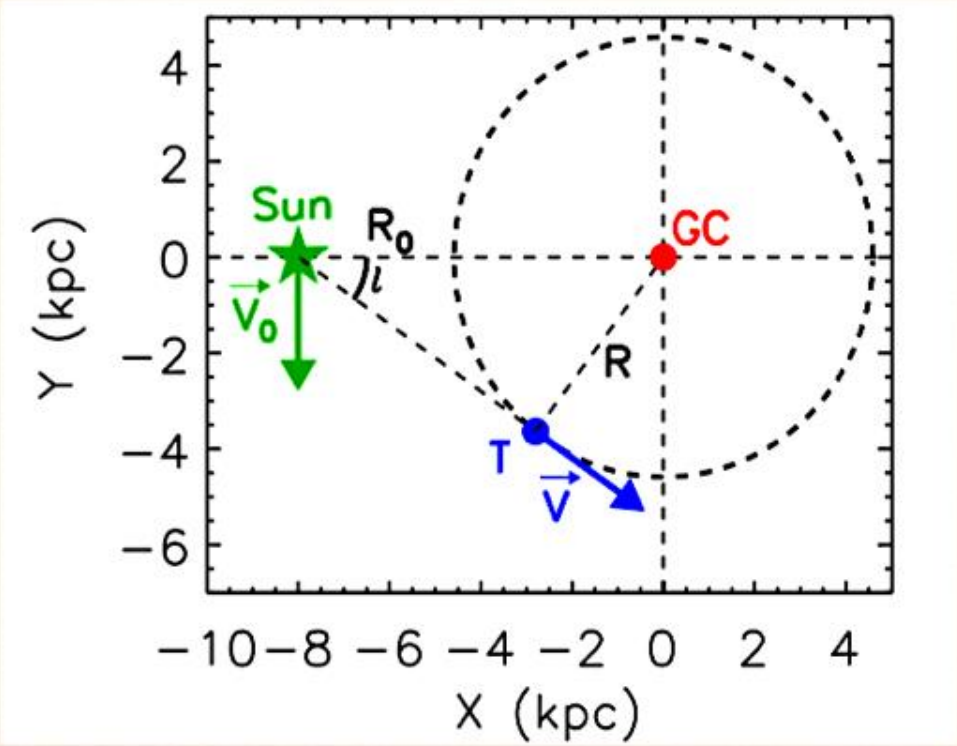


Figure 5 Illustration of tangential point: Sun, Galactic Center (GC), tangent-point (T) assumed by the tangential point method. (Renaud et al. 2013)

The data from SRT are calculated line-of-sight velocities (or called radial velocities) from Doppler shift effects which are used in tangential point method (TPM)The line-of-sight velocities at tangential point (T) are called tangential velocities which are used in Eq. 1 and Eq. 2 for calculating rotational velocities. The galactic distance can be calculated from Eq. 3 and then plot rotation curve of Galaxy.

Equation of tangential point method

$$V = V_{r,\max} + V_0 \sin l \quad ; \quad l > 0^\circ \qquad \text{Eq. 1}$$

$$V = V_{r,\min} + V_0 \sin l \quad ; \quad l < 0^\circ \qquad \text{Eq. 2}$$

$$R = R_0 \sin l \qquad \text{Eq. 3}$$

Mapping the Milky Way galaxy

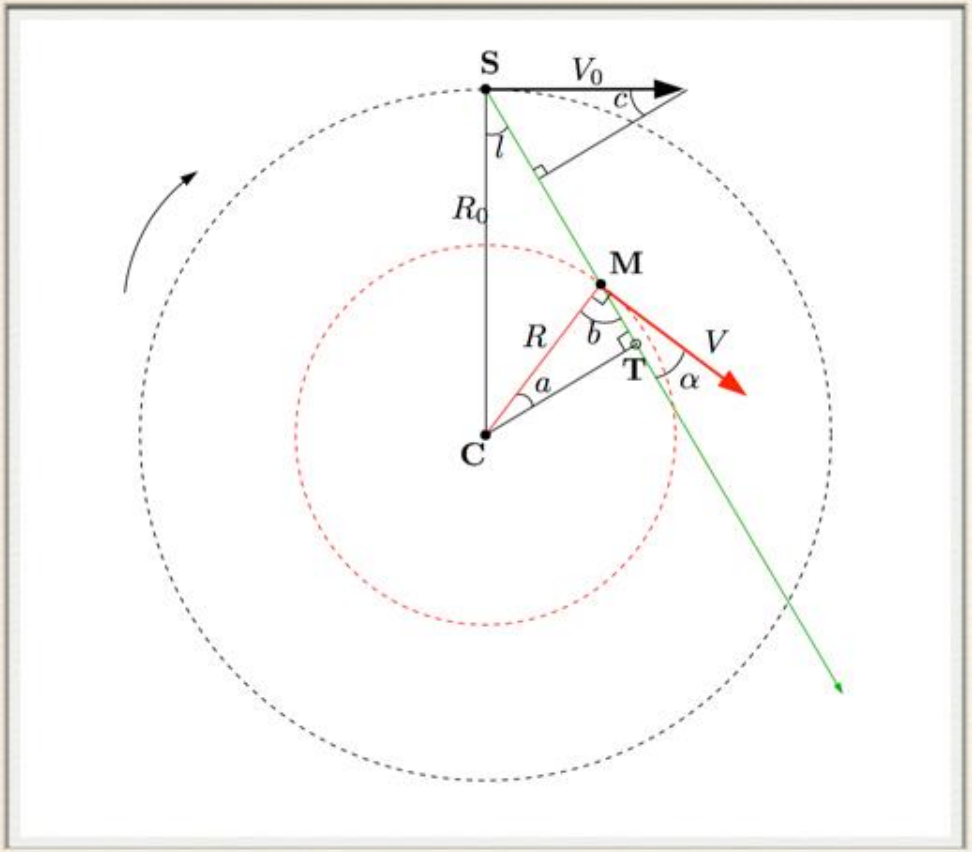


Figure 6 Geometry of our galaxy

(Cathy Horellou & Daniel Johansson)

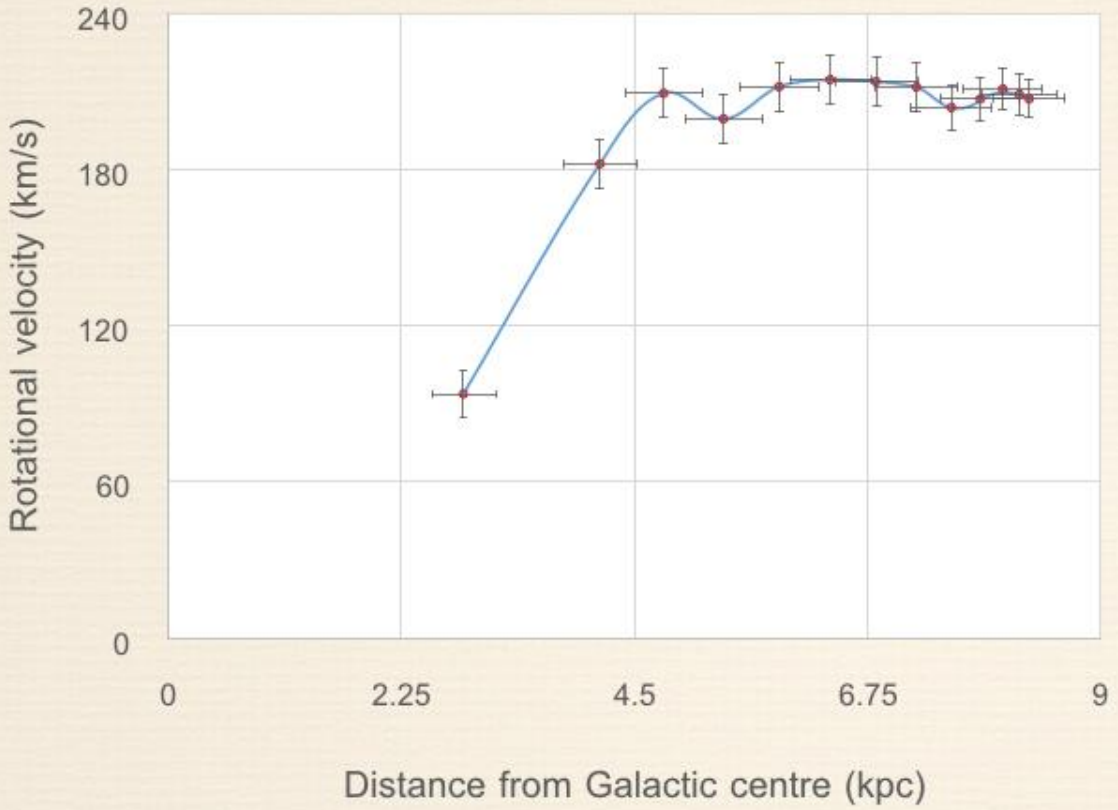
However, mapping our galaxy will give us to understand the physical properties and its morphologies. In each galactic longitude have many line-of-sight velocities which all those velocities will be calculated as the position of HI in our galaxy using Eq.4 and Eq. 5.

Equation for mapping

$$R = \frac{R_0 V_0 \sin l}{V_0 \sin l + V_r} \qquad \text{Eq. 4}$$

$$R^2 = R_0^{\,2} + r^2 - 2R_0 r \cos l \qquad \text{Eq. 5}$$

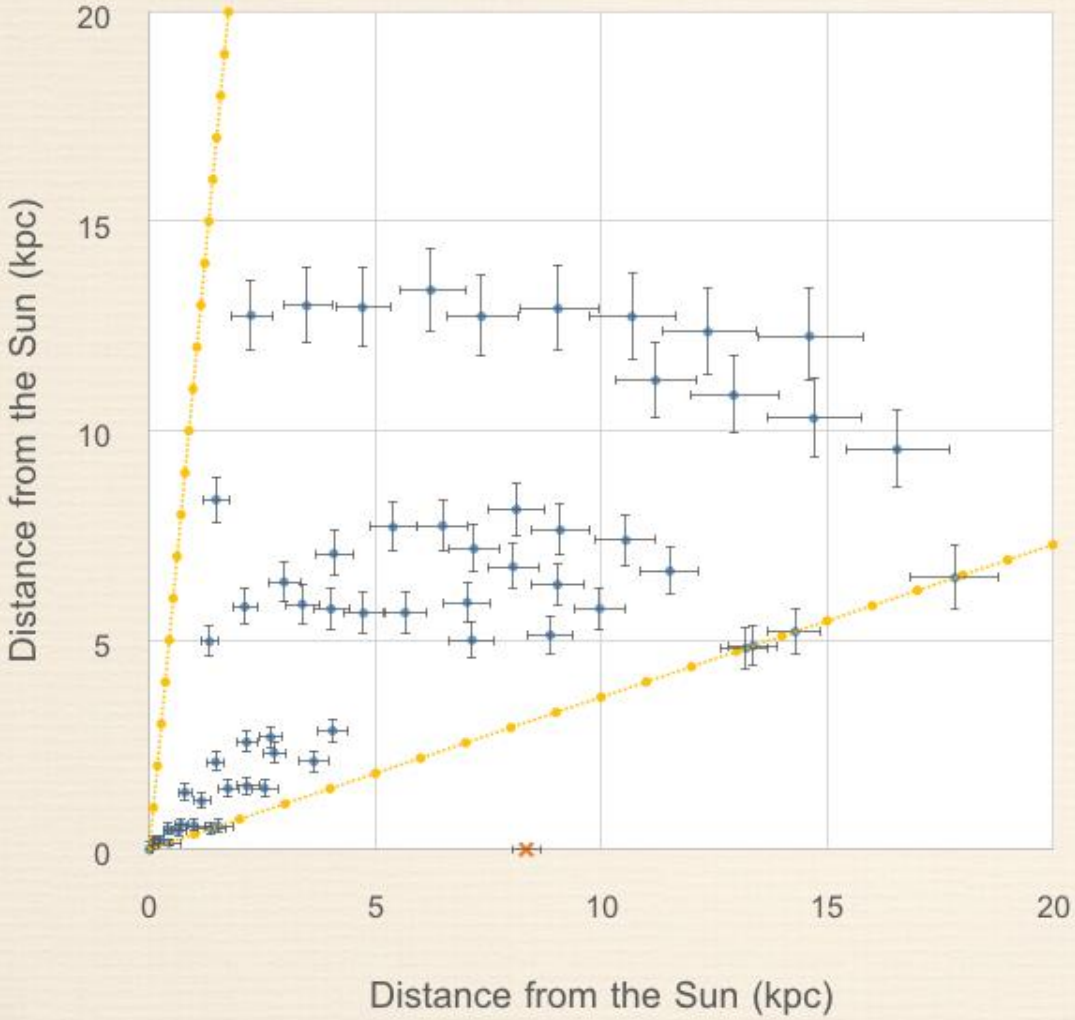
Results & Discussions



Scope of the study, HI spectrum is observed at galactic latitude 0° and from galactic longitude 25° to 85° with increasing 5° in each step. The parameters are used in this calculation as follows; the rotational velocity of Solar system is equal to 225±5 km/s and galactic distance of Solar system is equal to 8.34±0.34 kpc respectively. The rotation curve of our galaxy is almost flat showing constant velocity with increasing distance from the Galactic center.

Figure 7 Rotation curve of our galaxy obtained from SRT observation

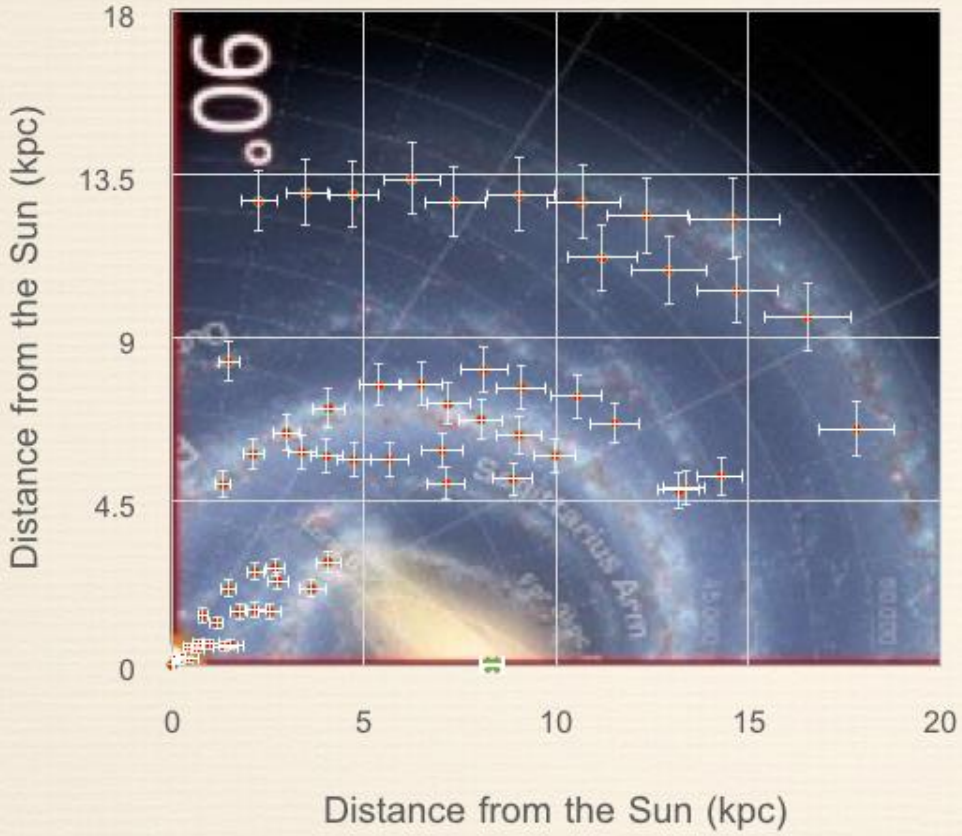
Results & Discussions



The error bars of HI's positions are increased when the Galactic distance is increasing. The distributions of HI in the map are well compatible with the arm of our galaxy especial in the first quadrant.

Figure 8 The distribution of HI in Milky Way galaxy using SRT 4.5 m of NARIT

Results & Discussions



Plotting the HI's position in the map is similar to arm schematic of Milky Way galaxy which represents reliability of 4.5 m SRT.

Figure 9 The comparison between HI's map from SRT and schematic of the Milky Way by R. Hurt (SCC-Caltech)

Conclusions

The rotation curve of our galaxy is almost flat showing constant velocity with increasing distance from the Galactic center which contradicts the Kepler's law. The result reveals that total mass within the Milky Way galaxy increases nearly constantly with increasing galactic radius.

The distribution of HI's in the map is similar to the arm structure in schematic of Milky Way galaxy obtained from R. Hurt (SCC-Caltech) which represents reliability results of 4.5m SRT. Moreover, the line-of-sight velocities are observed at galactic longitude with increasing 5° in each step which is big size step and effect to reliability of rotation curve data. Therefore, we will re-observe at galactic longitude with increasing 2° to 3° in each step.

References

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Acknowledgments

Thank You

for your attention