The Molecular Perseus Arm

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Abstract

We present initial results from a comprehensive survey of the Molecular content of the Outer Galaxy. Using FCRAO[1,2] observations of ^{12}CO, J(1->0), to infer the presence of molecular Hydrogen within the Outer Galaxy Survey (OGS), Extended Outer Galaxy Survey (EOGS) and the EOGS Anti-Centre Survey (EOGSAC). All the identified Galactic Molecular Clouds (GMCs) reside within the Galactic plane between longitudes of 55° and 193°. In addition to the CO survey a Distance and Velocity structure model for the Perseus Arm is also presented here.

Introduction

Galactic Molecular Clouds (GMCs) are sites of all known star formation, hence any attempt to understand the process by which the stars form must include an understanding as to the formation, evolution and properties of the host GMC. To investigate the GMCs, first one must find the location of the Galactic spiral arms. For this work the closest spiral arm, Perseus, will be used. This will require knowledge of the spatial and velocity structure of the arm itself.

Perseus Arm Structure

The physical location of the arm as it passes through the Galaxy is expressed as a logarithmic spiral, $R_{arm}=R_i.e^{b.\theta}$. θ is zero at the positive x-axis centered at the Galactic centre increasing counter-clockwise. R_i and b were derived from fitting to tracers[3].

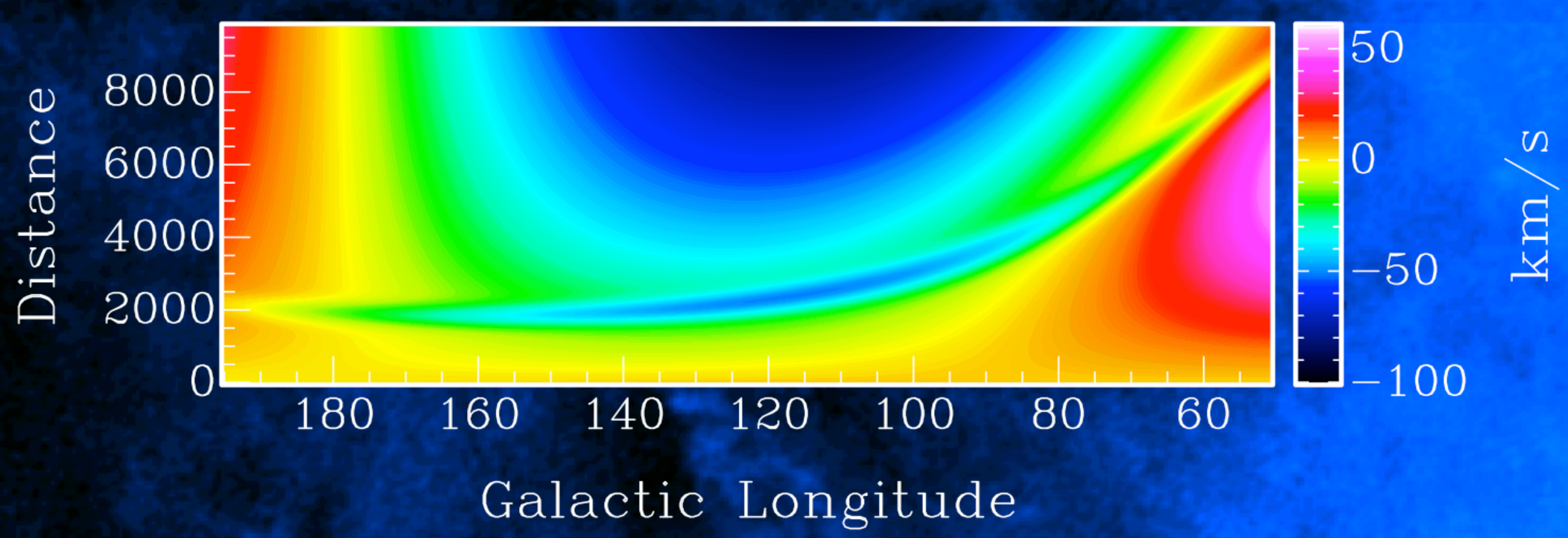

Figure 1; Velocity Field of the Outer Galaxy in (l, d_{helio}, V_{LSR})

For the initial attempt at pinning the velocity and distance structure across the arm, we assume flat rotation and that there is constant shock velocity, V_{shock}, varying due to the line of sight, ϵ. Figure 1 shows the (l,d,V) structure and figure 2 shows the geometry.

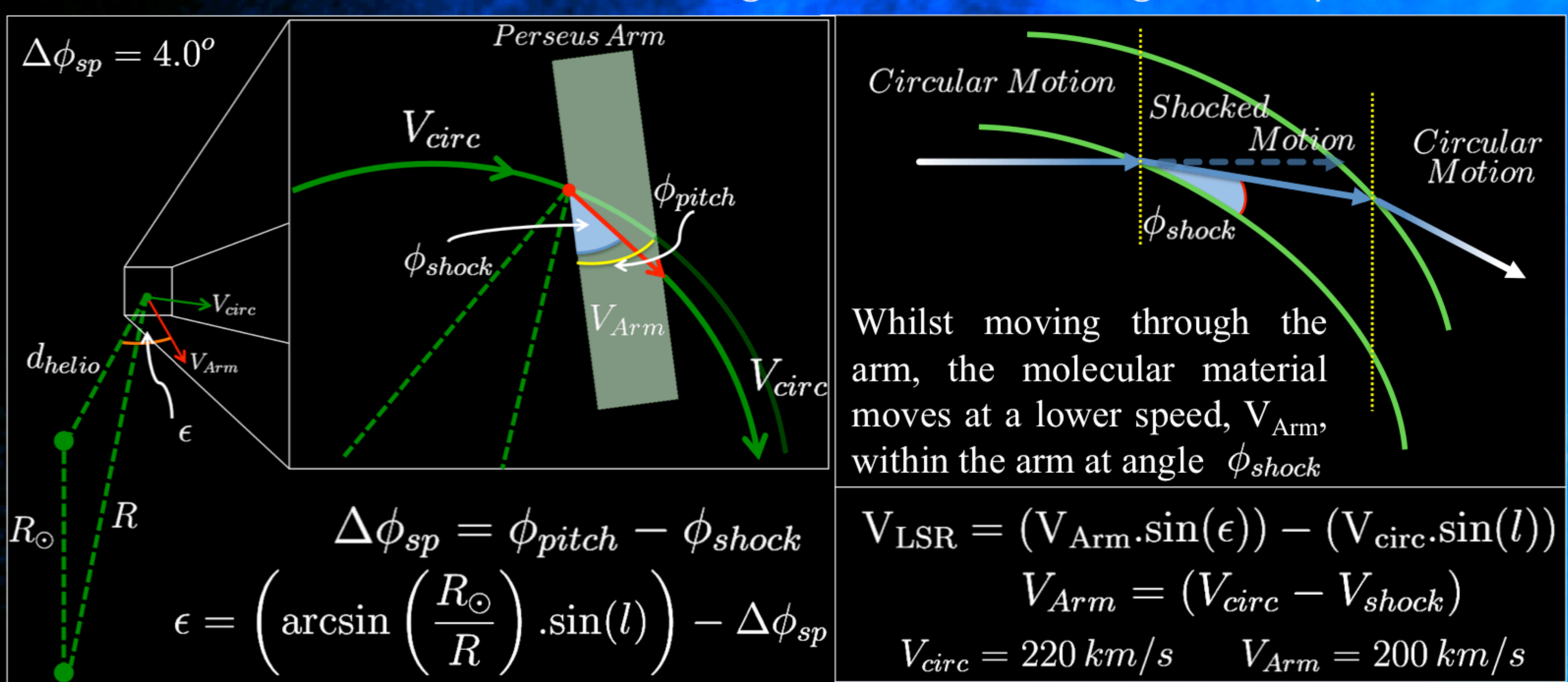

Figure 2; Geometry of the Arm Model

This model matches the (l,V) structure of GMCs within the Perseus Arm, see figure 3, with the parameters defined in figure 2. We defined a cloud threshold to be T_{min}>4.0K. The distribution of the Perseus arm GMCs can then be adequately represented by a direct quartic polynomial fit to the (l,V) data-points.

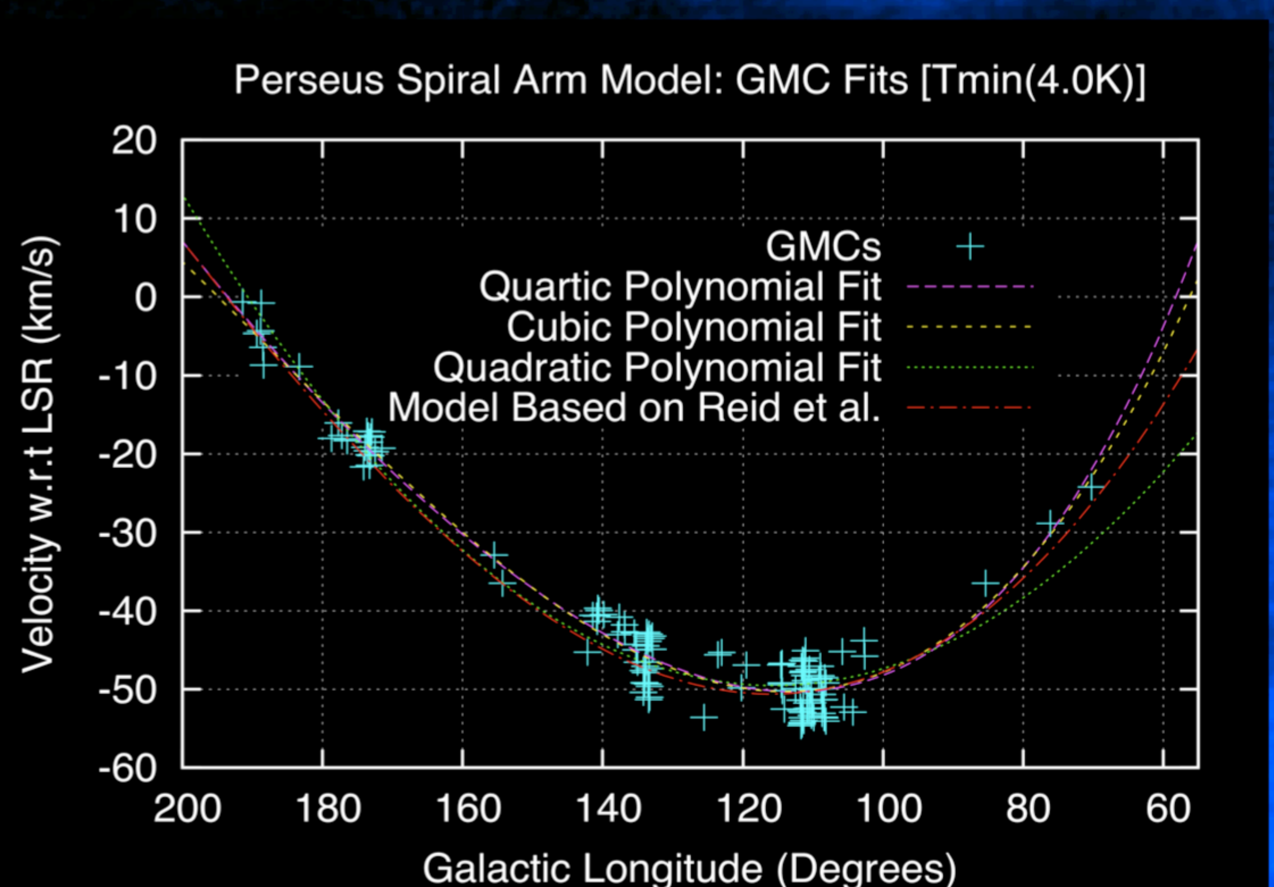

Figure 3; Fits for the Longitude-Velocity Model of the Arm

When overlaid on the CO data directly, it is shown that the quartic polynomial model not only tracers the centroids, but also the continuous data in figure 4.

$$V_{LSR} = 256.171 - 7.22442.\theta_l + 0.0595035.\theta_l^2 - 2.05907x10^{-4}.\theta_l^3 + 2.89305x10^{-7}.\theta_l^4$$

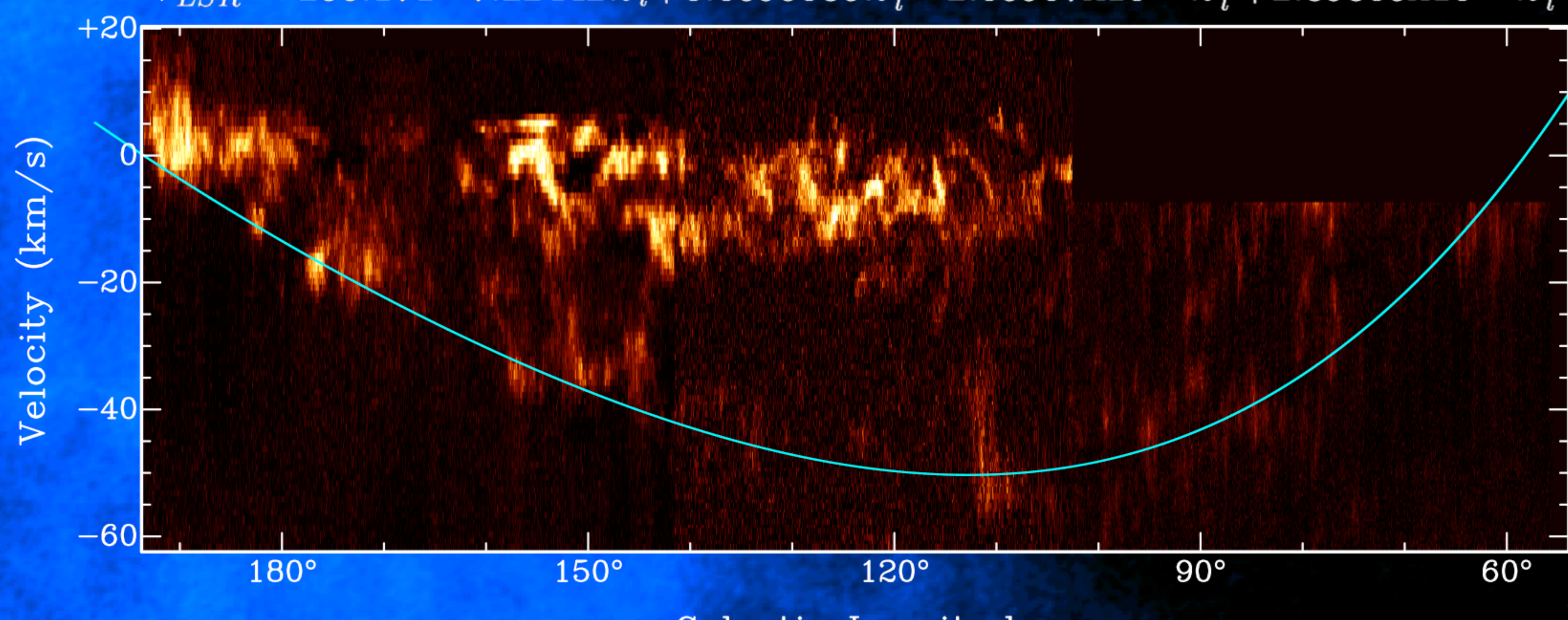

Figure 4; Longitude-velocity plot of CO data overlaid with a quartic polynomial fit

Perseus Arm Material

We resample the spectra to a new velocity axis centred on the Perseus arm. The data were then spatially convolved and re-sampled to produce a position-position-velocity data cube of the arm over 9.5 kpc in length at a uniform linear resolution of 2 pc.

Using this "Arm-Zeroed" map we project the original angular position of the arm onto a constant linear scale map, with the data expressed as X and Z which are length along the arm from the anti-centre and height out of the plane respectively.

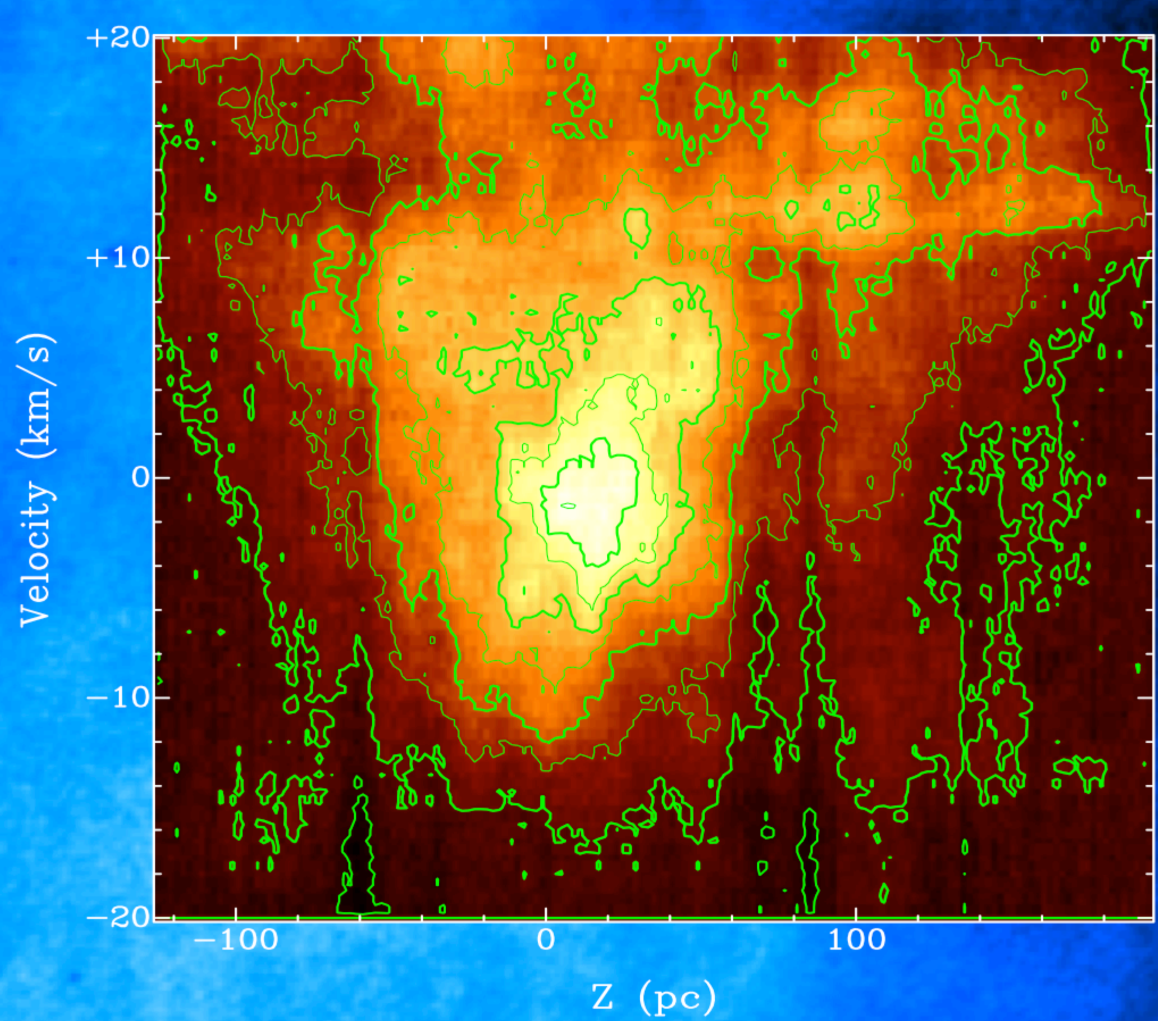

Figure 5; Z-velocity, integrated over X, plot of Perseus Arm-Zeroed CO data.

Figure 5 shows that, as expected, most of the emission is located at the arm centroid (0 km/s) and in the plane (Z=0pc). The contours are spread at 100K intervals.

Figure 6 shows the Scaled Linear Arm Projection, integrated over +/- 20km/s, where X is distance along the arm and Z is height out of the plane.

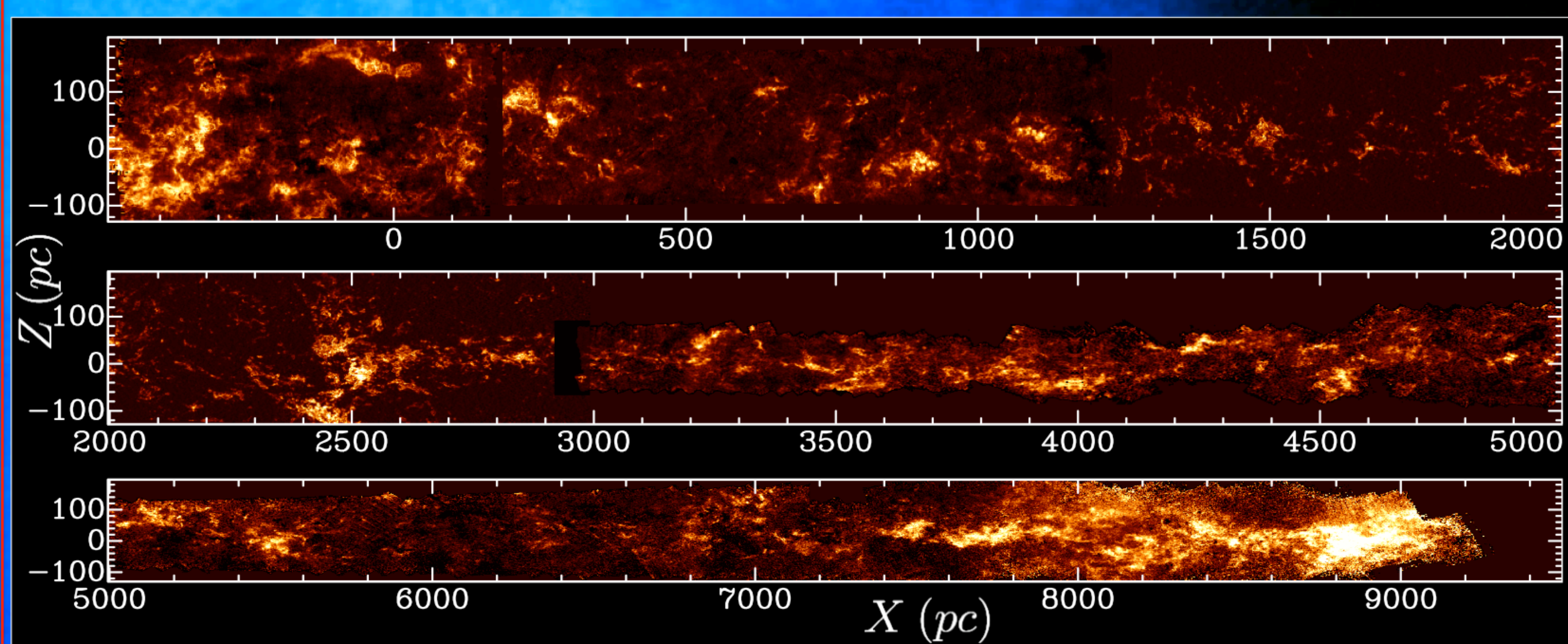

Figure 6; Plot of Length along the arm, X, against height above the plane, Z, integrated over +/-20km/s of the arm centroid (bottom).

References;

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2) Heyer M. H. et al. 1998, ApJS, 115, 241
3) Reid M. et al 2009., ApJ, 700, 137-148
4) Summers L. J. & Brunt C.M., 2010, in prep