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# Mapping the Asymmetric Thick Disk

# I. Field Star Distributions of the Hercules Thick Disk Cloud

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## Introduction

The Hercules Thick Disk Cloud (Larsen et al. 2009) was initially discovered as an excess in the number of faint blue stars between quadrants I and IV of the Galaxy. The field stars responsible for the excess, are between 2 and 4 kiloparsecs from the Sun, 1.2 kpc above the Galactic plane, and the asymmetry feature or Cloud is kiloparsecs in length -- a major substructure in the Galaxy. The origin of the Cloud could be an interaction with the disk bar, a triaxial thick disk or a merger remnant or stream. To better map the spatial extent of the Cloud along the line of sight, we have obtained multi-color UBVR photometry for 1.2 million stars in 67 fields of approximately 1 square degree each. Our analysis of fields beyond the apparent boundaries of the excess rule out a triaxial thick disk as a possible explanation for the Cloud (Larsen et al. 2010, AJ in press). In this poster we present our results for the counts over all of our fields and characterize the size of the excess. Over the entire 500 square degrees of sky containing the Cloud, we estimate about a quarter of a million F/G type stars, bringing the estimated mass of the Cloud to over a million solar masses.

## 1) Data and GALMOD

We present Hess diagrams (number binned by B-V color and magnitude) for all of our program fields in Figure 1. These fields represent 1.2 million stars in 67 fields of 1 square degree each. The field placement is given in Figure 2 and the format in Figure 3.

We ran GALMOD with the parameters derived by Larsen and Humphreys 2003 and created model Hess diagrams for each field, shown in Figure 4. In addition to being a good match to the data, the model allowed us to determine portions of the Hess diagram dominated by disk/halo/thick disk stars for § 2.

## 2) Model Dependent and Independent Count Ratios

In order to identify the cloud in terms of the various components of the Galaxy we performed a series of tests which are presented in Figures 5-8. In Figure 5, we use the simple "blue ridgeline" to isolate a pure sample of halo and thick disk stars from the disk. To create a ratio in the plot we counted all stars blueward of the blue ridge and then compared with the numbers counted on the symmetric lines of sight about l=0. The ratio is expressed as the number of Q1 stars divided by Q4 stars and the cloud is readily visible in Figure 5.

GALMOD was then used to isolate color/magnitude regions in the Hess diagrams dominated (>50%) by each population (disk, thick disk and halo). New count ratios were computed using these color ranges. In Figure 6 we find that disk stars can be part of the cloud but only for high latitude fields. Figure 7 shows that the intermediate colors of the thick disk trace the cloud very well while in Figure 8 we find that the cloud does not appear to be traced in the colors typical of halo stars.

## Acknowledgements

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**Figure 5:** Count ratios between paired fields across the l=0 line of symmetry using stars with bluer colors than the "blue ridgeline" to completeness limit.

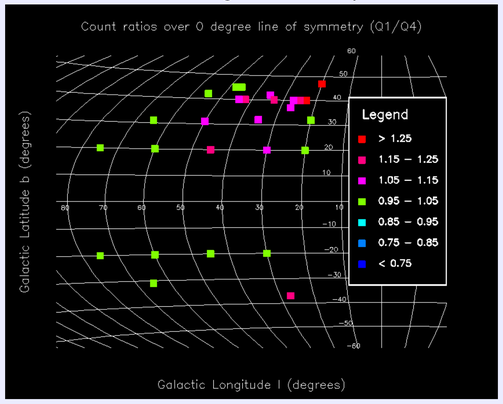



**Figure 6:** Count ratios between paired fields across the l=0 line of symmetry for stars in a color range expected by GALMOD to be dominated by the disk.

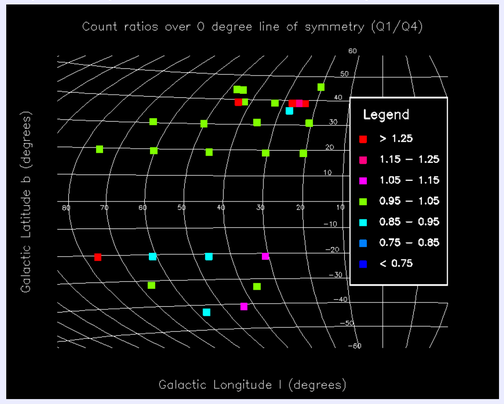



**Figure 7:** Count ratios between paired fields across the l=0 line of symmetry for stars in a color range expected to be dominated by the thick disk,.

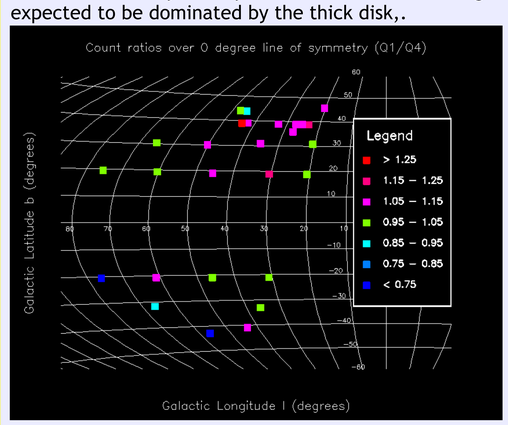



**Figure 8:** Count ratios between paired fields across the l=0 line of symmetry for stars in a color range expected by GALMOD to be dominated by the halo.

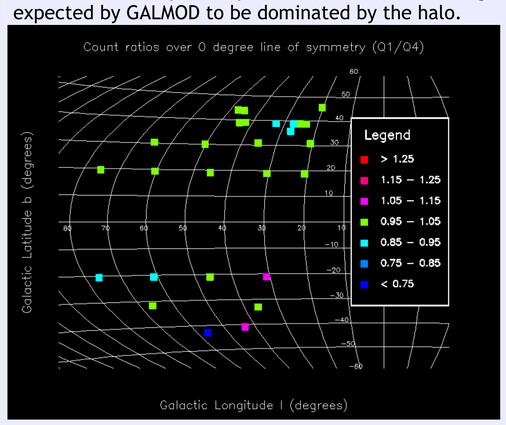



**Figure 1:** Hess Diagrams for data from all project fields. Format is explained in Figure 3.

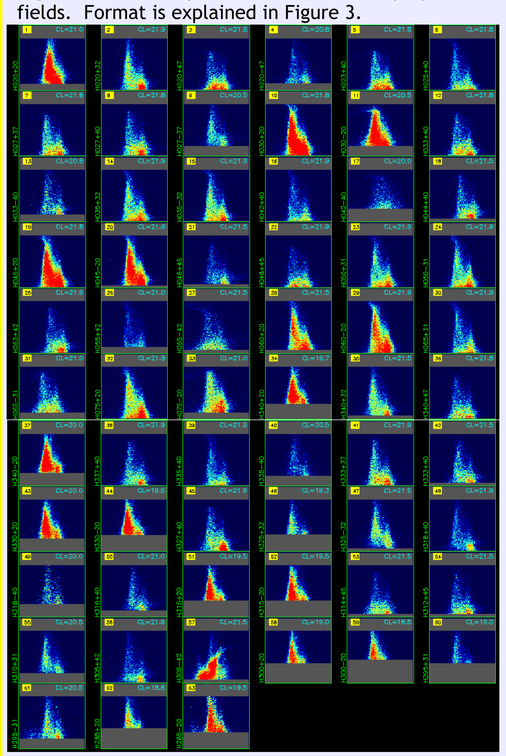


**Figure 2:** Field placement on the Galactic sky. Yellow numbers match the tags on Figures 1 and 4.

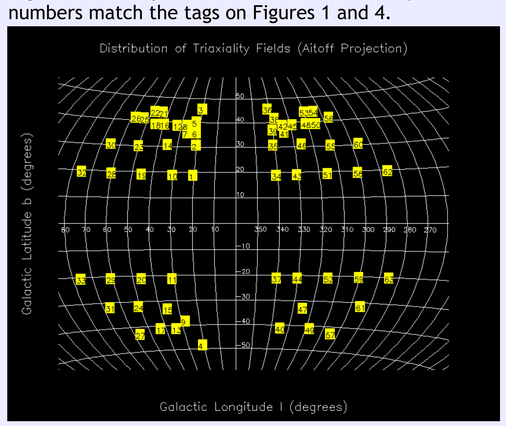



**Figure 3:** Sample Hess diagram showing explaining the parameters of Figures 1 and 4.

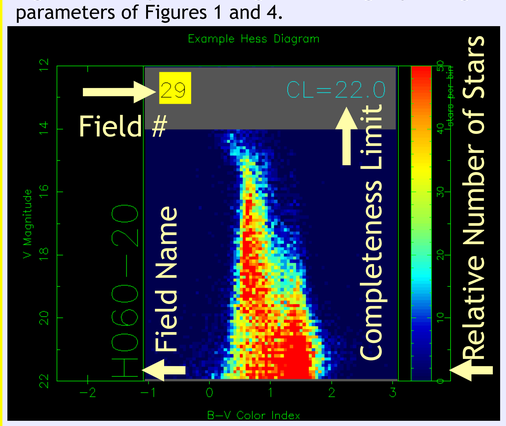
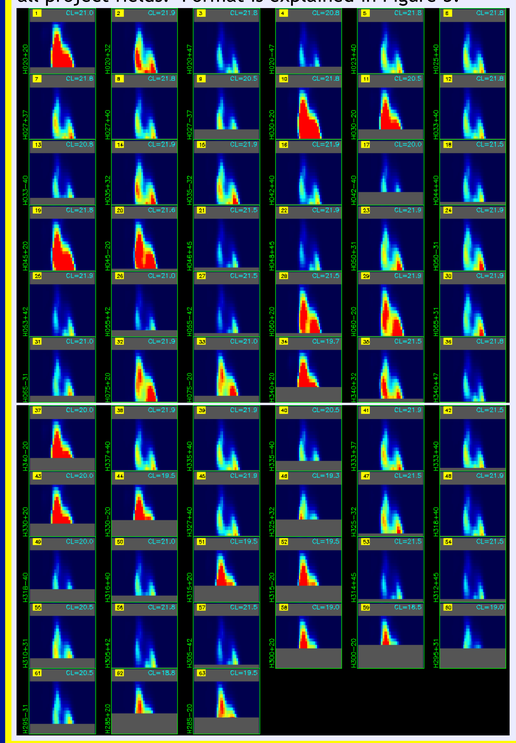



**Figure 4:** Hess diagrams predicted by GALMOD for all project fields. Format is explained in Figure 3.



## 3) Photometric Parallax

We also show a breakdown of number vs. star distance for paired fields about the l=0 line of symmetry. In Figure 9 presents the calculation for two fields where the excess was not seen and Figure 10 presents the excess for two fields with the excess.

While no difference is seen in the distribution of Figure 9, Figure 10 shows the Q1 line of sight has more stars between 1000 and 3500 pc than the Q4 line of sight. We note that we are not sensitive to smaller distances due to the small size of the Line of sight volume cone near the Sun.

**Figure 9:** Number vs. distance from photometric parallax for a paired field without the excess stars.

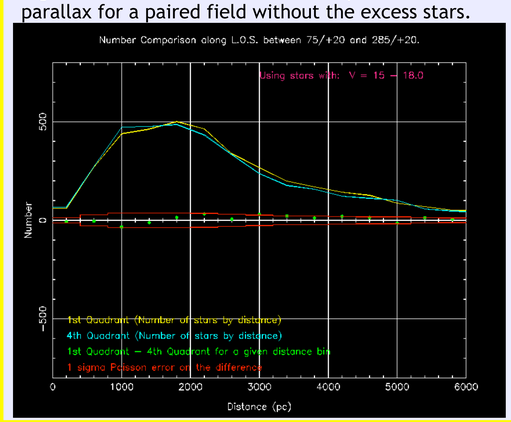
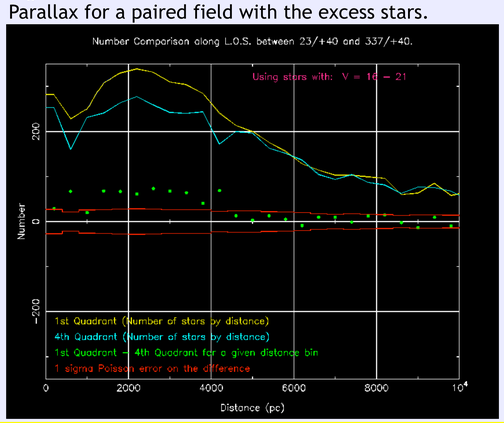



**Figure 10:** Number vs. distance from photometric Parallax for a paired field with the excess stars.




## Main Conclusions

- The Hercules Thick Disk cloud is indeed associated with an intermediate color population similar to the Thick Disk.
- This population is moderately close to the Sun (closer than 5000 kpc) and may be connected with the Hercules Stream in the Solar neighborhood.
- We currently estimated its mass (from star counts) at being about a million Solar masses, though a comprehensive star count model is currently being developed.