Painting a More Accurate Picture of the Sagittarius Dwarf Tidal Stream

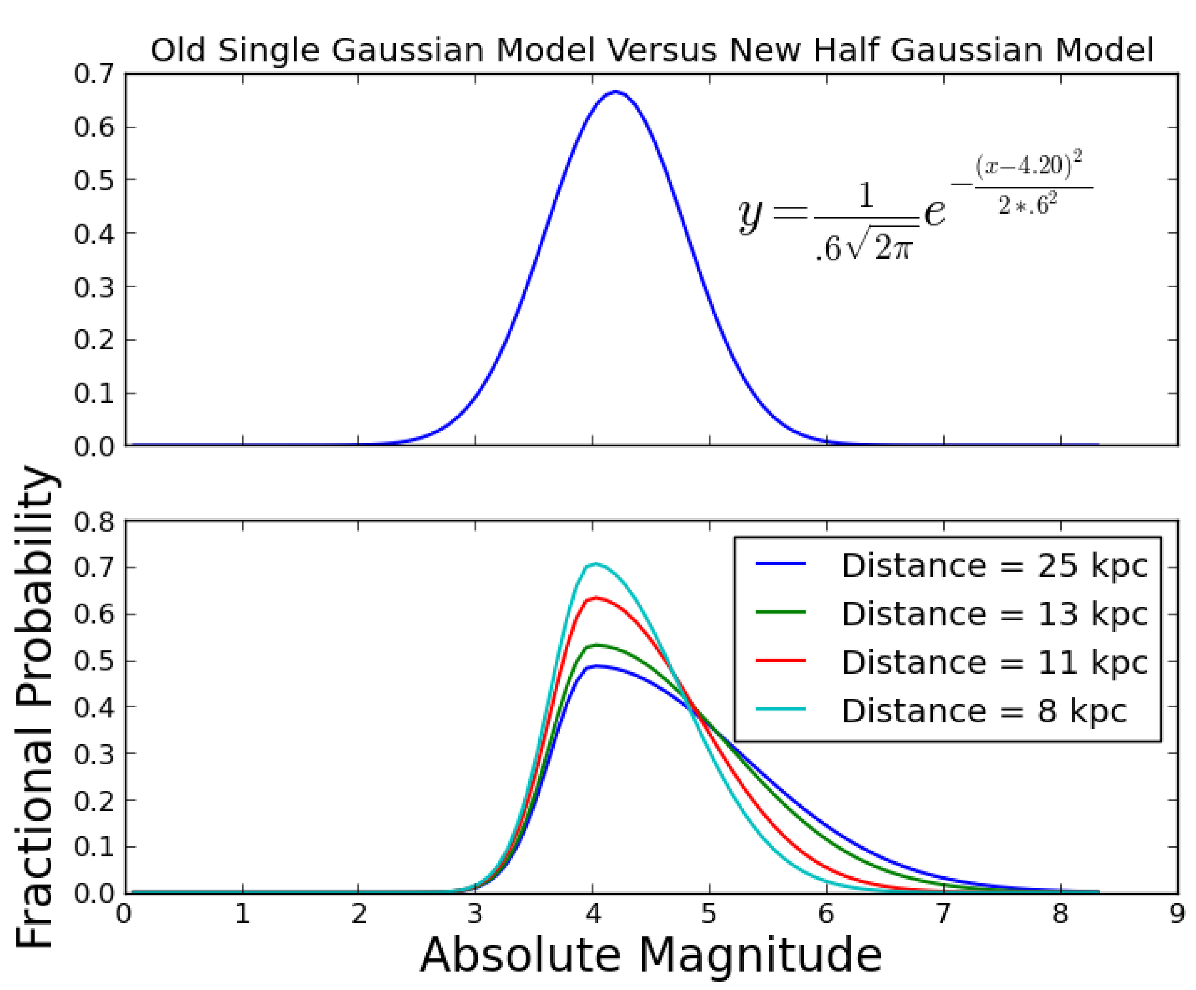
Jake Weiss[1], M. Arsenault[1], T. Bechtel[2], T. Desell[3], H. Newberg[1], M. Newby[1], J. Thompson[1]

[1]Rensselaer Polytechnic Institute, [2] University of Wisconsin-Madison, [3] University of North Dakota

Abstract:

We are improving the current spatial density profile for the Sagittarius dwarf tidal stream and other tidal streams in the Milky Way halo, using new color corrections to the Sloan Digital Sky Survey and a new statistical model for main sequence turnoff stars absolute magnitude distribution. Using the MilkyWay@home distributed computing platform, we implement a method of maximum likelihood to fit a model to both tidal streams and a smooth component of the halo. With this technique, we currently have one of the most accurate descriptions for part of the Sagittarius dwarf tidal stream's spatial density profile as well as a spatial density profile for part of a second (bifurcated) stream near the Sagittarius dwarf tidal stream, whose origins are not well understood. Along with fitting the width, positions, and orientations of the previously mentioned streams, we also have found that the smooth component of the Milky Way halo is oblate. Using these results, we hope to run N-body simulations of the dwarf galaxy tidal disruption that created the tidal debris to constrain the dark matter profile of the Milky Way galaxy. This research was funded by NSF grant AST 10-09670 and the Rensselaer Center for Open Source Software (RCOS).

Main Sequence Turn-Off (MSTO) Star Distribution:



Originally, the absolute magnitude distribution of MSTO stars was simplified in Newberg & Yanny 2006 to follow a Gaussian profile with a mean magnitude of 4.20 and a standard deviation of .6 as is shown in the figure above. Newby et al. 2011 revisited this model and made some minor adjustments to the distribution now modeling the distribution with two half Gaussian profiles where the left has a standard deviation of .36 and the right has a standard deviation that follows the function:

$$\sigma_r = \frac{\alpha}{1 + e^{-(d_{eff} - \beta)}} + \gamma$$

where α = 0.52, β = 12.0, and γ = 0.76. The standard deviation increases with distance on the right hand side because redder stars leak into MSTO selection bin as photometric errors increase.

Broken Power Law:

Akther et al. 2012 found, based on observations of RR Lyrae stars, the galactic halo follows a broken power law distribution in the form:

$$\rho(R) = \rho_0 \left(\frac{R}{R_0}\right)^n$$

where

$$n = \begin{cases} -2.78, R < R_{Break} \\ -5.0, R > R_{Break} \end{cases}$$

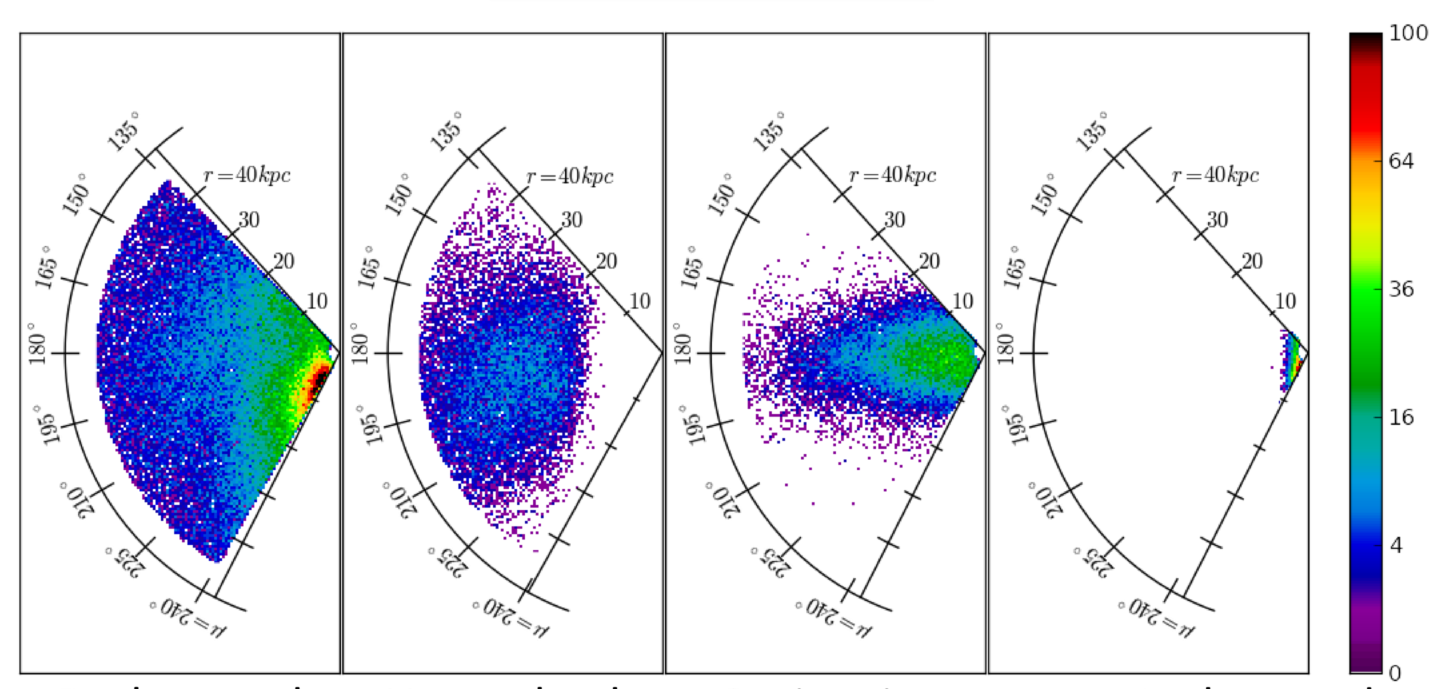
and

$$R = \sqrt{X^2 + Y^2 + \left(\frac{Z}{q}\right)^2}$$

Here, X, Y, and Z are galactic Cartesian coordinates, q is a flattening parameter for the halo, ρ_0 is the local space density, and R_0 is the distance from the galactic center to the sun. This model is expected to eliminate the need for an extra stream during fitting to collect stars that do not fit the current model.

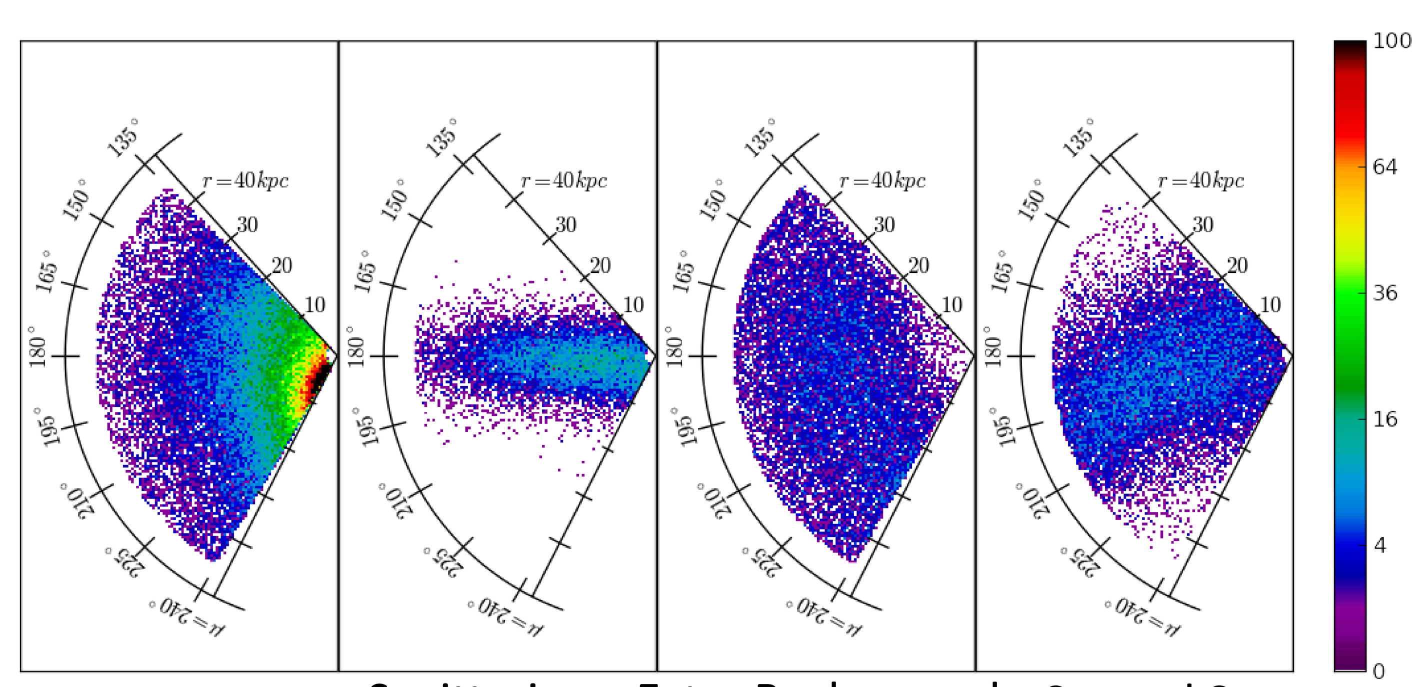
Results For Sloan Digital Sky Survey Stripe 15:

Broken Power Law



Background | Unresolved Second Stream | Sagittarius | Extra Background

Corrected MSTO Distribution and Broken Power Law



Background | Sagittarius | Extra Background | Second Stream

References:

- Abazajian et al.2009
- Akther et al. 2012
- Cole et al. 2008
- Newberg and Yanny 2006
- Newby et al. 2011
- Newby et al. 2013

Results For Sloan Digital Sky Survey Stripe 15:

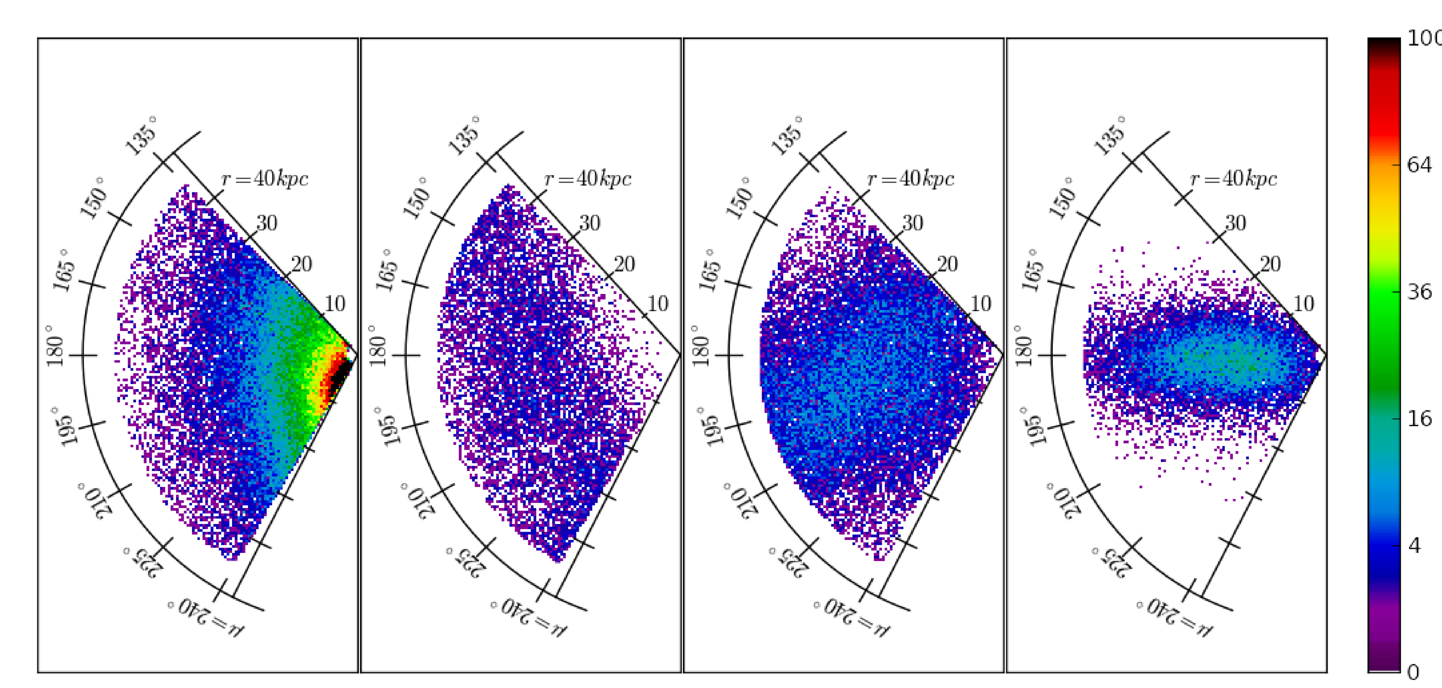
Broken Power Law:
- Minimized extra stream
- Found Sagittarius
- Started to resolve the second (bifurcated) stream

Corrected MSTO Distribution:
- Required extra stream for background fitting
- Found Sagittarius
- Resolved the second (bifurcated) stream

Combined:
- Required extra stream for background fitting
- Found Sagittarius
- Started to resolve the second (bifurcated) stream

To Do:
- Fit nearby wedges
- Constrain to be continuous and rerun all wedges
- Remove Sagittarius for better second stream resolution

Corrected MSTO Distribution



Background | Extra Background | Second Stream | Sagittarius

AAS 223RD Meeting
American Astronomical Society
Washington, DC | 5–9 January 2014

http://extras.aas.org/meeting/aas223/346/346.11