Modelling the Sagittarius stream

September 23, 2015

Some characteristics

- First observed by Ibata 94
- Large population of young relatively metal rich Sgr M-giant wrapping 360 across the sky (Majewski 03)
- debris streamer continues through the North Galactic Pole passes over the solar neighborhood toward the galactic anitcenter. (Belokurov 06)
- Evolution in metallicity distribution function.

Efforts trying to modelled the stream.

- Johnston 95, 99
- Velazquez & White 95
- Edlesohn & Elmegreen 97
- Ibata et al 07
- Gomez-Flechoso et al 99
- Helmi & White 2001
- Martinez-Delgado et al 2004

MW DM halo:

- Ibata et al 01 (Spherical)
- Helmi 04 (Prolate)
- Johnston et al 05 (Oblate halo)
- Law et al 05
- Fellhauer et al 06 (Spherical)
- Martinez Delgado et al 07 (Oblate)
- Law, Majewski, Johnston 09 ()
- Law & Majewski (Triaxial)

1 The Milky Way Dark Matter halo

1.1 Vera Ciro13

(?) study a dark matter halo that is oblate in the center and triaxial in the outskirts.

This study is motivated by expectations that the disk would modify the

The motivations are that the disk is expected to modify the

inner halo shape towards one that is oblate, in which case disk stability is ensured.

also if the halo is oblate at the inner the disk stability is ensured.

They argue that the triaxial halo configuration of (?) it's not common in the LCDM model due to the small c/a ratio compared to LCDM predictions.

*** Is this actually an issue - can't the MW be an outlier? *** How much of an outlier is the Law model vs average properties

They integrate orbits of test particles in the potential Eq.?? for a period of 2gyr backwards and forwards.

For every test particle they select 10 random locations in its orbit and store the position and velocity. orbit of this test particle from which they have positions and velocities.

With this methodology they reproduce observables that might be compared with the Sgr stream.

The results from this numerical experiment is that

They find a good fit in some parts of the orbits (see Fig.2 of that paper) and that the fit does not depend strongly on the parameter r_a of the halo potential.

In the second part of this paper they study the effect of torques in the Sgr stream. The authors argue that there are two torques, one from the triaxiality of the halo itself and the other due to the LMC. Interestingly, the major axis of the triaxial potential in (?) is in the direction towards the LMC. They studied the magnitude of both torques and found that both have an equal effect on the Sgr stream.

As a result, they modify the parameters of the halo model in order to account for the additional torque of the LMC, these new parameters are now more consistent with those expected from the LCDM model. For the orbit integration they also take into account the potential of the LMC. With these considerations, they find a better fit for the Sgr stream (see Fig.5 of that paper).

2 How common is the Milky Way

2.1 There's no place like home? Statistics of Milky Way-mass dark matter haloes (MBK10)

The MW dark matter halo range between $[1 \times 10^{12} - 3 \times 10^{12}]$ typical $Rvir = 200h^{-1}$. It is not common to have large satellites as the MW.

2.2 The shape of the gravitational potential in cold dark matter haloes (Hayashi07)

Goal: Study the shape of the gravitational potential of CDM halos. Radial dependence of triaxilaity in the potential of CDM halos.

Main Results: Near the center the halo is prolate $c/a = 0.72 \pm 0.04$ and $b/a = 0.78 \pm 0.08$. in the outer regions the halo is more sphereical.

Method: Simulate 7 MW sized halos and 4 dwarf galaxies and meauser the b/a, c/a ratios at $z = 0$

2.3 Meausuring a, b, c.

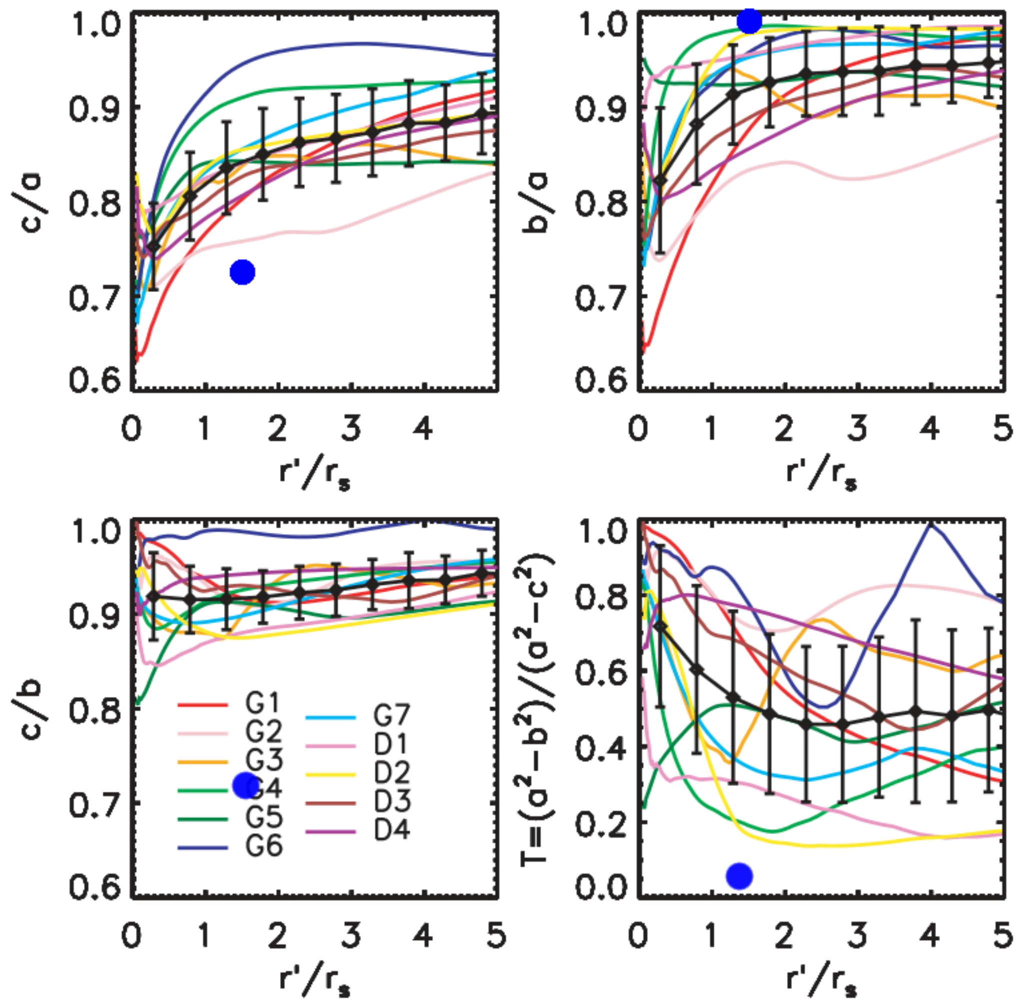
Rememer $c < b < a$

2.4 Halo shapes

The monopole dominates in the outer regions of a centrally conentrated mass distribution, the n in the puter regions the potential is more spherical.

$$T = (a^2 - b^2)/(a^2 - c^2) \tag{1}$$

- $T = 0$ -¿ Oblate
- $T = 1$ -¿ Prolate

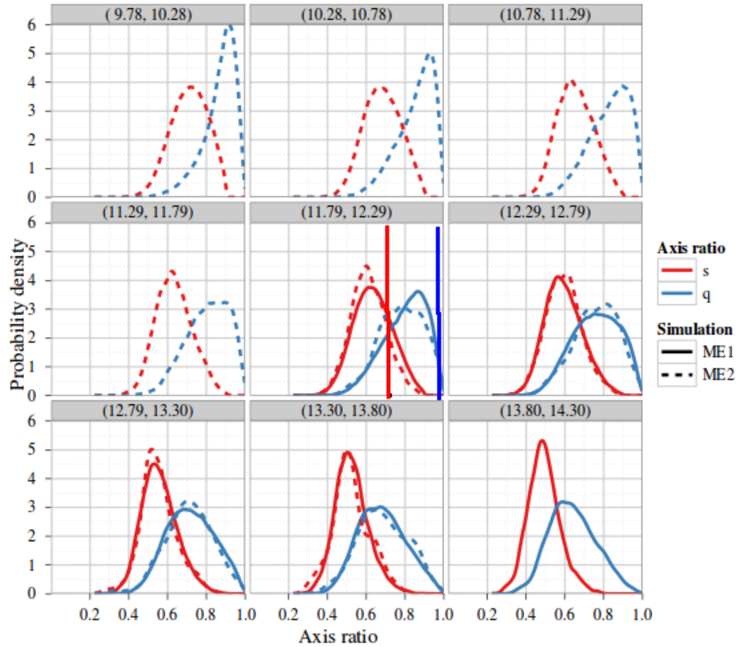


From the figure:

- c/b is almost constant.

They study 7 galaxies how is this statistically significant?, always 3 galaxies are outside the error bars

The MW values according to (?) are: $c/a = 0.72$ $b/a = 0.99$, $c/b = 0.72$, $T = 0.042$



2.5 The shapes and alignments of dark matter halos Schneider, D(2012)

They study halos from $z = 0 - 1$

Halos: they can resolve down to the 10% of the virial radius. They use MilleniumI & II.

$a < b < c$

$s = a/c$, $q = b/c$

For the MW this is: $s = 0.72$, $q = 0.99$

2.6 How the shape changes in time: (Vera-Ciro2011)

Goal: Determine the shape of the MW Dark Matter halo.

Main Results: individual halos changes with time, from prolate at earlier times to triaxial/oblate at present time measured in the virial radius. The halo shope is affected by accretion processes, if accretion is due to filaments the halo tends to be more prolate. When the accertio is more isotropic the halo is triaxial/oblate. The shape of the Dark Matter halo at diffeent radii shows the accertion history of the halo.

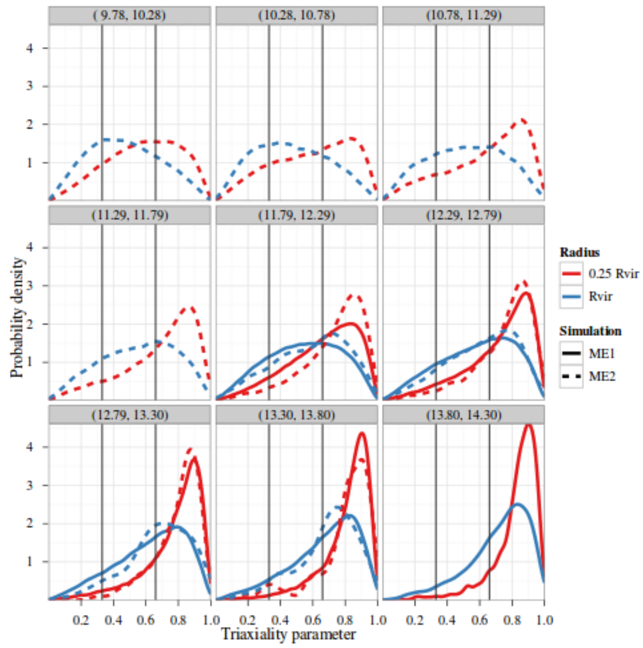


Figure 6. Triaxiality parameter, $T \equiv (a^2 - b^2)/(a^2 - c^2)$ at $z = 0$. The panels indicate bins in $\log_{10}(M_{200}/h^{-1}M_{\odot})$. $T \lesssim 0.33$ indicates an oblate ellipsoid while $T \gtrsim 0.66$ indicates a prolate ellipsoid.