Mass Modelling of Milky Way

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1 Calculation of the Andromeda Influence

So, if we consider the mass of Andromeda to be M and the distance between the Andromeda and Milky Way to be d and the size of halo to be R, then we can calculate the average potential due to Andromeda (assumed to be a point mass) over the spherical surface, we get the average potential to be,

$$\bar{\phi}(R,\theta) = \frac{\frac{GM}{d}\left(1 - \frac{d}{R} + \sqrt{1 + \left(\frac{d}{R}\right)^2 - 2\frac{d}{R}\cos\theta}\right)}{1 - \cos\theta}$$

If we do it over an arbitrary θ_1 to θ_2 then the expression is,

$$\bar{\phi}(R,\theta_1,\theta_2) = \frac{GM}{(1-\cos\theta)Rd}\left[\sqrt{R^2 + d^2 - 2dR\cos\theta_2} - \sqrt{R^2 + d^2 - 2dR\cos\theta_1}\right]$$

Now if we do it for θ going from 0 to $\pi/2$ then the expression becomes,

$$\bar{\phi}(R) = \frac{GM}{d}\left[1 - \frac{d}{R} + \sqrt{1 + \frac{d^2}{R^2}}\right]$$

and for θ going from $\pi/2$ to π,

$$\bar{\phi}(R) = \frac{GM}{d}\left[1 + \frac{d}{R} - \sqrt{1 + \frac{d^2}{R^2}}\right]$$

Let the distance between the Milky Way and the andromeda galaxy be defined as:

$$d = 800\,\text{kpc}$$

Below is a table of values for the average potential for the θ going from 0 to $\pi/2$ at different values of R

$$\phi(R) \text{ in units of } \frac{GM}{d}$$

R/d	$\phi(R)$ $\left(\frac{GM}{d}\right)$
80	1.0062
8	1.06
4	1.12
8/3	1.18
2	1.236