Revista Mexicana de Astronomía y Astrofísica
Universidad Nacional Autónoma de México
rmaa@astroscu.unam.mx
ISSN (Versión impresa): 0185-1101
MÉXICO

2003
E. L. Lokas
DARK MATTER IN DWARF SPHEROIDAL GALAXIES
Revista Mexicana de Astronomía y Astrofísica, número 017
Universidad Nacional Autónoma de México
Distrito Federal, México
pp. 38

Galaxy Evolution: Theory and Observations (Cozumel, Quintana Roo, México, 8-12 April 2002)
Editors: Vladimir Avila-Reese, Claudio Firmani, Carlos S. Frenk & Christine Allen

DARK MATTER IN DWARF SPHEROIDAL GALAXIES

E. L. Łokas[1]

I study the distribution of dark matter in dwarf spheroidal (dSph) galaxies by modelling their line-of-sight velocity dispersion profiles. Different dark matter profiles are considered, both cuspy and with flat density cores. The predictions are made in the framework of standard dynamical theory of two-component spherical systems with different anisotropy parameters. Comparison with observations for the Fornax dwarf shows that all dark matter profiles yield good fits but only profiles with cores are consistent with isotropic orbits.

DSph galaxies provide a unique testing tool for the presence and distribution of dark matter because due to their large velocity dispersions they are probably dominated by this component. With the measurements of velocity dispersion profiles of dSphs becoming available now, their mass distribution can be studied without the simplifying assumption of isotropic orbits.

The line-of-sight velocity dispersion profile data for the Fornax dwarf (Mateo 1997) are modelled here (for details see Łokas 2001, 2002) by solving the Jeans equation with constant anisotropy parameter $\beta = 1 - \sigma_\theta^2(r)/\sigma_{\rm r}^2(r)$. The input from the stars to the gravitational potential is obtained by deprojecting the surface brightness distribution and assuming the mass-to-light ratio $\Upsilon_{\rm V} \approx 1 M_\odot/L_\odot$. The contribution from dark matter is incorporated by assuming density profiles which all have $\varrho \propto r^{-3}$ behavior at large distances from the center but differ in the inner slope where $\varrho \propto r^{-\alpha}$. They are also characterized by the concentration $c = r_v/r_{\rm s}$ (r_v and $r_{\rm s}$ are the virial and scale radius, respectively) and the virial mass M_v (encompassing the region where the mean halo density is 200 times the critical density).

The data were fitted for different assumed concentrations by minimizing χ^2 and adjusting two parameters: M_v and β. The best fits were obtained for concentrations of the order of $c = 30$ ($\alpha = 0$), $c = 25$ ($\alpha = 1/2$), $c = 20$ ($\alpha = 1$) and $c = 10$ ($\alpha = 3/2$). For these values Fig. 1 shows 1σ, 2σ and 3σ confidence regions in the M_v-β parameter plane found from the fitting procedure.

[1]Nicolaus Copernicus Astronomical Center, Bartycka 18, 00-716 Warsaw, Poland (lokas@camk.edu.pl).

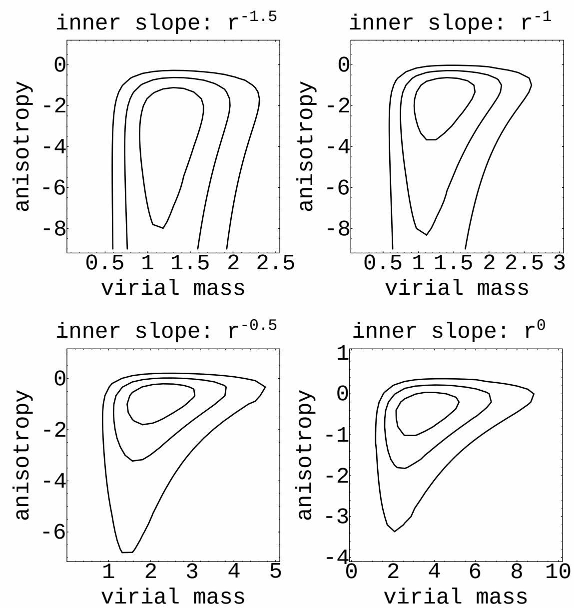

Fig. 1. 1σ, 2σ and 3σ confidence regions in the M_v - β plane for the best fits to the velocity dispersion profile of Fornax for different inner dark halo slopes $r^{-\alpha}$ indicated at the top of each panel. M_v is in units of $10^9 M_\odot$. Note the different scales in each panel.

It turns out that equally good fits can be obtained for all α; however, dark matter profiles with steeper inner slopes require more tangential velocities (more negative β) and do not exclude circular orbits. Only the profiles with cores ($\alpha = 0$) are consistent with isotropic orbits ($\beta = 0$). Without any prior knowledge of velocity distribution in order to distinguish between different dark matter profiles one has to resort to higher order velocity moments like kurtosis. It has been shown (Łokas 2002) that profiles with cores yield kurtosis decreasing steeply with distance from the center, while cuspy profiles give almost constant values of this moment.

REFERENCES

Łokas, E. L. 2001, MNRAS, 327, 21P
Łokas, E. L. 2002, MNRAS, 333, 697
Mateo, M. 1997, in ASP Conference Series, 116, "The Nature of Elliptical Galaxies", eds. Arnaboldi, M., Da Costa, G. S. & Saha, P. (San Francisco: Astron. Soc. Pac.), 259