Oxford Physics

The halos of merger remnants

Some results from *N*-body simulations

Paul McMillan

Lia Athanassoula, Walter Dehnen

2007, MNRAS, 376, 1261

Collisionless (dry) simulations

1:1 mass ratio (identical galaxies), parabolic trajectories

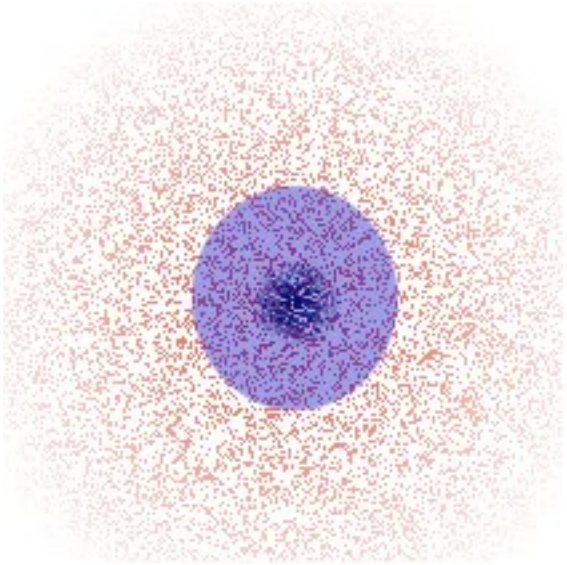
Milky Way-like galaxy models consist of NFW-like halo, disk & bulge.

$$\rho_{halo} \propto \frac{sech(r/r_t)}{r^{\gamma_0}(r+r_s)^{(3-\gamma_0)}}$$

Usually $\gamma_0 = 1.0$ but some simulations with $0 \leq \gamma_0 \leq 1.6$

New method for constructing the *N*-body model.

No Maxwellian approximation for the velocity distribution

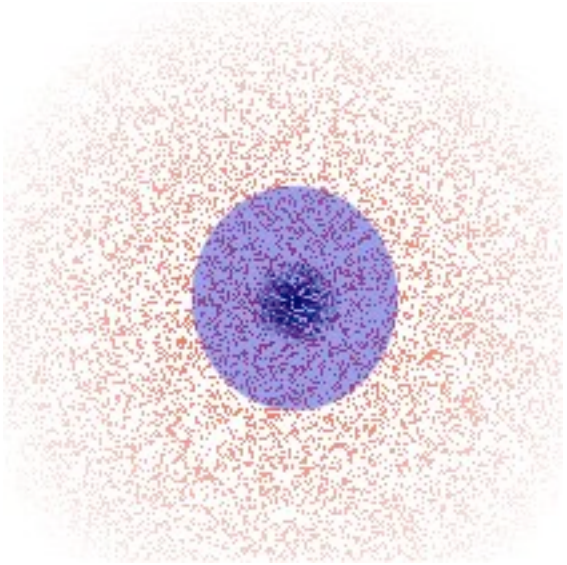


Halo (and bulge) distribution function:

Found using Cuddeford (1991) inversion, allowing for the monopole of the disc potential

Allows for variety of density profiles, anisotropies

$$\beta = 1 - \frac{\sigma_\theta^2}{\sigma_r^2} = \frac{r^2 + \beta_0 r_a^2}{r^2 + r_a^2}$$



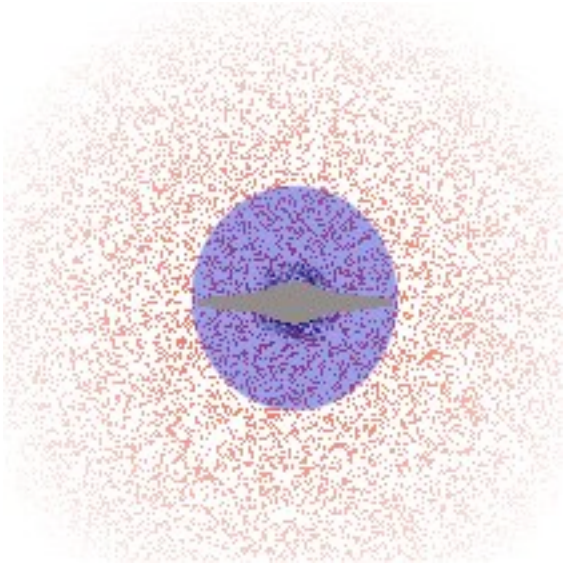
Halo (and bulge) distribution function:

Found using Cuddeford (1991) inversion, allowing for the monopole of the disc potential

Allows for variety of density profiles, anisotropies

$$\beta = 1 - \frac{\sigma_\theta^2}{\sigma_r^2} = \frac{r^2 + \beta_0 r_a^2}{r^2 + r_a^2}$$

Full disc potential grown adiabatically from monopole



Halo (and bulge) distribution function:

Found using Cuddeford (1991) inversion, allowing for the monopole of the disc potential

Allows for variety of density profiles, anisotropies

$$\beta = 1 - \frac{\sigma_\theta^2}{\sigma_r^2} = \frac{r^2 + \beta_0 r_a^2}{r^2 + r_a^2}$$

Full disc potential grown adiabatically from monopole

Halo (and bulge) distribution function:

Found using Cuddeford (1991) inversion, allowing for the monopole of the disc potential

Allows for variety of density profiles, anisotropies

$$\beta = 1 - \frac{\sigma_\theta^2}{\sigma_r^2} = \frac{r^2 + \beta_0 r_a^2}{r^2 + r_a^2}$$

Full disc potential grown adiabatically from monopole

Halo (and bulge) distribution function:

Found using Cuddeford (1991) inversion, allowing for the monopole of the disc potential

Allows for variety of density profiles, anisotropies

$$\beta = 1 - \frac{\sigma_\theta^2}{\sigma_r^2} = \frac{r^2 + \beta_0 r_a^2}{r^2 + r_a^2}$$

Full disc potential grown adiabatically from monopole

Disc populated by an implementation of Dehnen's (1999) distribution function

McMillan & Dehnen 2007, MNRAS, 378, 548
Available as part of **NEMO** (soon…)

Density Profiles

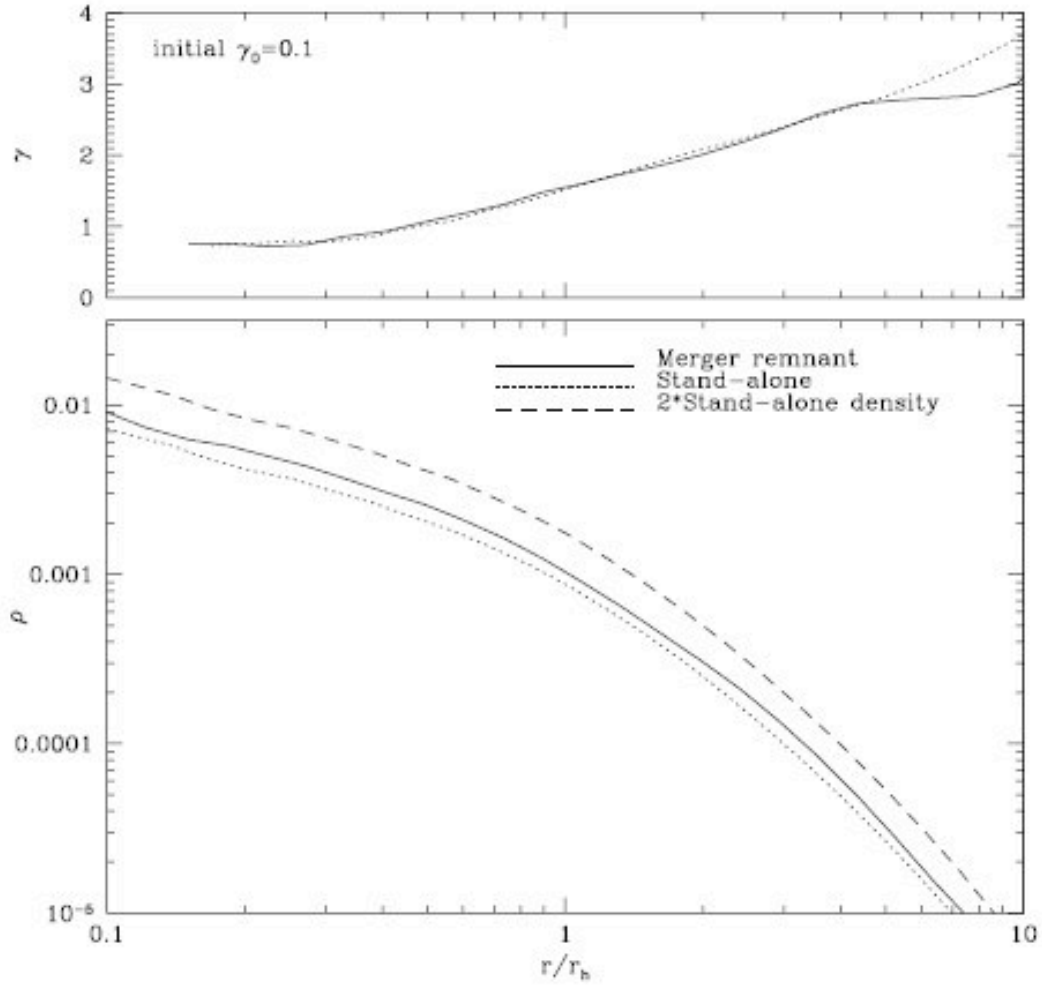
Density Profiles

Cusp strength virtually unchanged by mergers, in all cases, e.g.

Density Profiles

Cusp strength virtually unchanged by mergers, in all cases, e.g.

$$\gamma_0 = 0.1$$

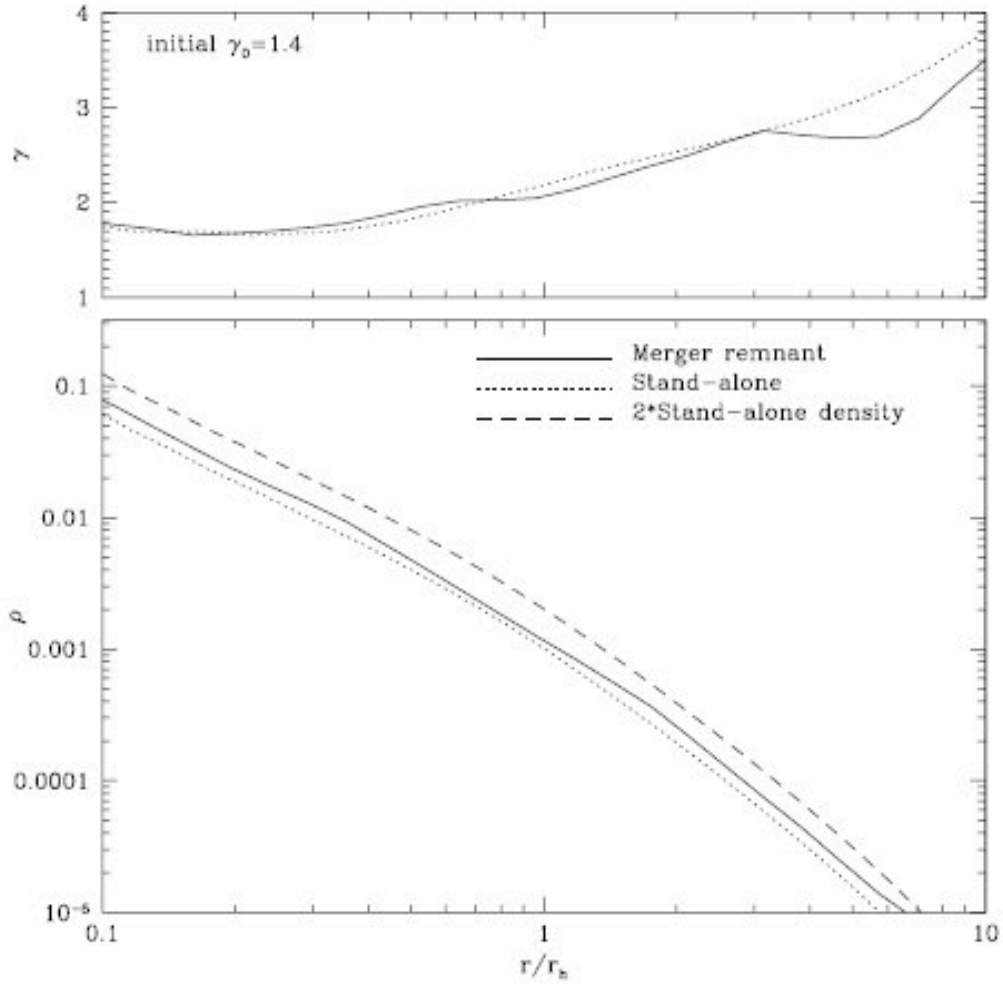


Density Profiles

Cusp strength virtually unchanged by mergers, in all cases, e.g.

$$\gamma_0 = 0.1$$

$$\gamma_0 = 1.4$$



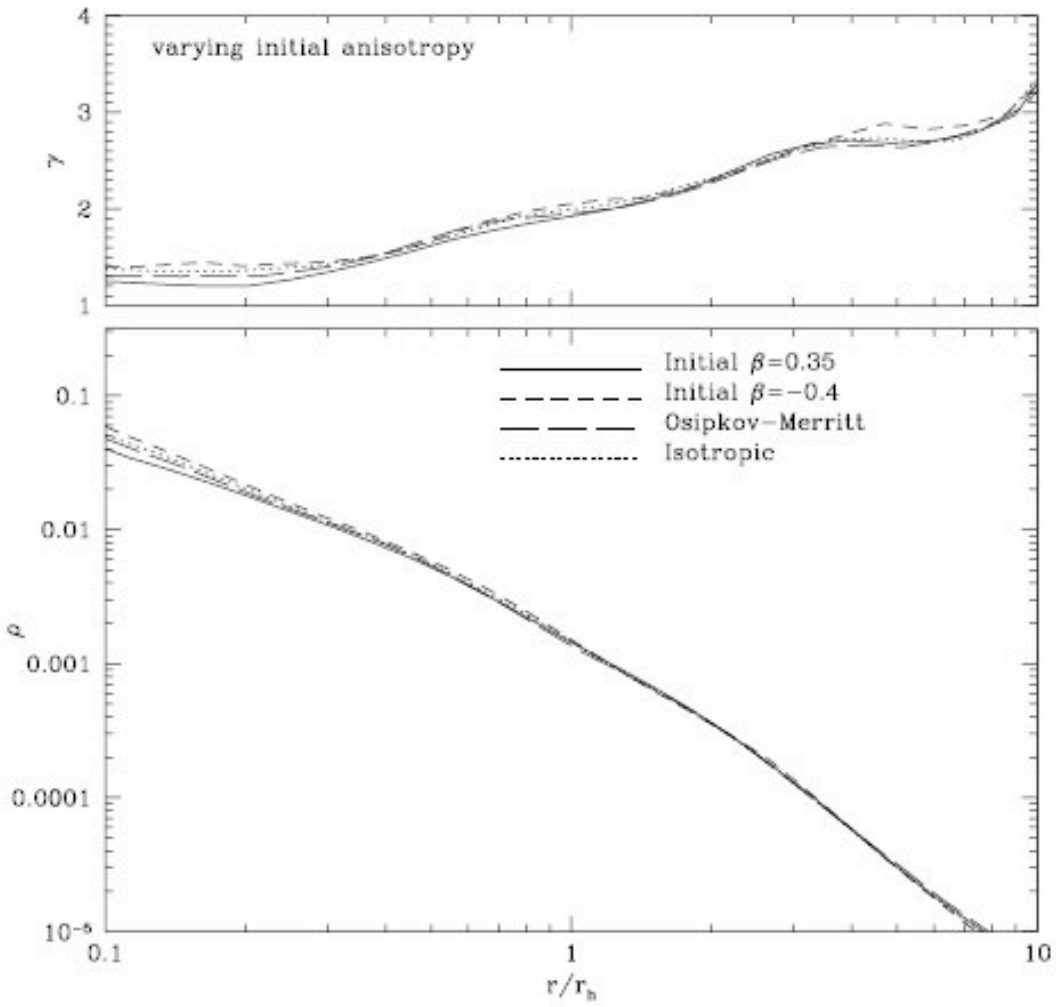
Density Profiles

Cusp strength virtually unchanged by mergers, in all cases, e.g.

$$\gamma_0 = 0.1$$

$$\gamma_0 = 1.4$$

Varying anisotropy



Anisotropy

Hansen & Moore (2006) suggest that one should find

$$\beta(\gamma) = 1 - \xi(1 - \gamma/6)$$

If one also assumes that

$$\rho/\sigma^3 \propto r^{-\alpha}$$

(e.g. Taylor & Navarro 2001)

These define a single analytical dynamical equilibrium (Dehnen & McLaughlin 2005)

Anisotropy

Hansen & Moore (2006) suggest that one should find

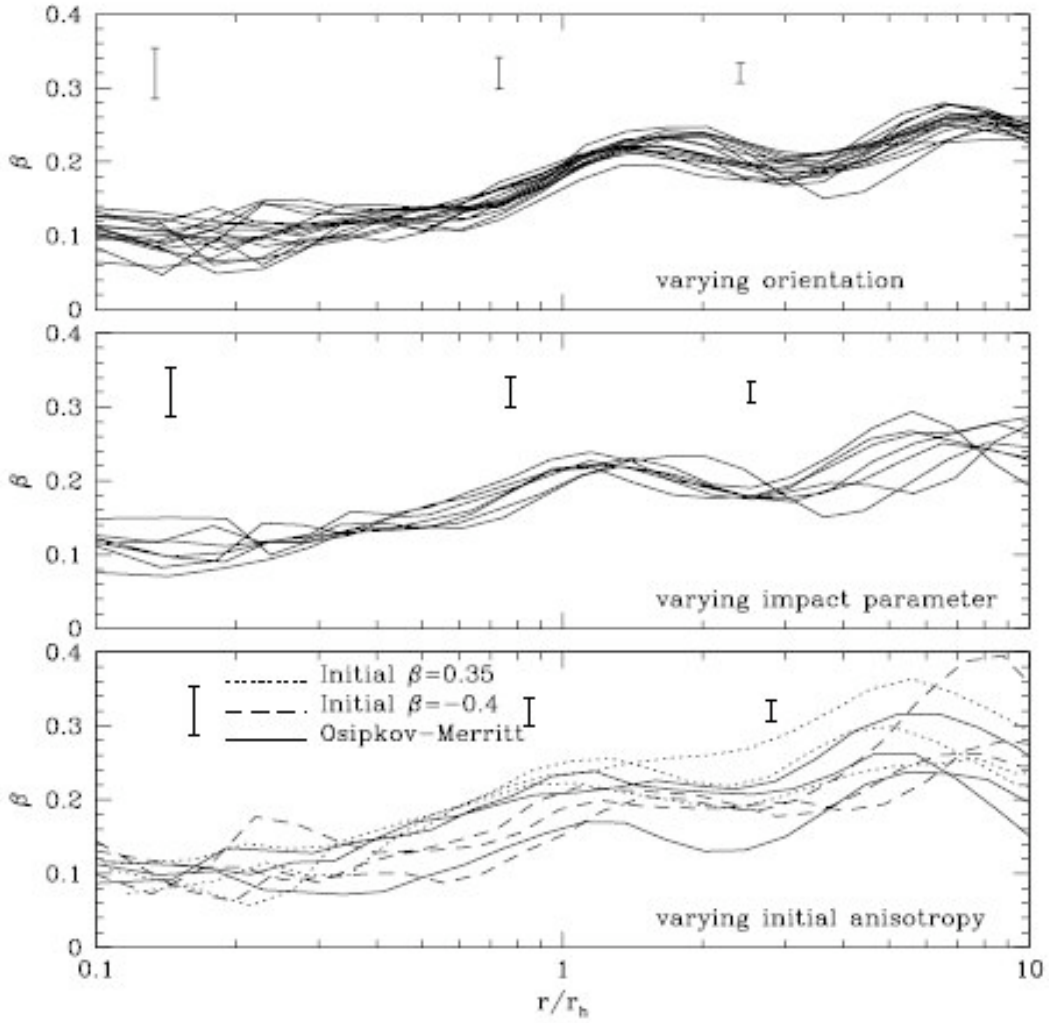
$$\beta(\gamma) = 1 - \xi(1 - \gamma/6)$$

If one also assumes that

$$\rho/\sigma^3 \propto r^{-\alpha}$$

(e.g. Taylor & Navarro 2001)

These define a single analytical dynamical equilibrium (Dehnen & McLaughlin 2005)



Anisotropy

Hansen & Moore (2006) suggest that one should find

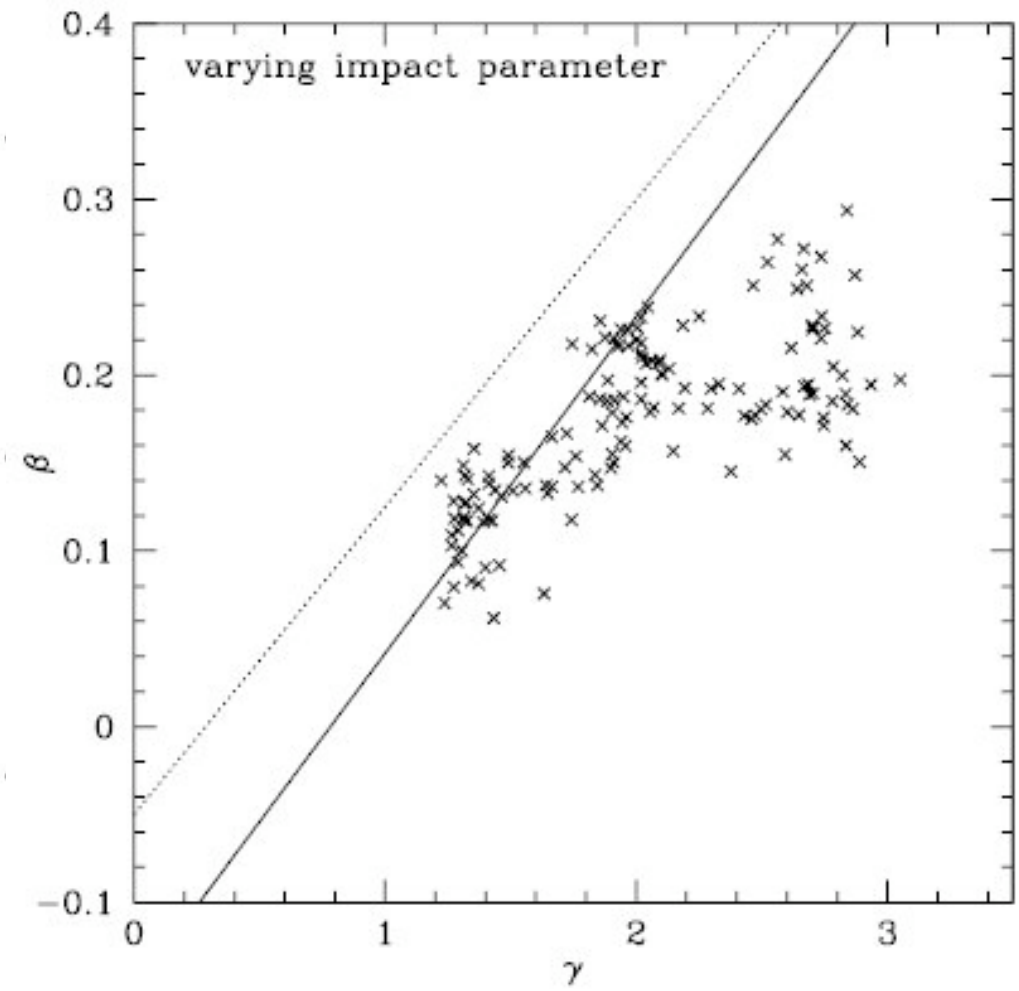
$$\beta(\gamma) = 1 - \xi(1 - \gamma/6)$$

If one also assumes that

$$\rho/\sigma^3 \propto r^{-\alpha}$$

(e.g. Taylor & Navarro 2001)

These define a single analytical dynamical equilibrium (Dehnen & McLaughlin 2005)



Anisotropy

Hansen & Moore (2006) suggest that one should find

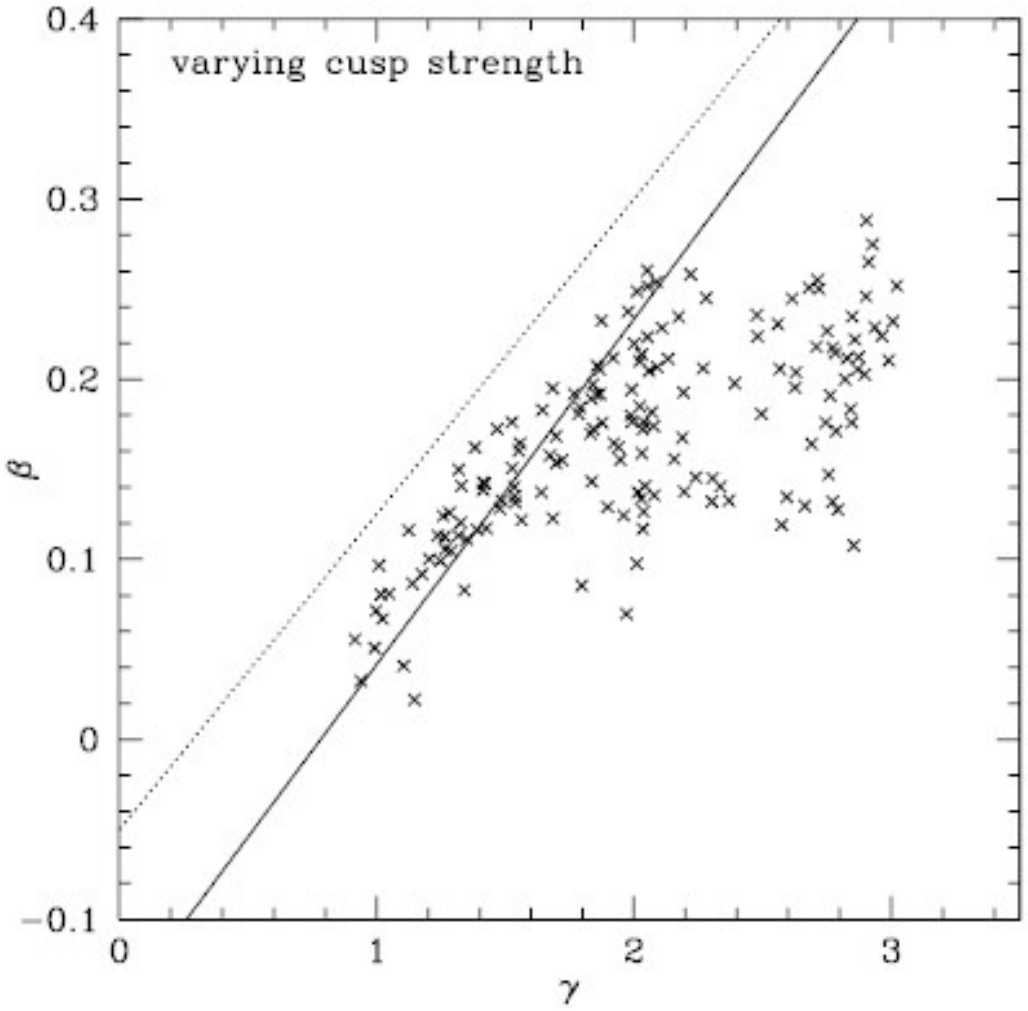
$$\beta(\gamma) = 1 - \xi(1 - \gamma/6)$$

If one also assumes that

$$\rho/\sigma^3 \propto r^{-\alpha}$$

(e.g. Taylor & Navarro 2001)

These define a single analytical dynamical equilibrium (Dehnen & McLaughlin 2005)



Anisotropy

Hansen & Moore (2006) suggest that one should find

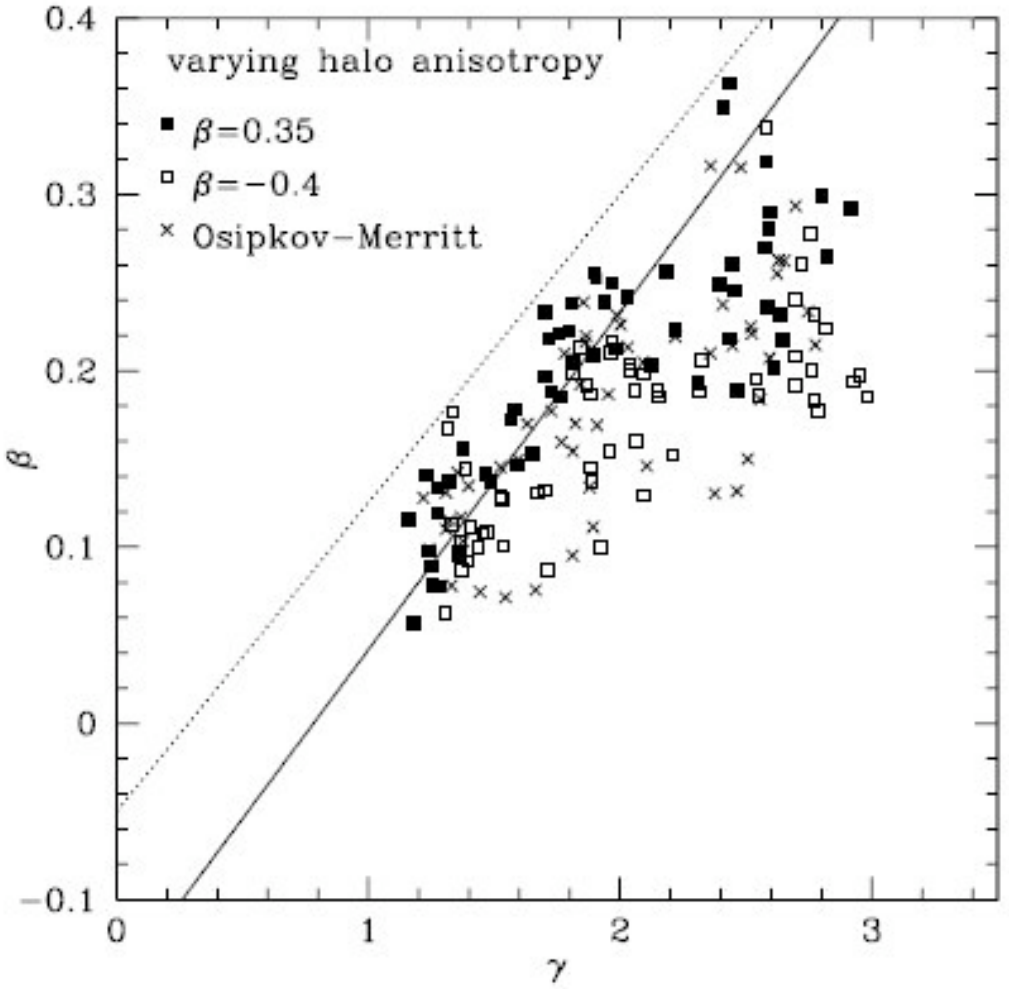
$$\beta(\gamma) = 1 - \xi(1 - \gamma/6)$$

If one also assumes that

$$\rho/\sigma^3 \propto r^{-\alpha}$$

(e.g. Taylor & Navarro 2001)

These define a single analytical dynamical equilibrium (Dehnen & McLaughlin 2005)



Halo Shape

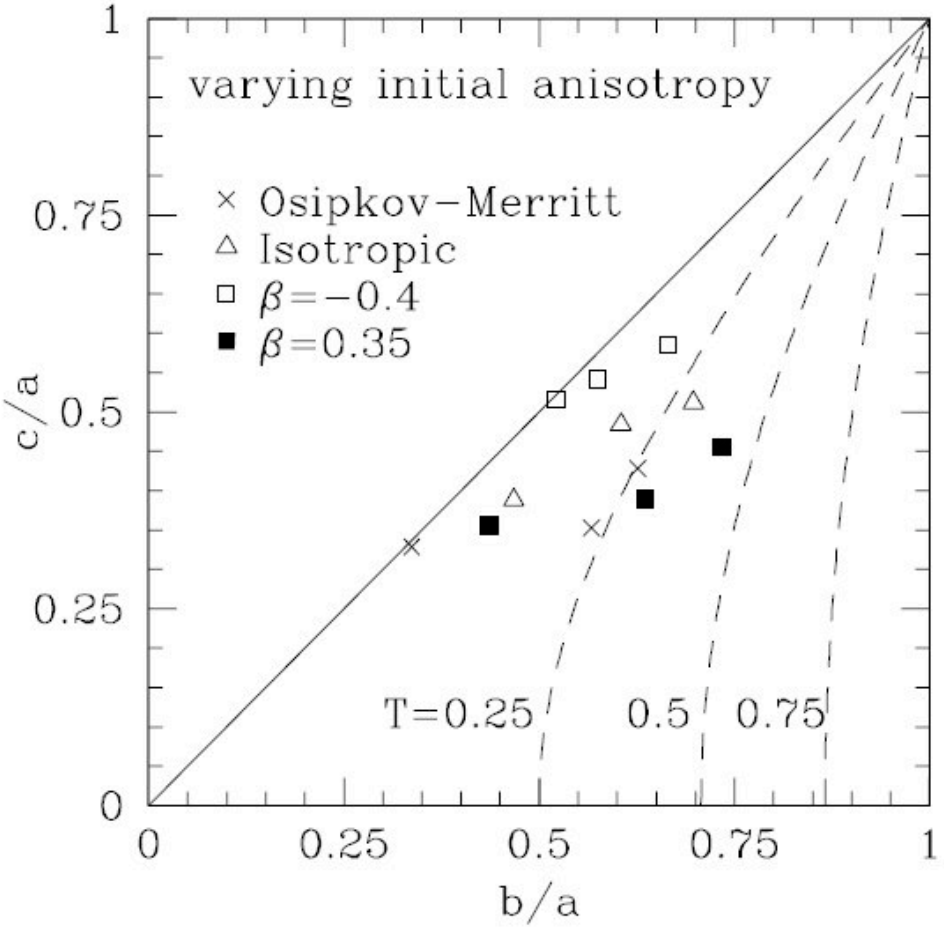
Some observations suggest axis ratios of ~0.4 for elliptical galaxies' DM haloes (e.g. Buote et al. 2002)

SPH simulations of major mergers (Novak et al. 2006) produce haloes with axis ratios greater than ~0.75

Halo Shape

Some observations suggest axis ratios of ~0.4 for elliptical galaxies' DM haloes (e.g. Buote et al. 2002)

SPH simulations of major mergers (Novak et al. 2006) produce haloes with axis ratios greater than ~0.75



Conclusions

- Used new galaxy models to investigate 1:1 mass ratio mergers.
- Cusp strengths unaffected by merger.
- Anisotropy follows Hansen & Moore relation in inner parts, but not outer.
- Haloes significantly further from spherical than in SPH simulations.