

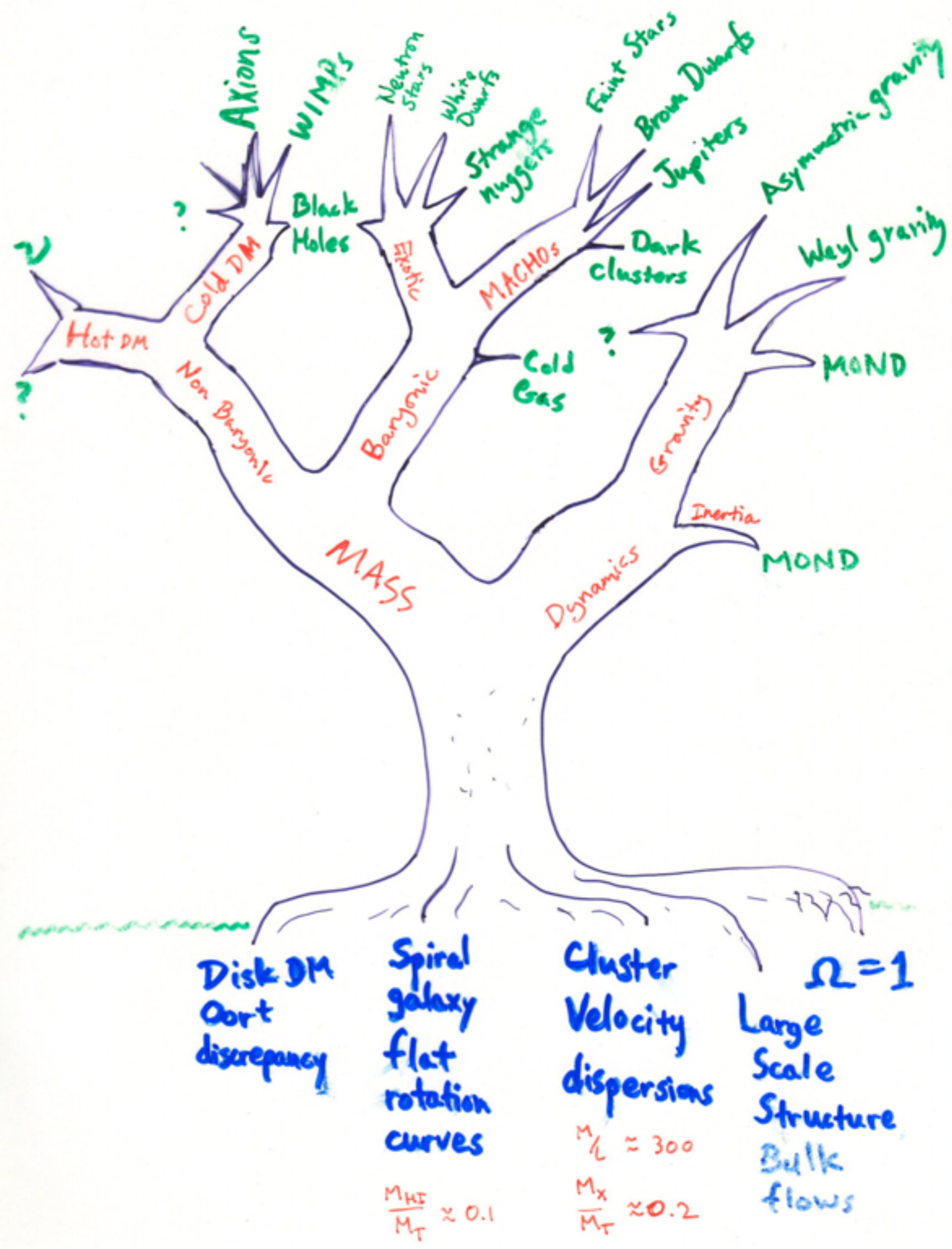
DARK MATTER

ASTR 333/433

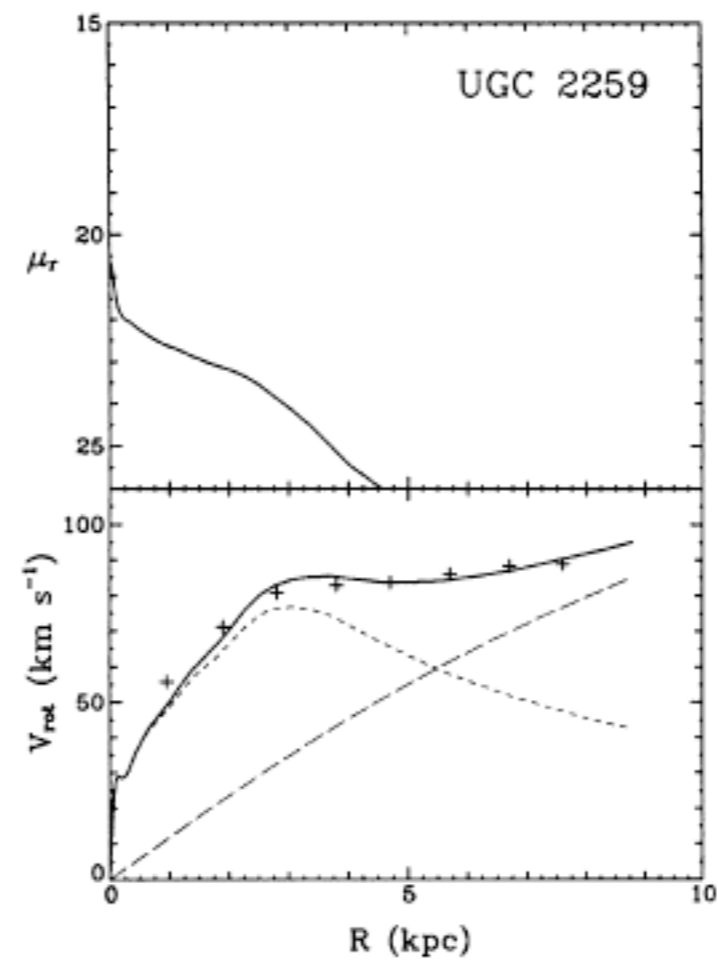
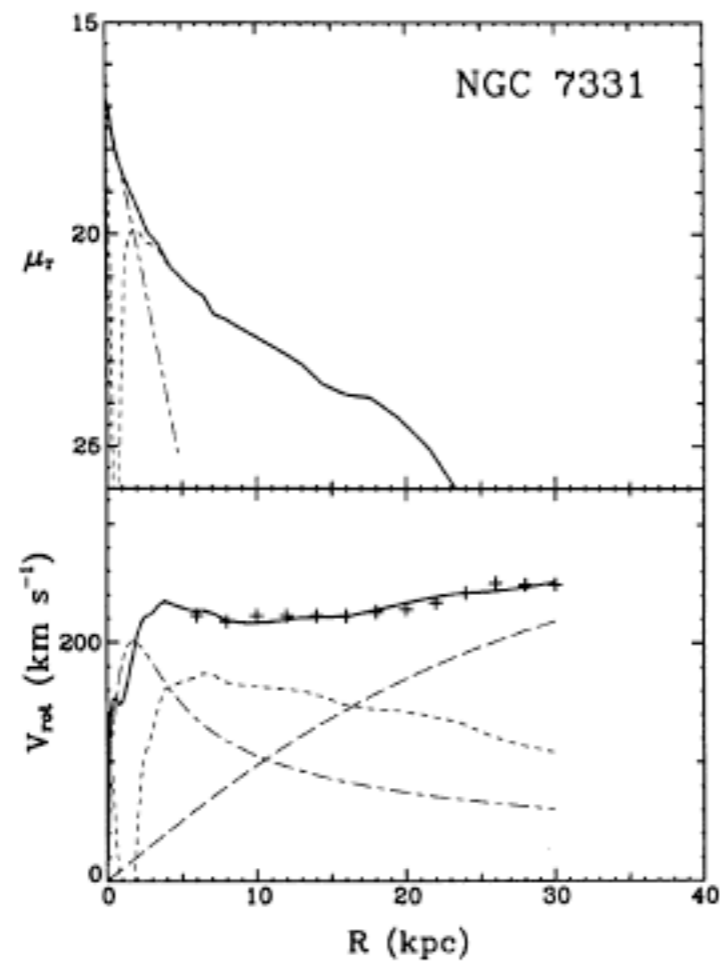
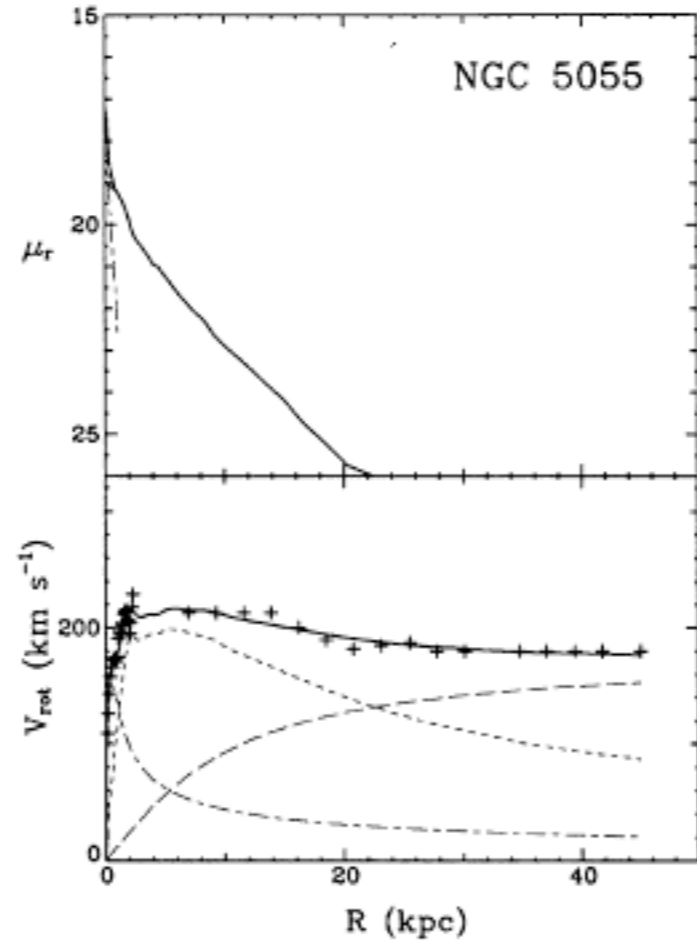
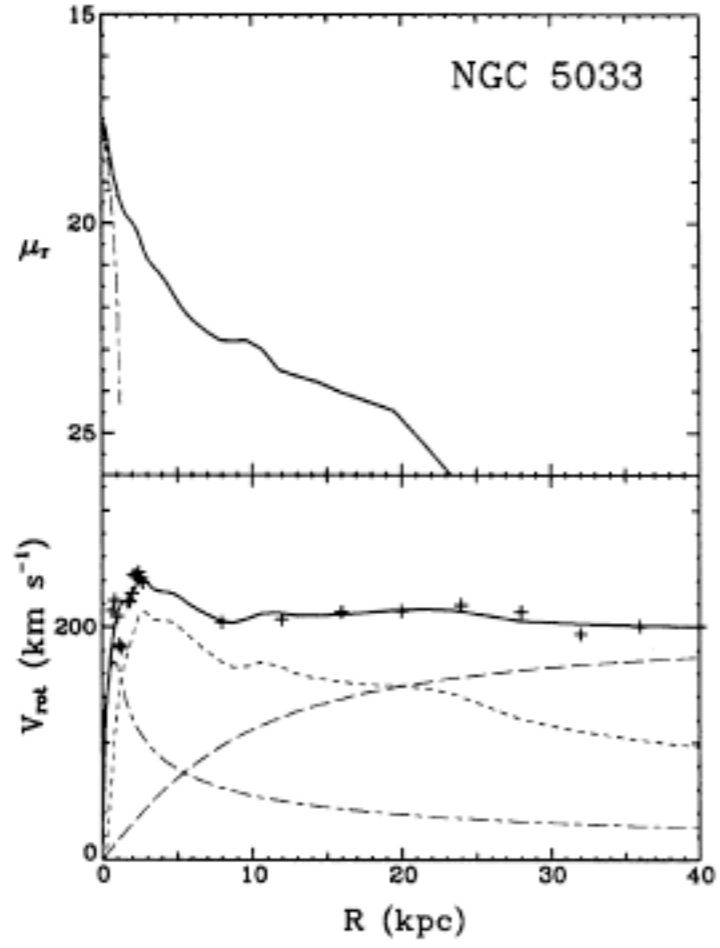
HALO MODELS APPLICATION TO DATA

Homework 2 Due Feb. 25

Midterm March 1

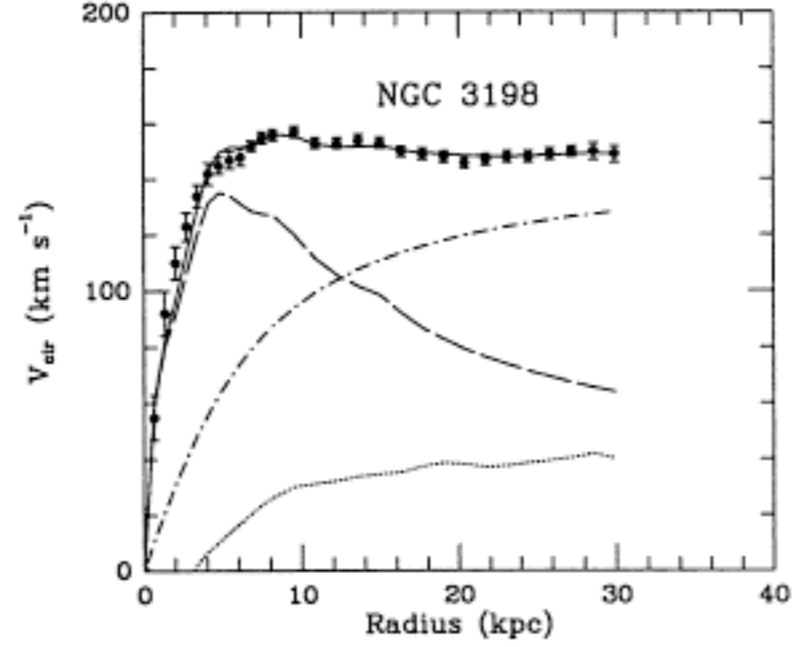
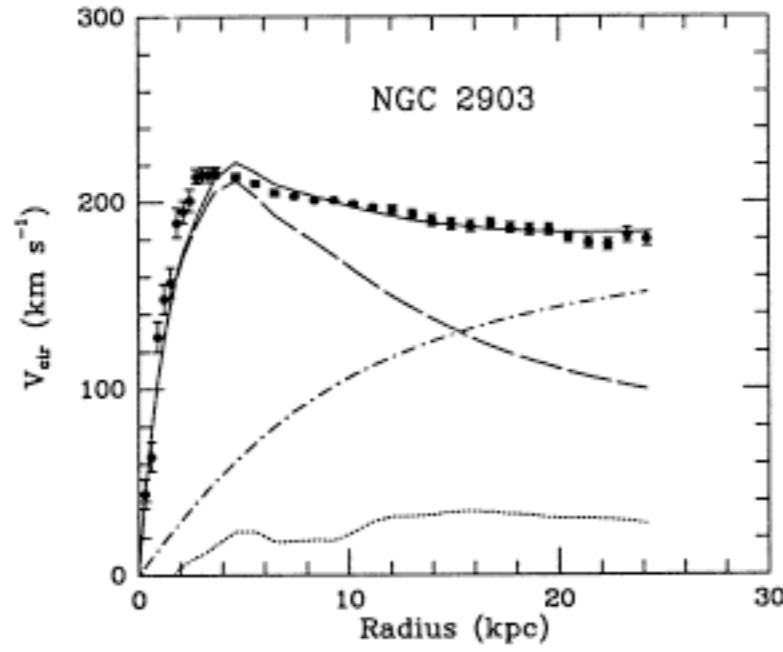
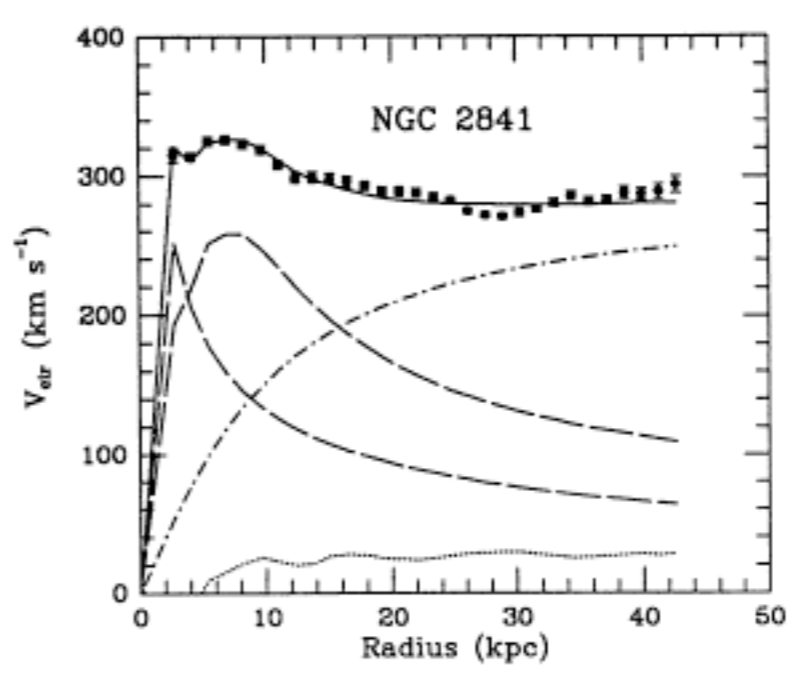
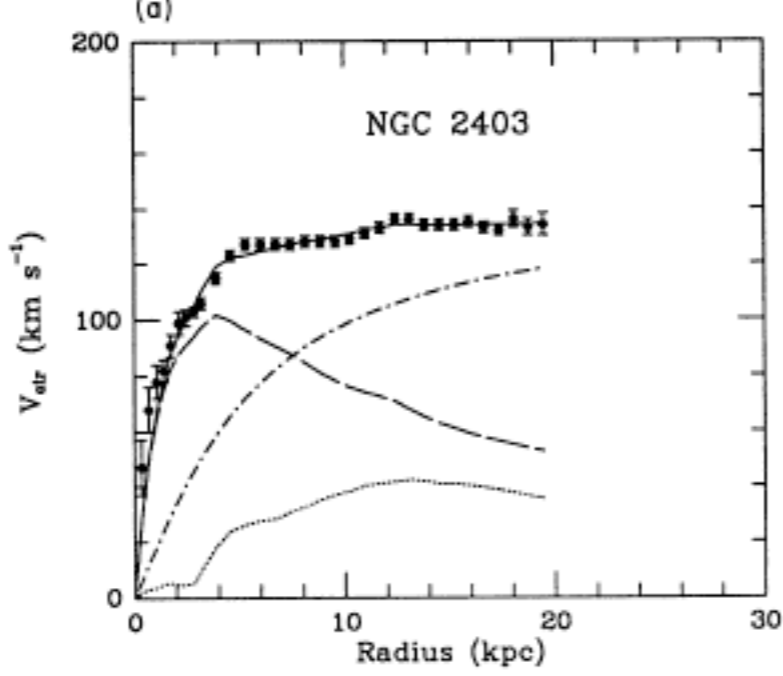


pseudo-isothermal
fits

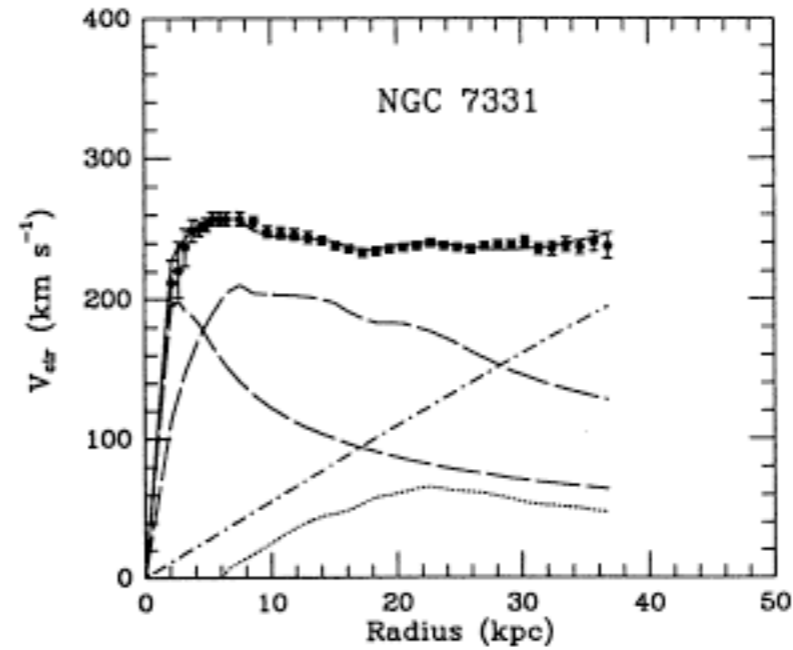
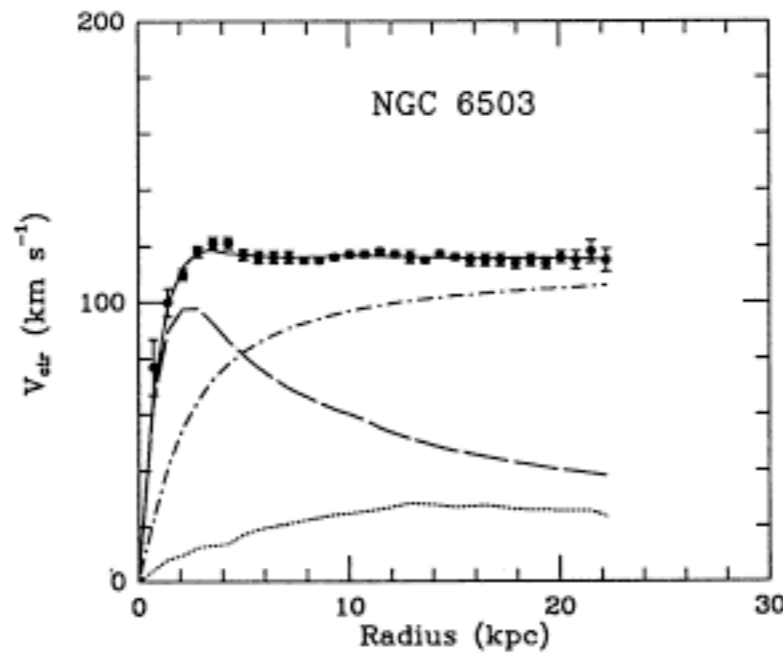


Kent (1987)

pseudo-isothermal
fits



Begeman, Broeils, &
Sanders (1991)



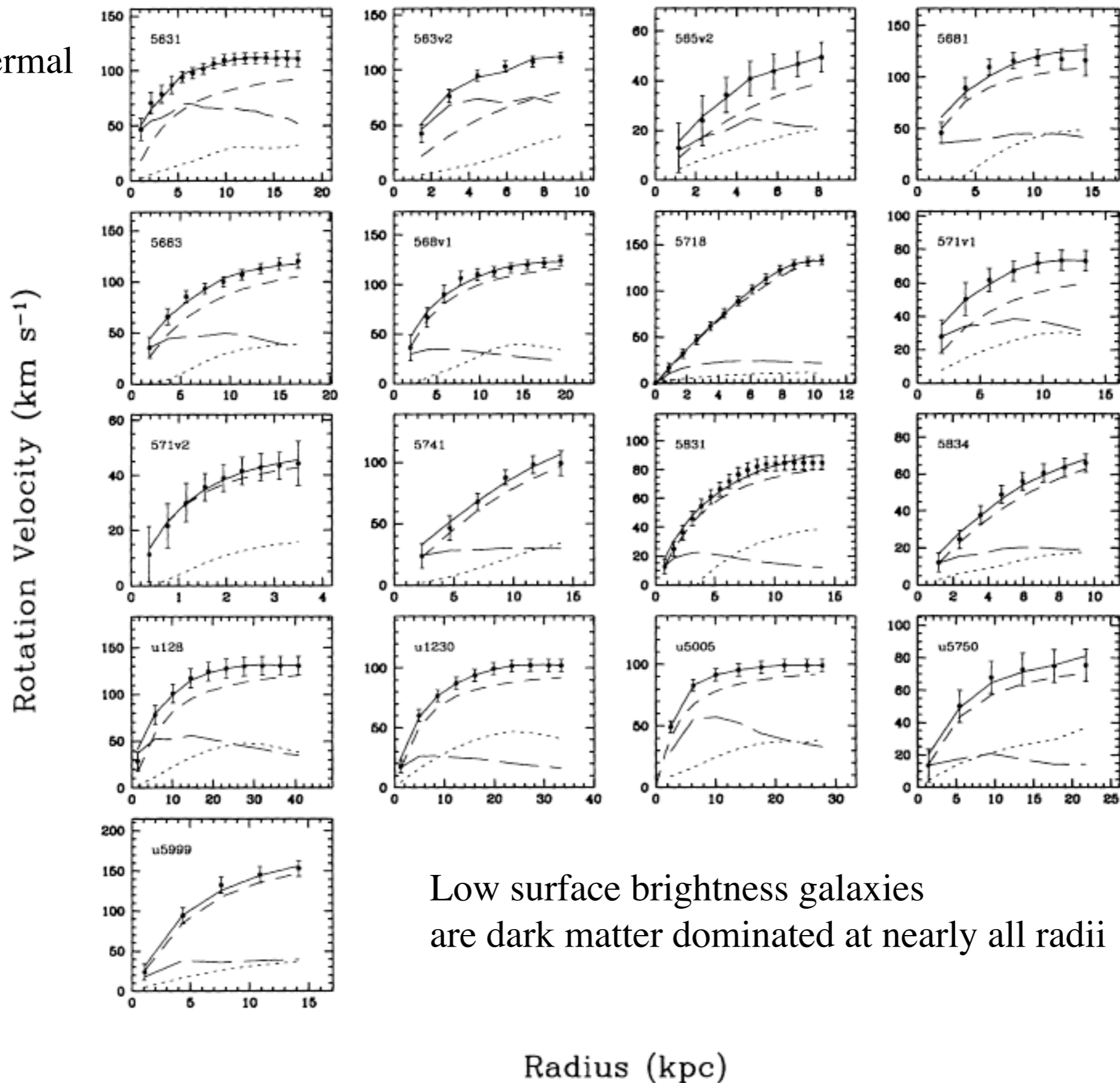
pseudo-isothermal
fits

Figure 5. Maximum disc rotation curve decompositions of the final sample of LSB galaxies. The dotted lines represent the rotation curves of the gas; the long-dashed line those of the scaled stellar disc; the short-dashed lines the rotation curves of the halo. The full line represents the total model rotation curve. Error bars are based on a combination of profile width in the position-velocity diagrams (BMH96) and the asymmetries between the rotation curves of both sides of the

pseudo-isothermal
parameters

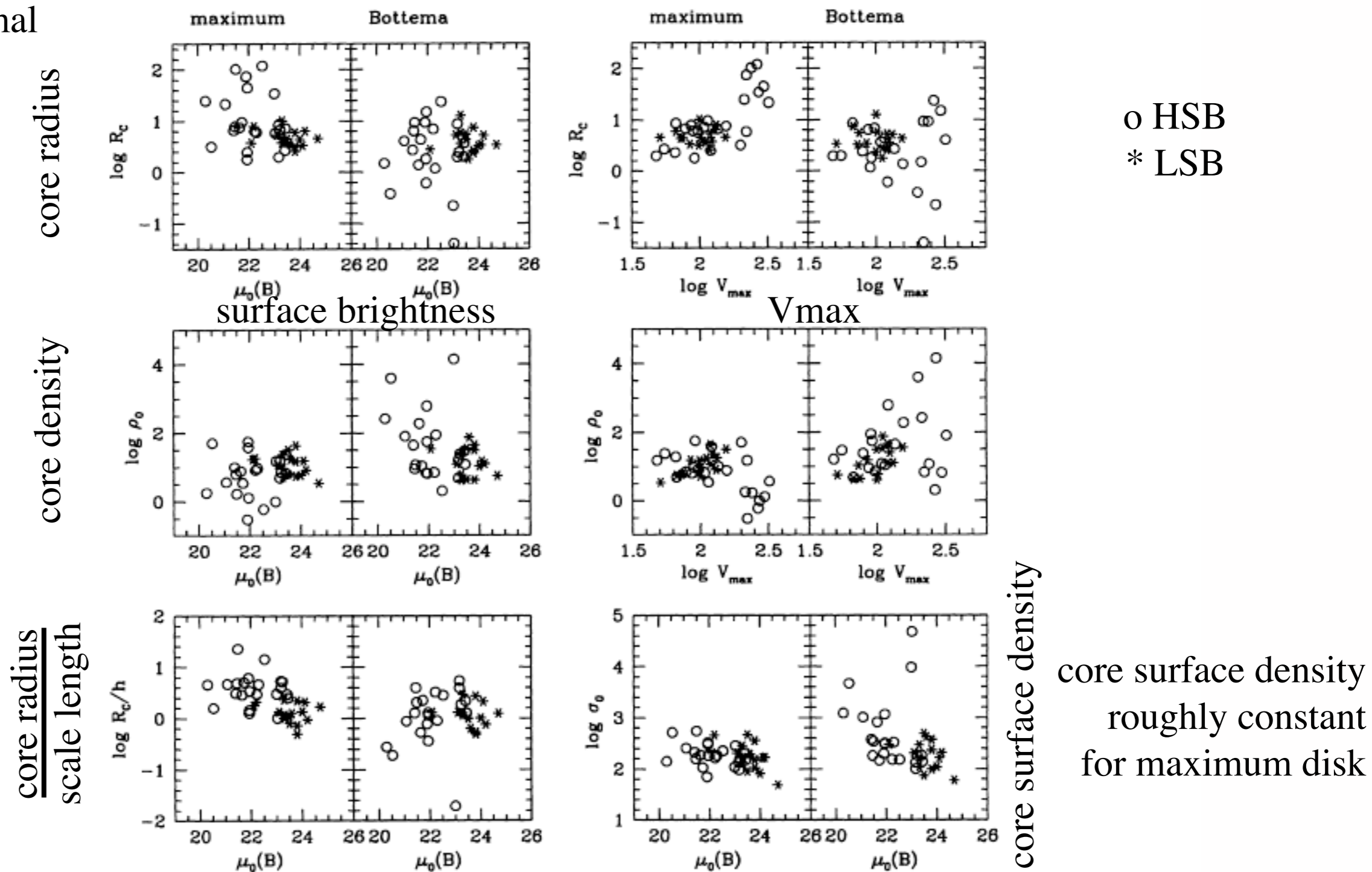


Figure 9. Isothermal halo fitting parameters for maximum disc fits (left panels) and Bottema disc fits (right panels). The open circles represent the HSB sample, the asterisks the LSB sample. ρ_0 is expressed in units of $10^{-3} M_{\odot} \text{pc}^{-3}$; R_c in kpc; σ_0 in $10^{-3} M_{\odot} \text{pc}^{-2}$; V_{\max} in km s^{-1} ; and $\mu_0(B)$ in mag arcsec^{-2} .

5.4 Minimum disc

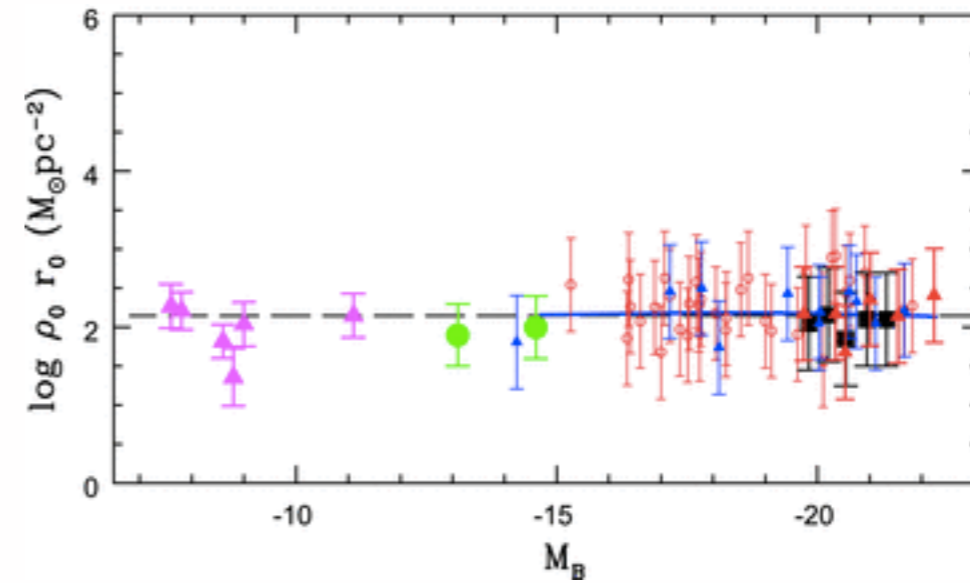
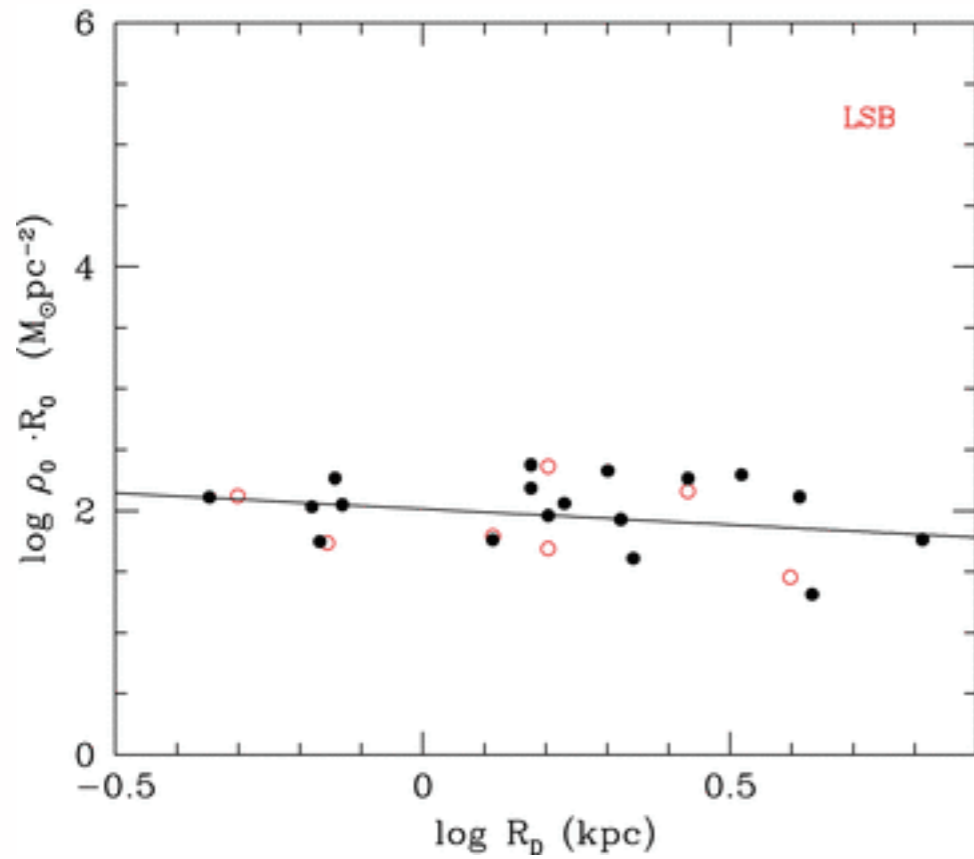
We can illustrate that the halo parameters derived for the LSB galaxies are robust values by comparing the values derived for maximum disc and minimum disc. This is done in Fig. 10, where the core radii and central densities as derived using these two extreme hypotheses are compared. The difference in maximum and minimum disc-halo parameters is clearly a strong function of surface

5.5 Bottema disc mass-to-light ratios

The most important property that distinguishes the Bottema disc from the maximum disc is its small range of $(M/L_B)_*$. This is immediately apparent in Fig. 8. The Bottema disc typically implies values of $(M/L_B)_*$ between 1 and 2. In general the reddest galaxies have the highest mass-to-light ratios.

The striking systematic offset in $(M/L)_*$ at fixed V_{\max} between

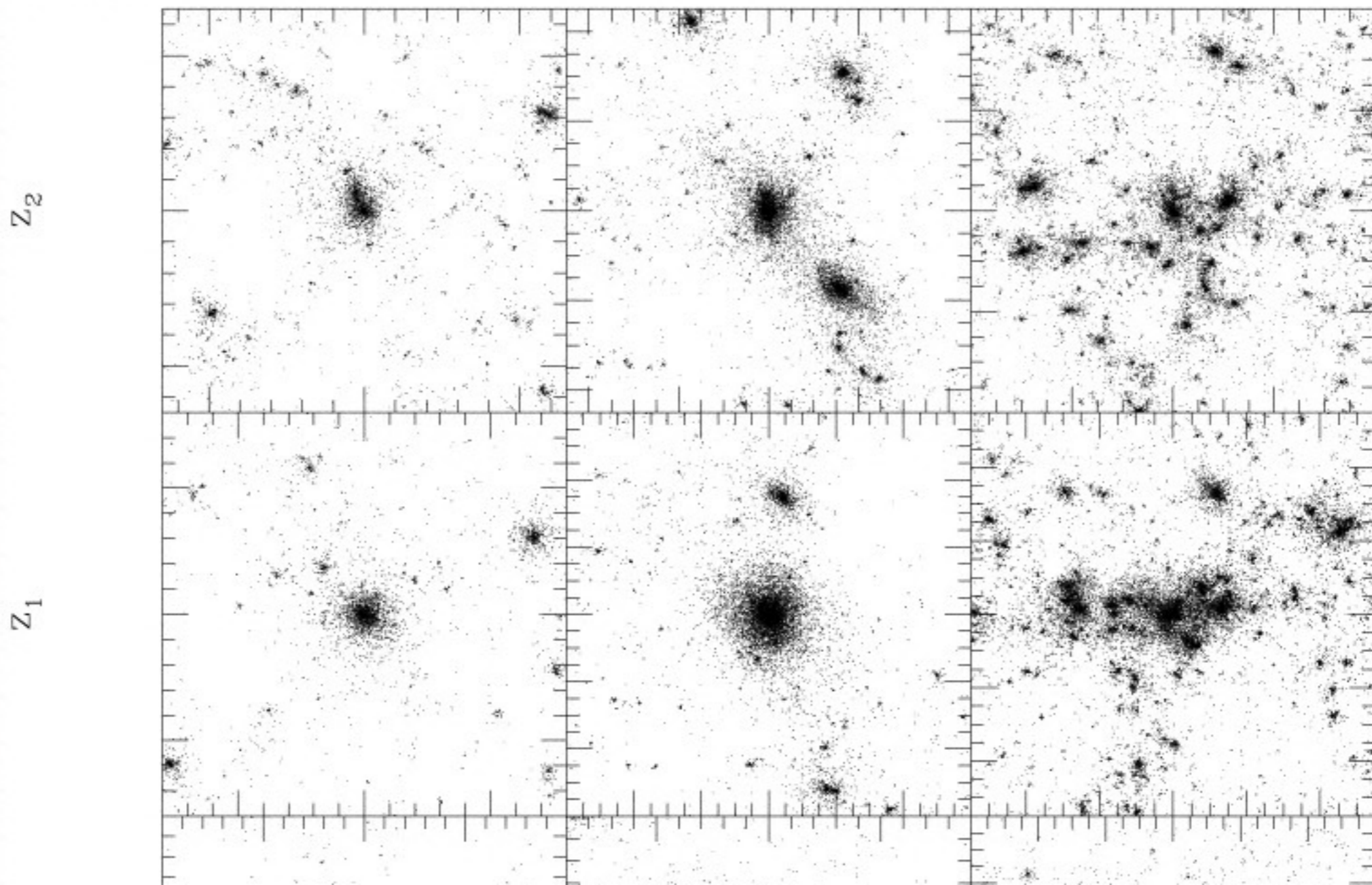
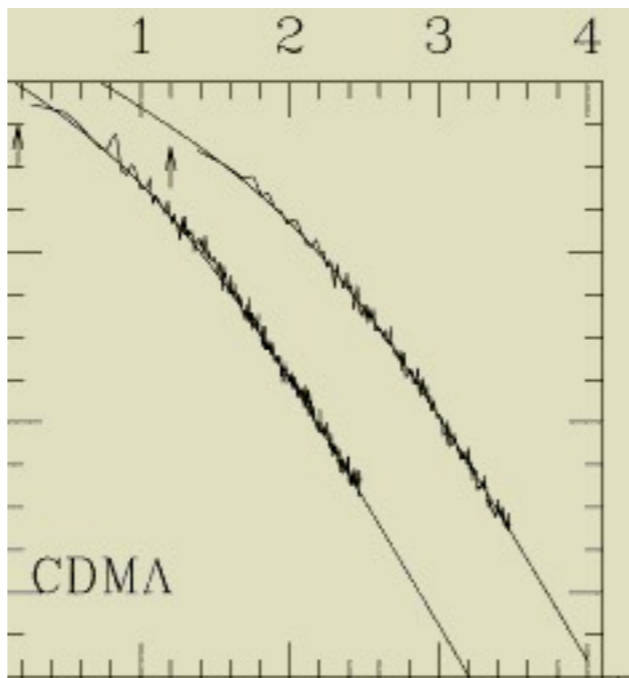
Halo core surface density (product of core density and core radius)
is nearly constant (Donato et al 2009)



$$\mu_{0D} = \rho_0 R_C$$

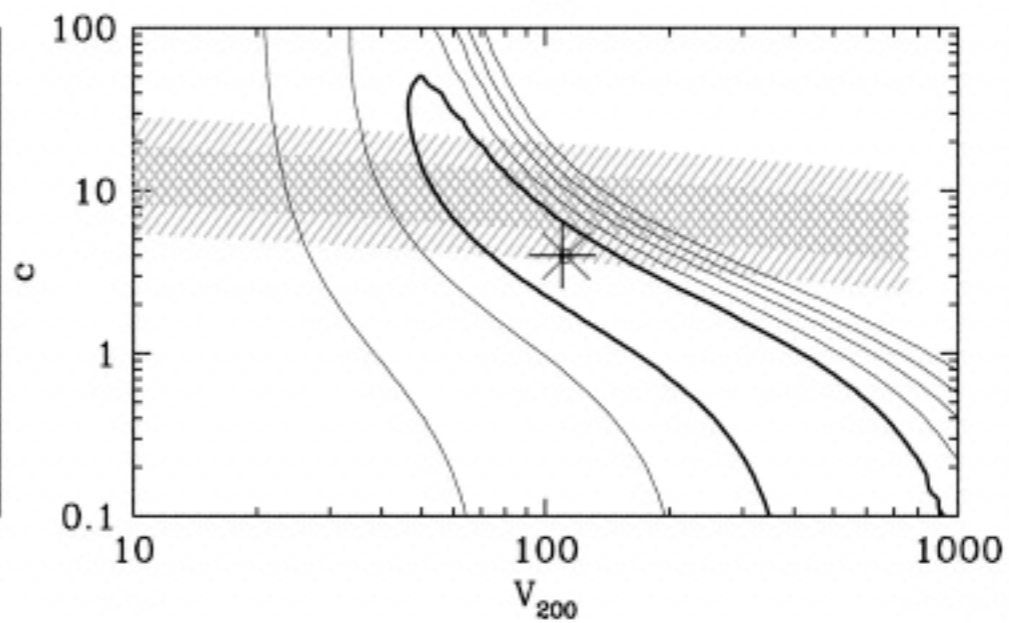
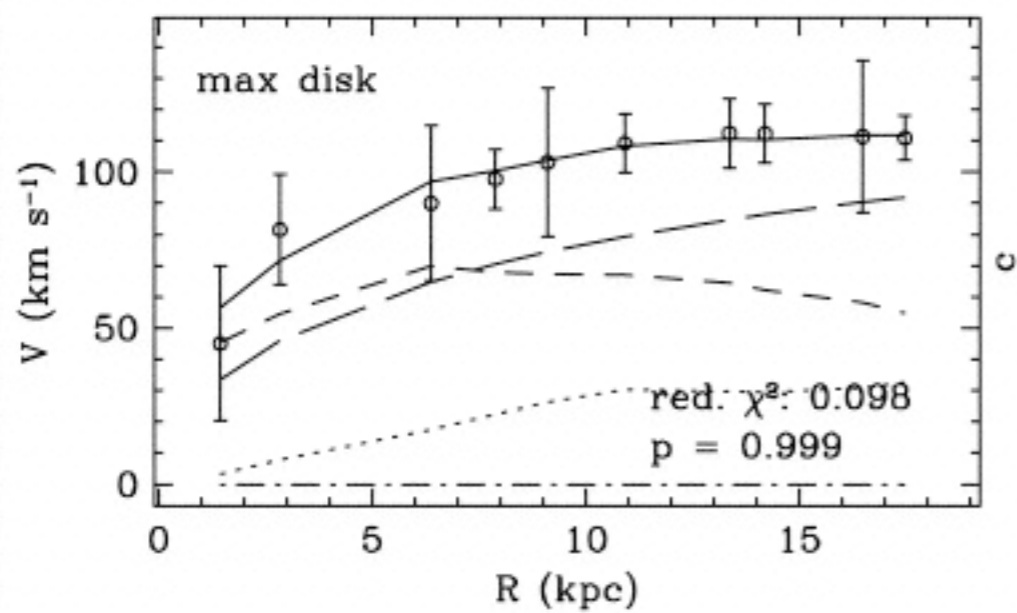
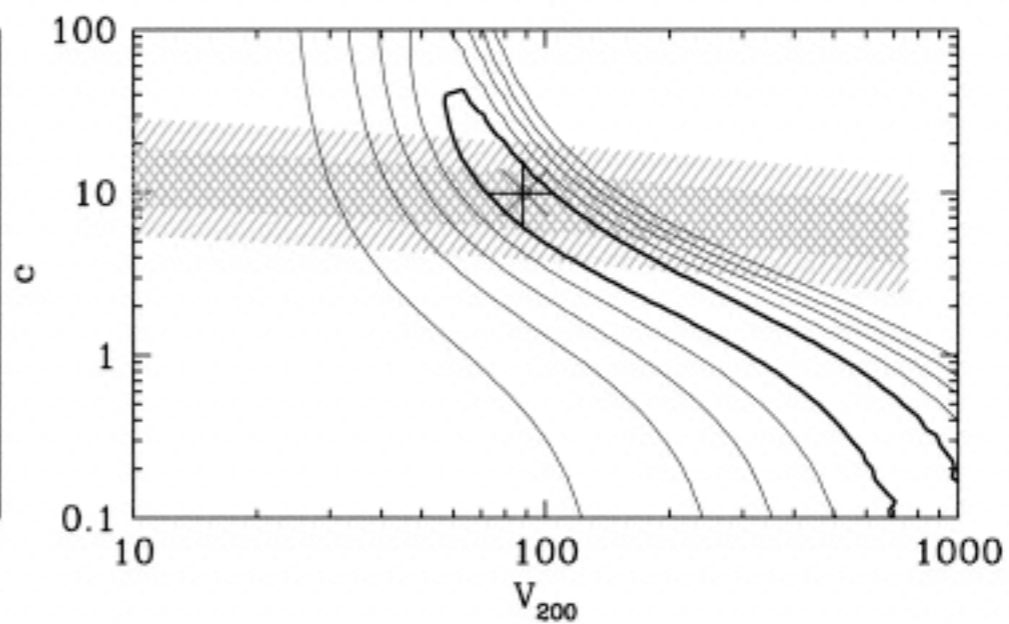
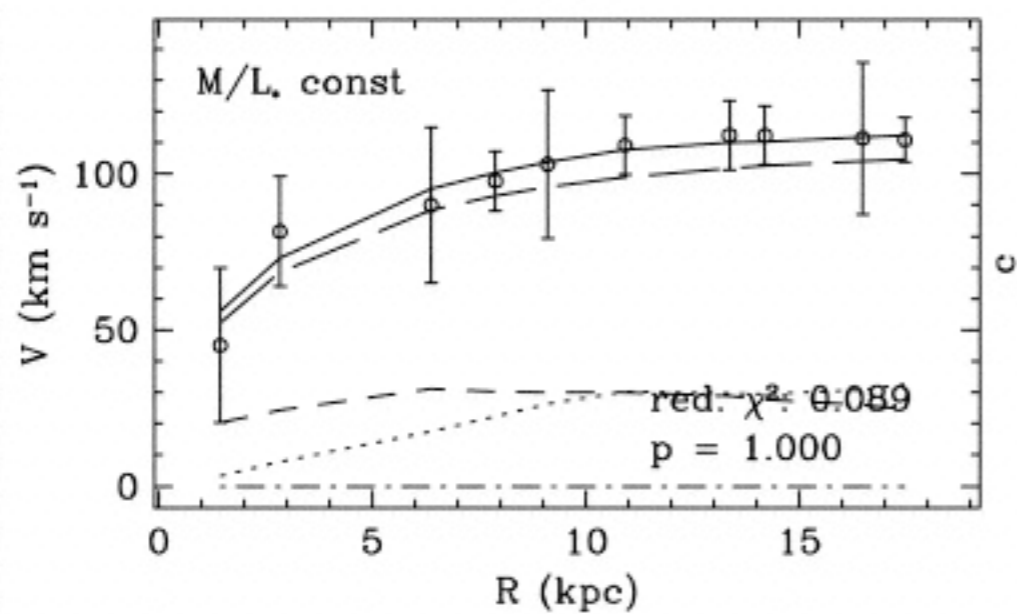
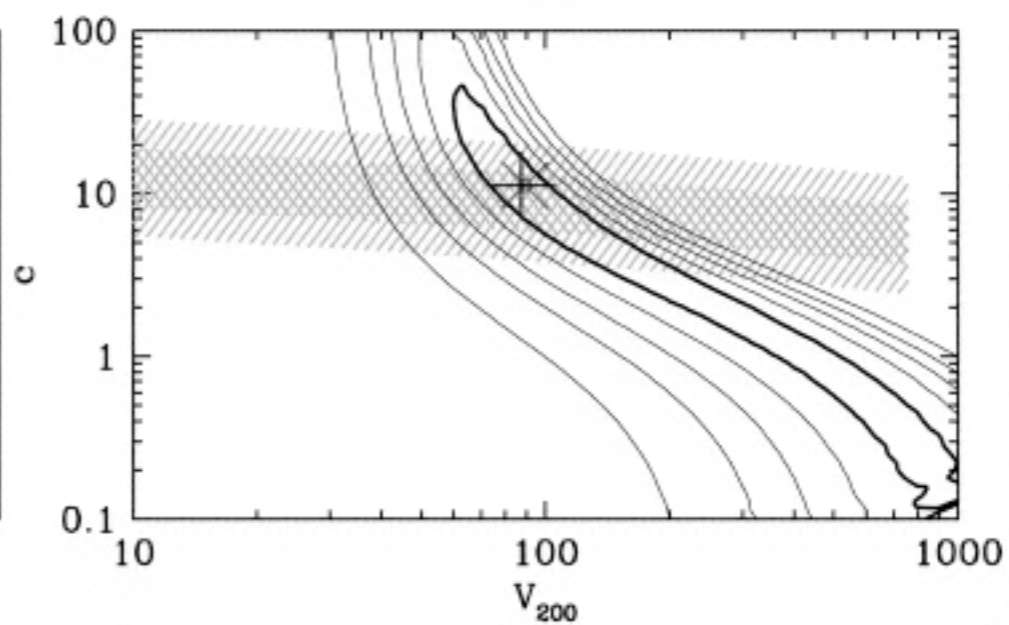
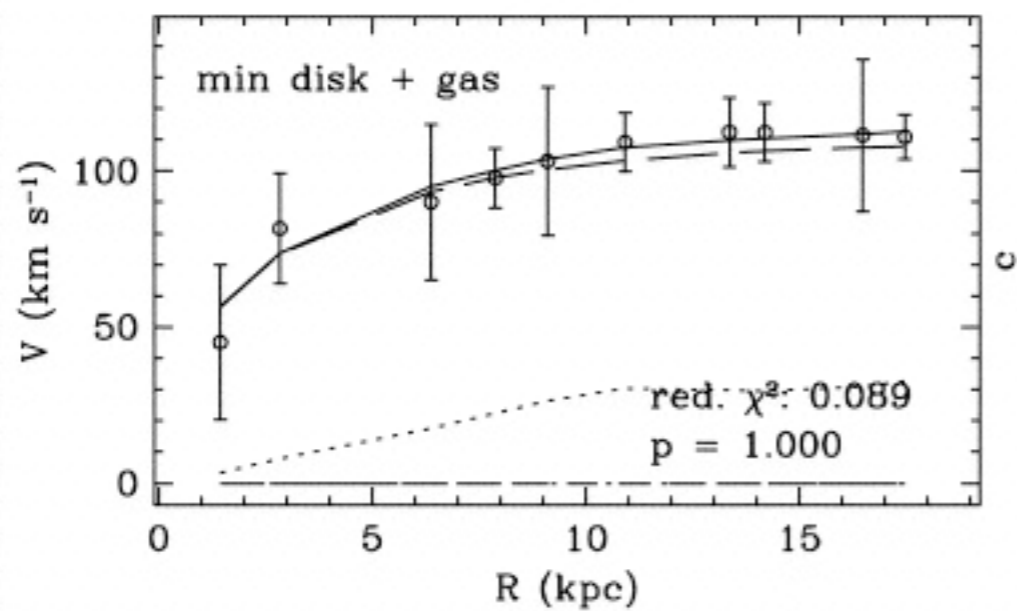
$$\log \mu_{0D} = 2.2 \pm 0.25 M_\odot \text{pc}^{-2}$$

NFW



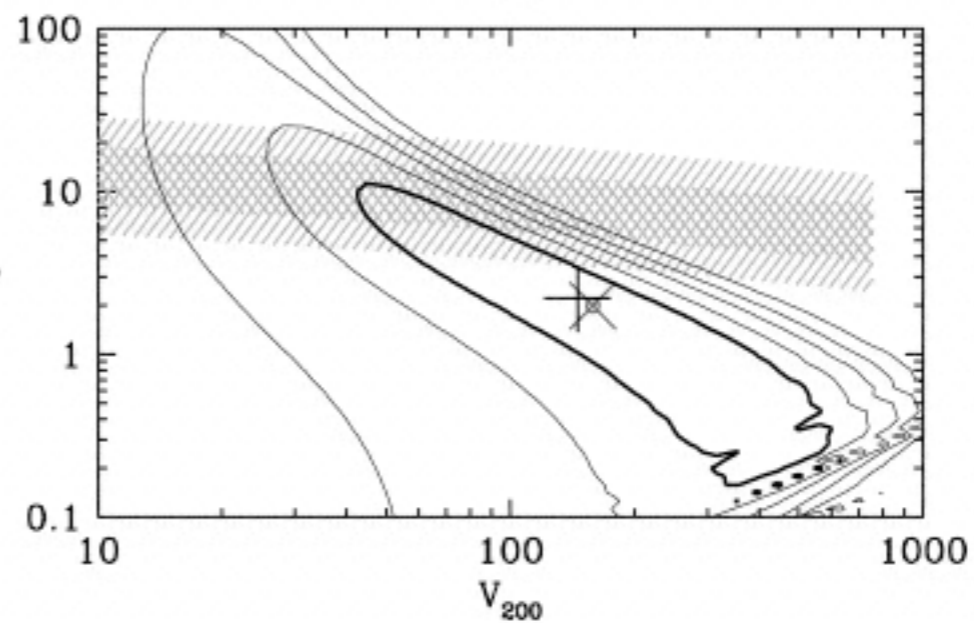
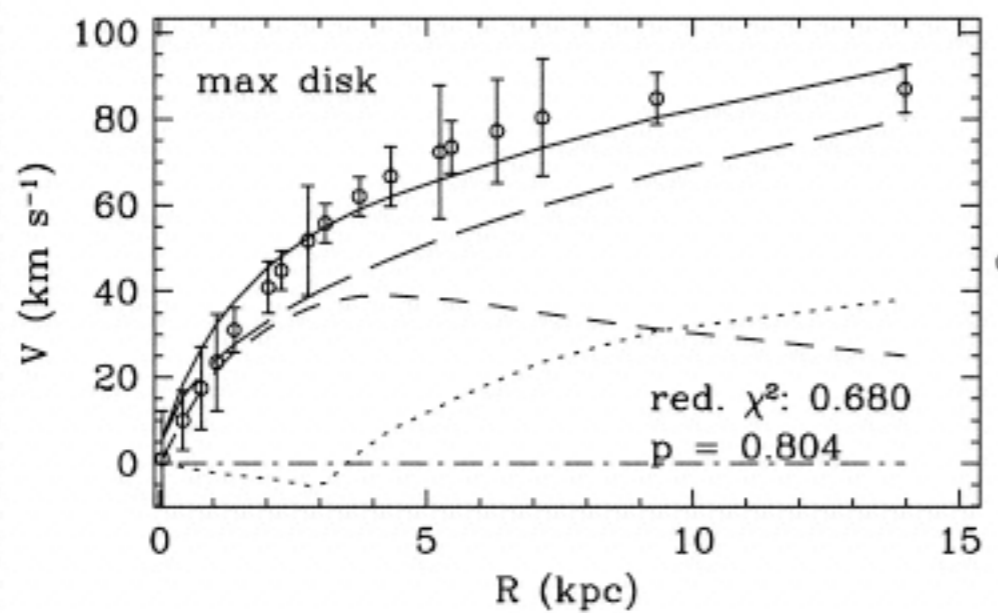
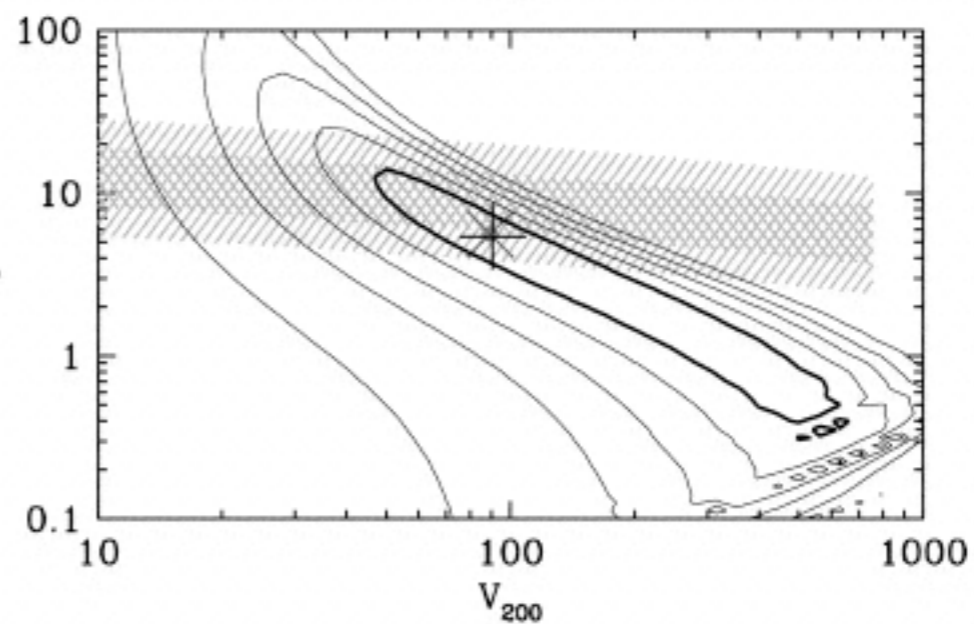
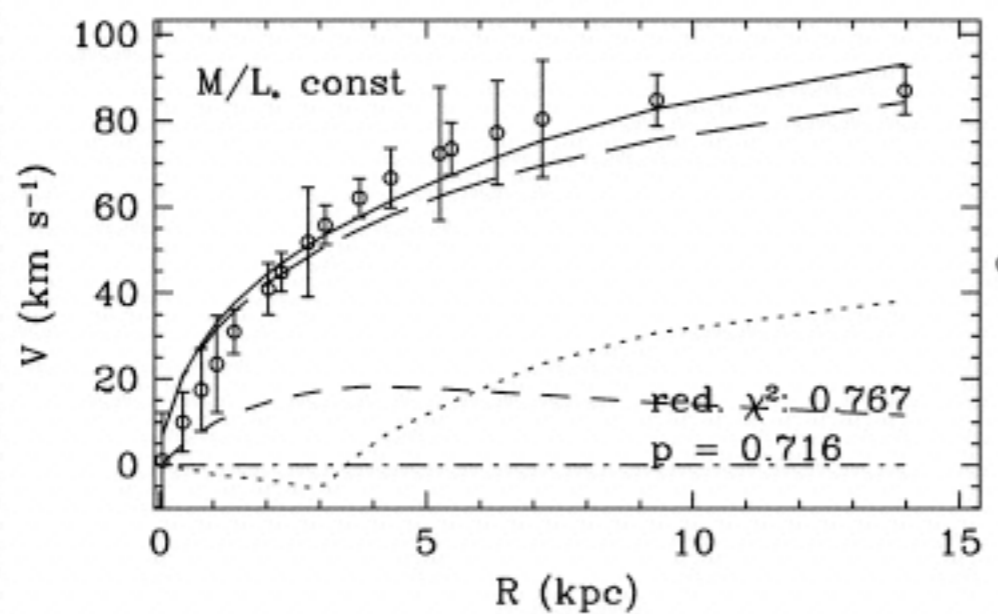
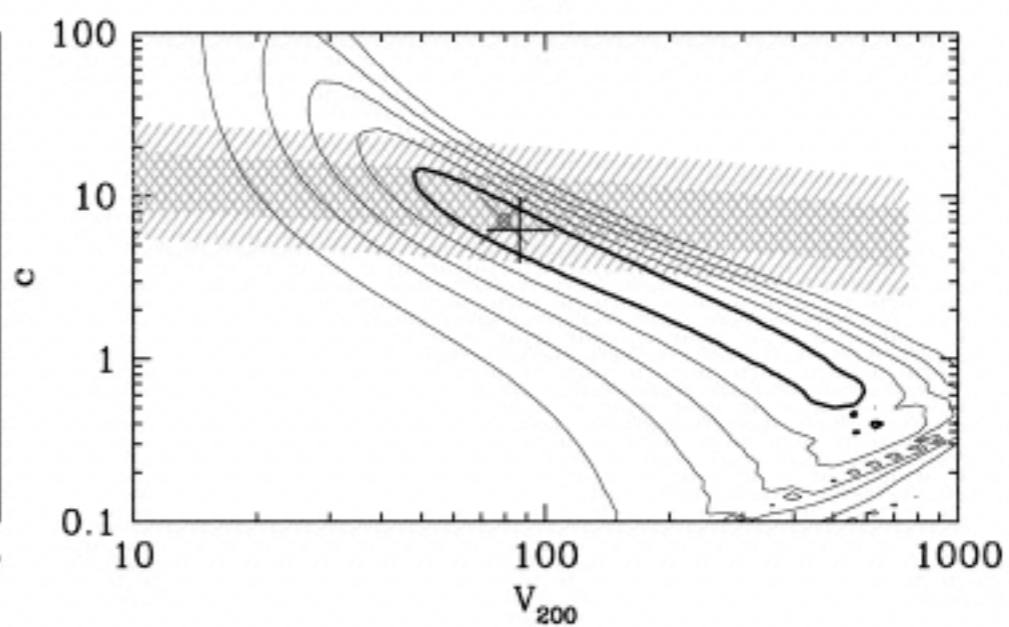
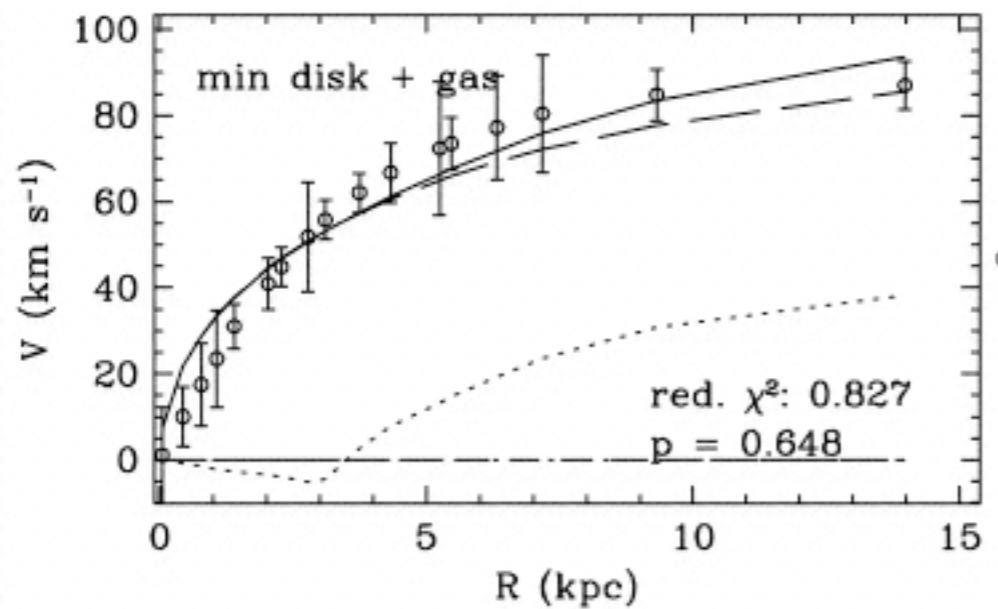
NFW
fits

LSB
F563-1



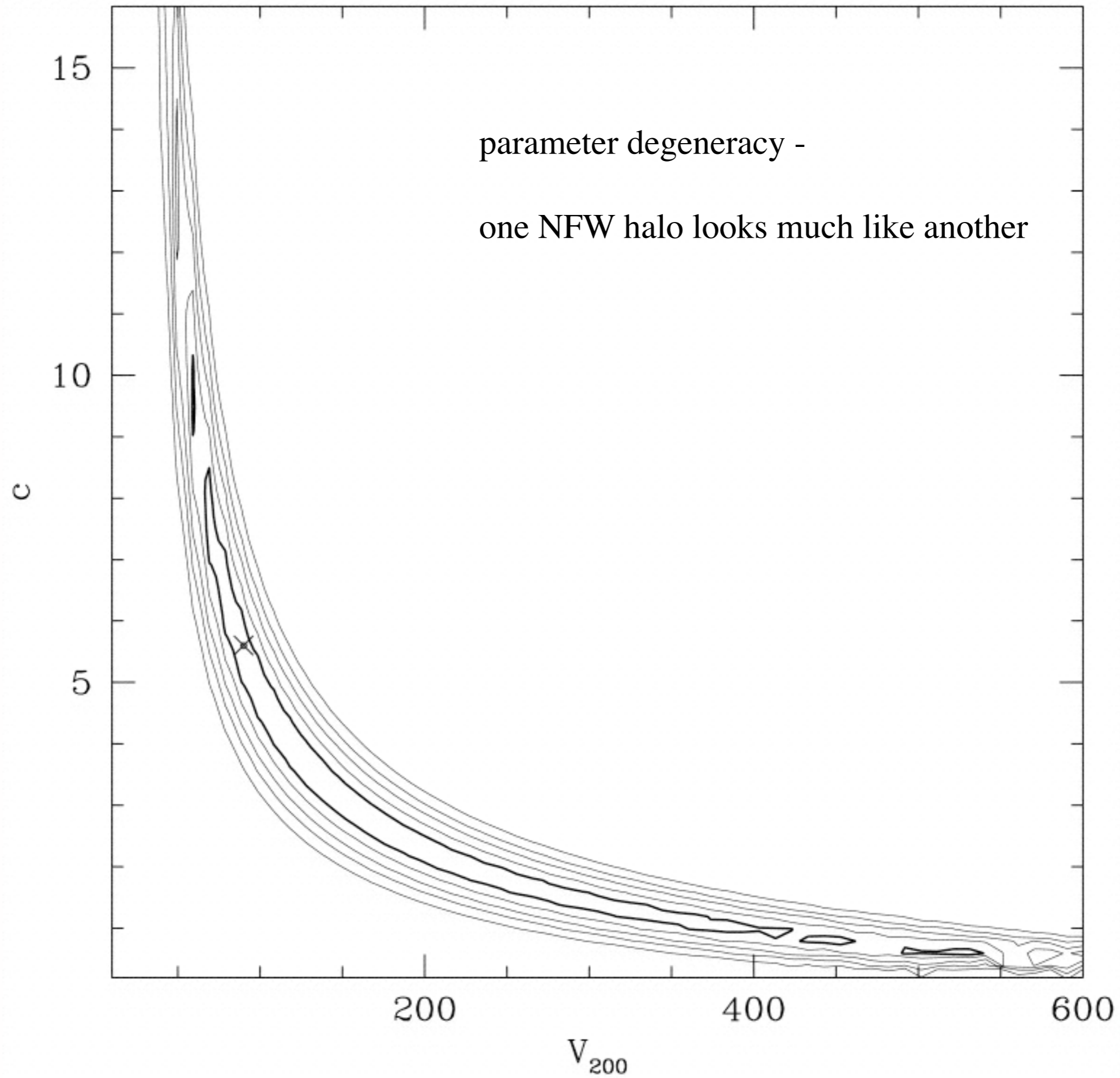
NFW
fits

LSB
F583-1

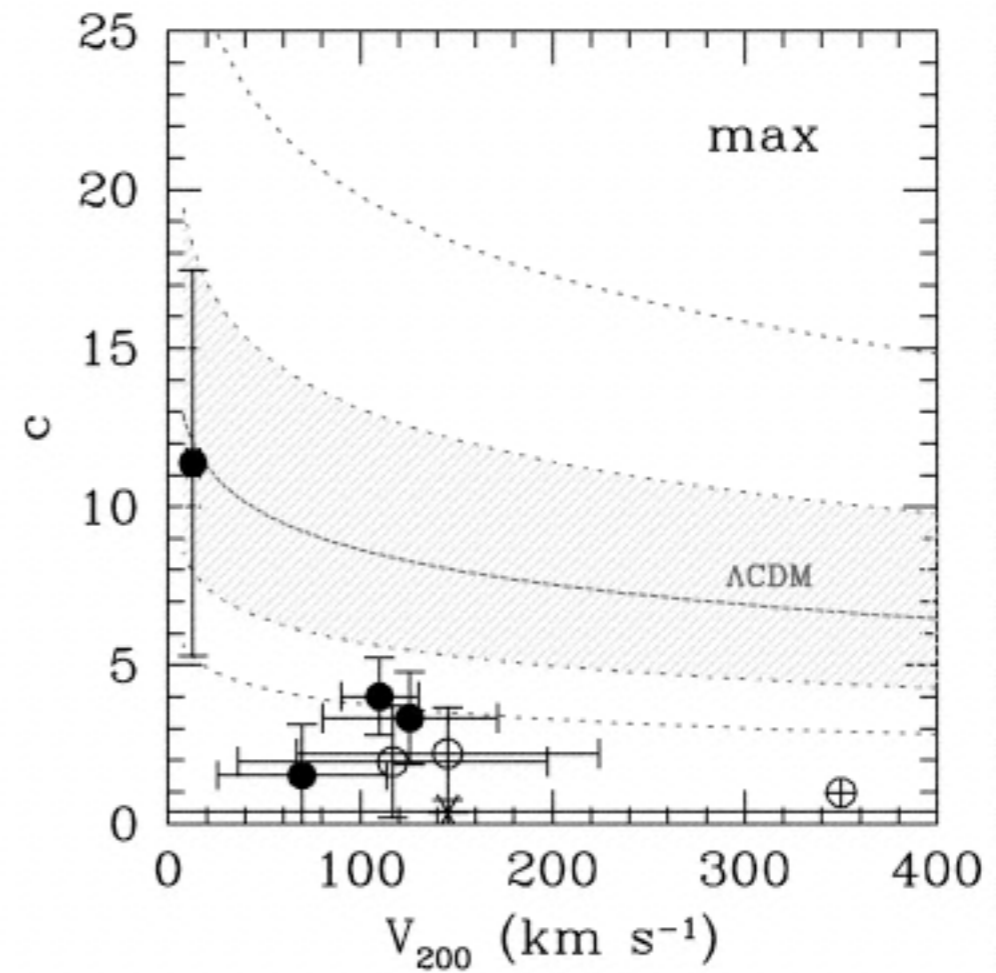
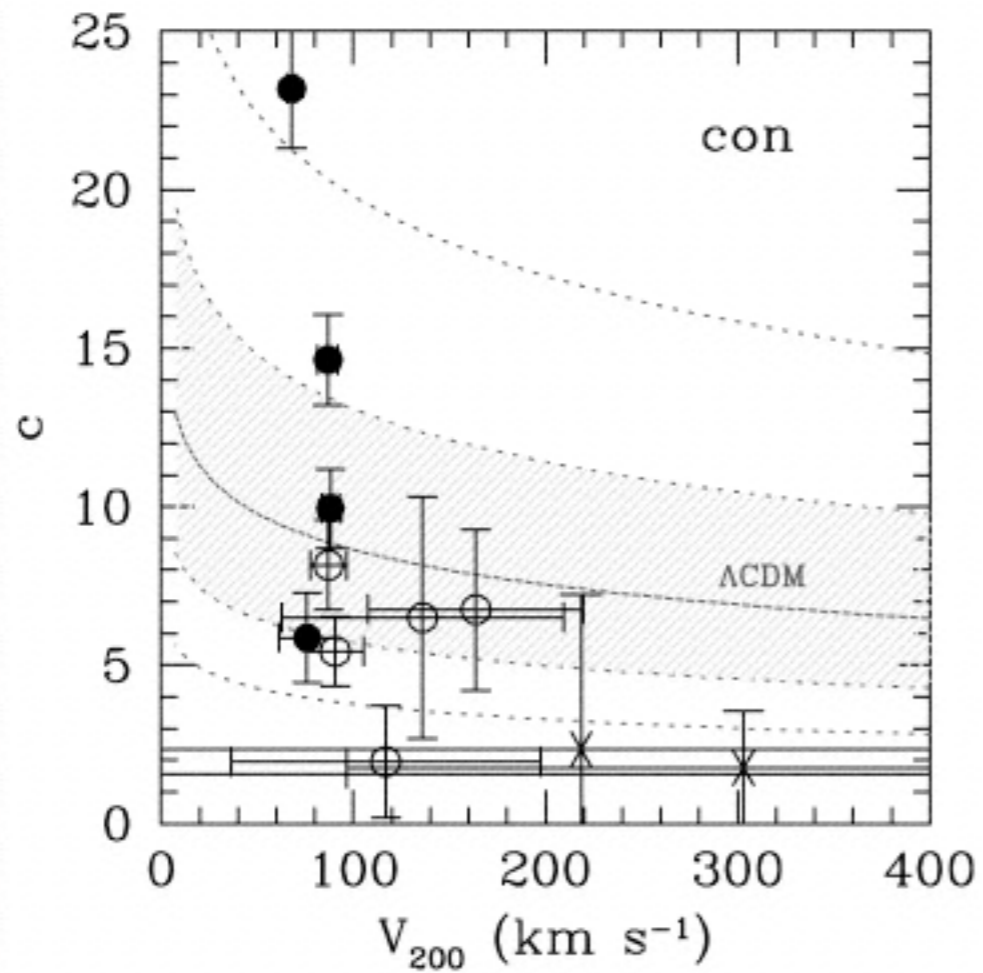
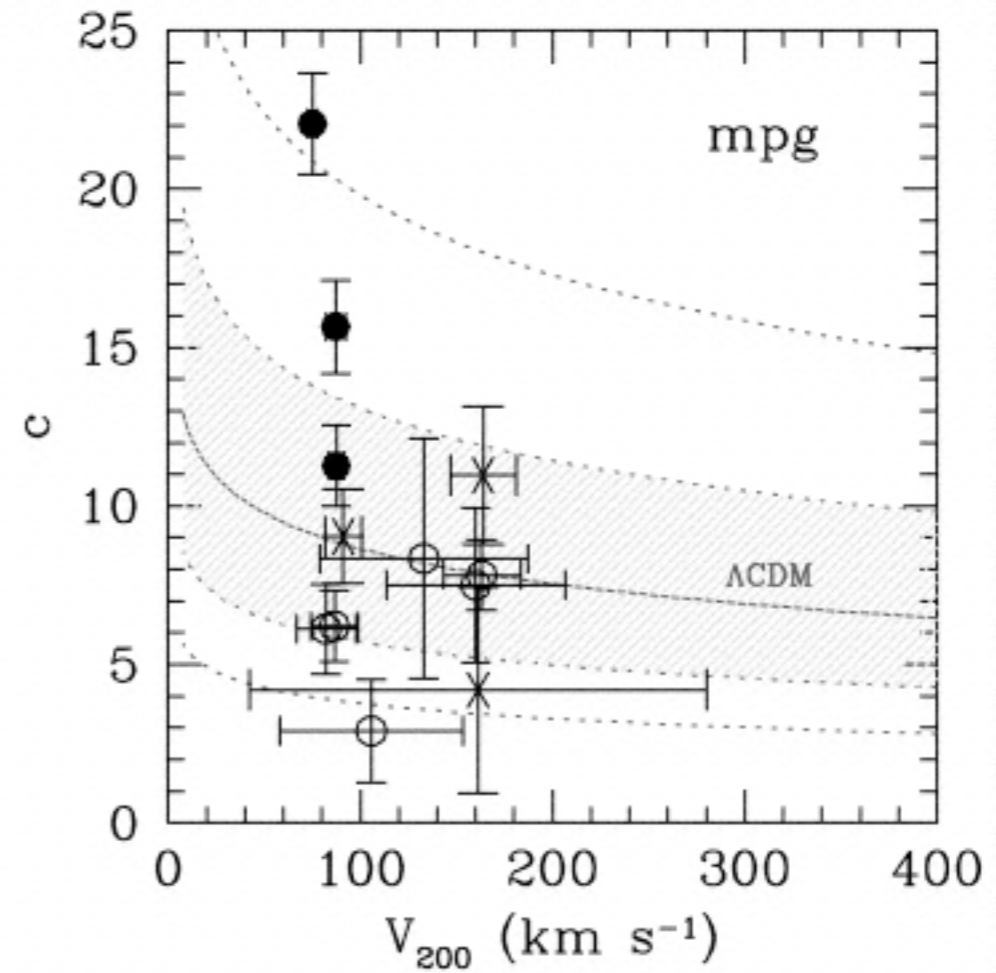
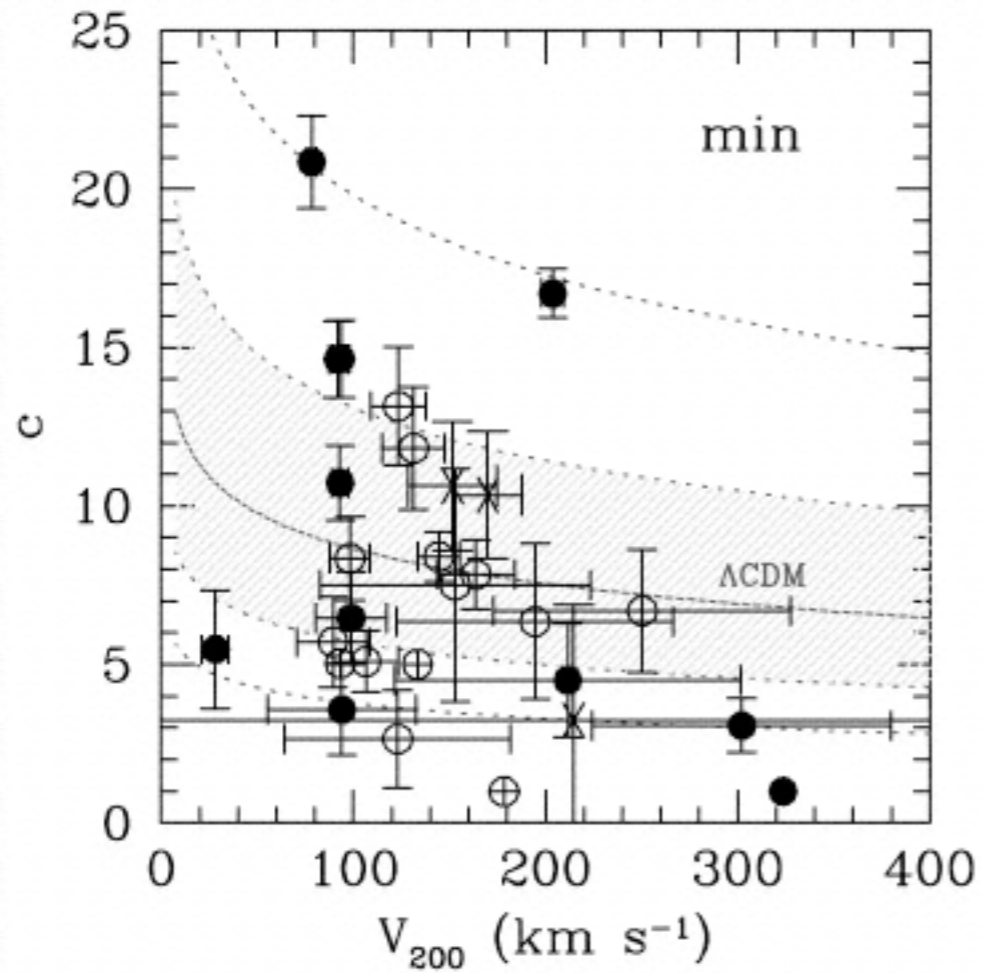


NFW
fits

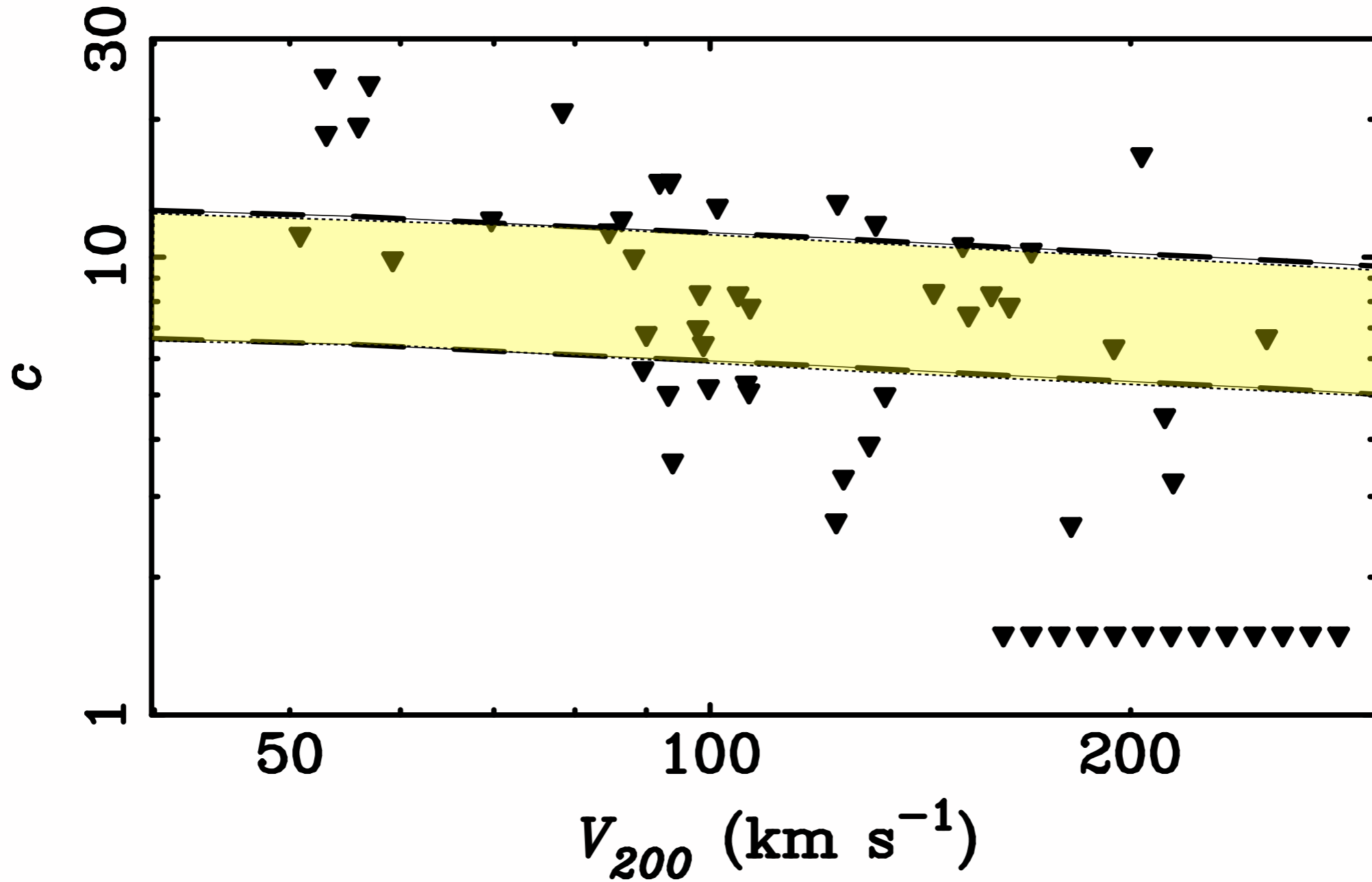
LSB
F583-4



NFW
c-V200
relation



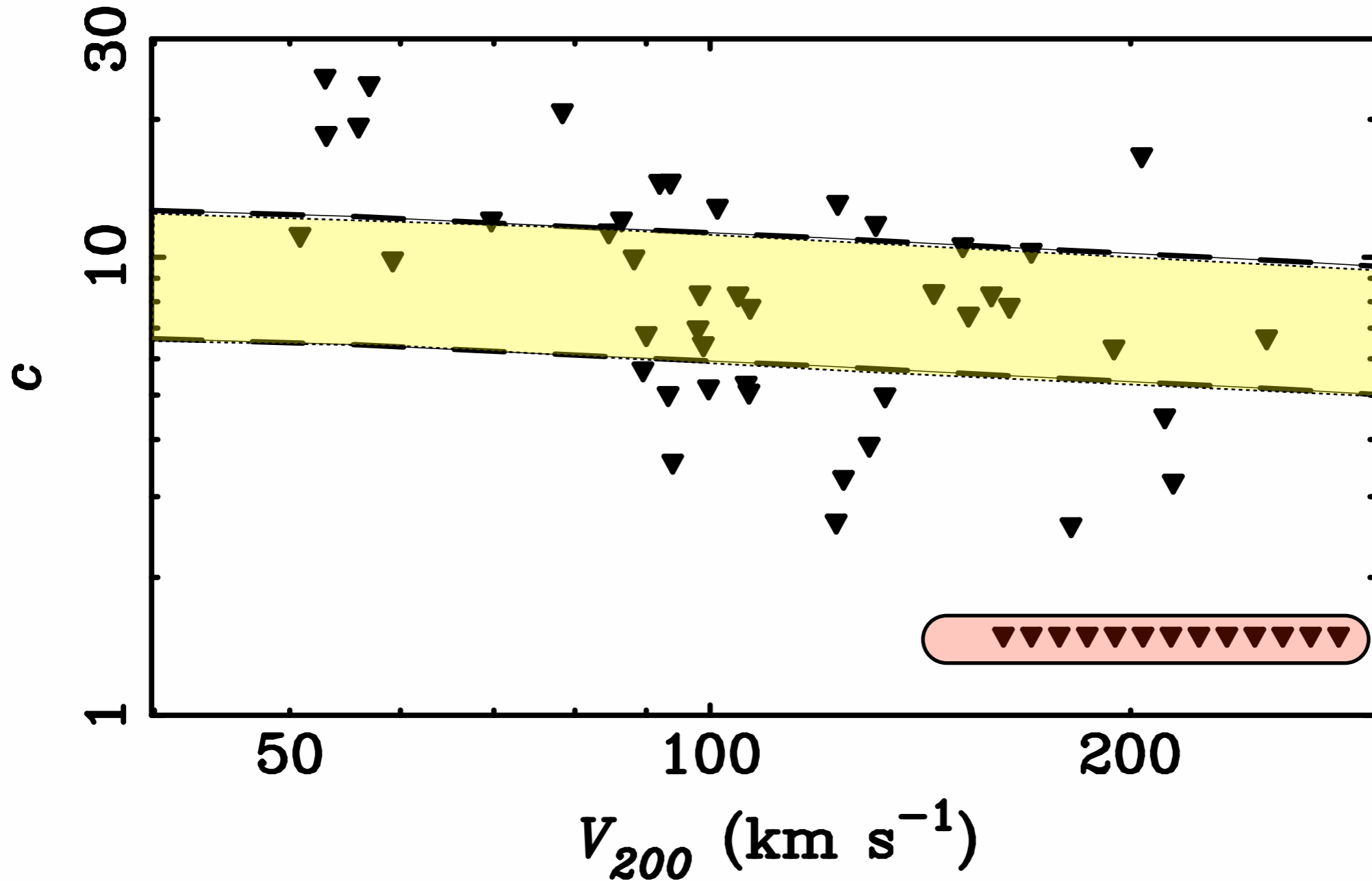
NFW
c-V200
relation



$$\log c = 0.844 - 0.098 \log \left(\frac{M_{200}}{10^{12} M_{\odot}} \right)$$

$$\sigma_{\ln c} = 0.25 \quad \text{Maccio, Dutton, \& van den Bosch 2008}$$

NFW
c-V200
relation

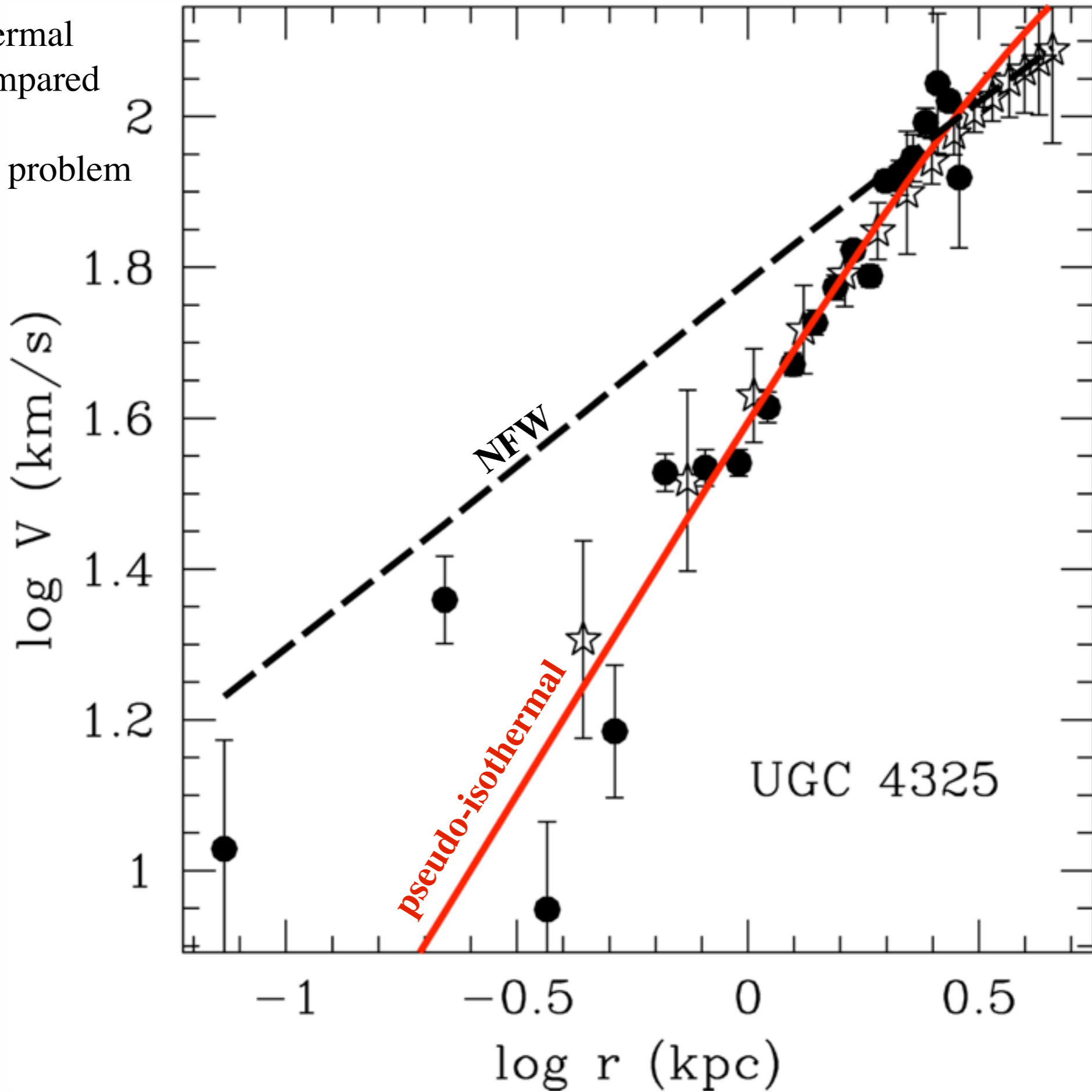


Many galaxies - especially LSBs - have upper limits on c that are unacceptably low. This is one indication of the “cusp-core problem.”

The central “cuspy” profiles predicted for dark matter halos are not always observed; much of the data prefer a nearly constant density core (like a pseudo-isothermal halo).

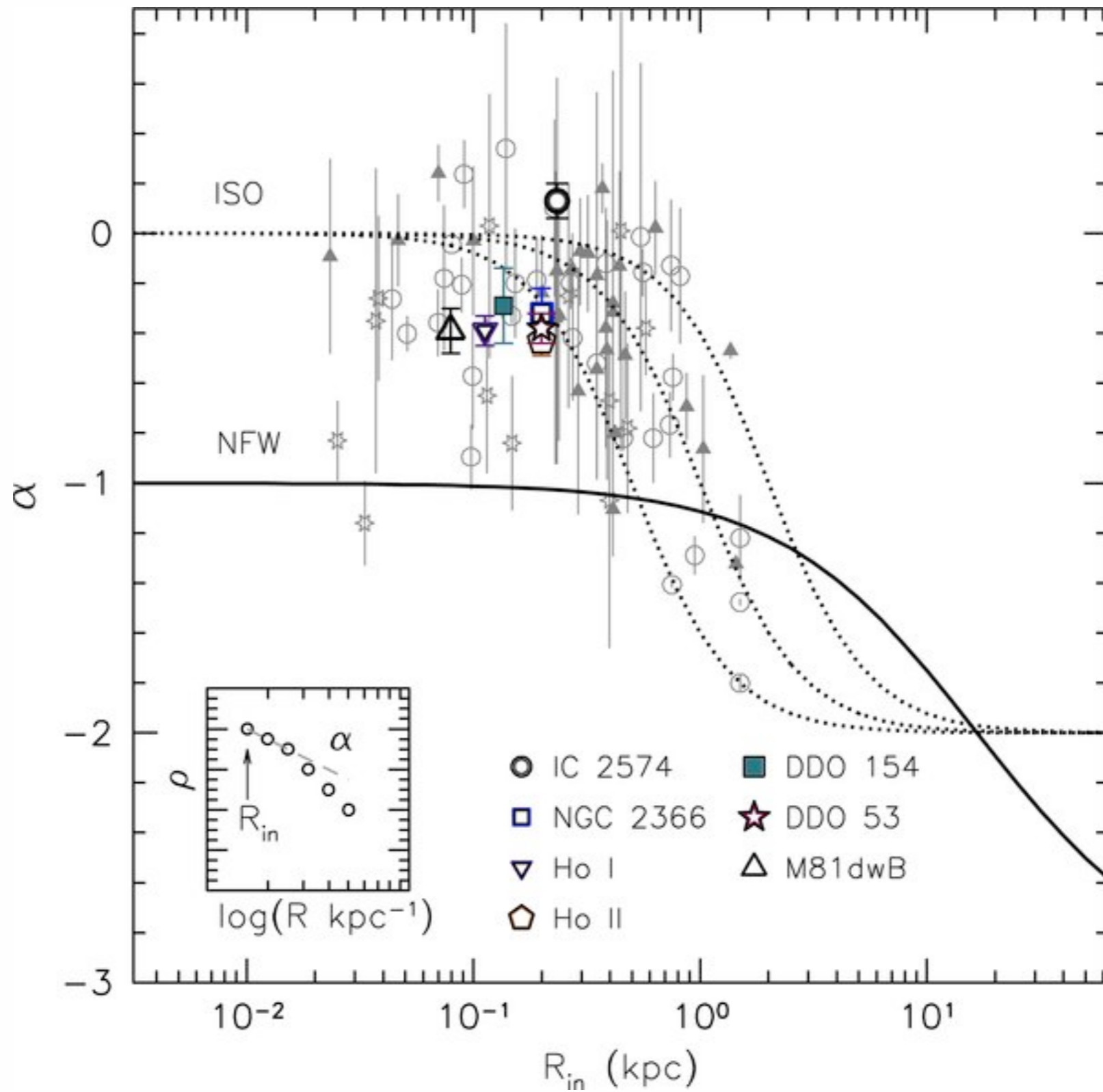
pseudo-isothermal
and NFW compared

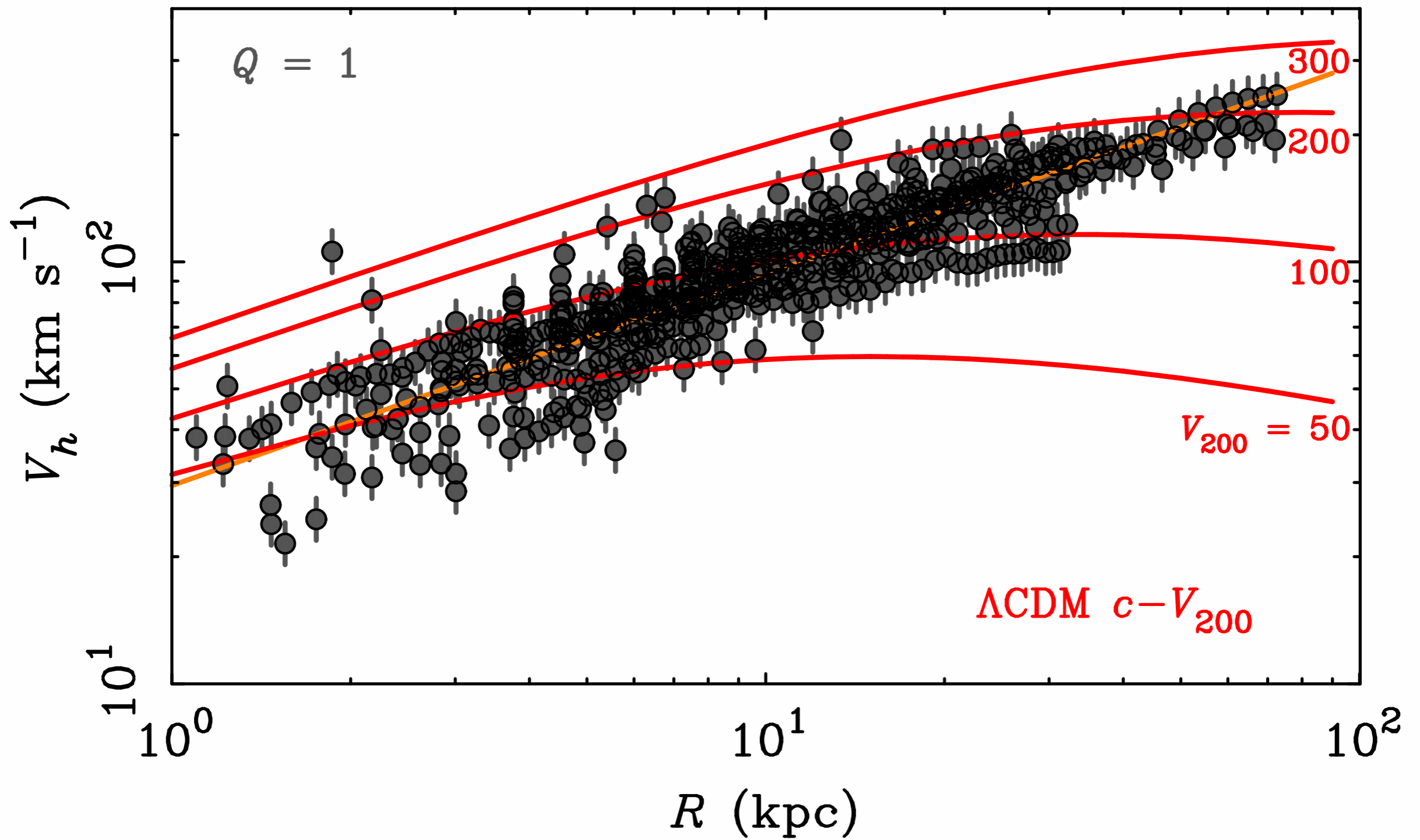
the cusp-core problem



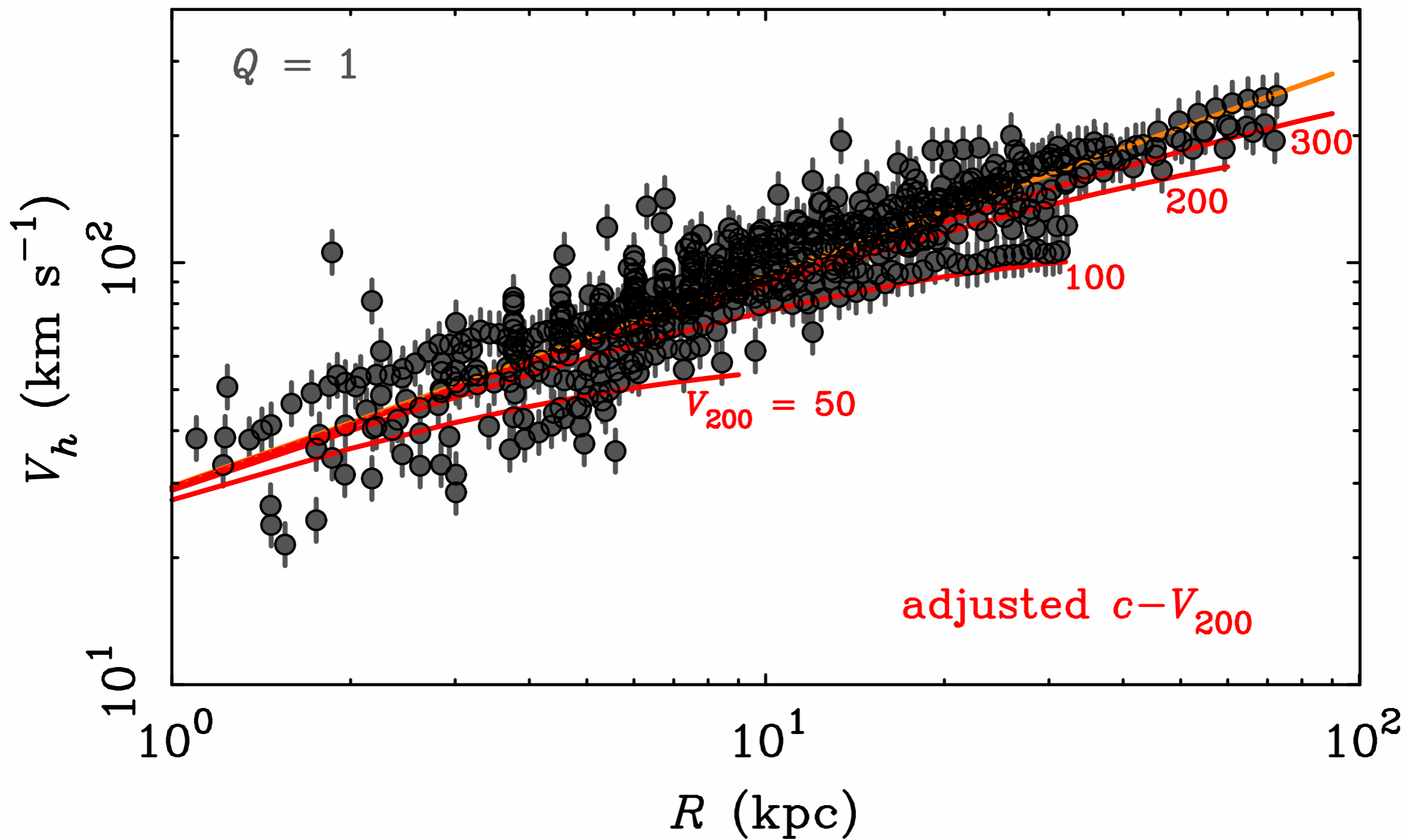
Inner density profiles of dark matter halos

$$\rho \sim r^\alpha$$

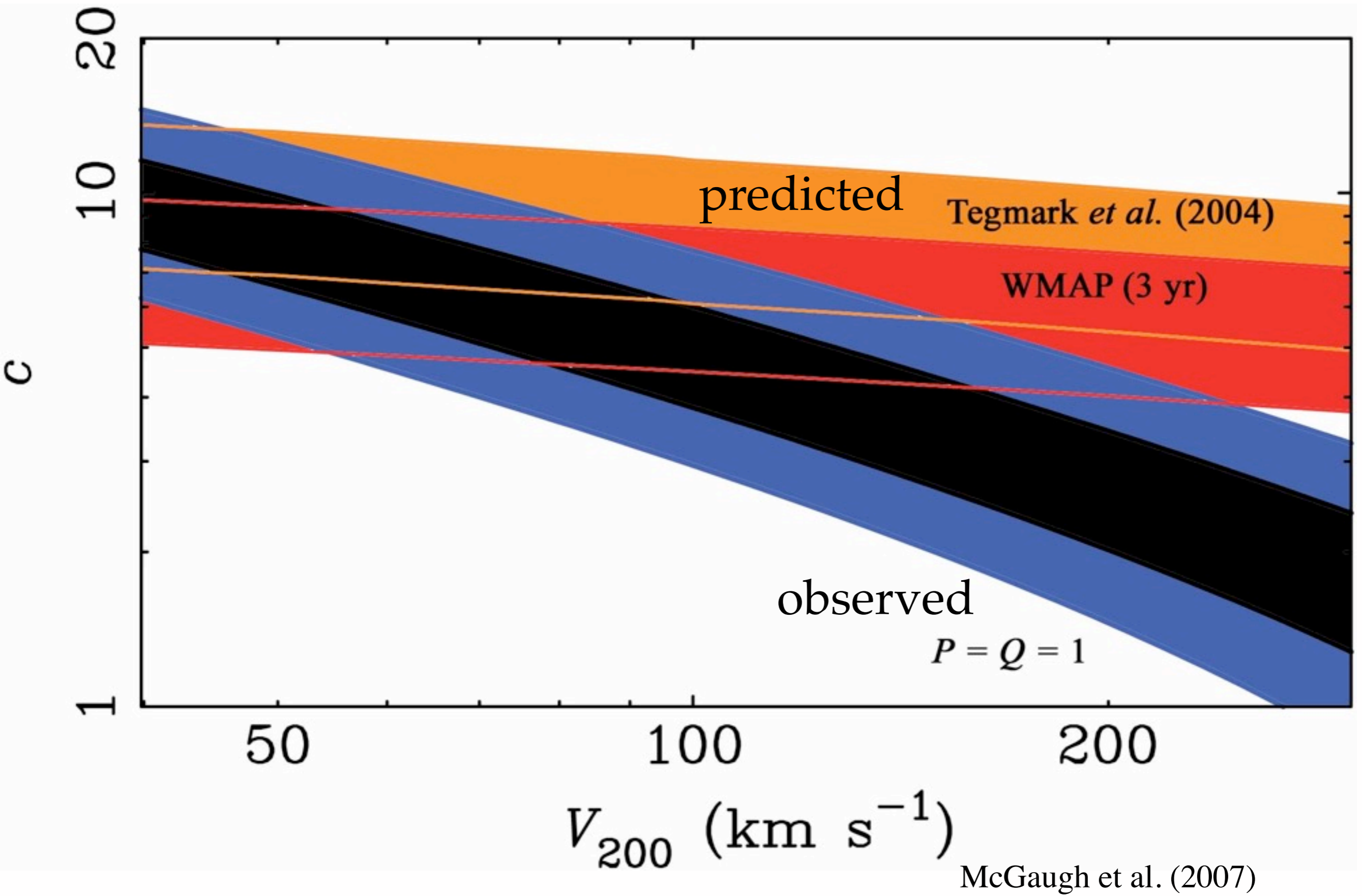




McGaugh et al. (2007)

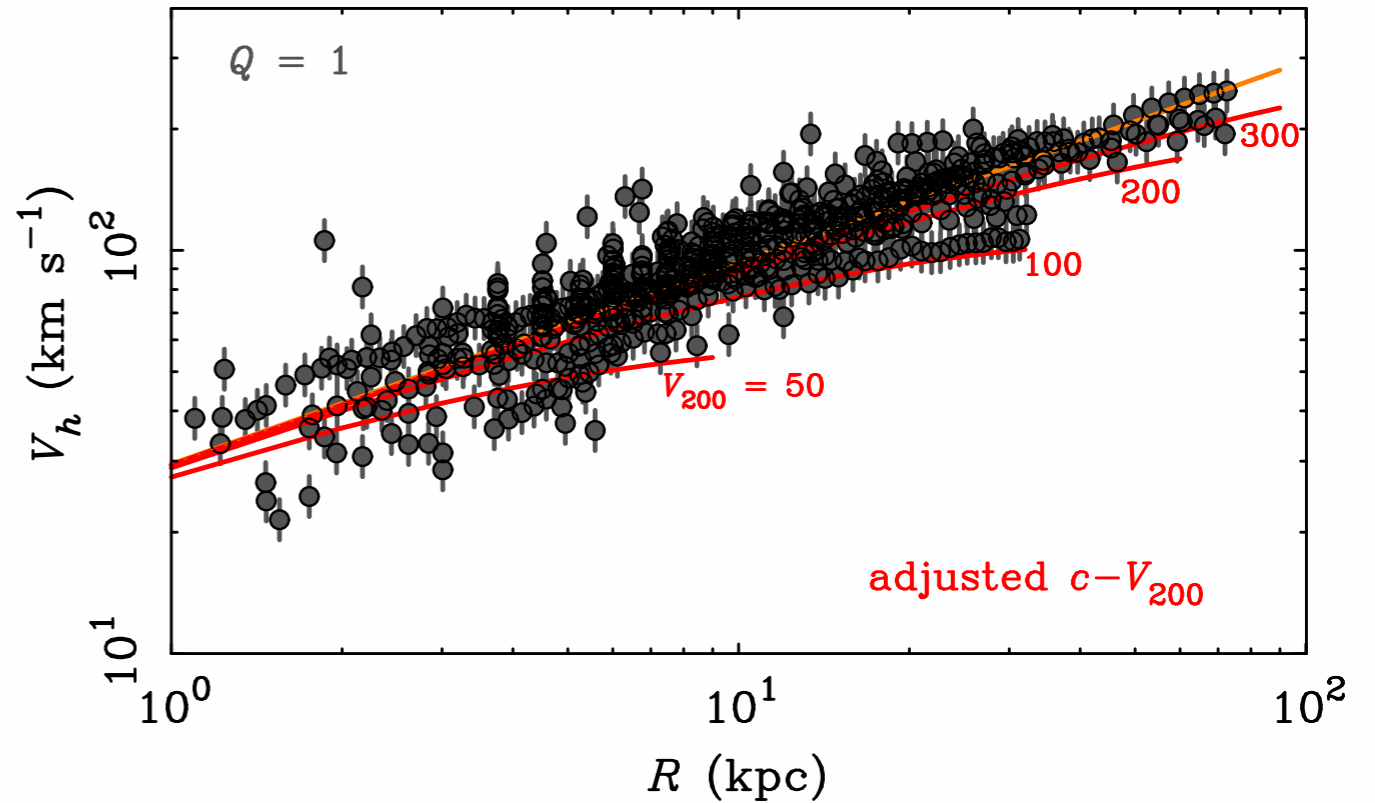


NFW c-V200 relation



Empirical DM halo

$$\frac{M_{DM}}{M_{\odot}} = 200 \left(\frac{R}{\text{pc}} \right)^2$$



McGaugh et al. (2007)

Walker et al. (2010)

$$\log \left(\frac{V_{DM}}{\text{km s}^{-1}} \right) = 1.47 + \frac{1}{2} \log \left(\frac{R}{\text{kpc}} \right)$$

$$g_{DM} = 3 \times 10^{-11} \text{ m s}^{-2}$$

Roughly constant acceleration - equivalent to constant surface density

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