Dark Matter

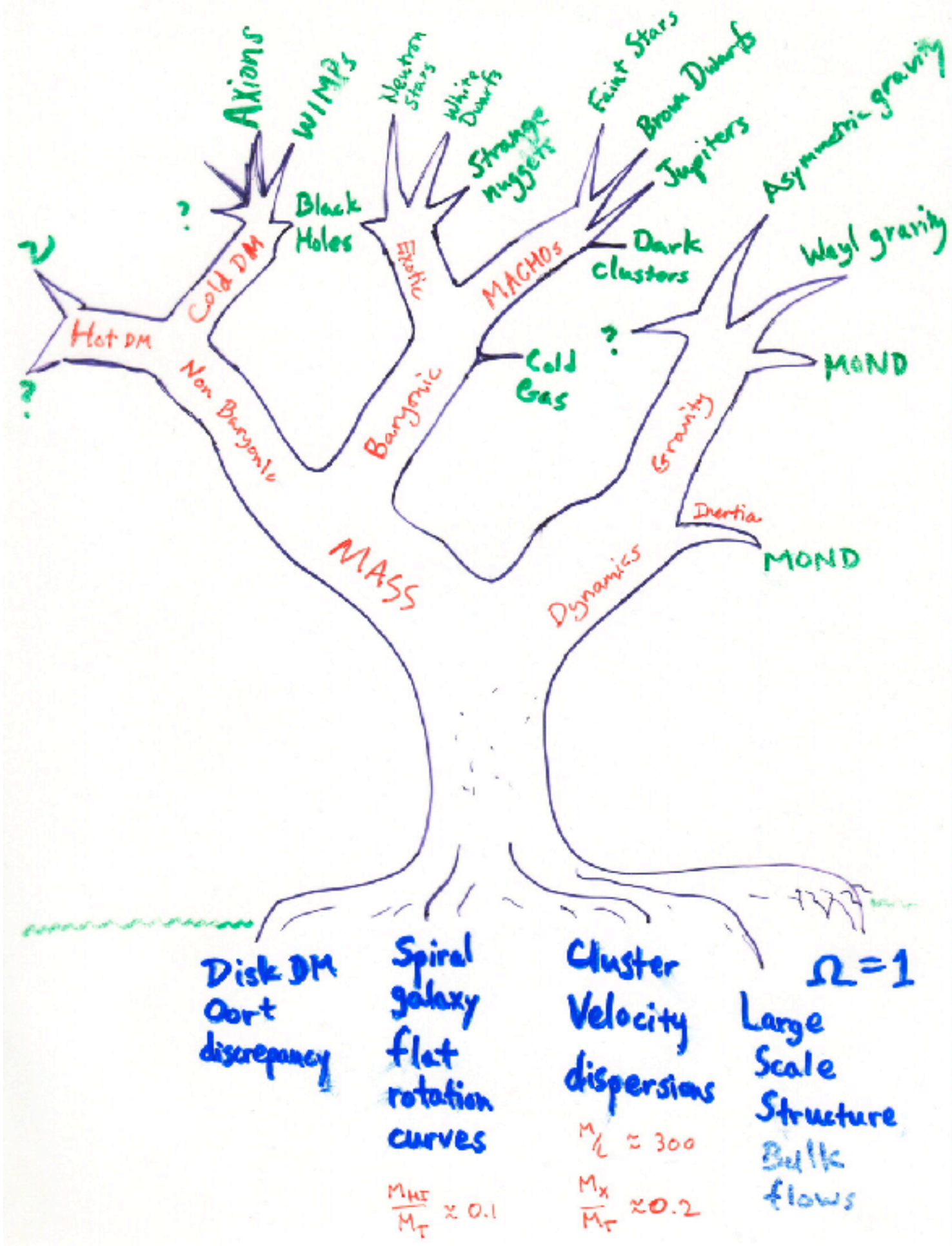
ASTR 333/433

Today

Fundamental Plane
Orbital Anisotropy

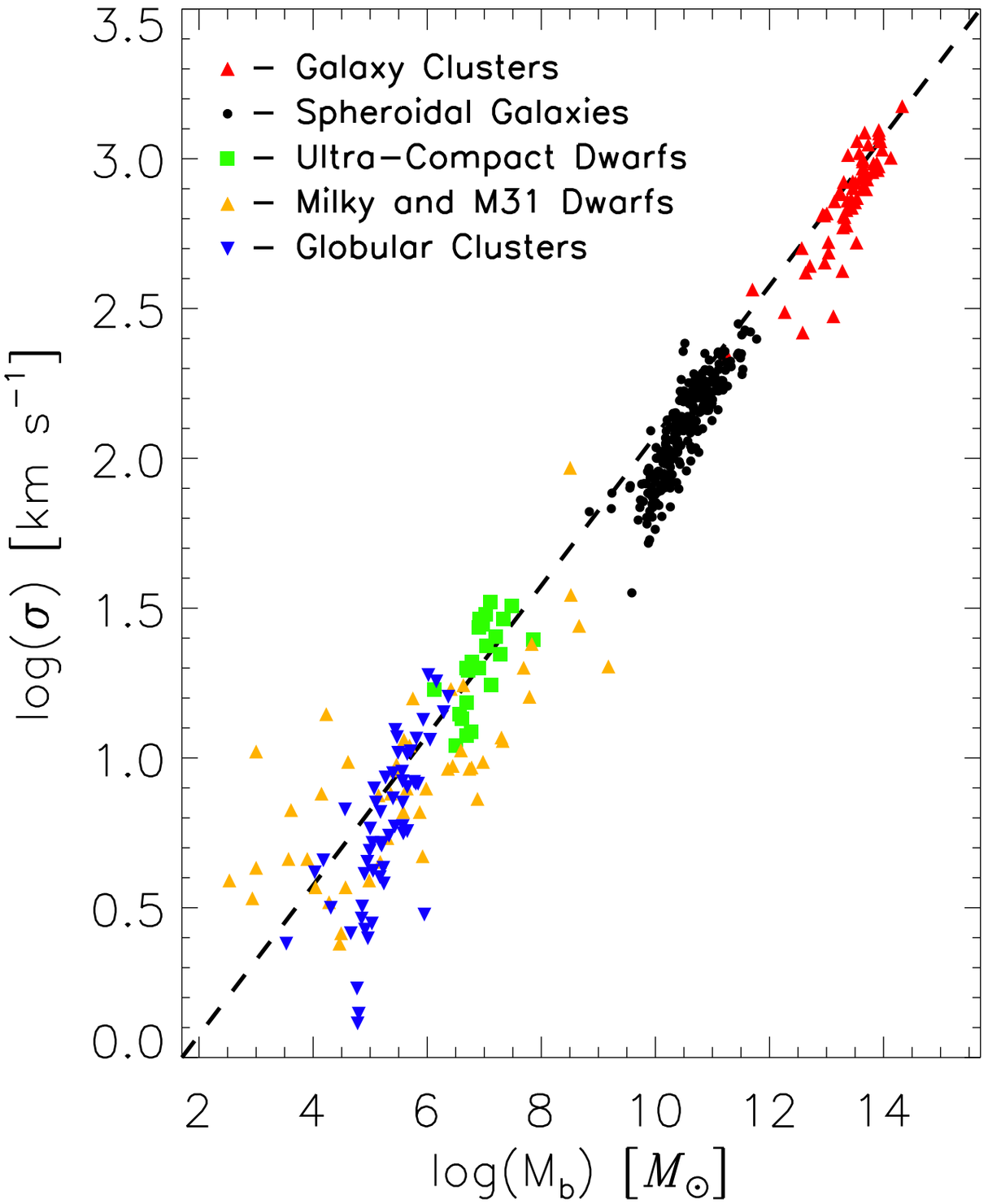
FEEDBACK
BARYON CONTENT

Homework 3 due April 5

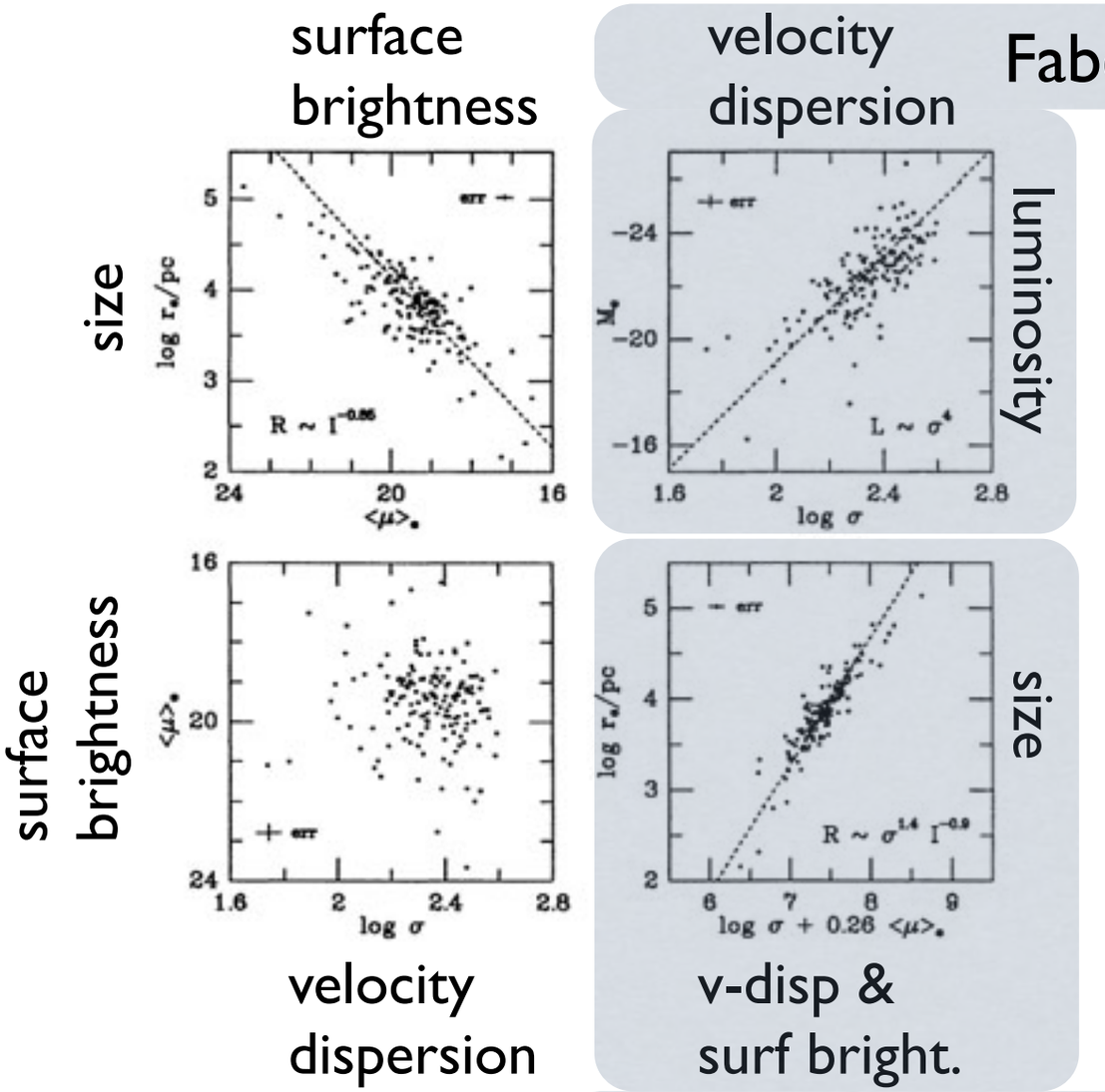


Faber-Jackson (pressure supported)

Tully-Fisher for Ellipticals



Fundamental Plane (pressure supported)



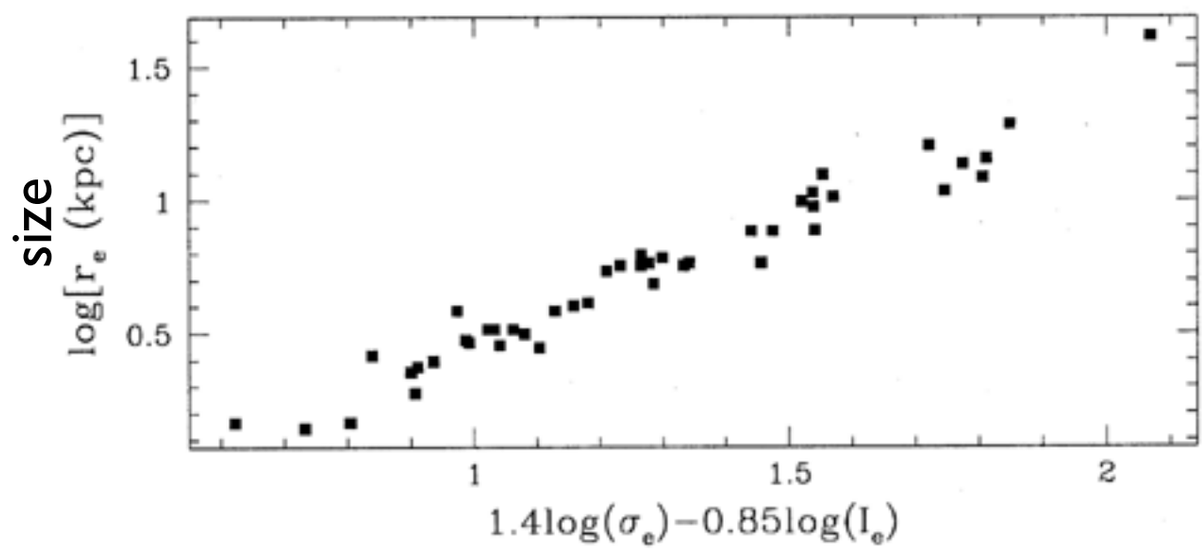
"Viral" fundamental plane

$$R_e \propto \sigma^2 I_e^{-1}$$

observed fundamental plane "tilted" wrt virial expectation:

$$R_e \propto \sigma^{1.4} I_e^{-0.85}$$

velocity dispersion & surface brightness



$M \propto \sigma^2 R_e$ virial theorom

$L \propto I_e R_e^2$ luminosity, surface brightness size

Orbital Anisotropy

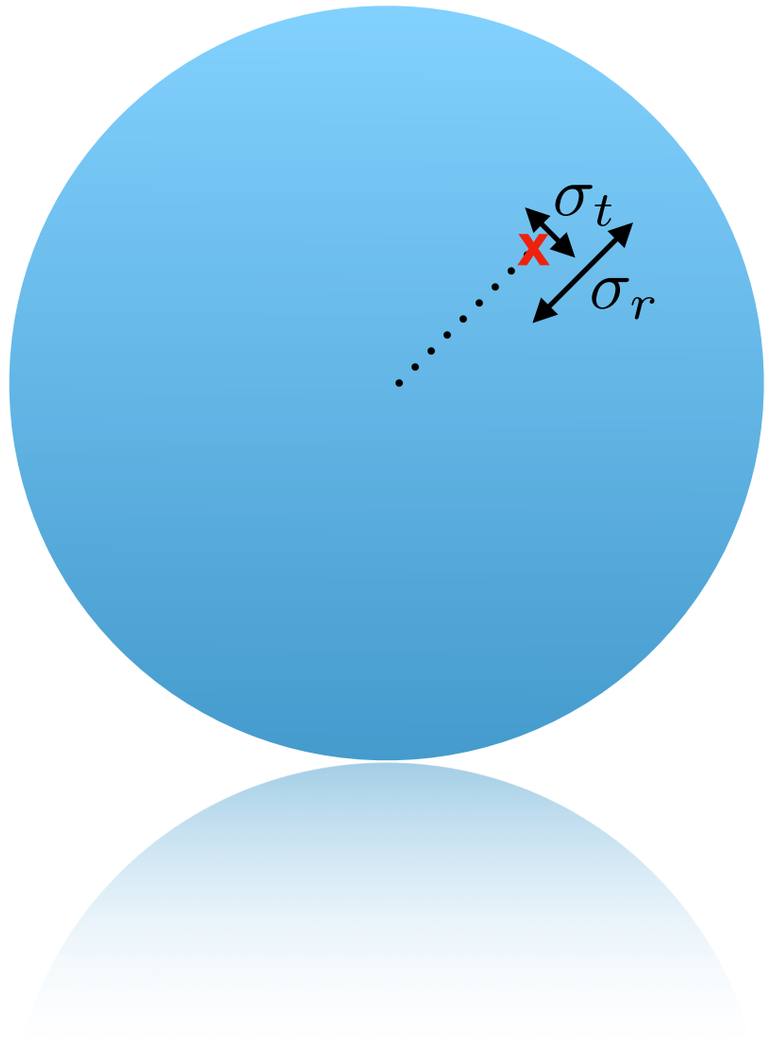
The anisotropy parameter measures how radial or circular orbits are

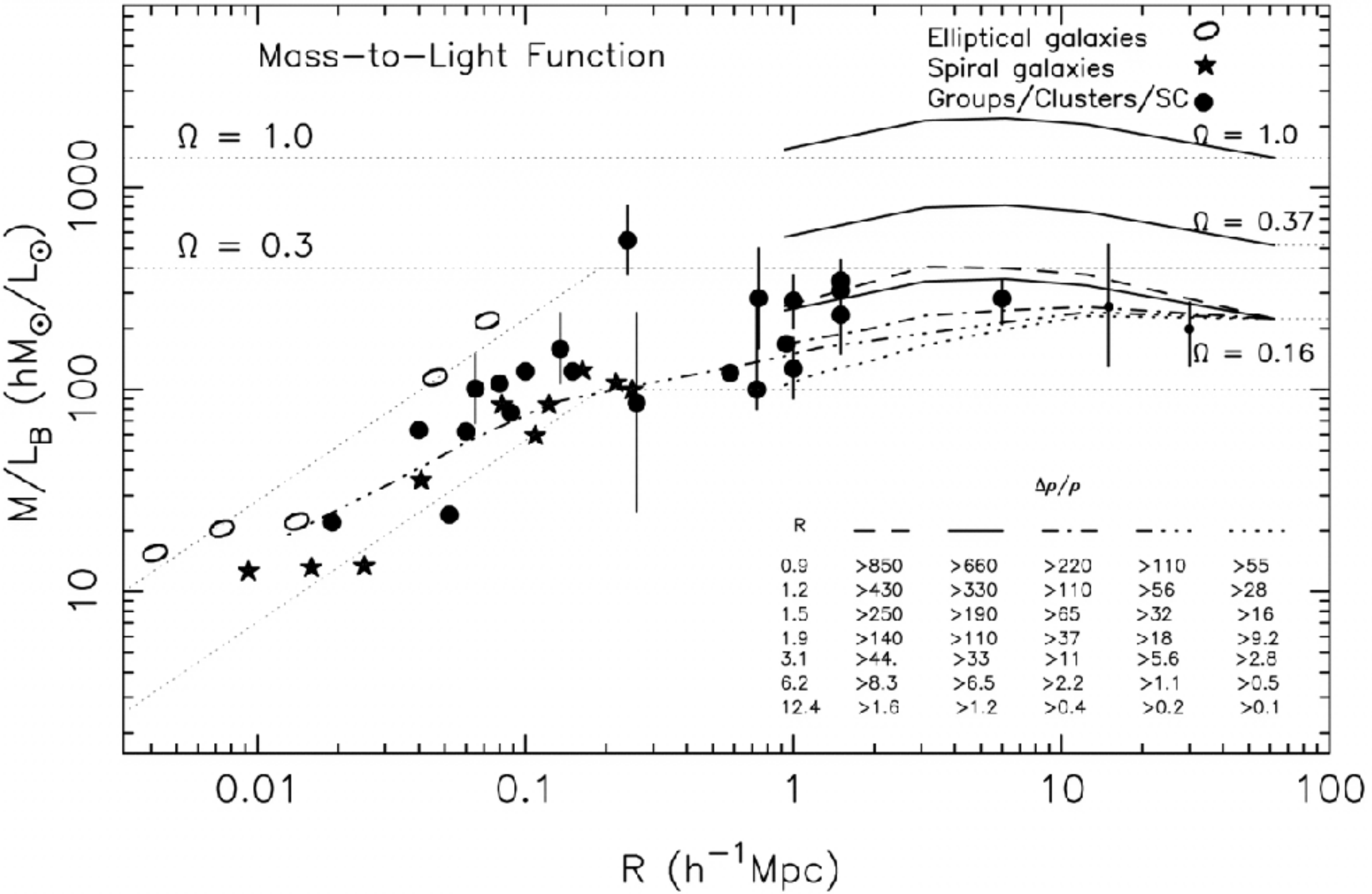
$$\beta = 1 - \frac{\sigma_t^2}{\sigma_r^2}$$

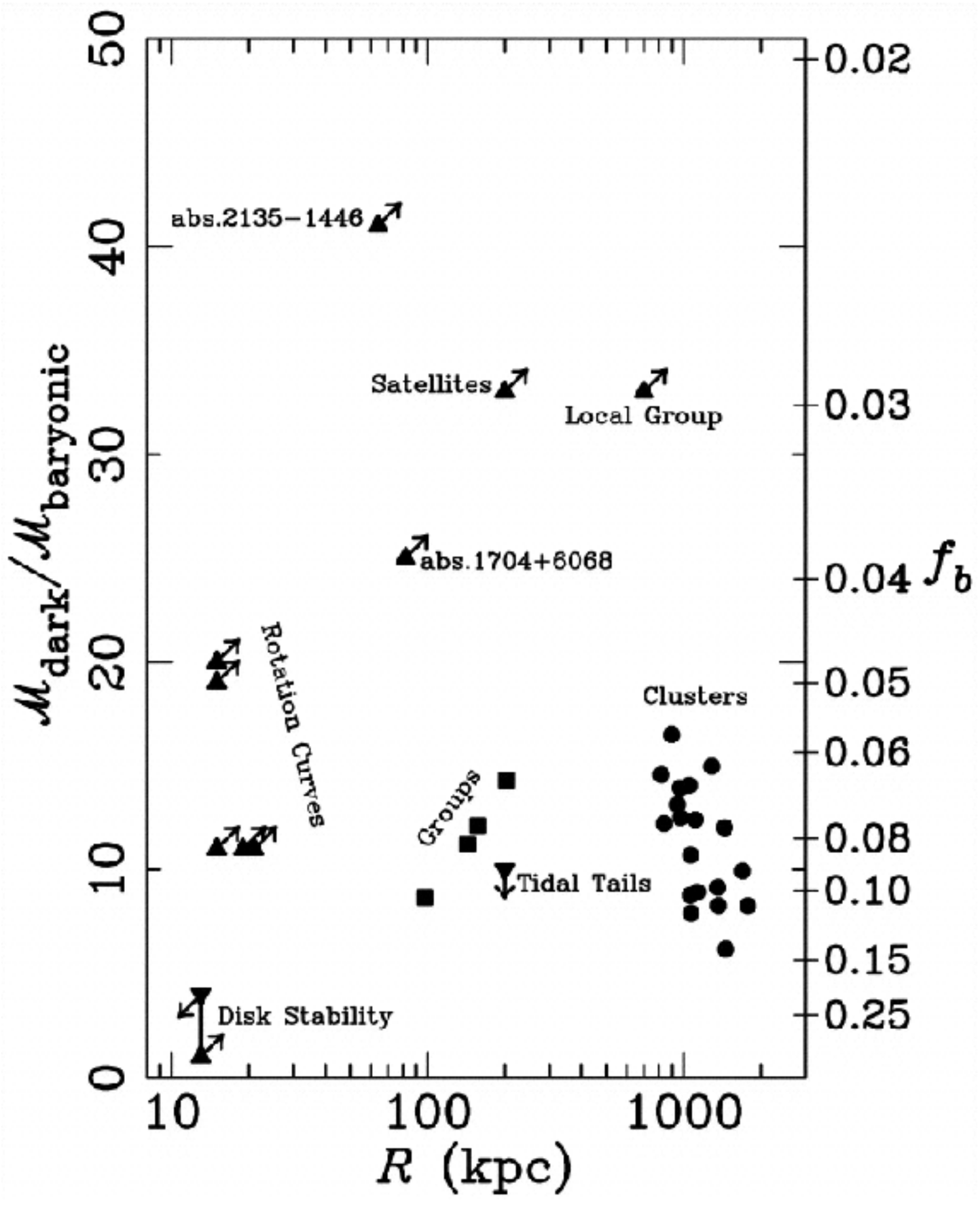
σ_t^2 ← tangential velocity dispersion

σ_r^2 ← radial velocity dispersion

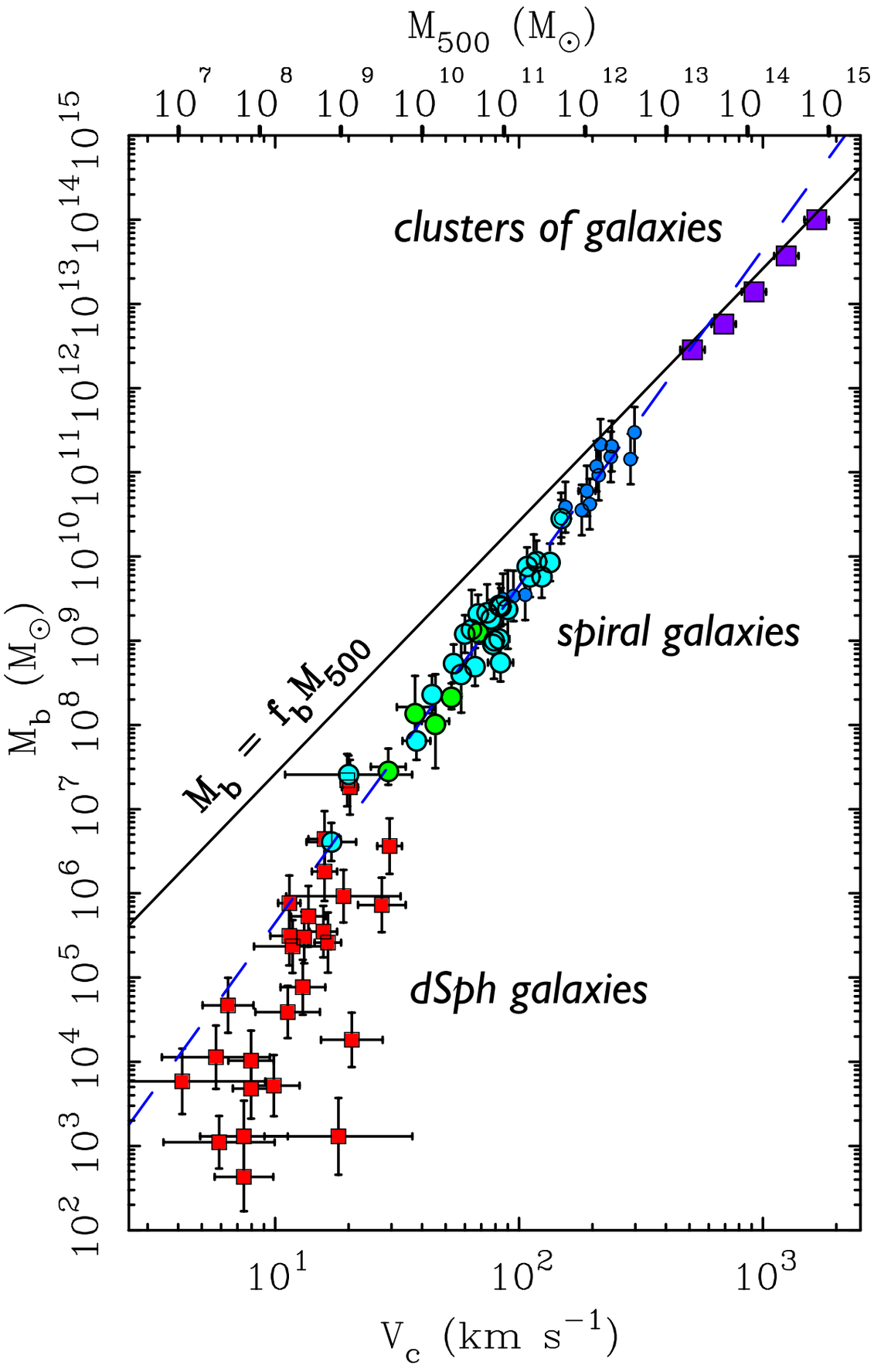
$$M(r) = G^{-1} r \sigma_r^2 \left(-\frac{d \ln n_*}{d \ln r} - \frac{d \ln \sigma_r^2}{d \ln r} - 2\beta \right)$$




Mass−to−Light Function
Elliptical galaxies
Spiral galaxies
Groups/Clusters/SC
Ω = 1.0
Ω = 0.3
Ω = 1.0
Ω = 0.37
Ω = 0.16
M/L_B (hM_⊙/L_⊙)
1000
100
10
0.01
0.1
1
10
100
R (h^−1 Mpc)
Δρ/ρ
R
0.9 >850 >660 >220 >110 >55
1.2 >430 >330 >110 >56 >28
1.5 >250 >190 >65 >32 >16
1.9 >140 >110 >37 >18 >9.2
3.1 >44. >33 >11 >5.6 >2.8
6.2 >8.3 >6.5 >2.2 >1.1 >0.5
12.4 >1.6 >1.2 >0.4 >0.2 >0.1

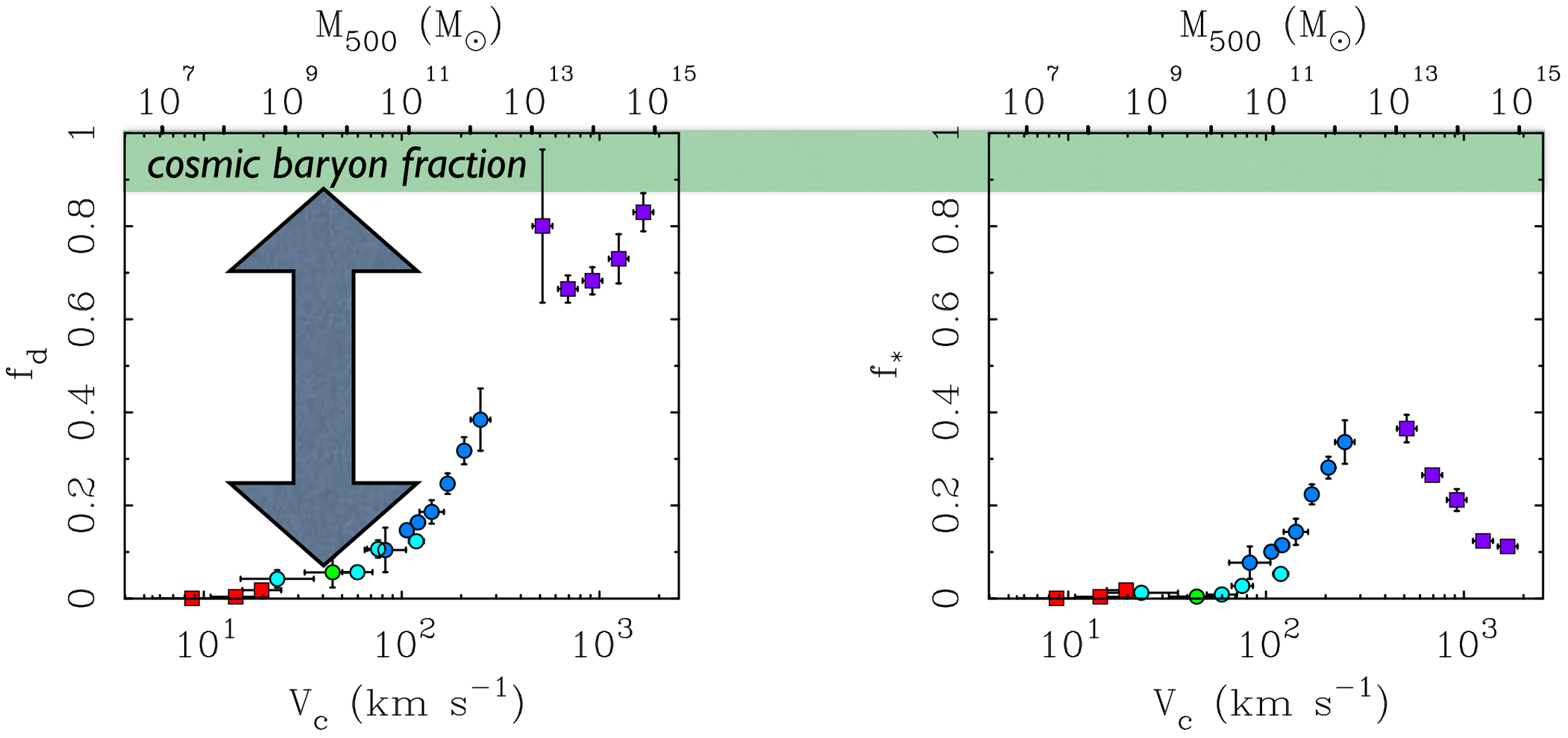

$\mathcal{M}_{\rm dark}/\mathcal{M}_{\rm baryonic}$
0
10
20
30
40
50
f_b
0.02
0.03
0.04
0.05
0.06
0.08
0.10
0.15
0.25
abs.2135−1446
Satellites
Local Group
abs.1704+6068
Rotation Curves
Clusters
Groups
Tidal Tails
Disk Stability
10
100
1000
R (kpc)

Extended TF


M_{500} ($M_\odot$)
clusters of galaxies
spiral galaxies
$M_b = f_b M_{500}$
dSph galaxies
M_b ($M_\odot$)
V_c (km s^{-1})

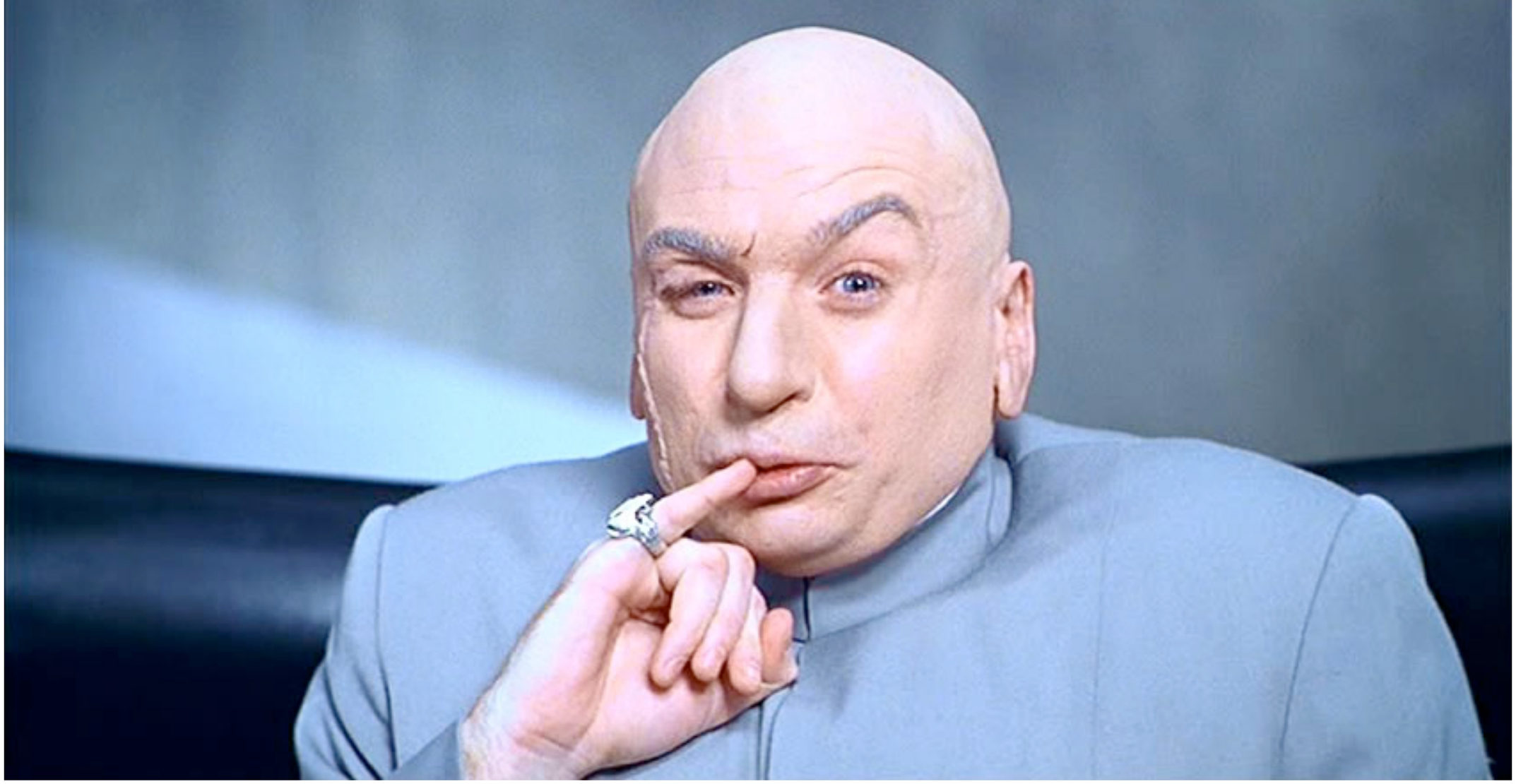
$$f_d = \frac{M_b}{f_b M_{500}}$$

$$f_* = \frac{M_*}{f_b M_{500}}$$



Halo by halo missing baryon problem

2 missing mass problems: baryonic AND non-baryonic DM



Theorist: I have an even better idea. I'm going to place model galaxies in easily escapable dark matter halos by invoking overly elaborate and exotic feedback schemes.
Observer: Wait, aren't you even going to test that? It might not work!
Theorist: No no no, I'm going to leave it alone and not actually witness it happening; I'm just gonna assume it all went to plan. What?