Dynamical Systematics

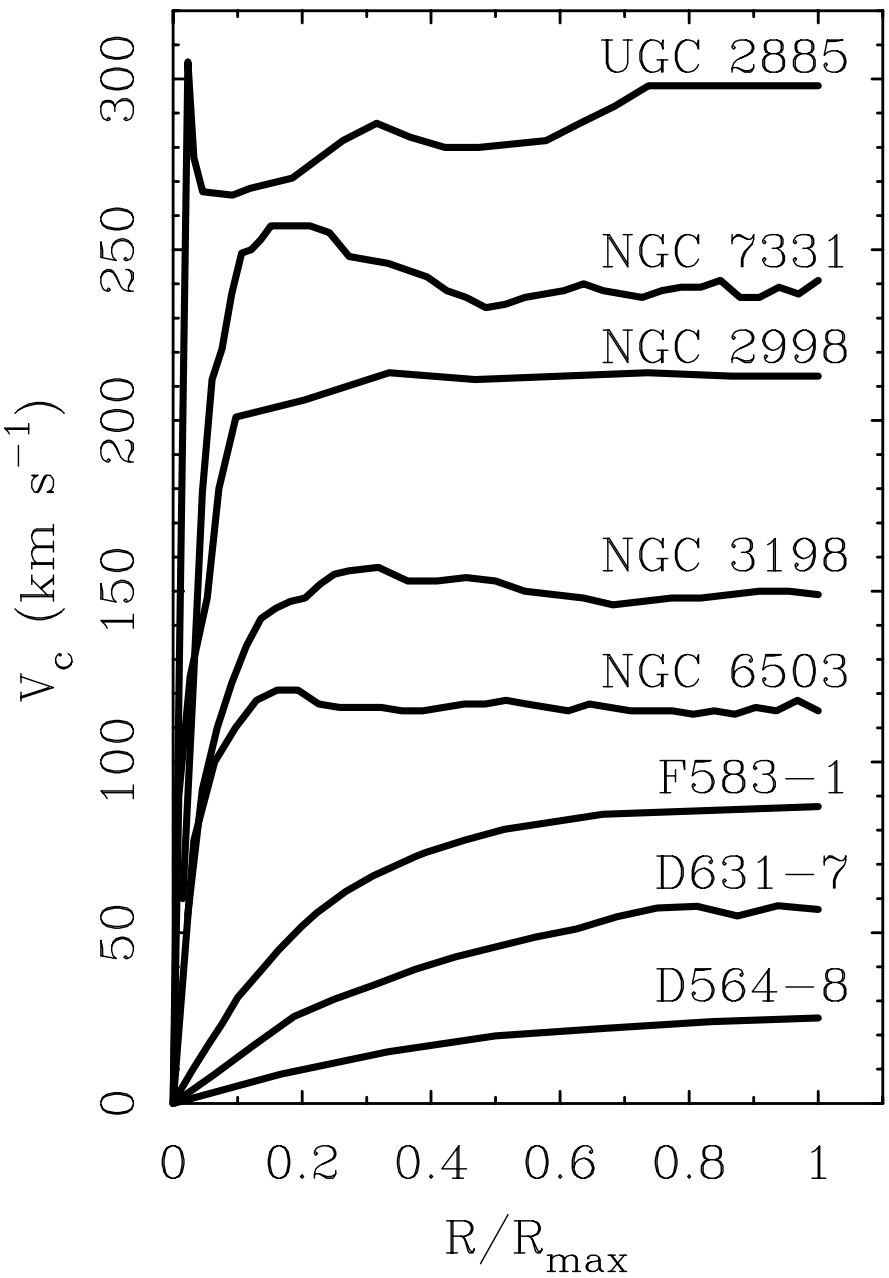
Homework due
Final one week from today
Discussion next time

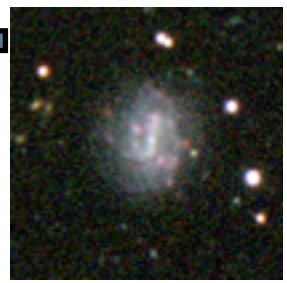
PLEASE EVALUATE THE COURSE

Dynamical Systematics

- Rotation curves roughly flat at large radius
- Inner RC well predicted by "maximum disk"
- Disk-halo "conspiracy"
- Tully-Fisher: $L \sim V^4$
- Rotation curve shape depends on light
- Mass Discrepancy-Acceleration relation

Rotation curves flat at large radius

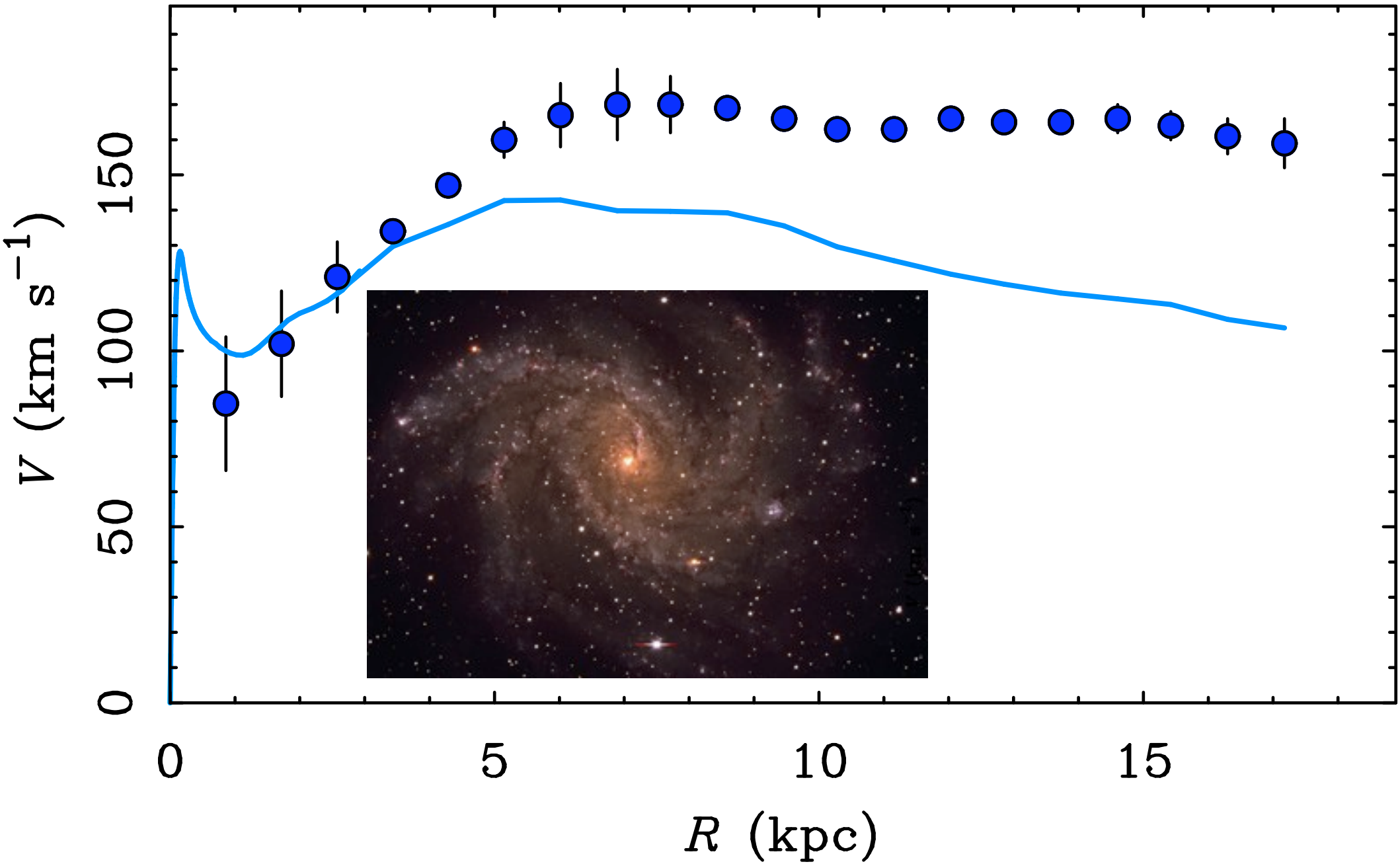


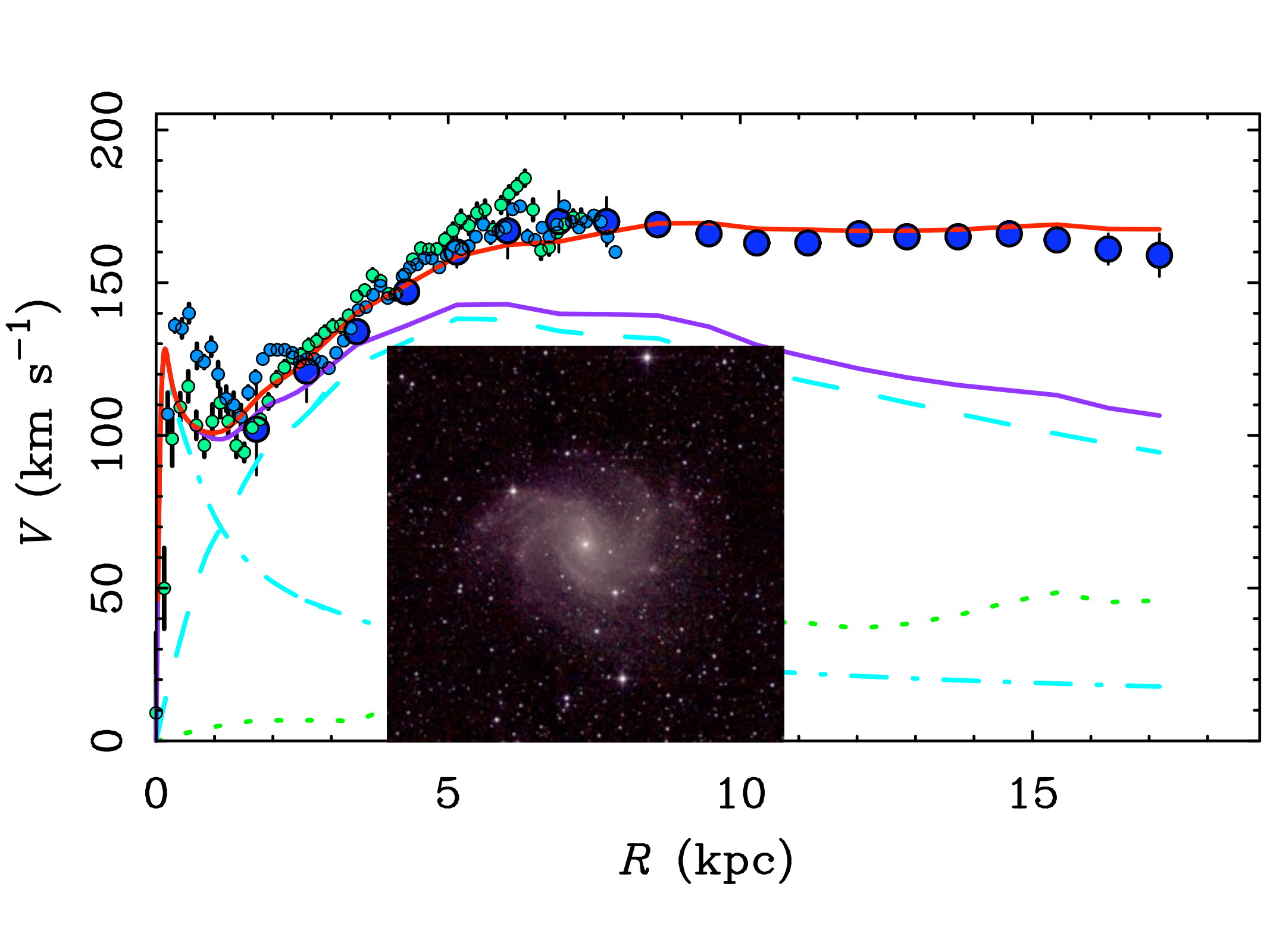


Rotation curves of late type disks (Sd, Sm, Irr)

Kuzio de Naray et al. (2006, 2008, 2009); Trachternach et al. (2009)

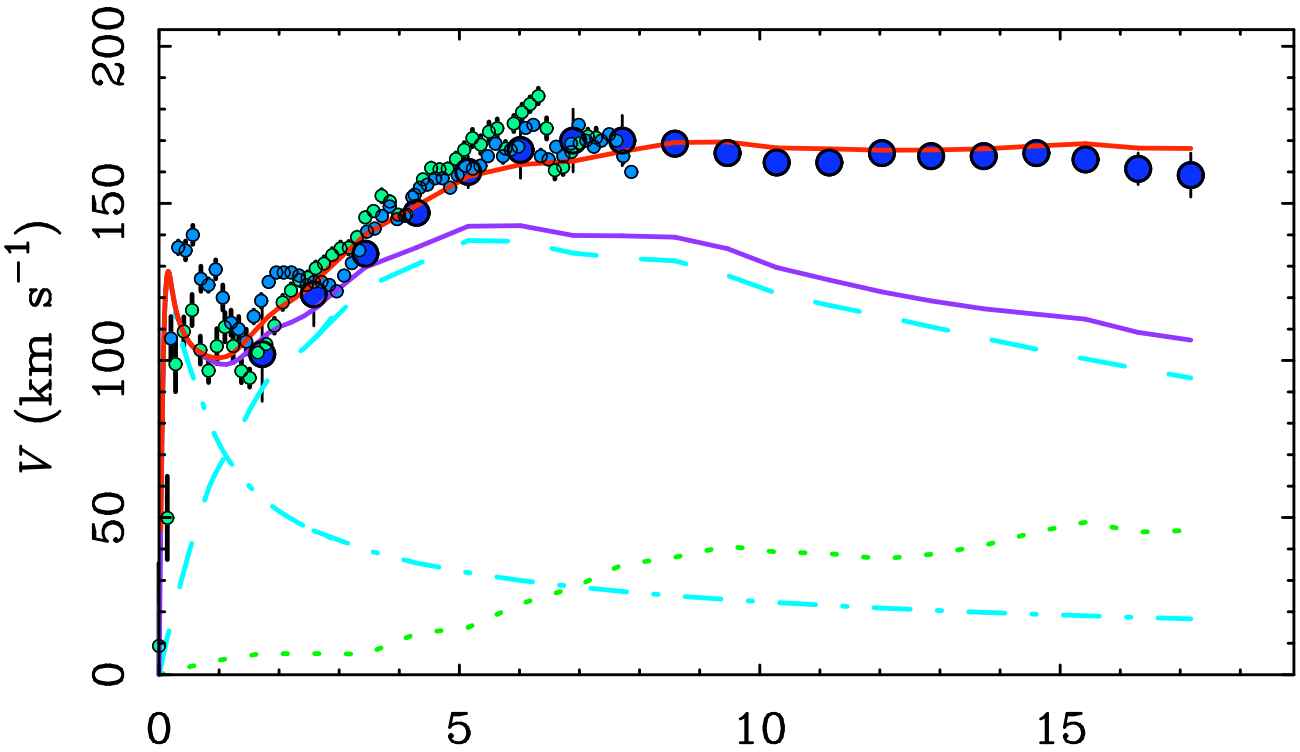
Light good predictor of inner RC - maximum disk




0
50
100
150
200
V (km s−1)
0
5
10
15
R (kpc)

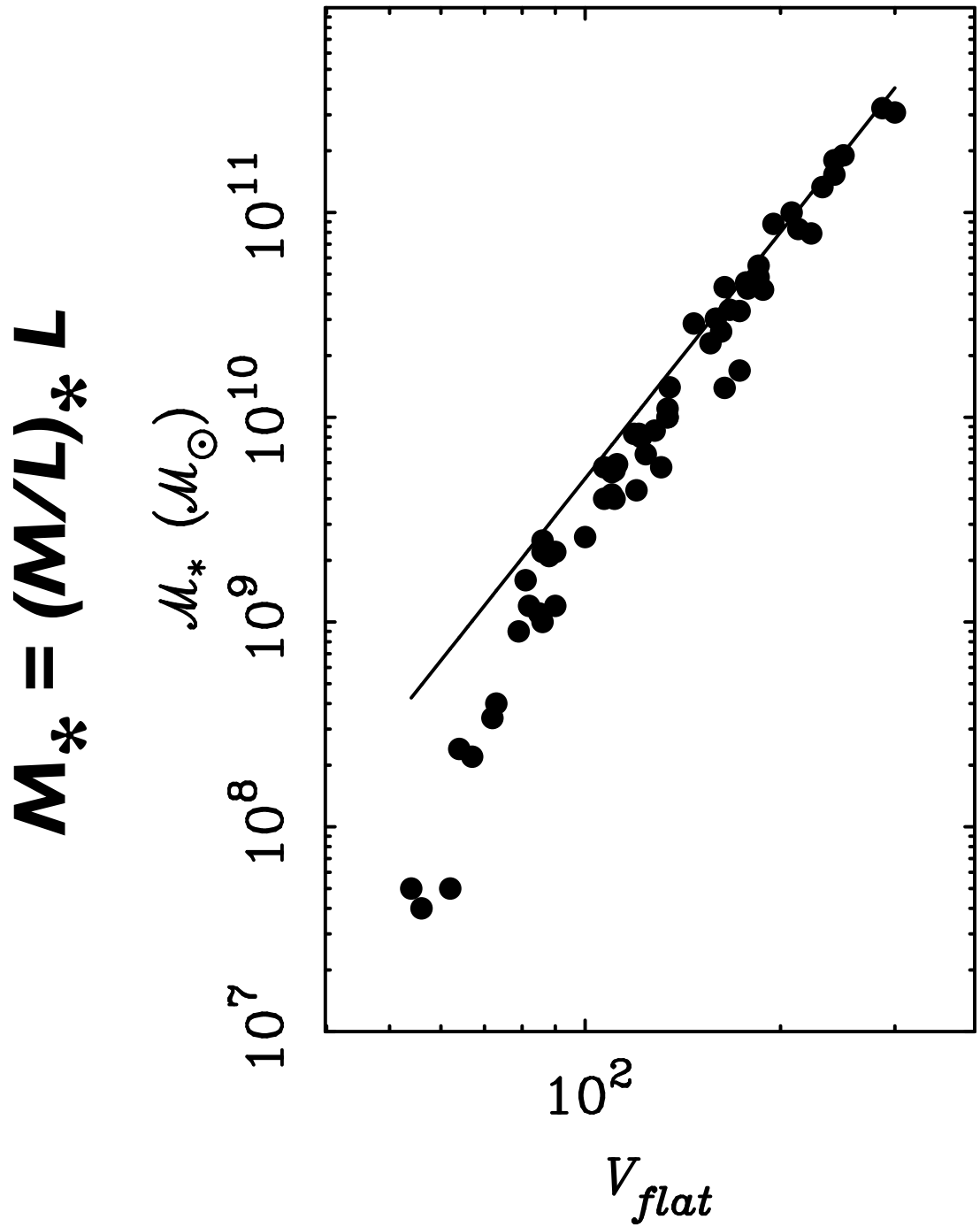
Also illustrates "disk-halo conspiracy"

- V(halo) ~ V(disk)
- no clear transition between disk and halo

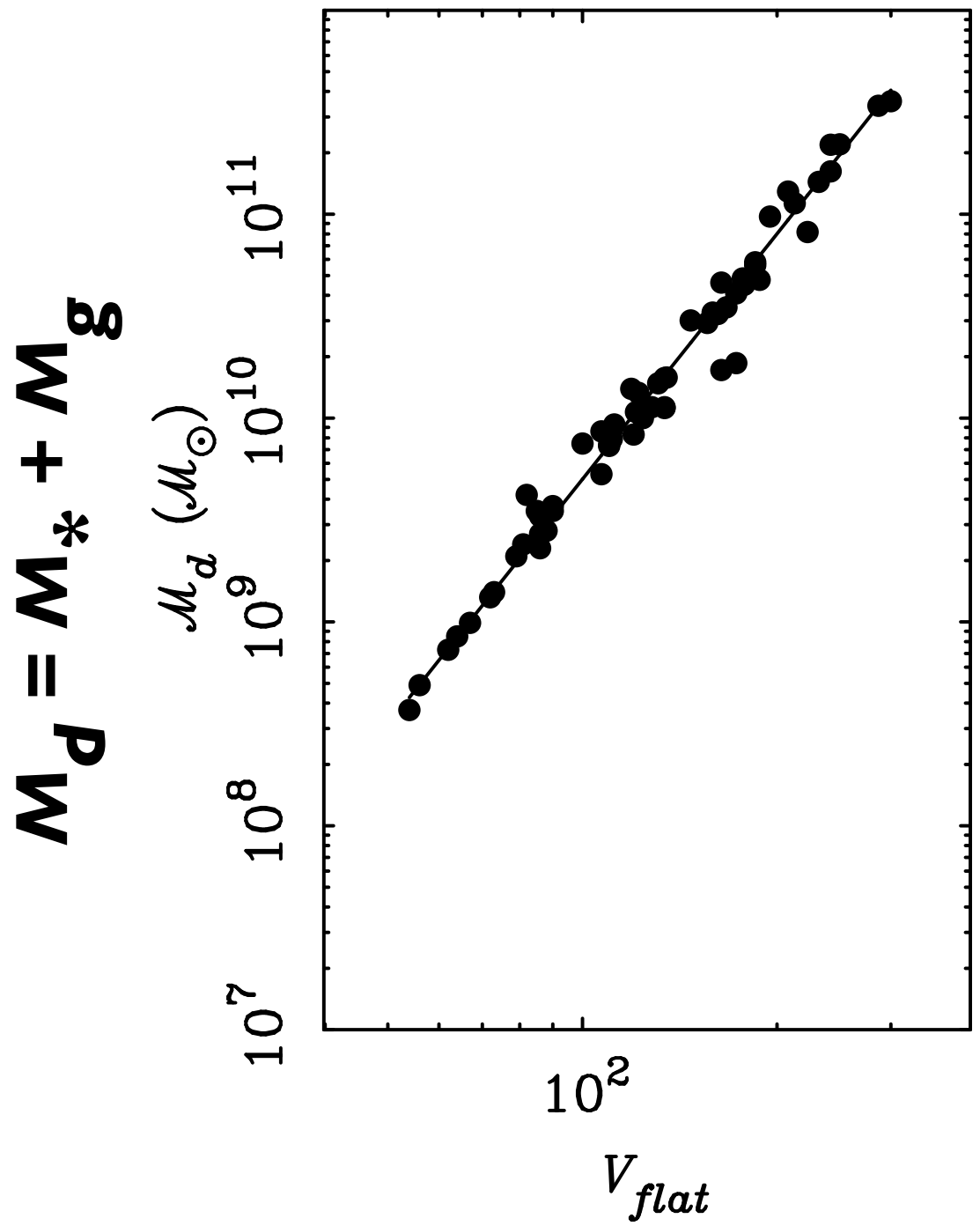


Tully-Fisher Relation

$M_* = (M/L)_* L$



Baryonic Tully-Fisher Relation



TF Relation

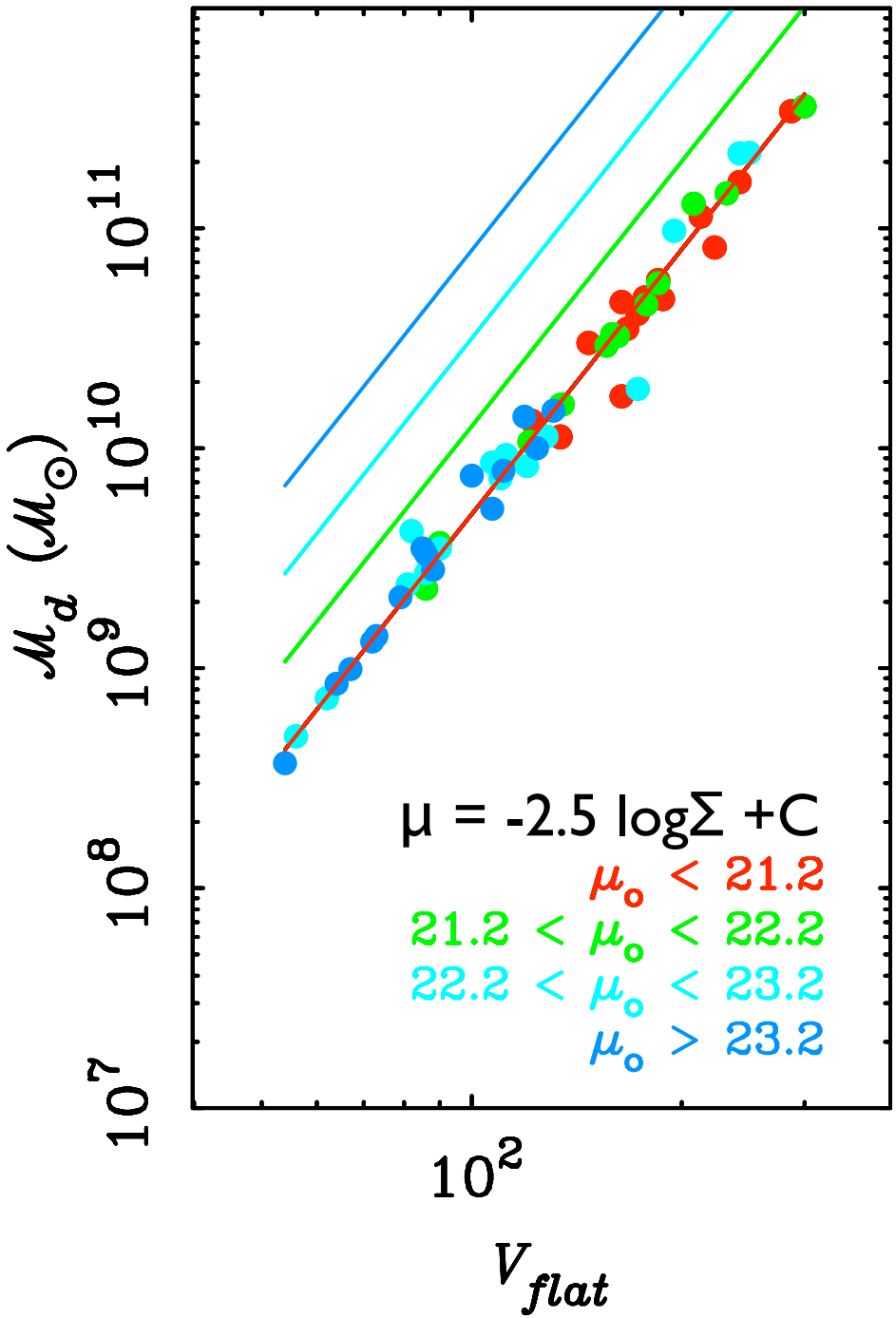
<u>Newton says</u>

$V^2 = GM/R.$

Equivalently,

$\Sigma = M/R^2$

$V^4 = G^2 M\Sigma$



<u>Therefore</u>

Different Σ *should* mean different TF normalization.

Rotation curve shape depends on light

The shapes of rotation curves vary systematically with luminosity.
Luminous galaxies have steeply rising V(r) which then decline
while dim galaxies have slowly rising V(r).
The scale depends on the size of the luminous disk R_{opt}.

"Universal" Rotation curve (Persic & Salucci):

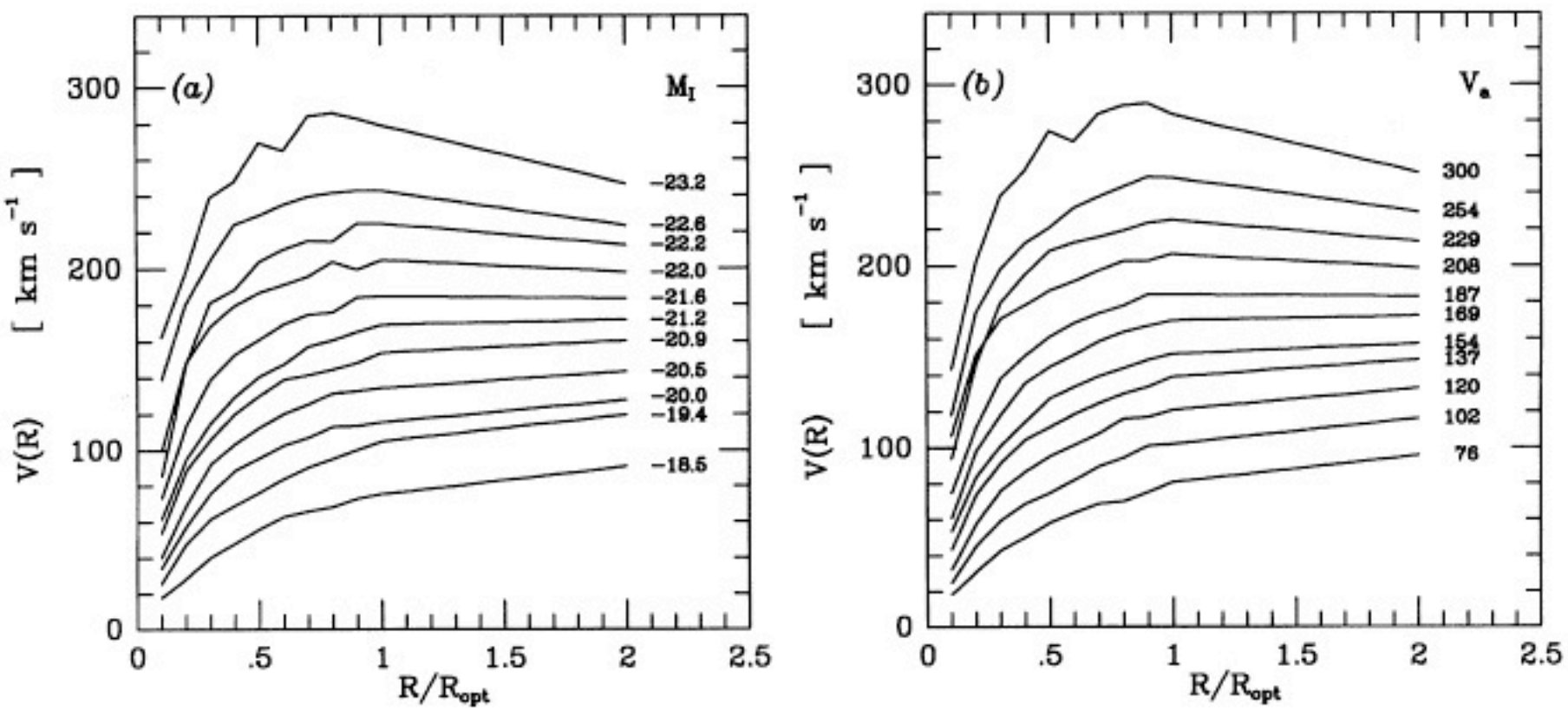
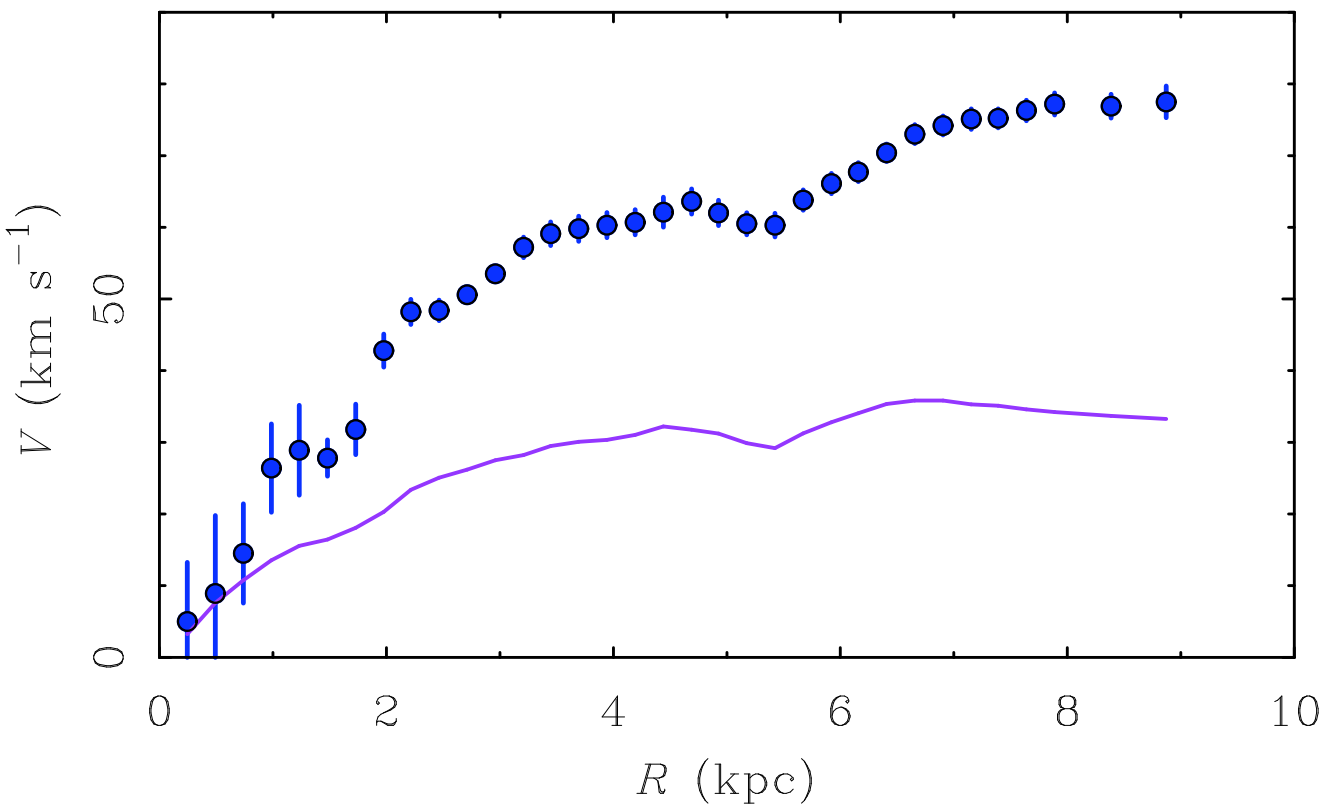


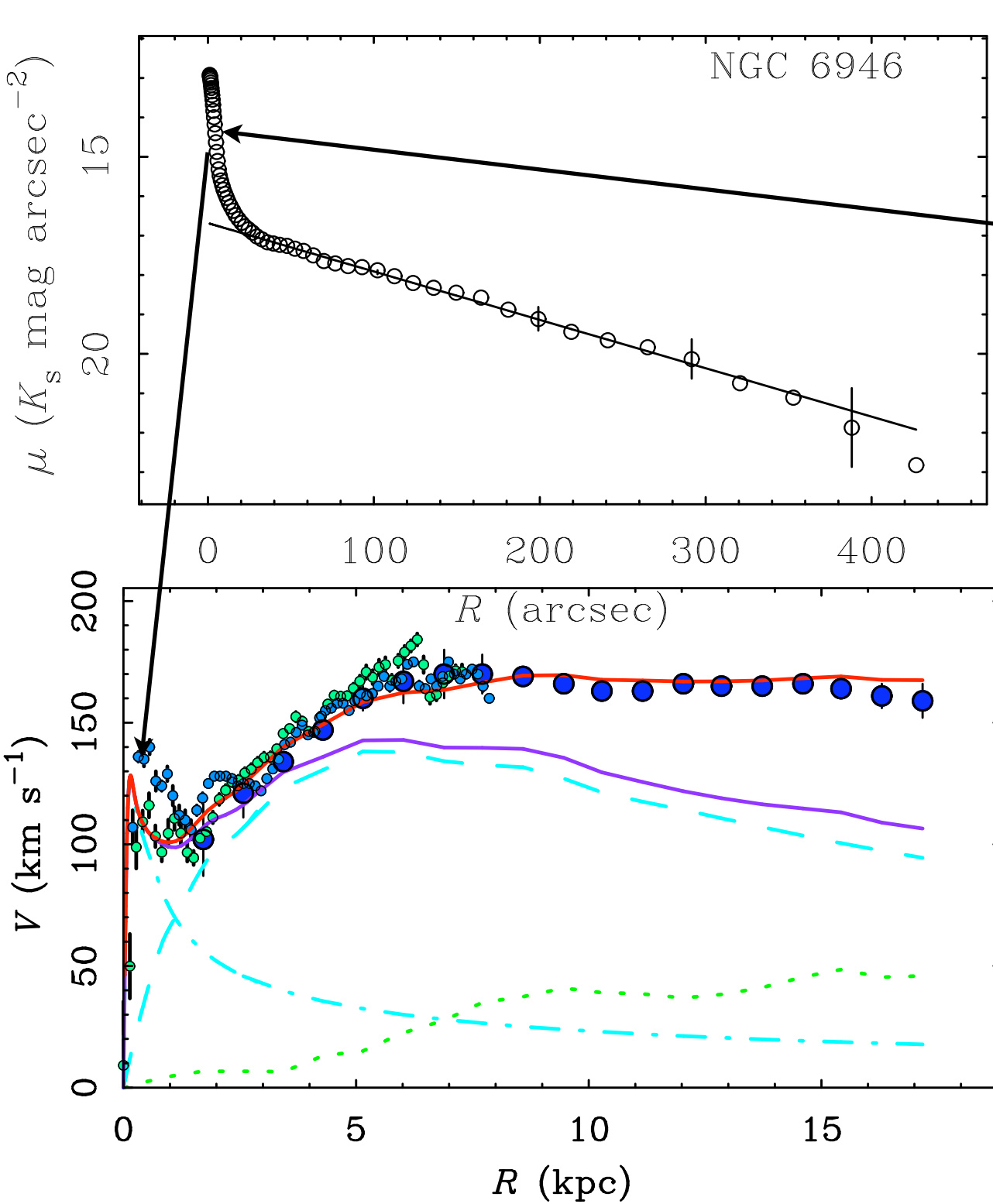
Figure 4. The universal rotation curve of spiral galaxies. Radii are in units of R_{opt}.

Rotation curve shape depends on light

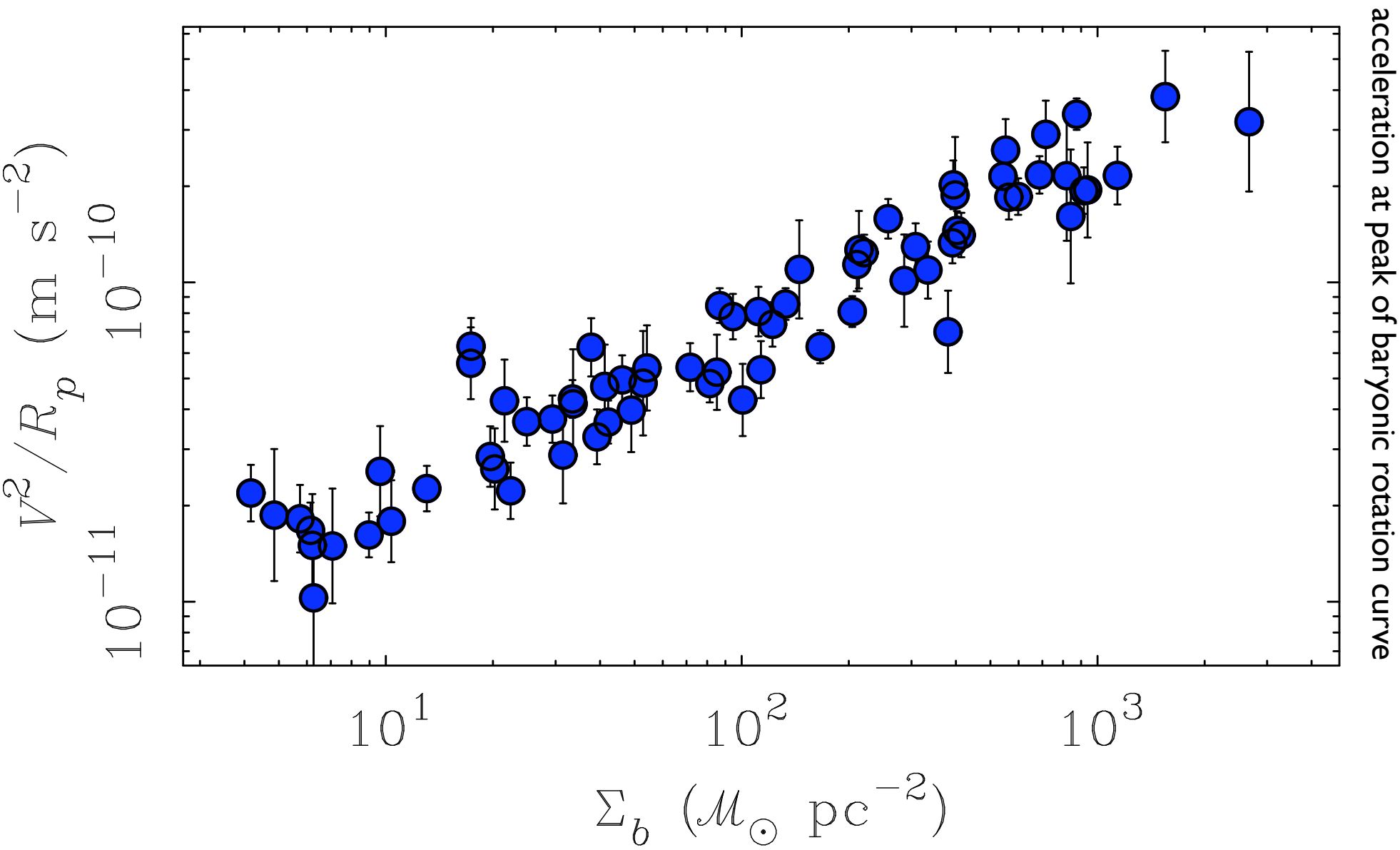
Renzo's rule: "When you see a feature in the light, you see a corresponding feature in the rotation curve"
(Sancisi 2004)

NGC 1560

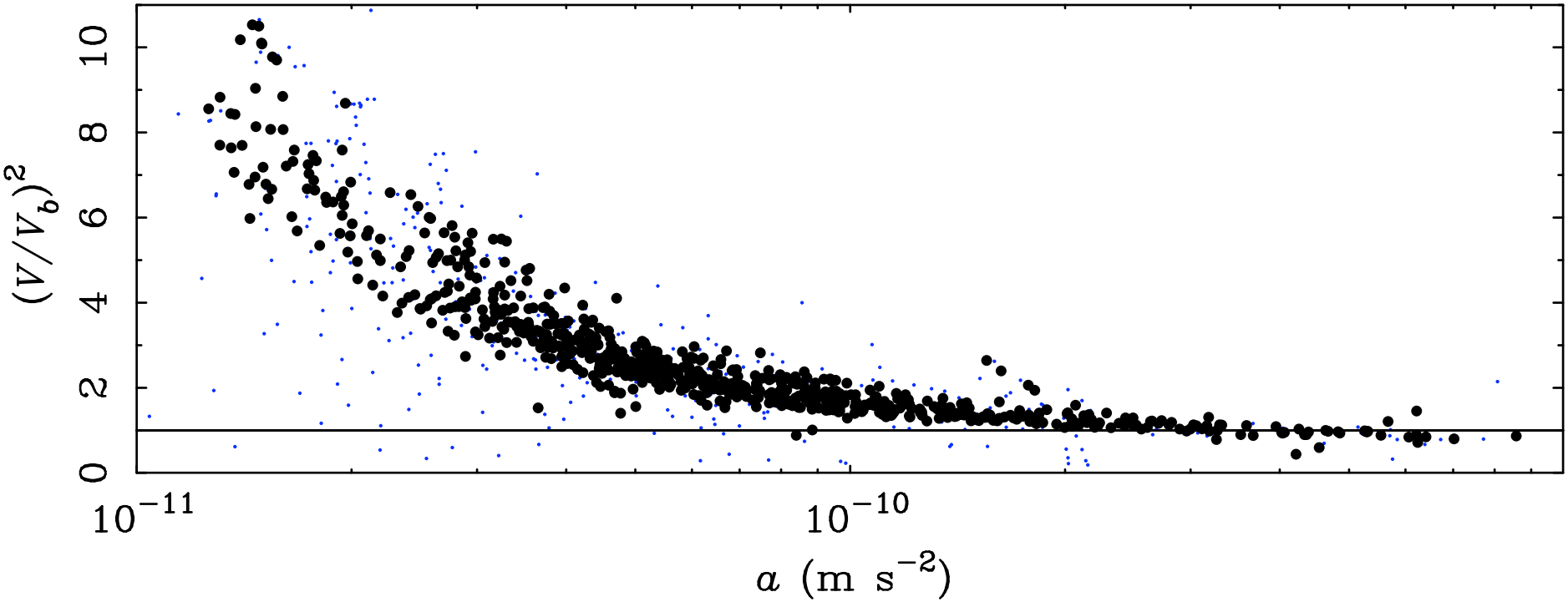



NGC 6946
μ (K_s mag arcsec^{-2})
15
20
0
100
200
300
400
R (arcsec)
V (km s^{-1})
0
50
100
150
200
0
5
10
15
R (kpc)

Acceleration related to baryonic surface density



Mass Discrepancy-Acceleration Relation



Spiral galaxies generally obey a mass discrepancy-acceleration relation (McGaugh 2004). The mass discrepancy "knows" about baryonic matter, appearing only at a critical scale in acceleration or surface density of

$$a_\dagger \sim 1 \text{ Å s}^{-2} \sim 3000 \text{ km}^2 \text{ s}^{-2} \text{ kpc}^{-1} \qquad \Sigma_\dagger \sim 10^3 \text{M}_\odot \text{ pc}^{-2}$$