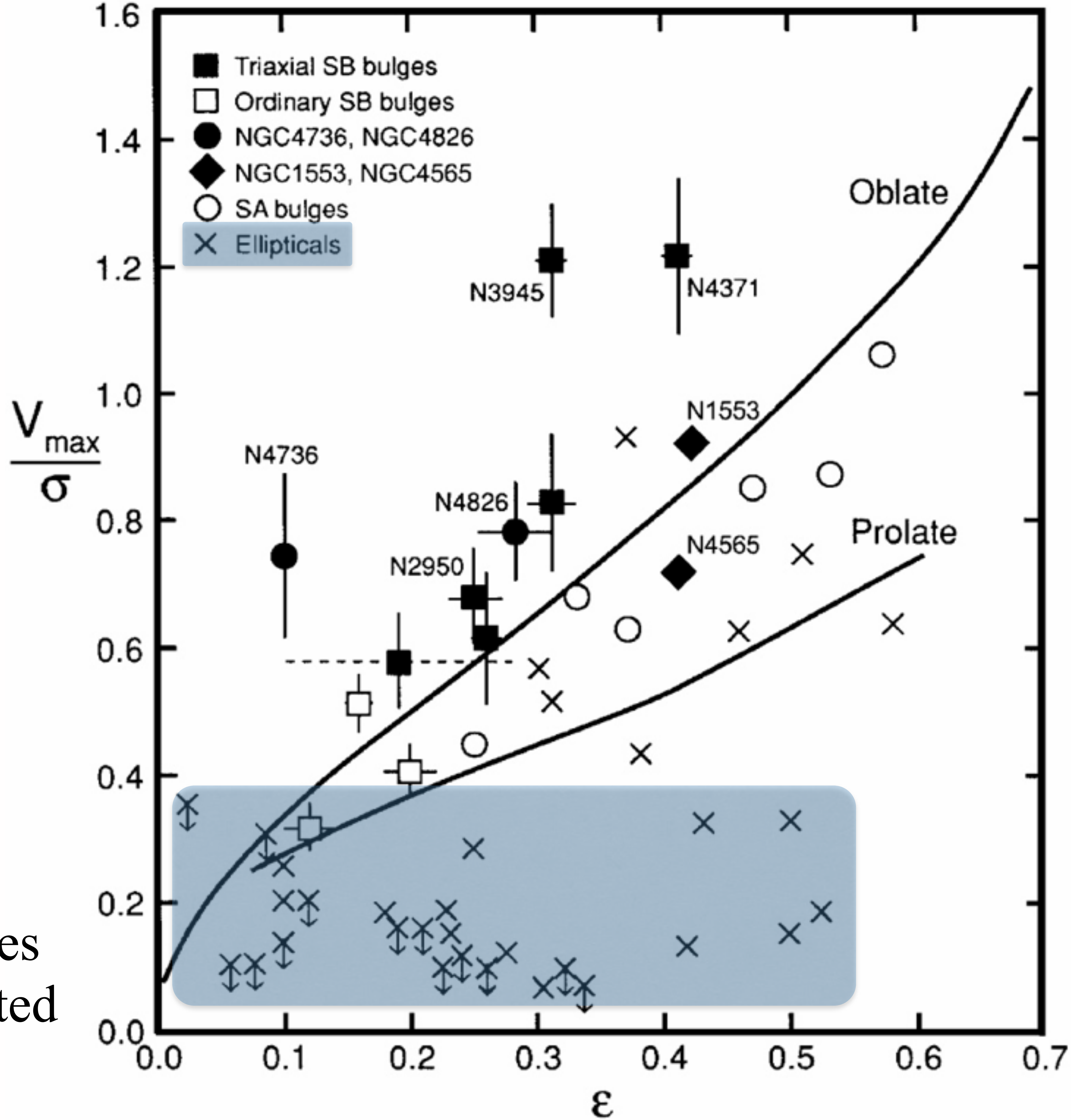
Galaxy Formation

adiabatic compression
feedback

Scaling relations

Spiral galaxies way off scale

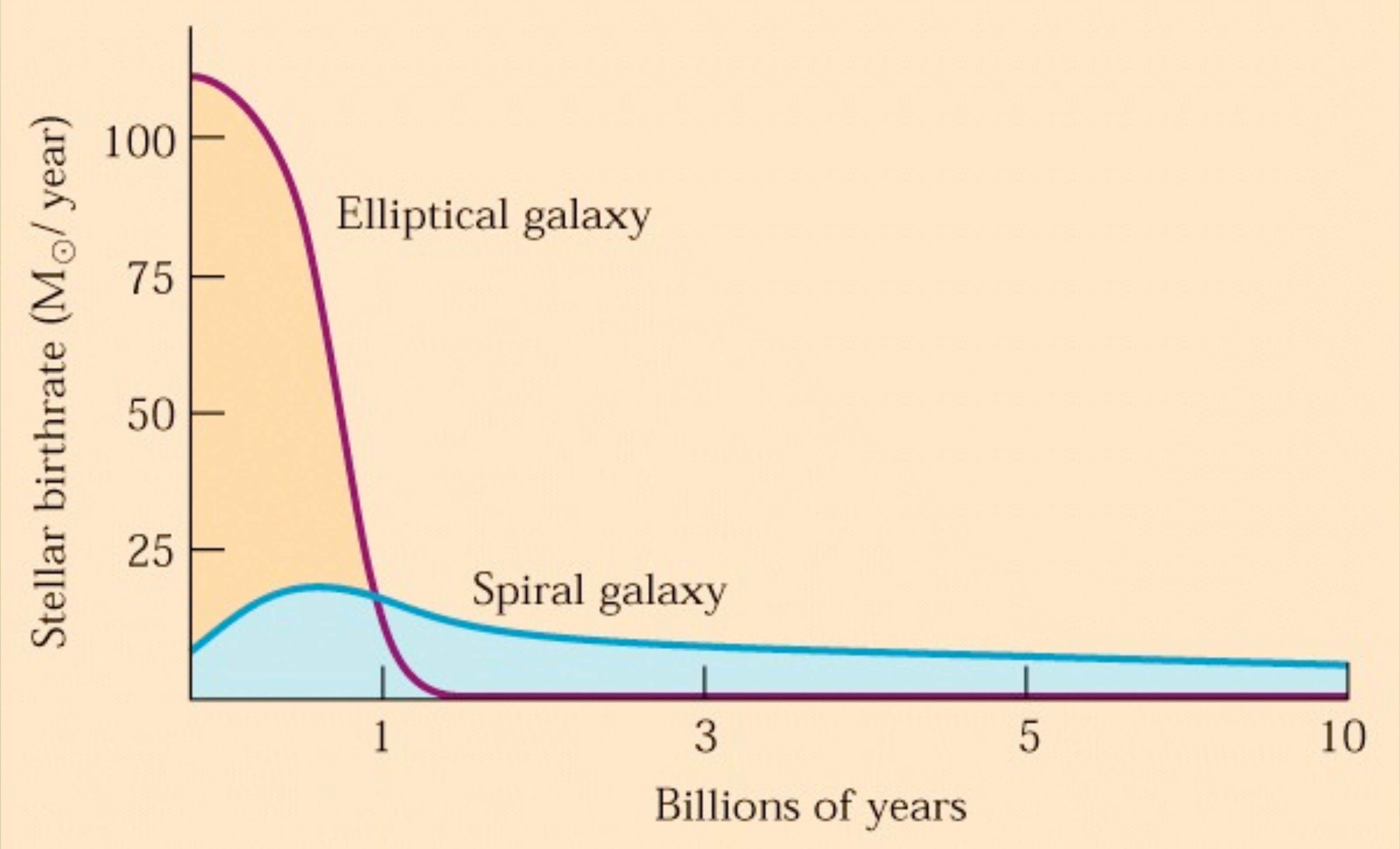


Elliptical galaxies pressure supported

Generic Star Formation History

Elliptical

old stars



Spiral

old stars
young stars
cold gas

Adiabatic Compression

In a spherical potential, the squared angular momentum of a circular orbit is $L^2 = rGM(r)$, and if this quantity is conserved as a disk with the mass profile Md(r) grows slowly, we have

$$r_i M_i(r_i) = r_f \left[M_d(r_f) + (1 - f_d) M_f(r_f) \right], \qquad (1)$$

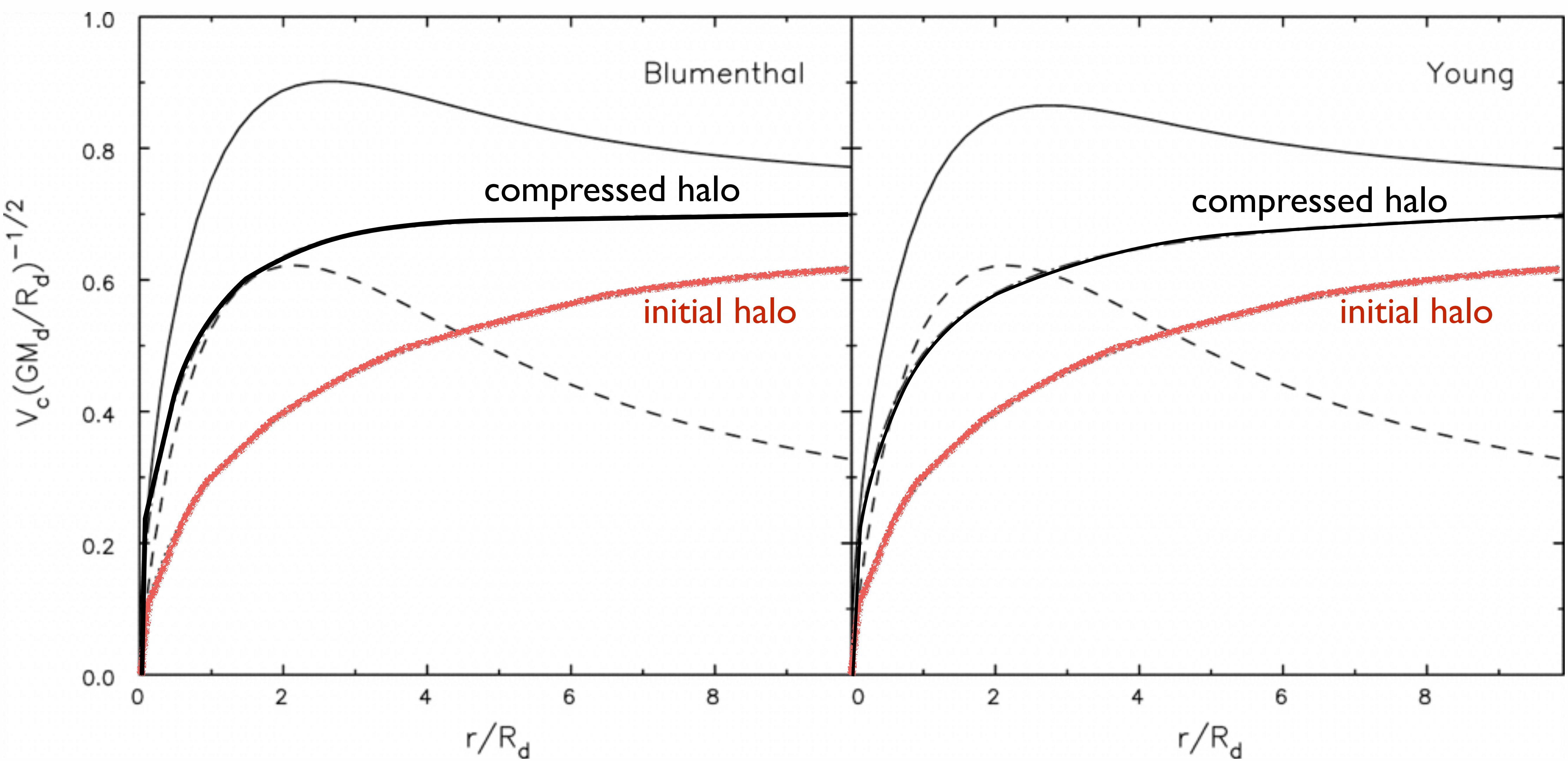
where Mi is the initial total mass (dark plus baryonic) profile, (1 - fd)Mf is the desired final dark matter mass profile, and rf is the final radius of the mass shell initially at radius ri. The quantity fd is the fraction of the initial total mass, assumed to be independent of radius, that condenses to form the disk. We can substitute for Mf(rf) by making use of the assumption

$$M_i(r_i) = M_f(r_f), \qquad (2)$$

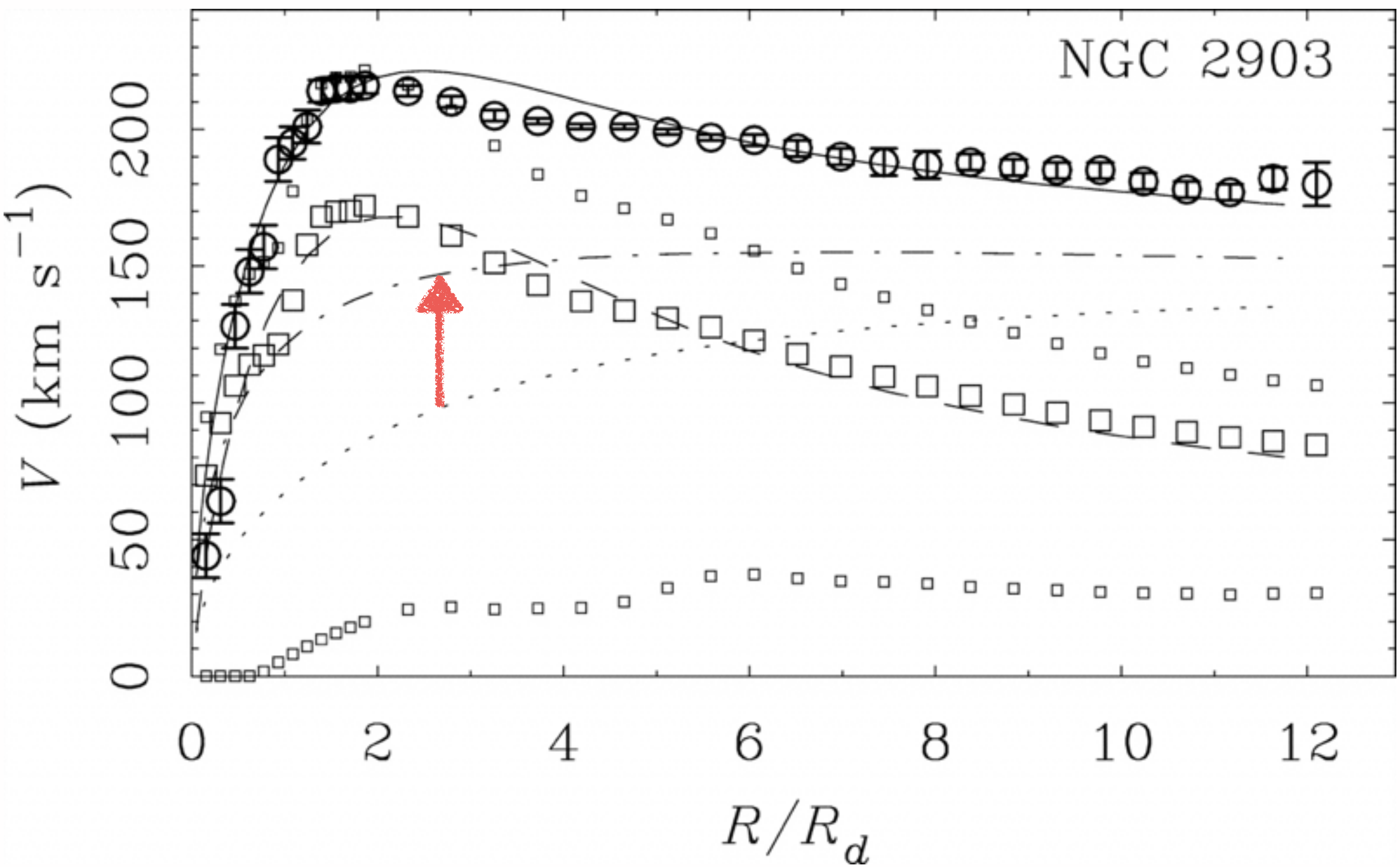
which is sometimes stated as "shells of matter do not cross." We can then find ri for any desired rf, and through equation (2), we can obtain the mass profile of the compressed dark matter halo. For convenience, we denote this the Blumenthal algorithm.

The Blumenthal algorithm only conserves angular momentum. Young's algorithm conserves the adiabats of the orbit, but is harder to implement (Sellwood & McGaugh 2005).

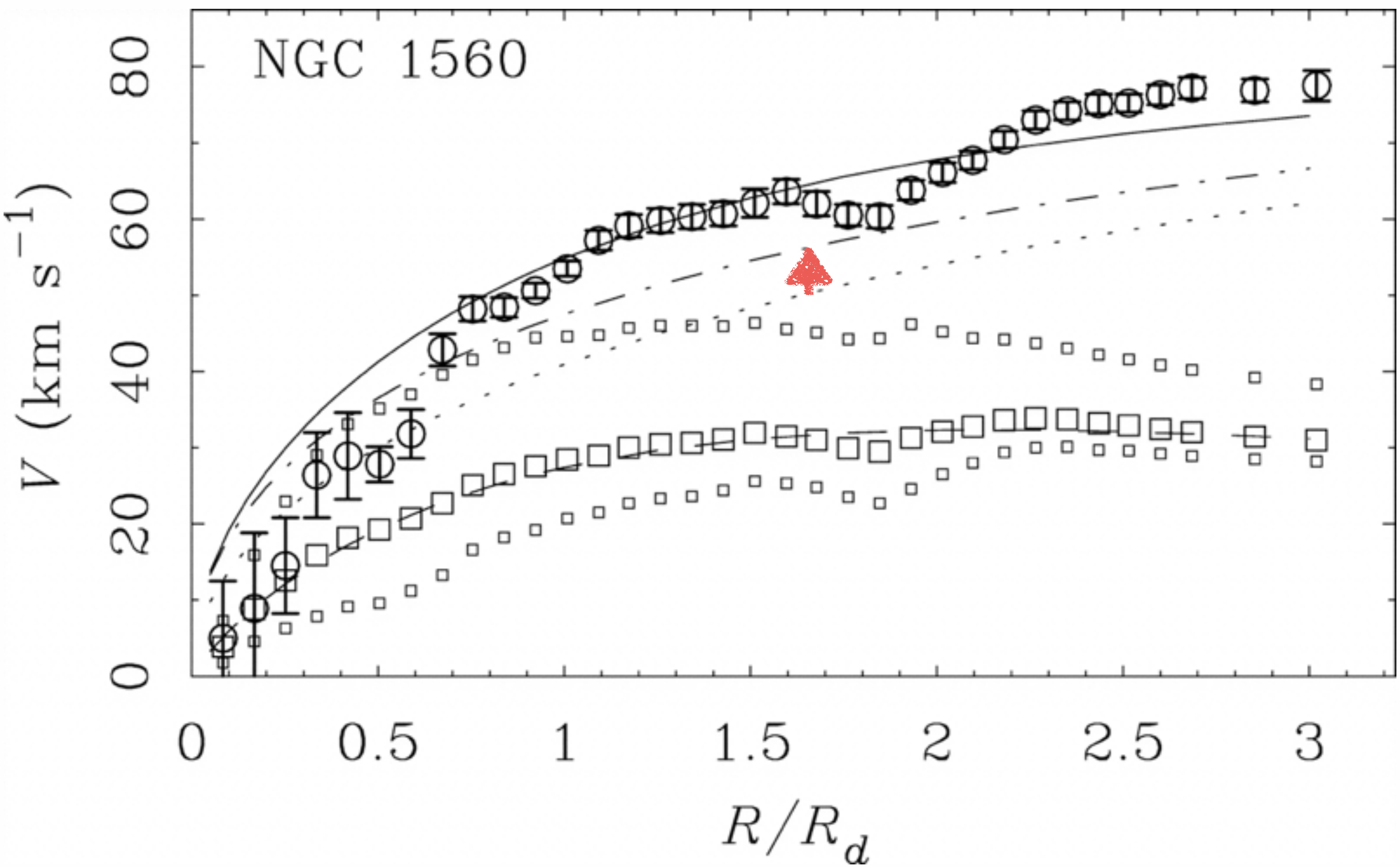
Adiabatic compression



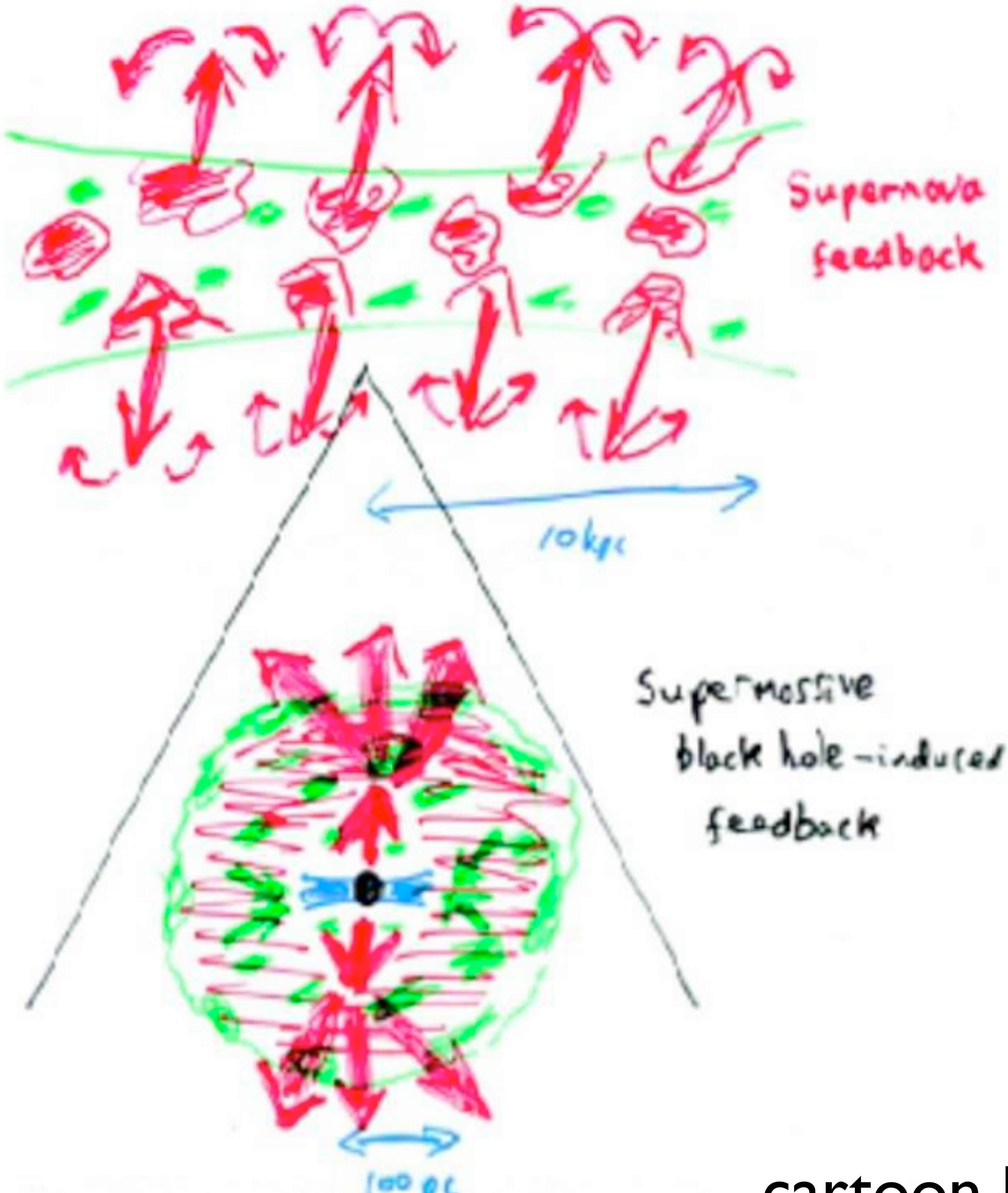
The Blumenthal algorithm over-compresses. Young's algorithm allows for more nearly maximal disks.



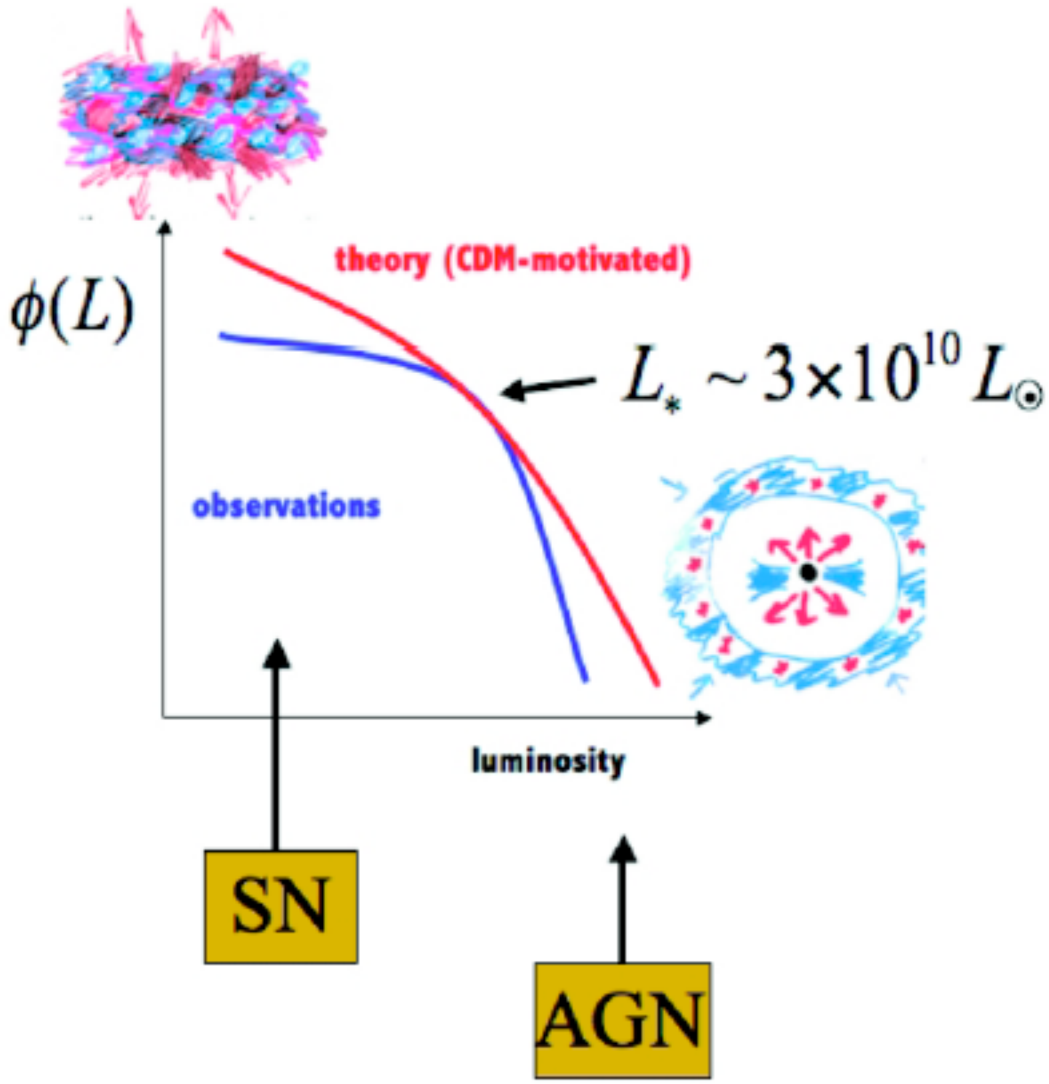
High surface density disks cause noticeable compression; tend to steepen halo profile



Low surface density disks cause only minor compression; don't affect profile much



cartoon by Joe Silk

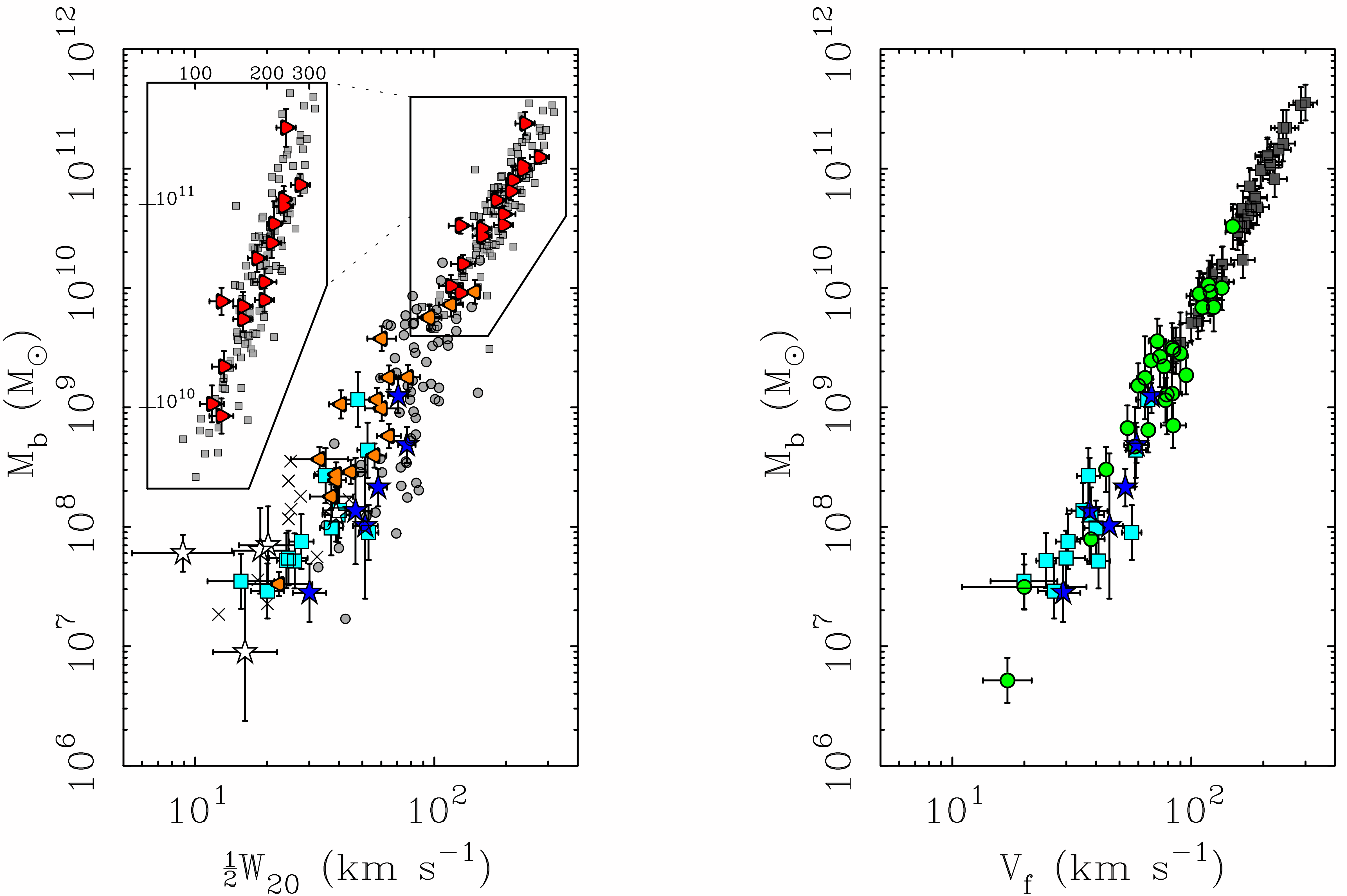


Basic idea: SN affect low mass halos
AGN affects high mass halos

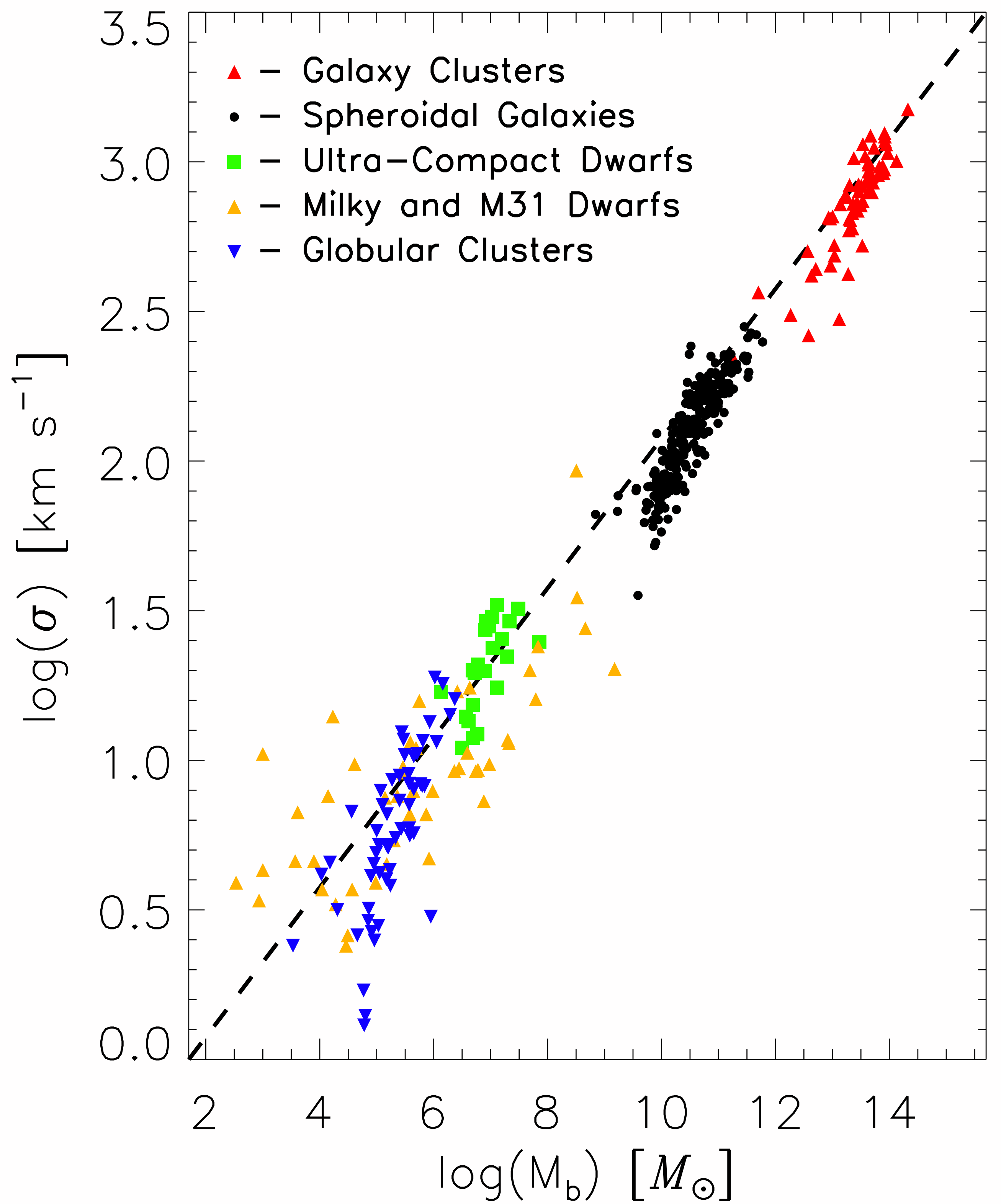
Scaling Relations

Tully-Fisher
Faber-Jackson
size-mass
Luminosity Fcn

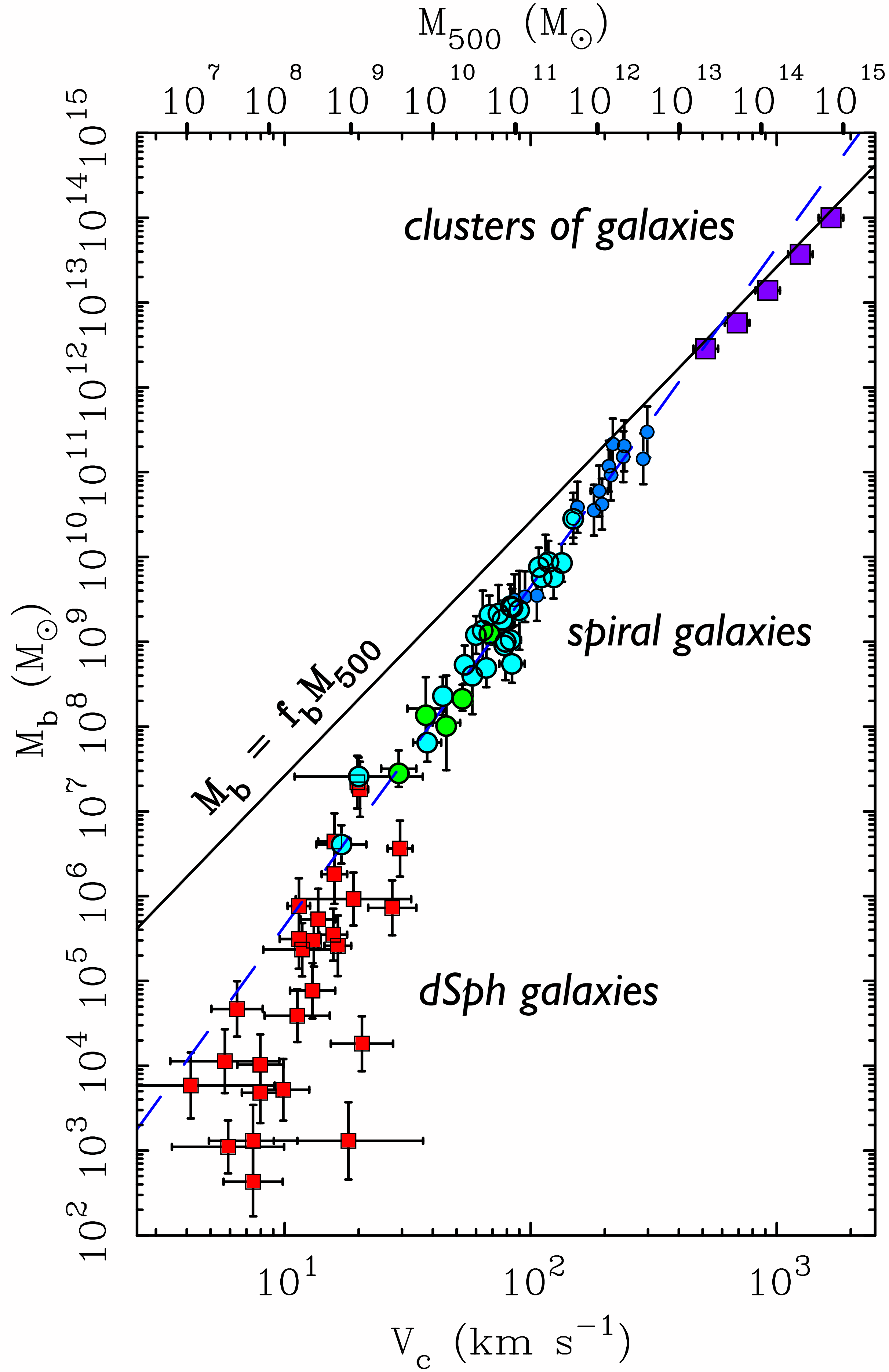
Tully-Fisher (rotationally supported)



Faber-Jackson (pressure supported)



Extended TF



M500 (M☉)
Mb (M☉)
Vc (km s−1)
clusters of galaxies
spiral galaxies
dSph galaxies
Mb = fb M500