

DARK MATTER

ASTR 333/433

FALL 2013

M T 4:00-5:15PM

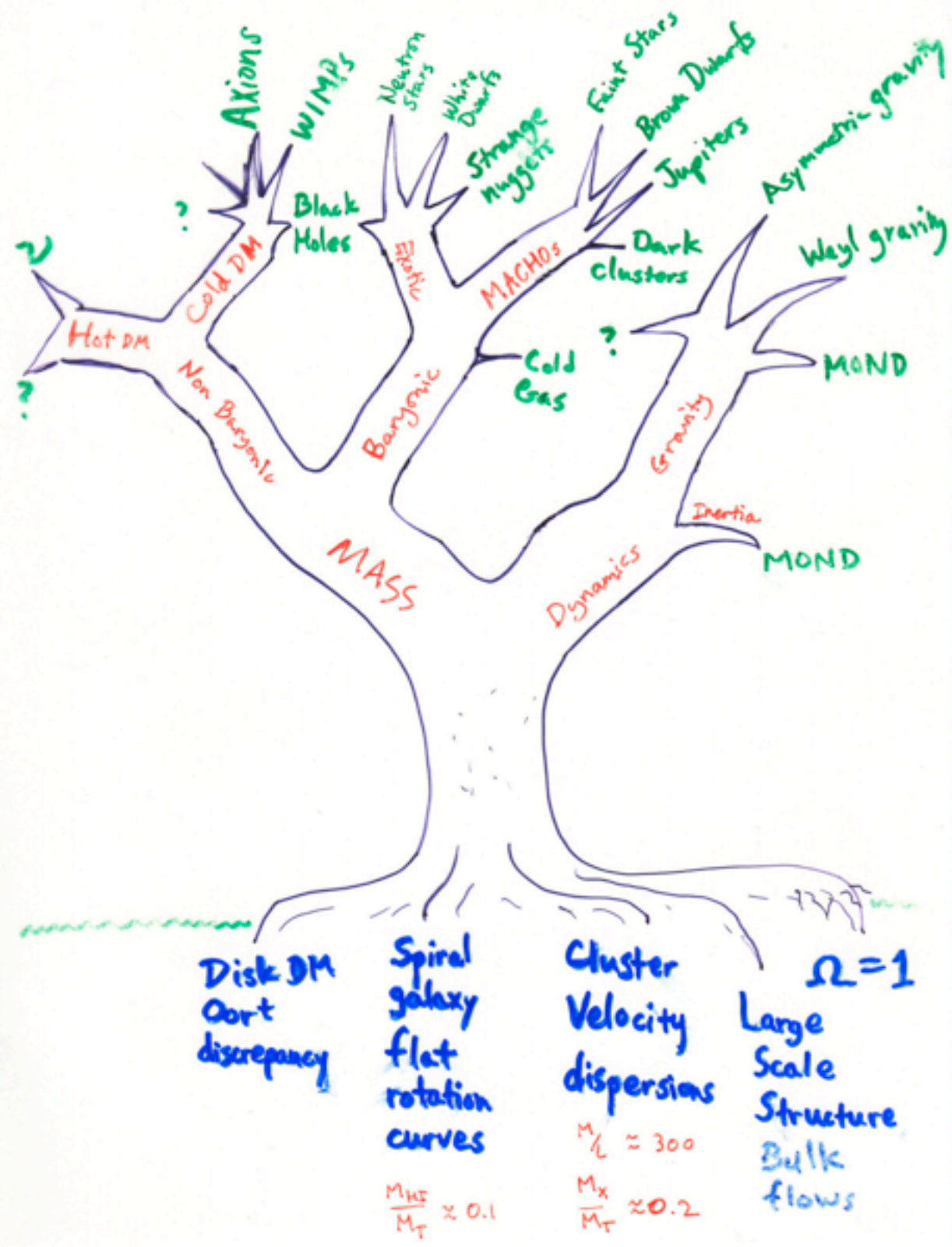
SEARS 552

PROF. STACY MCGAUGH

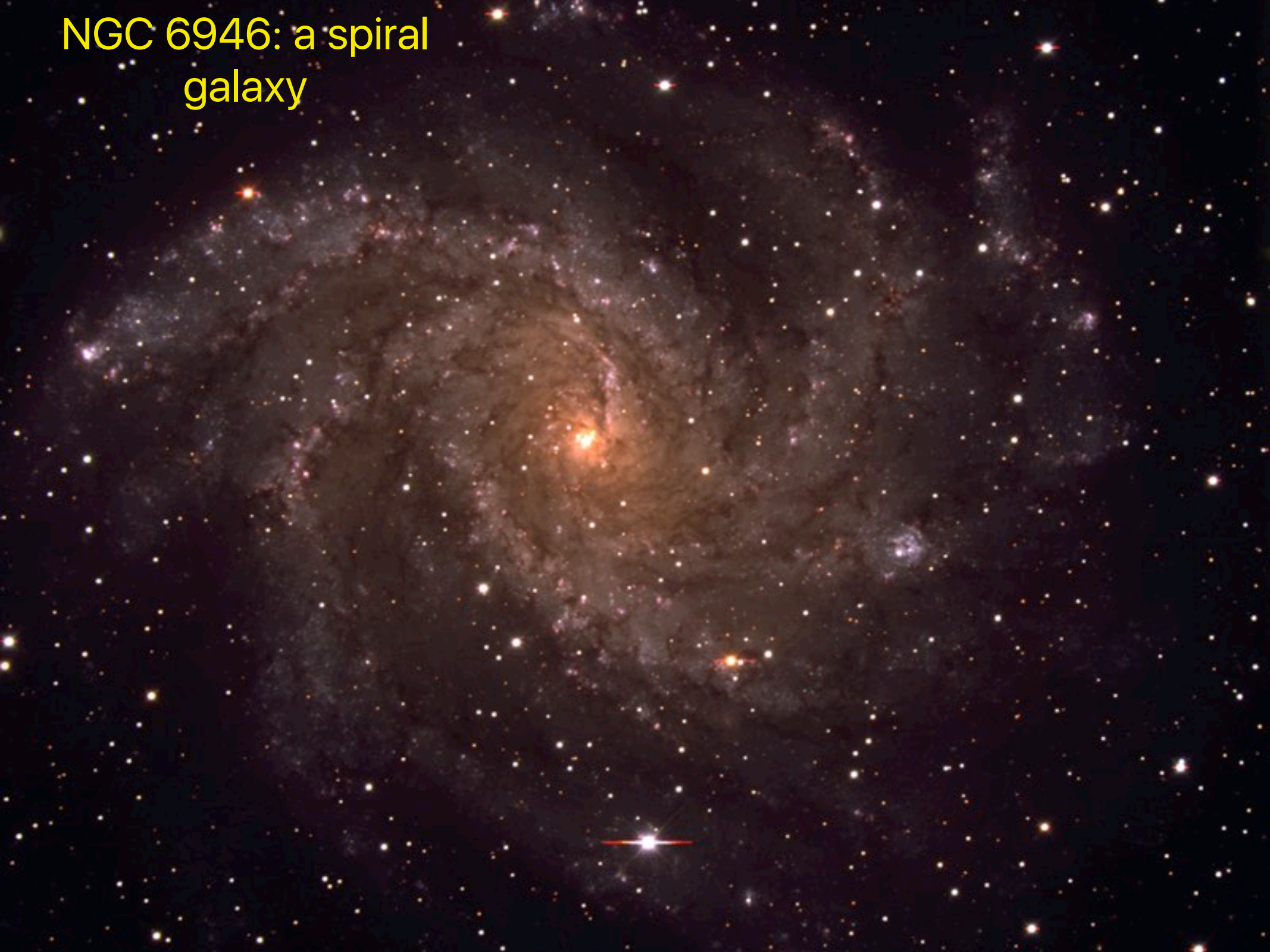
SEARS 573

368-1808

stacy.mcgaugh@case.edu



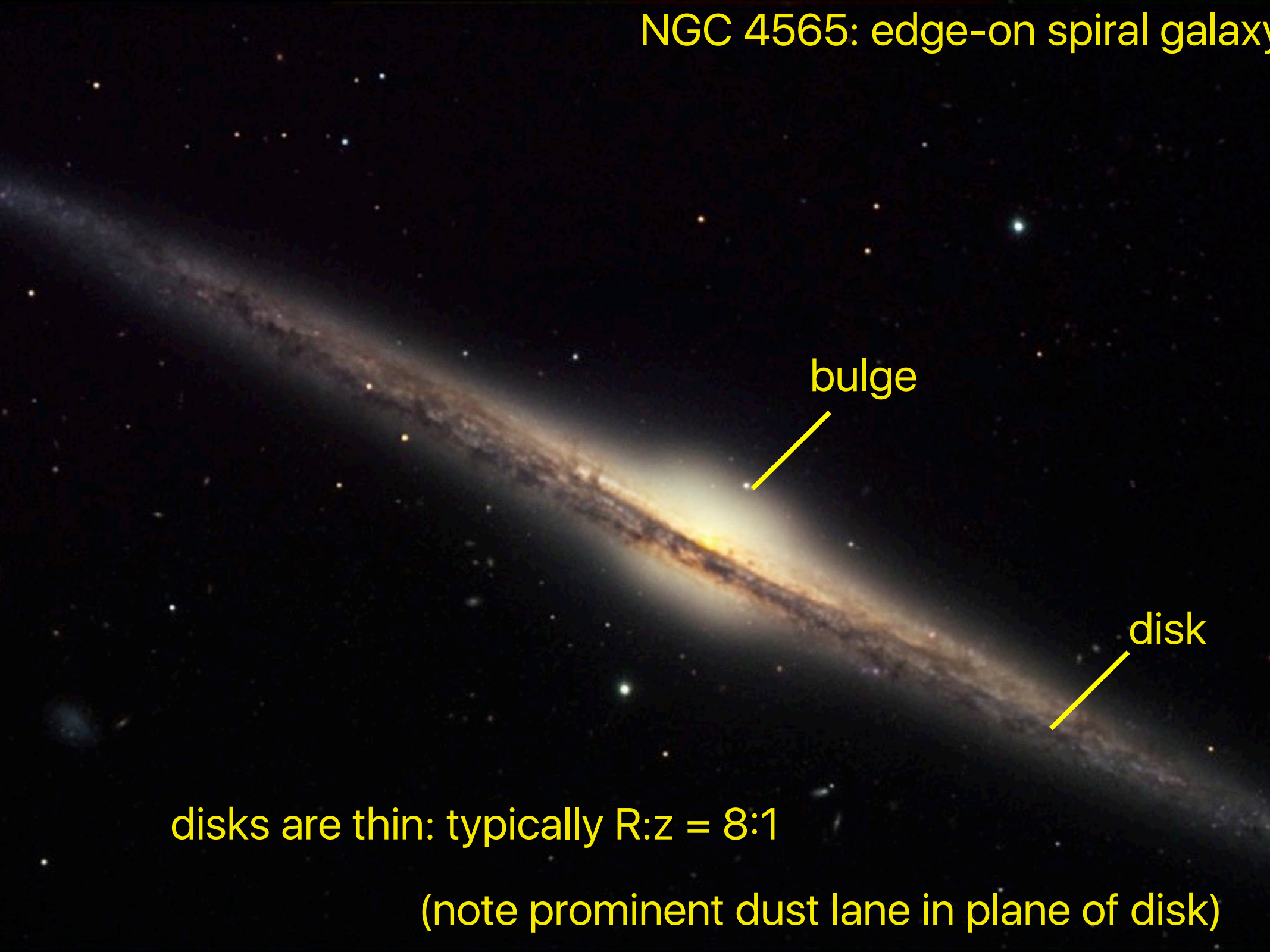
NGC 6946: a spiral
galaxy



NGC 1300: a barred spiral galaxy



NGC 4565: edge-on spiral galaxy



bulge

disk

disks are thin: typically $R:z = 8:1$

(note prominent dust lane in plane of disk)

M87: a giant Elliptical galaxy



M87 © Anglo-Australian Observatory
Photo by David Malin

Galaxy Classification

The Hubble Tuning-fork sequence

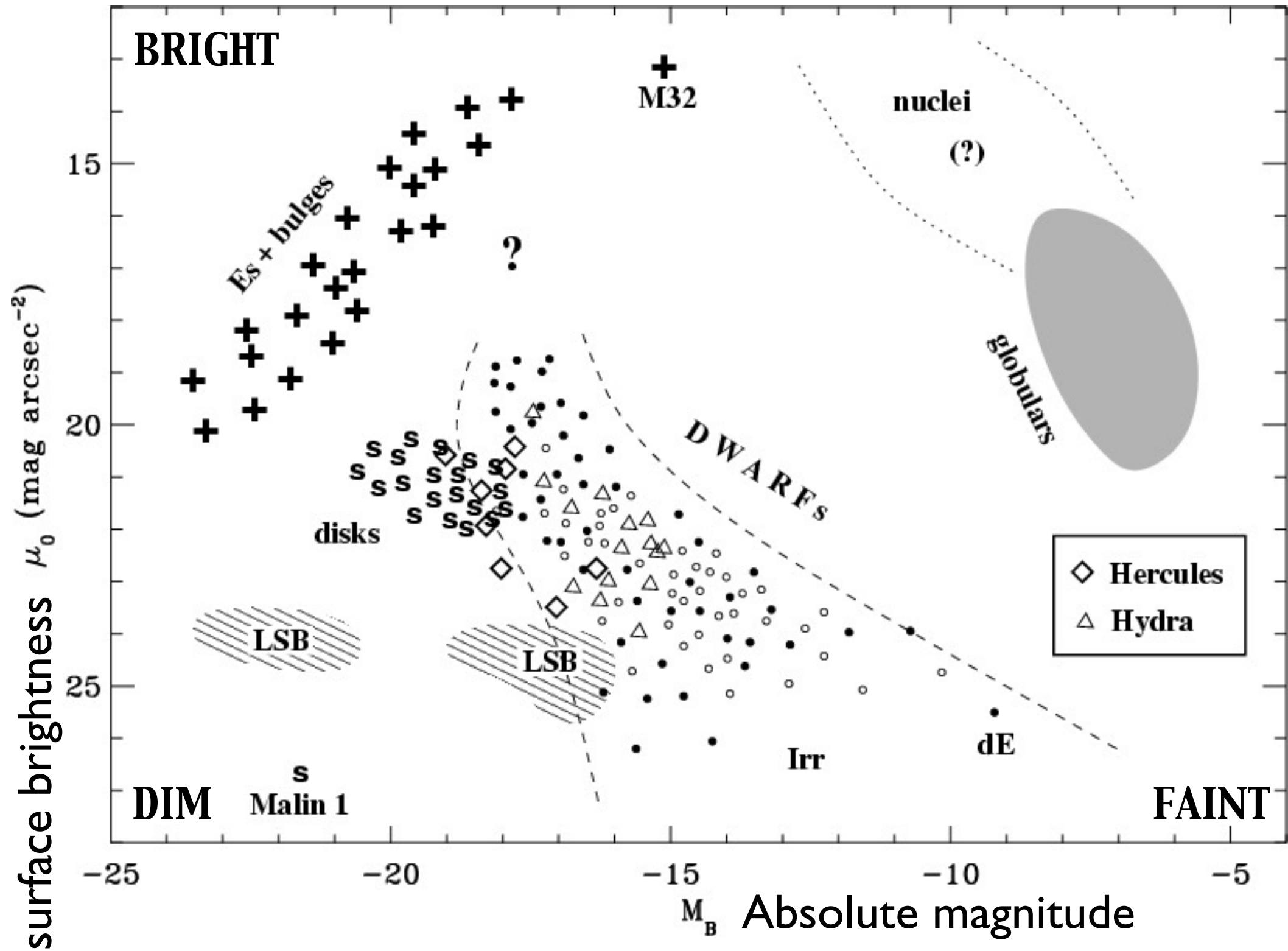
increasing bulge ←

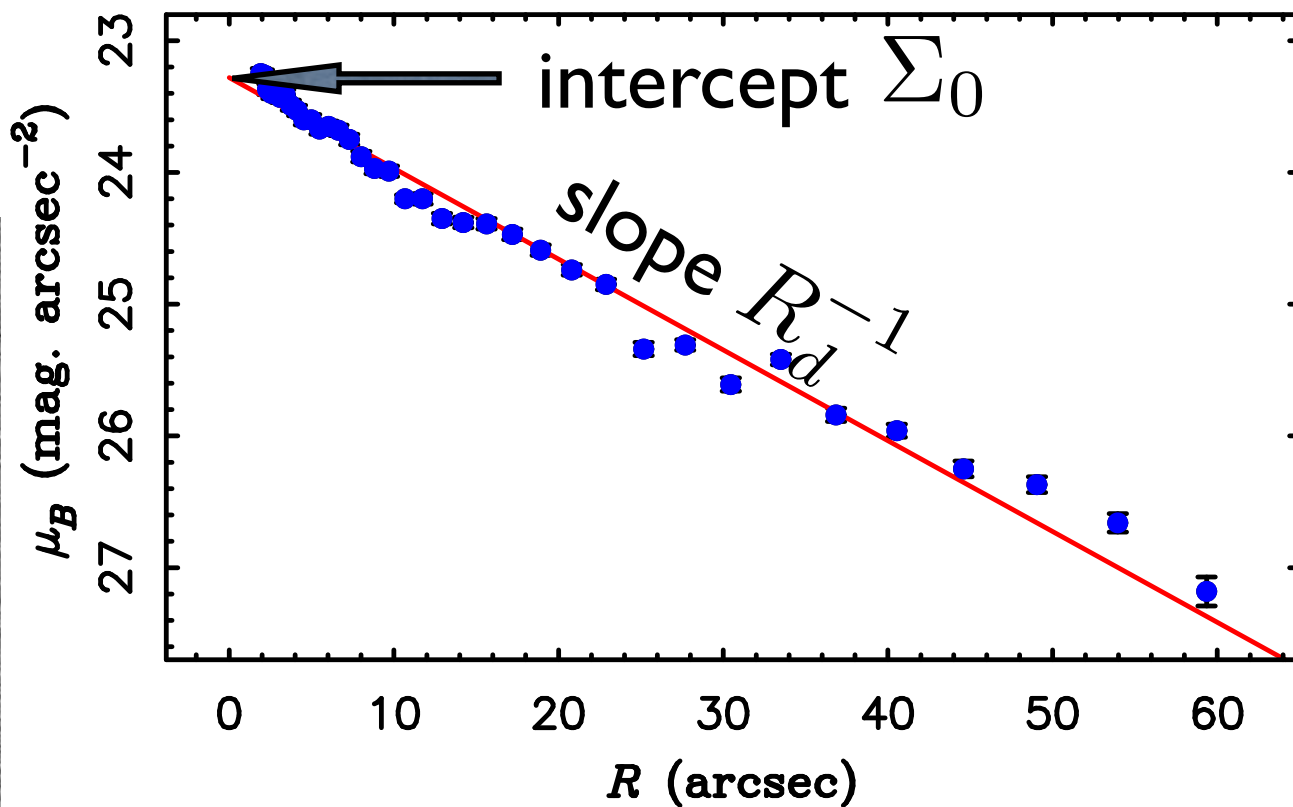
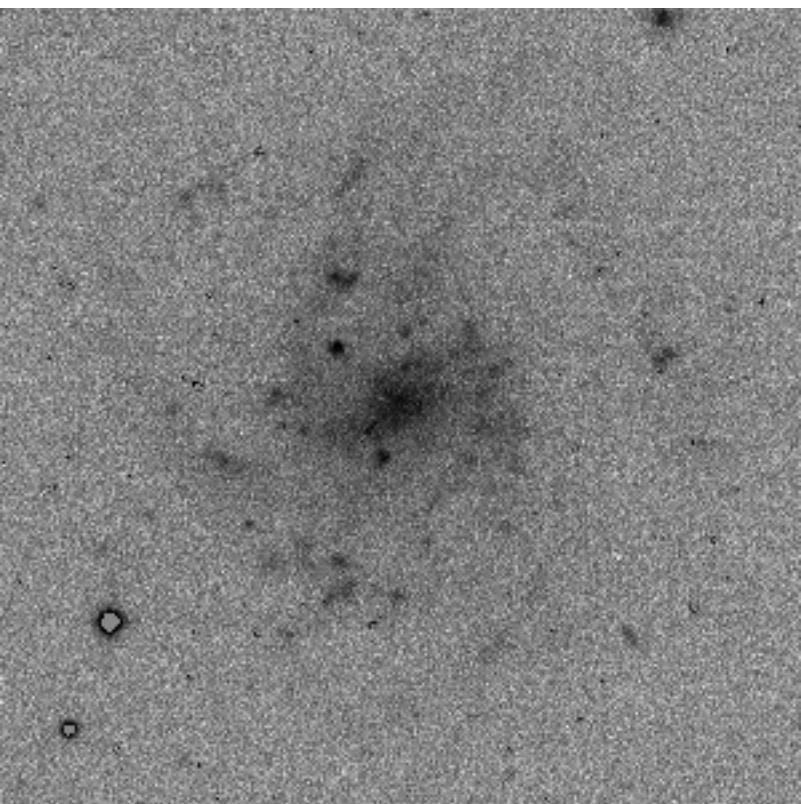
→ increasing disk



Ellipticals
(and bulges)
3D ellipsoids
pressure support
 V/σ small

Spirals
2D disks
rotational support
 V/σ large

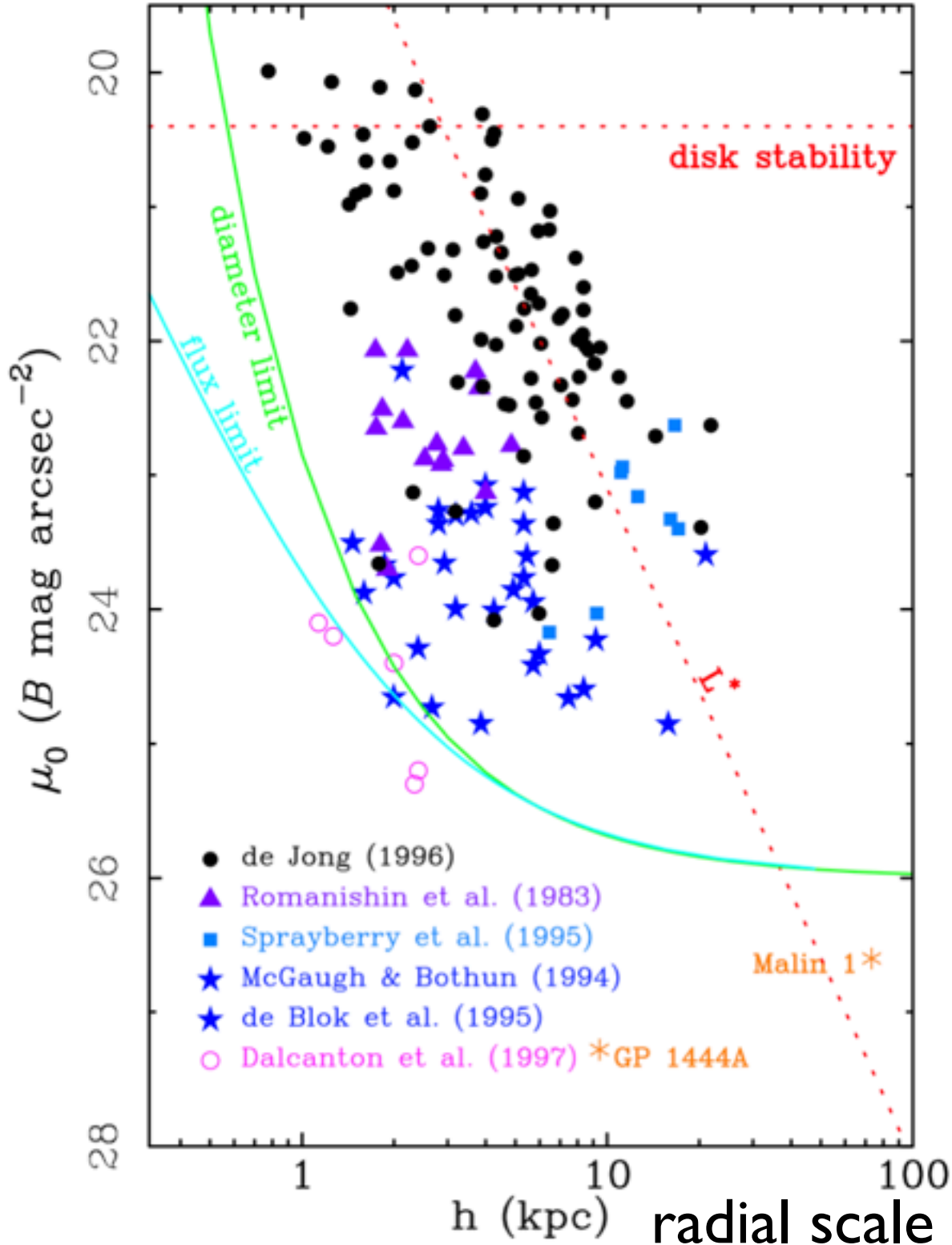




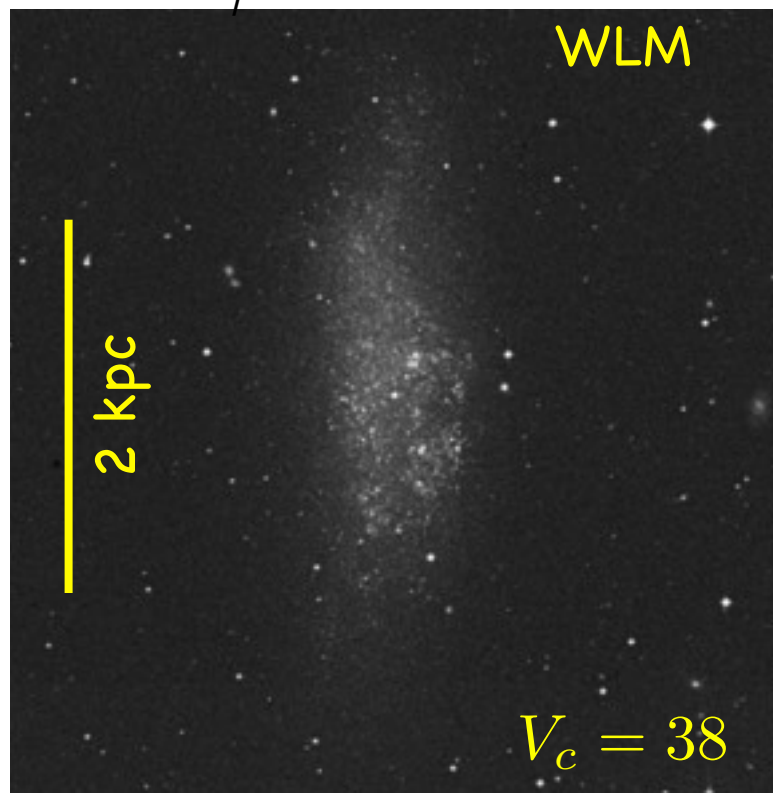
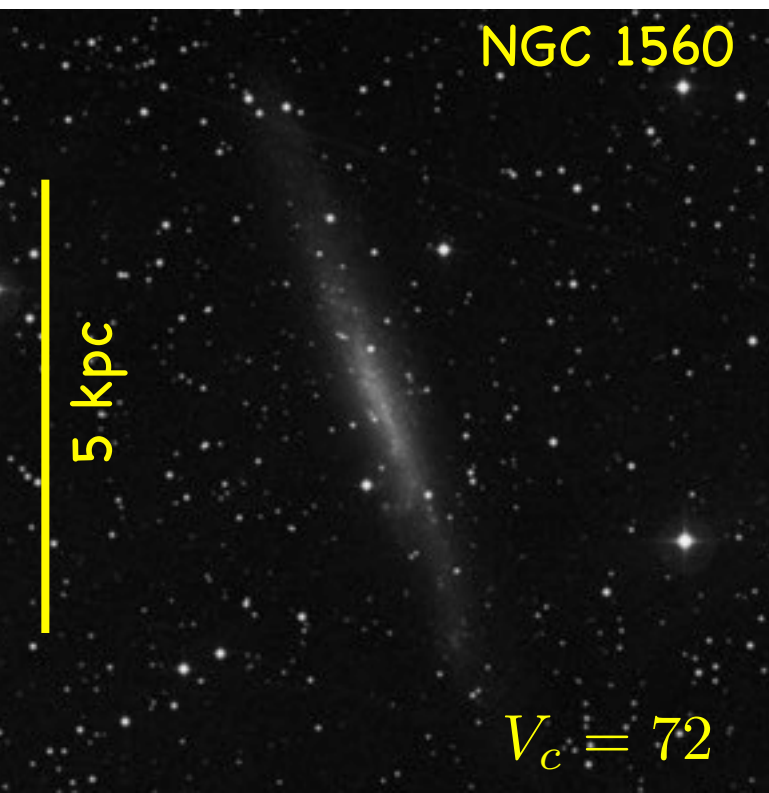
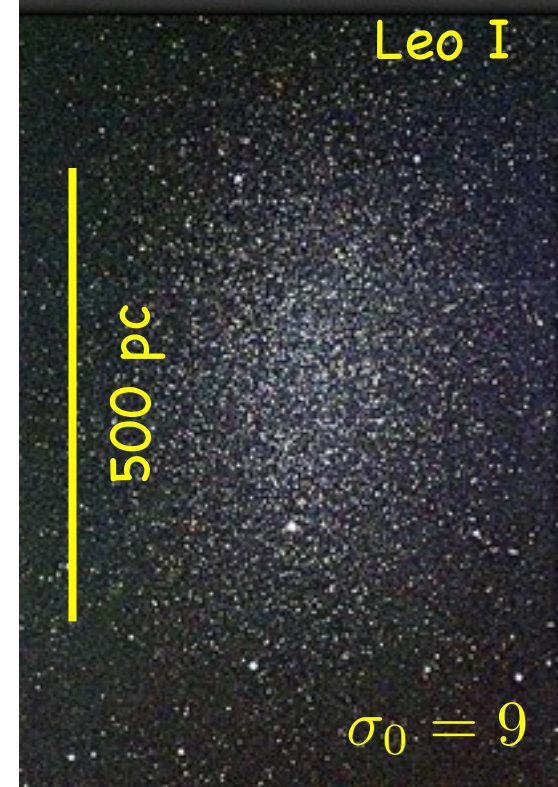
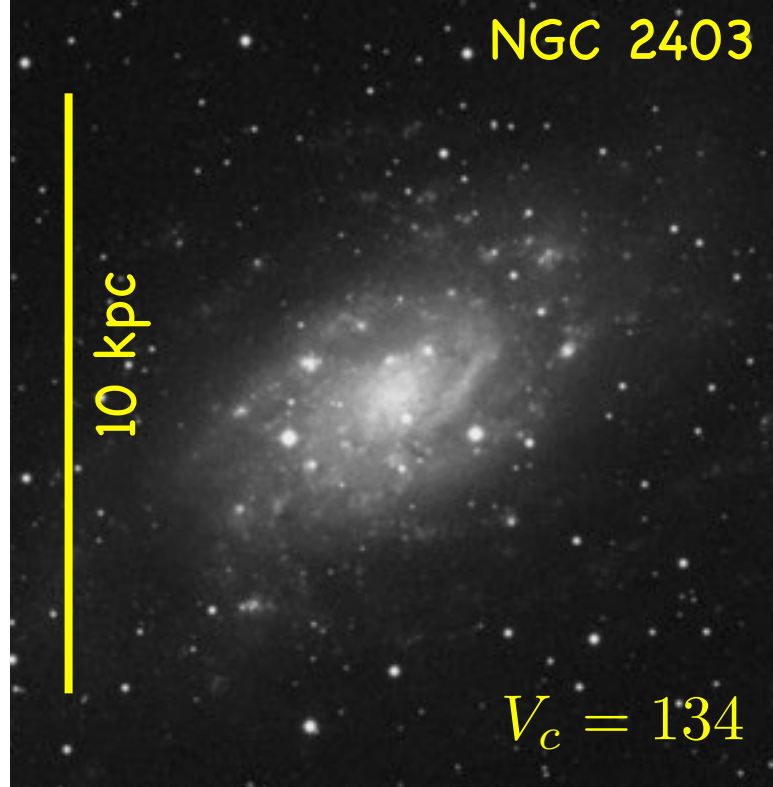
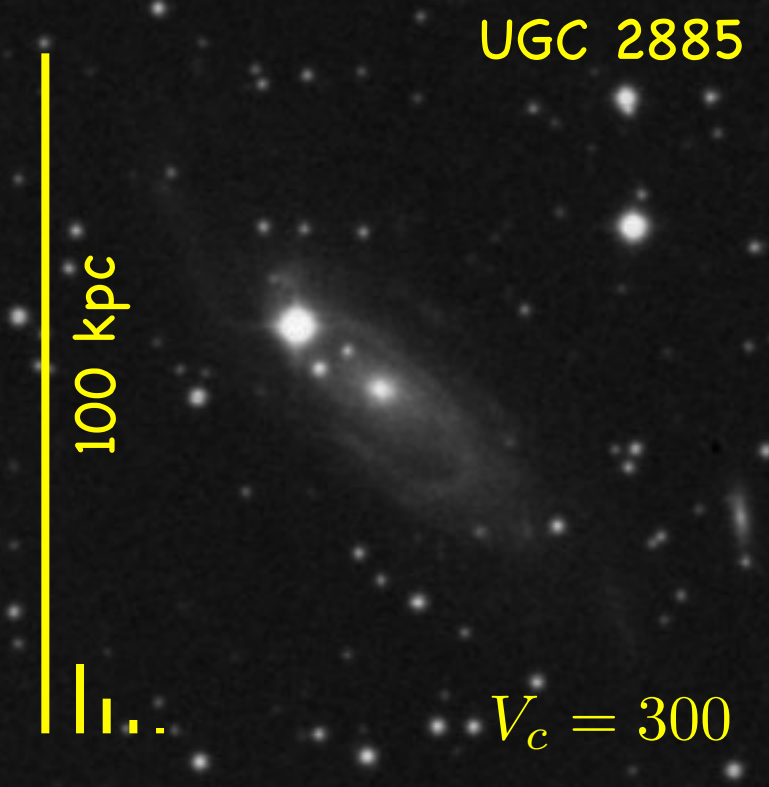
$$\Sigma(R) = \Sigma_0 e^{-R/R_d}$$

Azimuthally averaged light distribution
approximately exponential for spiral disks.

central surface brightness



Disk galaxies
(Spirals+Irrs)



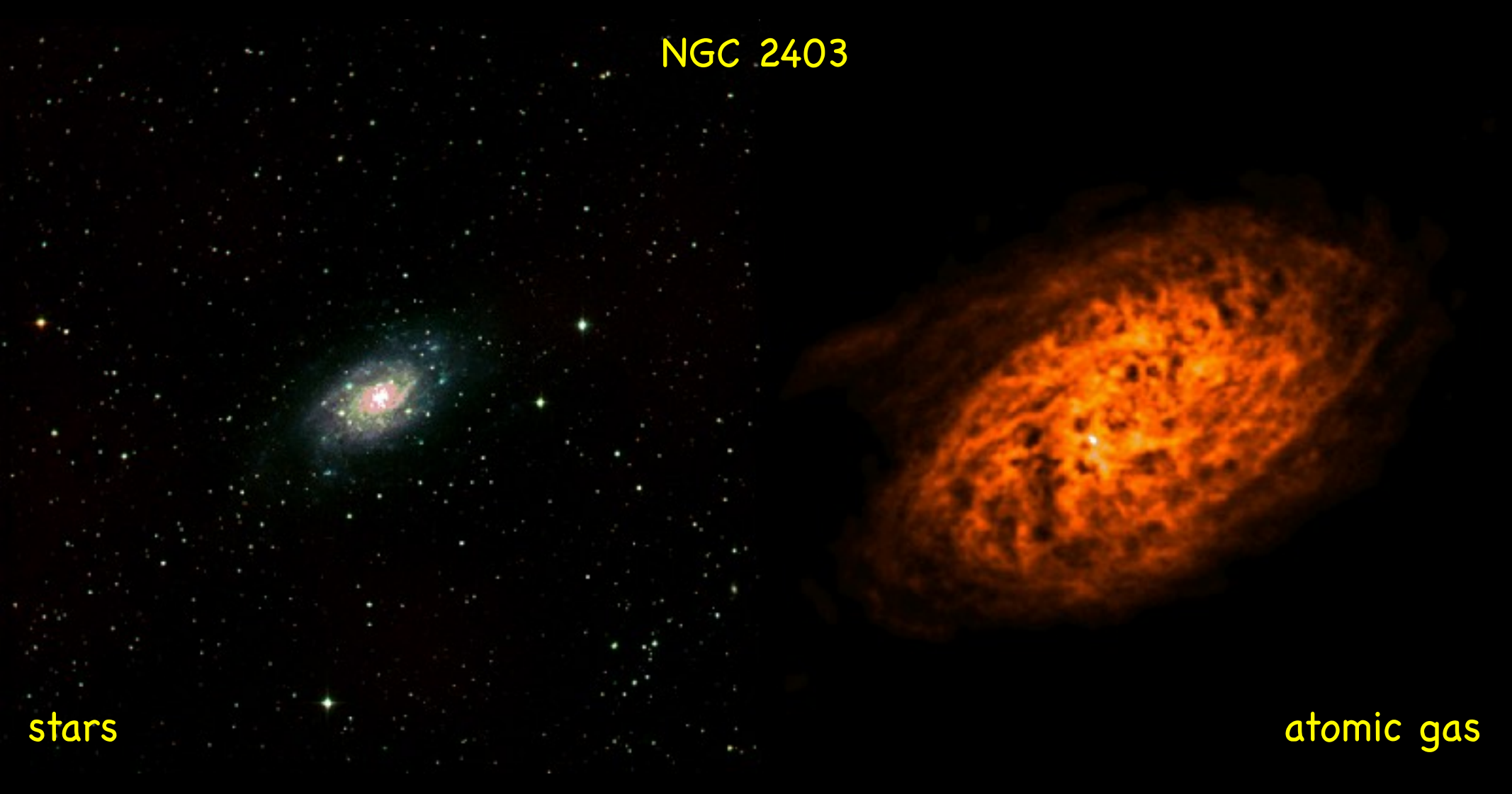
The atomic gas of the ISM is often more extended than the stars

NGC 2403

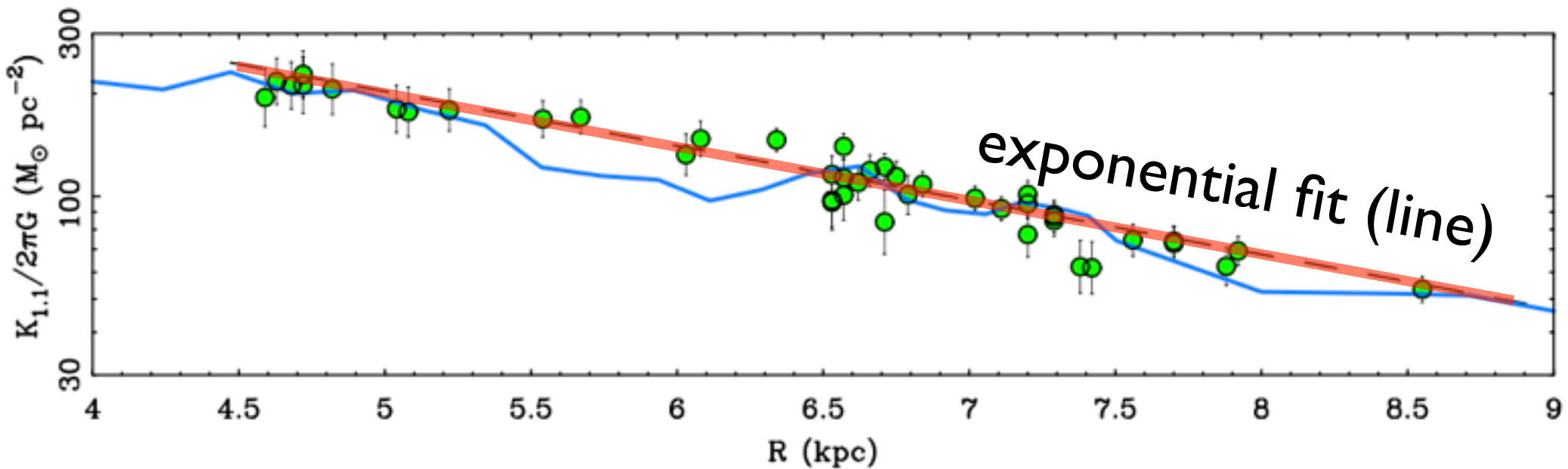
stars

atomic gas

Fraternali, F., Oosterloo, T., Sancisi, R., van Moorsel, G.A. 2001, ApJ, 562, L47



$$K_Z = 2\pi\Sigma + 2Z\frac{\partial V^2}{\partial R}$$



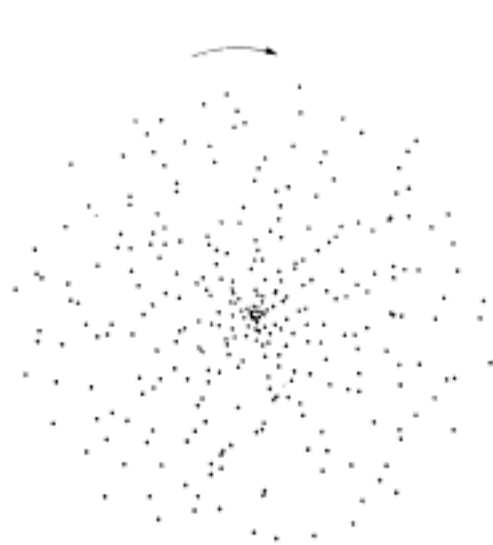
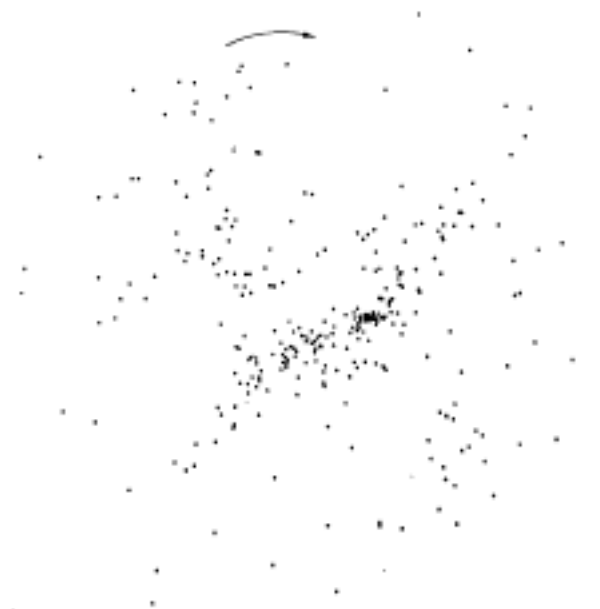
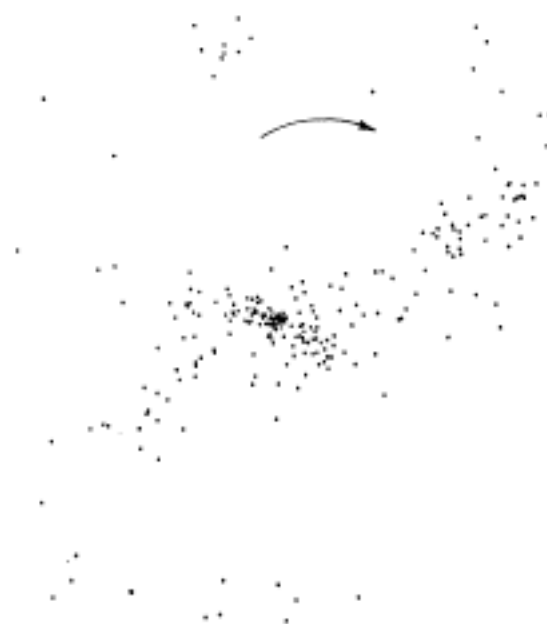
$$\Sigma(R) = \Sigma_{\odot} e^{-\frac{(R-R_{\odot})}{R_d}}$$

$$\Sigma_{\odot} = 38 M_{\odot} \text{pc}^{-2} \quad (\text{stars only})$$

$$R_d = 2.15 \text{ kpc} \quad \text{Bovy \& Rix (2013)}$$

The bar instability



(a) $\tau = 0$ (b) $\tau = 0.2$ (c) $\tau = 0.6$ (d) $\tau = 0.94$