Galaxy Kinematics

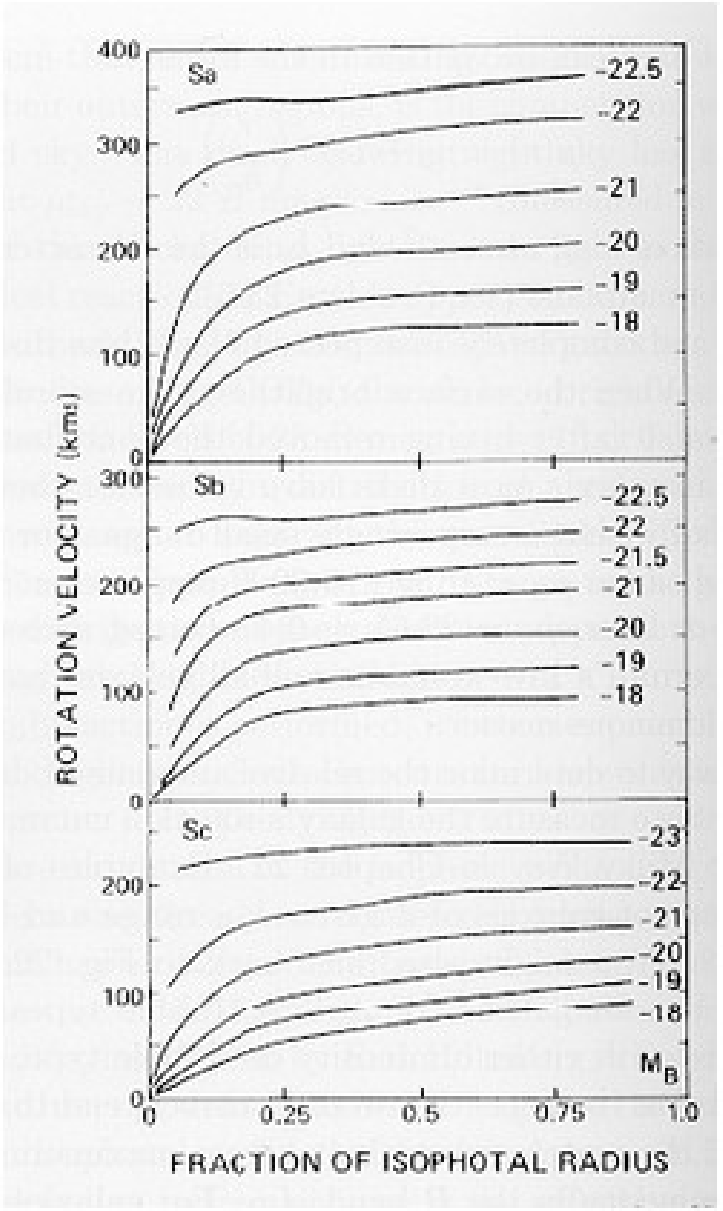
For Figures, credit to
http://burro.astr.cwru.edu/Academics/Astr222/Galaxies/Spiral/spiralprop.html
http://burro.astr.cwru.edu/Academics/Astr222/Galaxies/Elliptical/kinematics.html

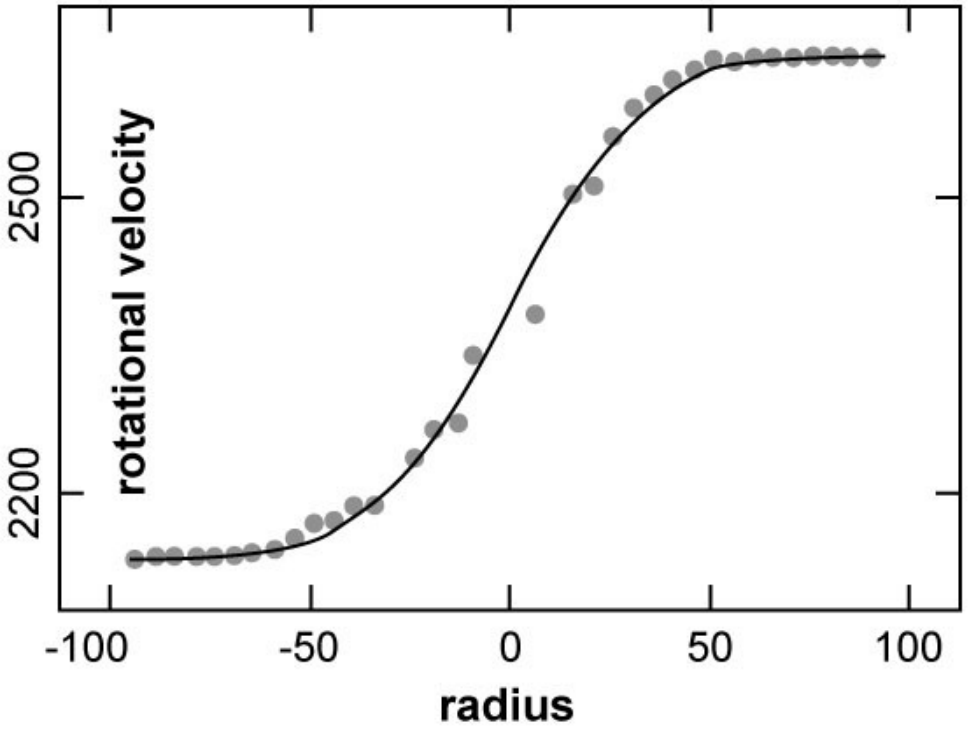
GALAXY DISKS are “cold” kinematical structures, i.e. mainly supported by the ordered motion of stars,, that is by velocity rotation (a few 100s of km/s depending on the Mass).
The random motion is small, consider e.g. the motion of the Sun (about 30 km/s) with respect to the main velocity of the disk stars.

ELLIPTICALS are “hot” kinematical structures, i.e. mainly supported by the pressure of the chaotic motion of stars, that is by velocity dispersion (a few 100s of km/s depending on the Mass). Less luminous galaxies have also an important component of rotation.

GALAXY DISK

Radial velocity vs galaxy radius. Observed.





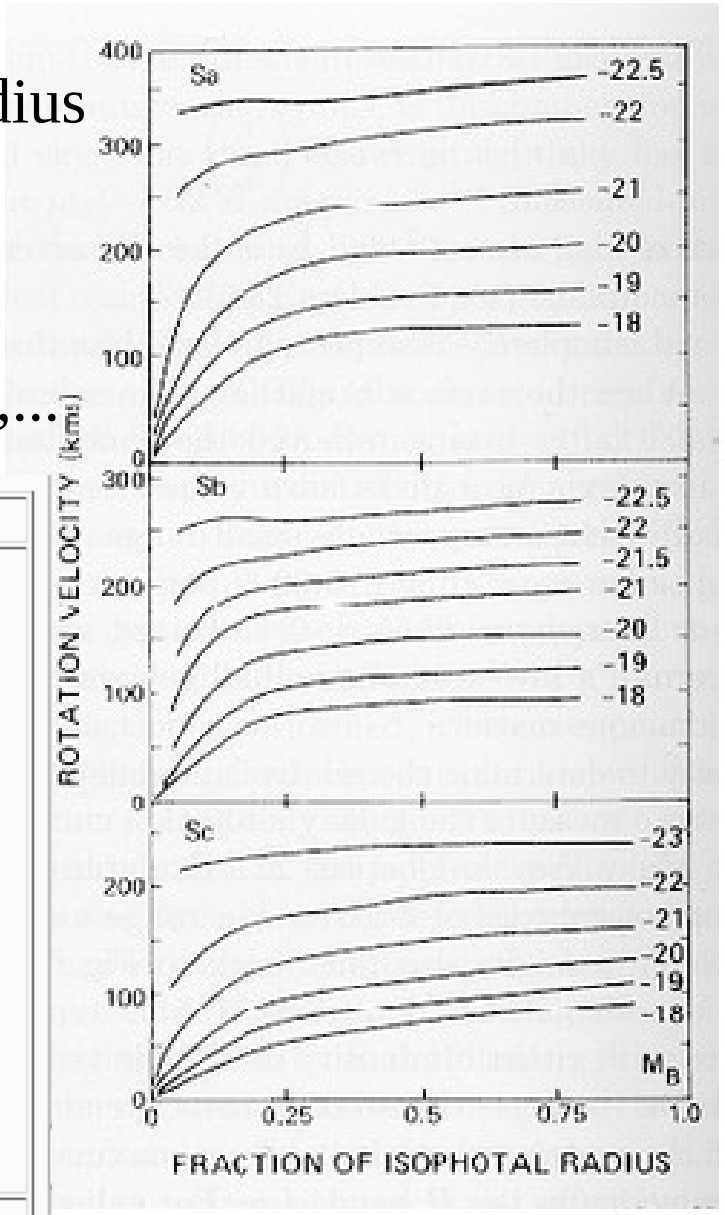
Setted in the rest velocity frame and combining info on both side (i.e. R<0 and R>0).

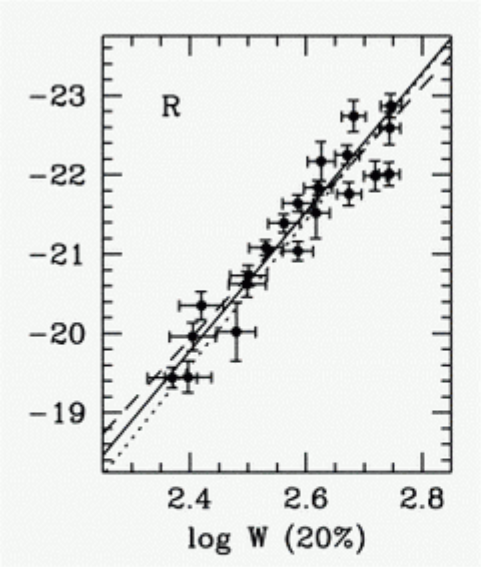
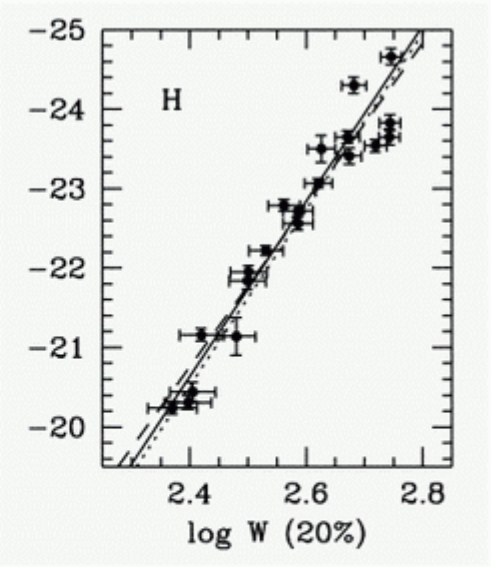
DISK GALAXIES

Radial velocity vs galaxy radius

The Tully Fisher relation $L \propto V^{3-4}$

The exponent depends on the analyzed band, R,IR,...



R (Red) Tully Fisher	H (Infrared) Tully Fisher
 X-axis: ~2Vcirc Y-axis: absolute R magnitude	 X-axis: ~2Vcirc Y-axis: absolute H magnitude
• slope: -8.8 • slope: 3.5 • scatter: 0.25 mag	• slope: -11.0 • alpha: 4.4 • scatter: 0.19 mag

ELLIPTICAL GALAXIES

In Ellipticals Vrot is small (see the Vrestframe on the Left, Vrot<50km/s in this case...and Velocity dispersion is high.

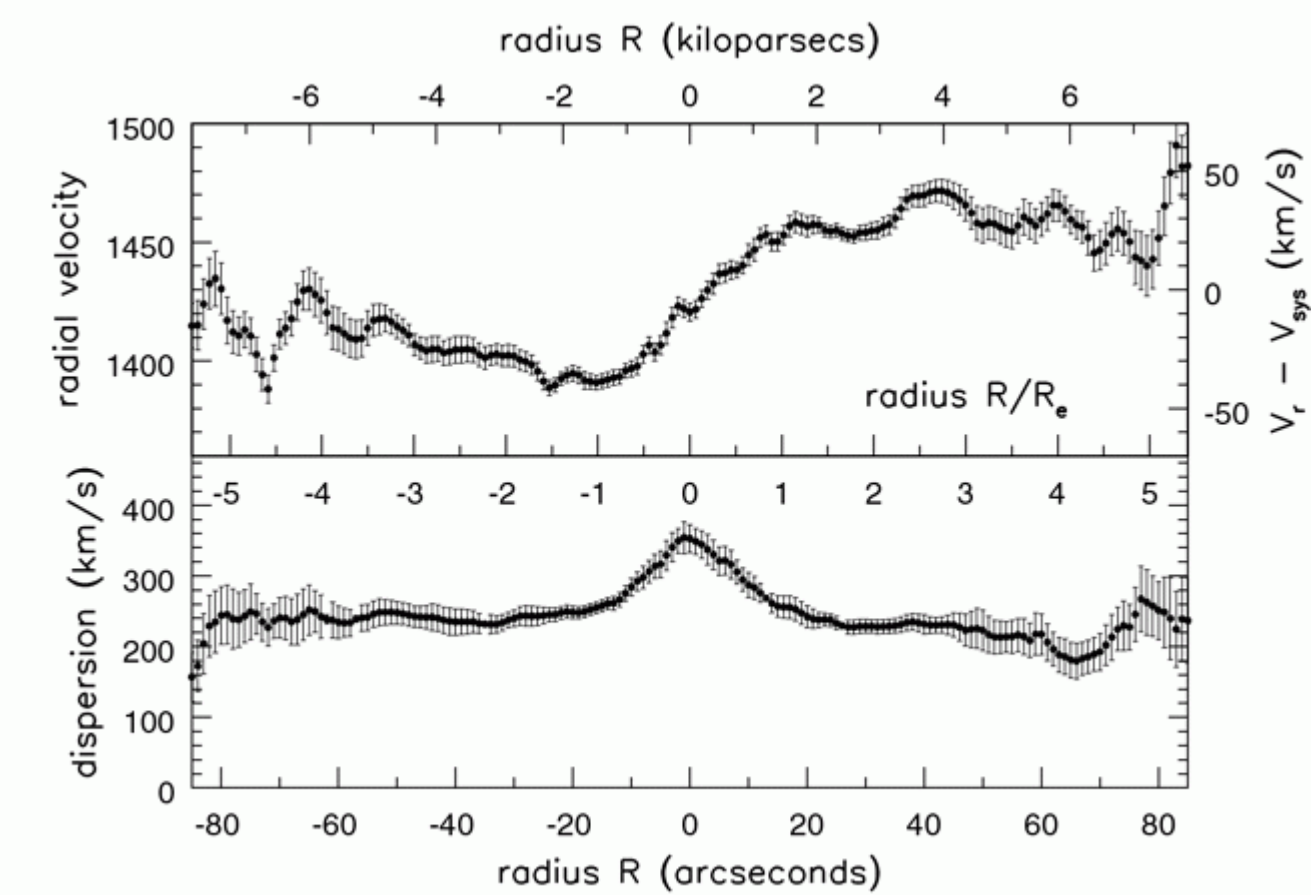


Fig 6.12 (A. Graham) 'Galaxies in the Universe' Sparke/Gallagher CUP 2007

ELLIPTICAL GALAXIES

The plot gives the ratioof radial velocity
over velocity dispersion
vs the ellipticity =1-b/a,
b/a axis ratio.
Curve is the prediction
in the assumption
that ellipticals are oblate bodies
due to the rotation.

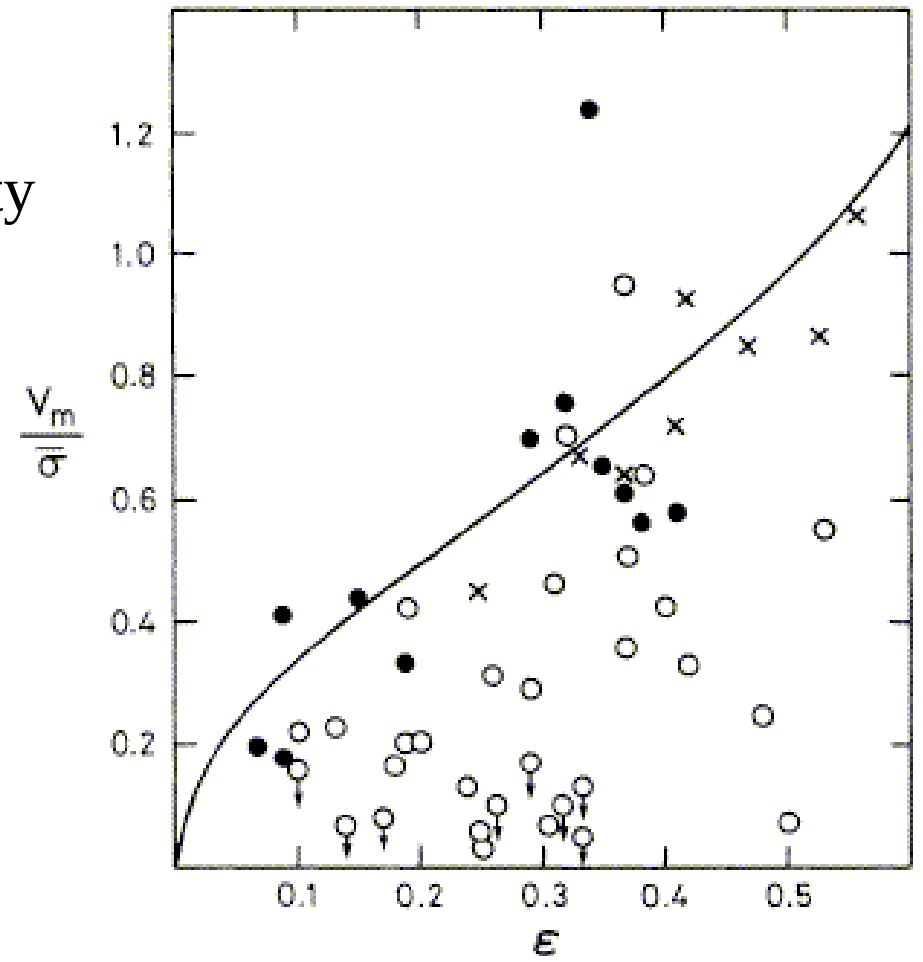
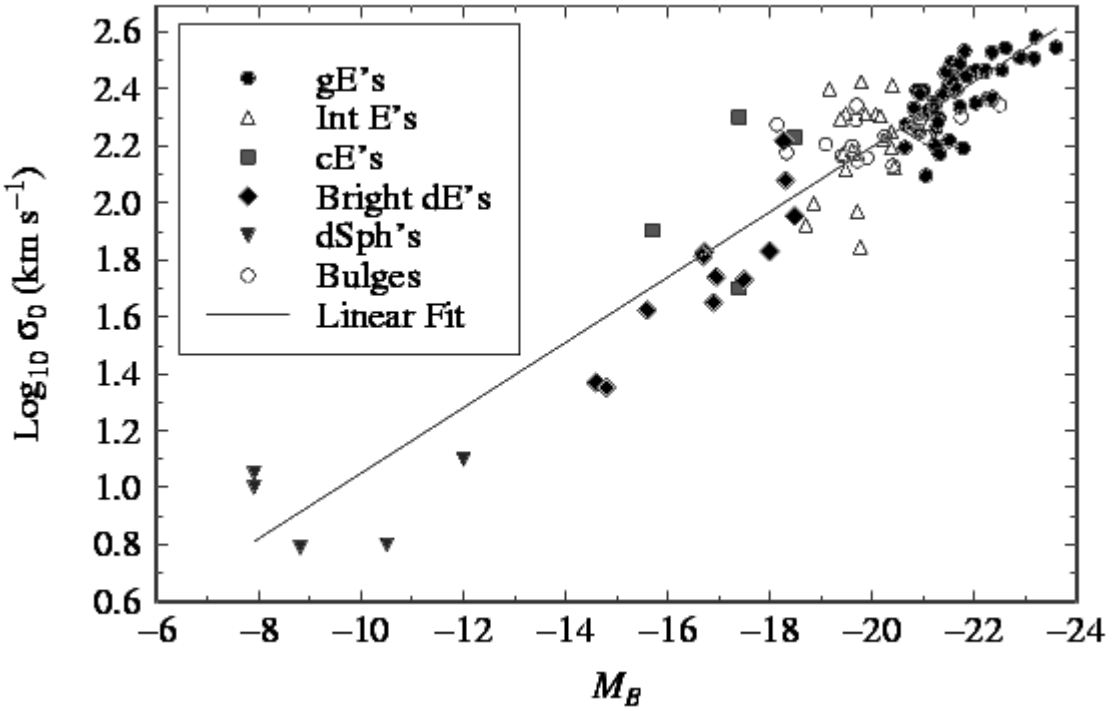


FIG. 3.—The quantity $V_m/\bar{\sigma}$ against ellipticity. Ellipticals with $M_B^{UH} > -20.5$ are shown as filled circles; ellipticals with $M_B^{UH} < -20.5$, as open circles; and the bulges of disk galaxies, as crosses. The solid line shows the $(V/\sigma, \epsilon)$-relation for oblate galaxies with isotropic velocity dispersions (Binney 1978).

Less luminous ellipticals
(solid points) are in agreement
With the assumption of oblate bodies.
Luminous elliptical do not, they
are triaxial bodies.
See, e.g., Binney And Tremaine for further discussions.

The Faber - Jackson relation $L \propto \sigma_v^4$

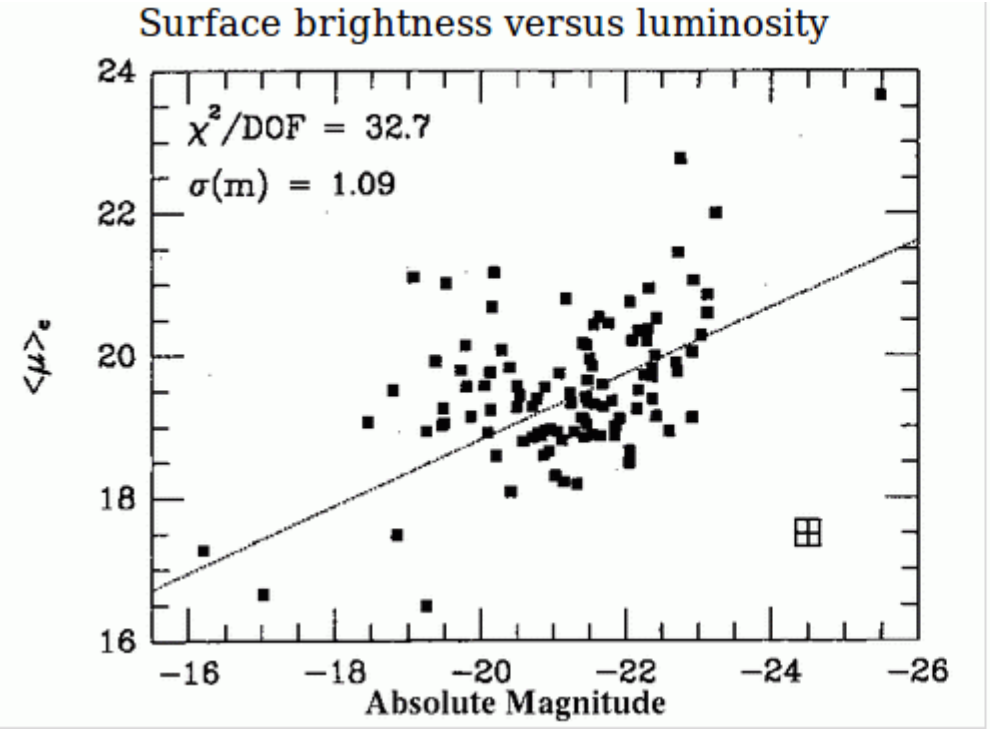


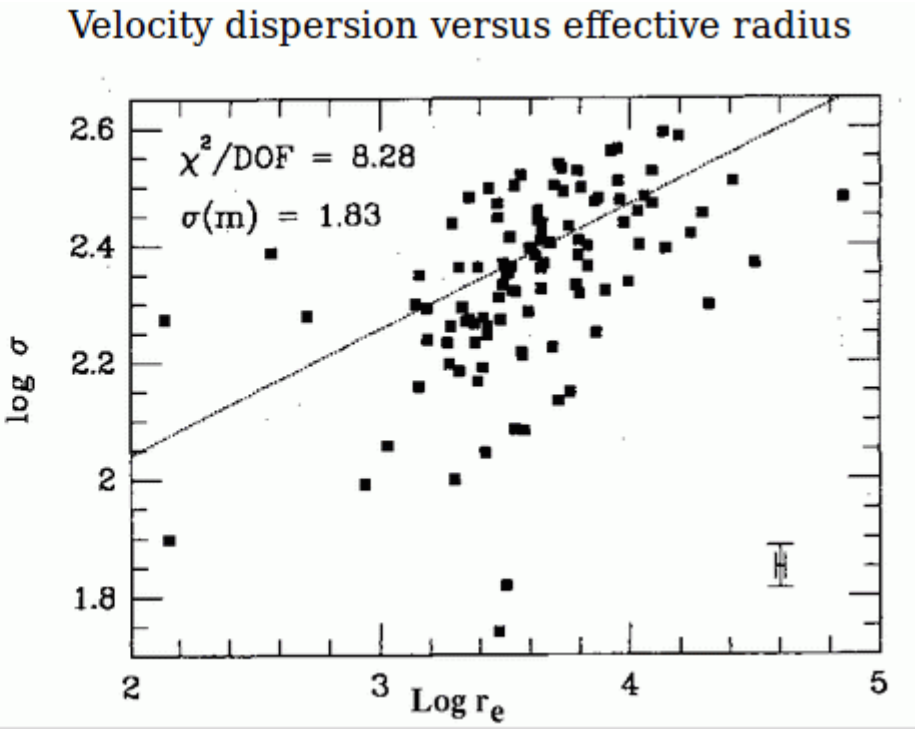
Using the usual relation between mag and luminosity, e.g.

$$\log \sigma_v = -0.1\, M_B + 0.2$$

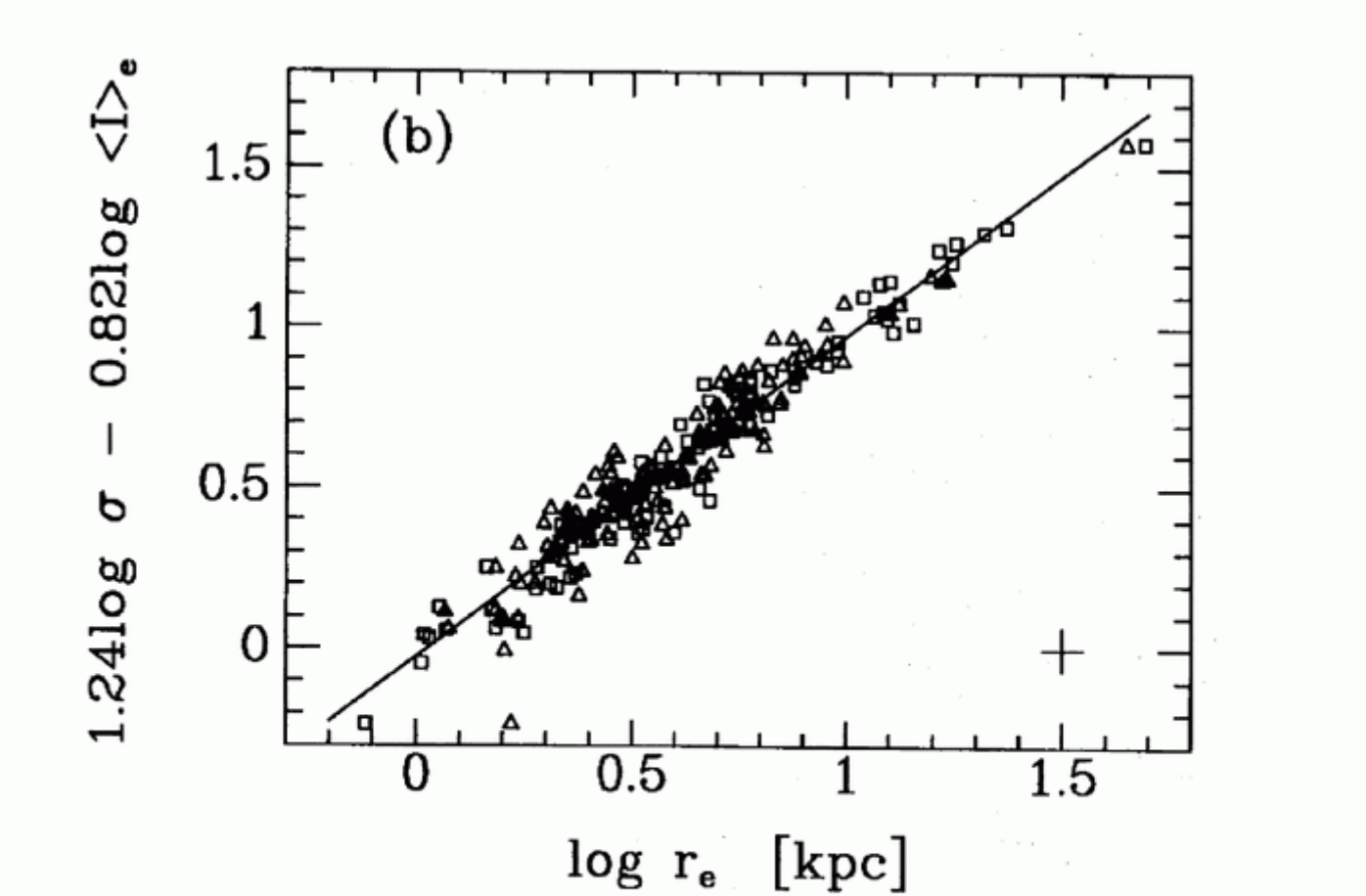
A lot of scatter! We need to introduce a second parameter!

For ellipticals both these correlations are observed





There is a relation among three variables which is much less scattered THE FUNDAMENTAL PLANE. The above relations are the projection of this plane, which should be seen in 3D.



Or in other words

$$r_e \sim \sigma^{1.24} \langle I \rangle^{-0.82}$$

3D view of the fundamental plane