

SPIRAL GALAXIES



Giant Interacting Galaxies NGC 6872 / IC 4970
(VLT ANTU + FORS1)

ESO PR Photo 20b/99 (30 April 1999)

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THE BULGE-DISK DECOMPOSITION

Bulge: $r^{1/4}$ law

Exponential disk

Total profile

(Borson 1981)

1861apz...46..177B

Surface brightness

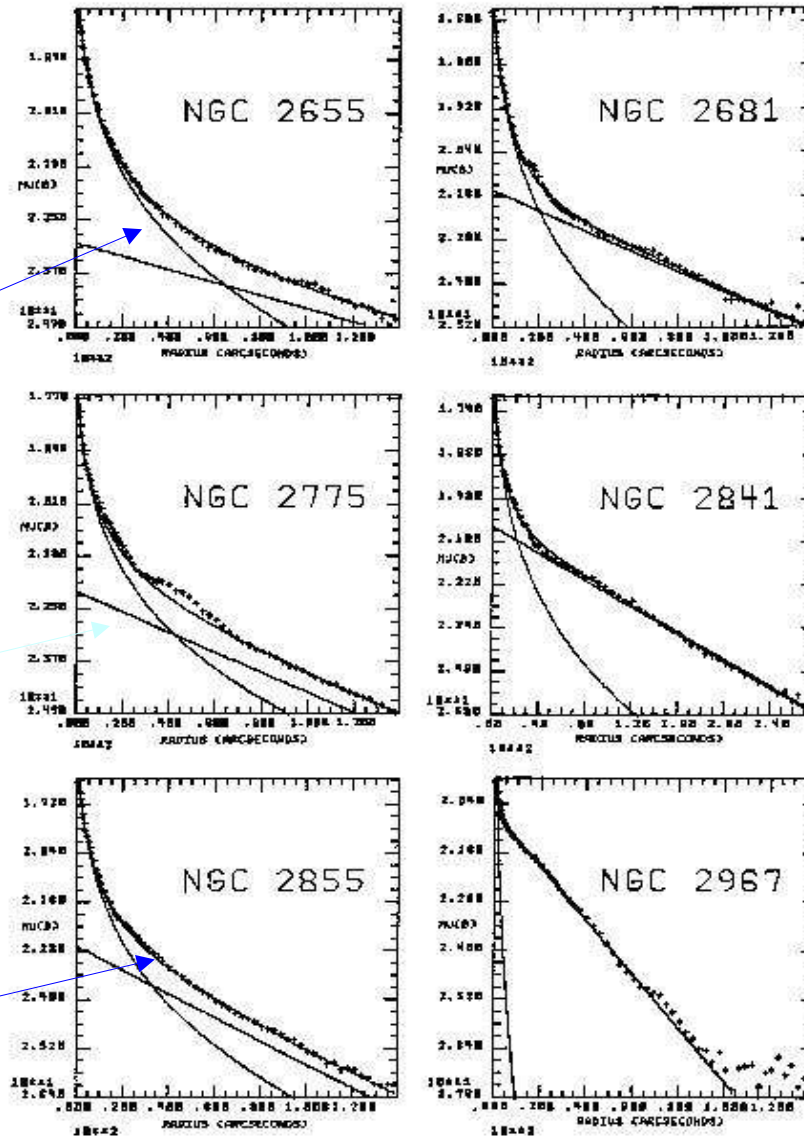


Fig. 6—Continued
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THE B/T-MORPHOLOGY CORRELATION

$$B/T = \text{Bulge/Total luminosity} = \frac{\text{Bulge}}{\text{Bulge} + \text{Disk}}$$

S0
Sa
Sb
Sc

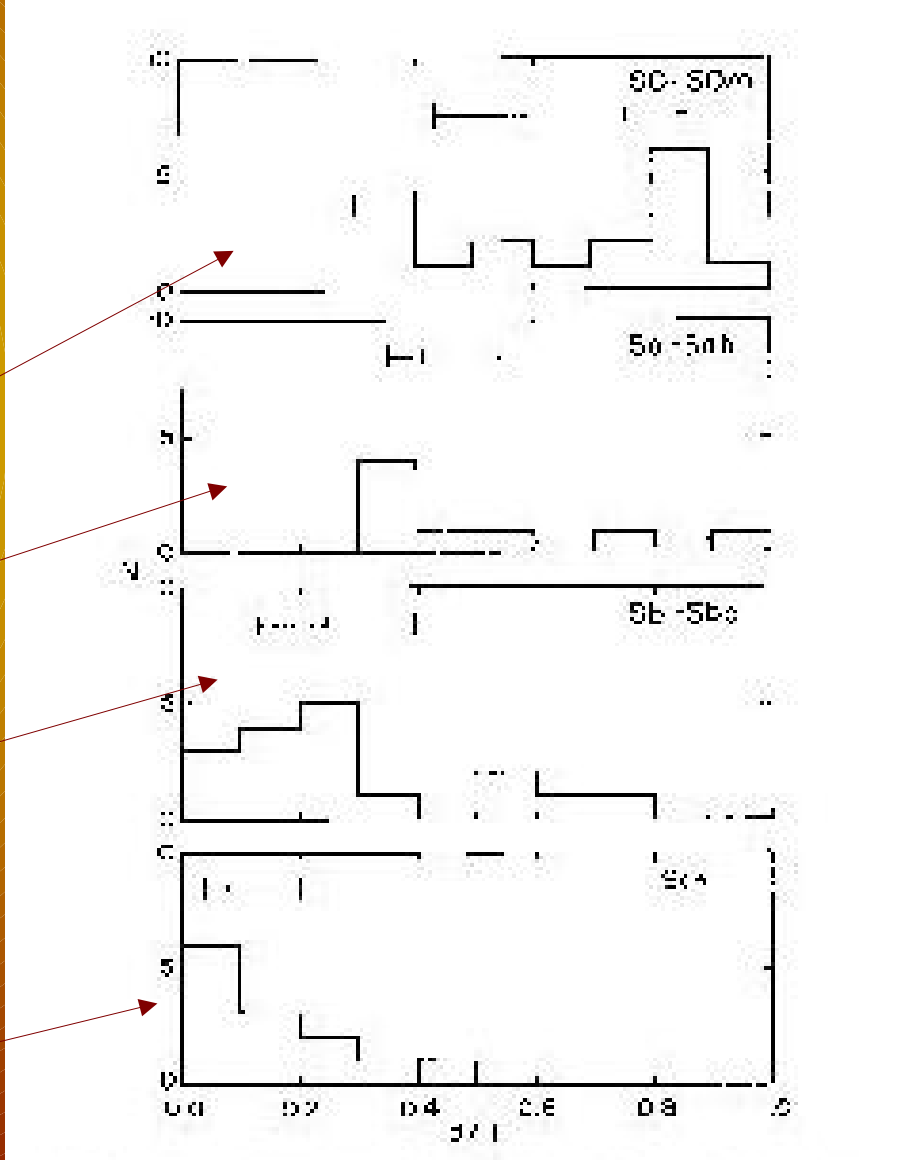


FIG. 6.—Distribution of B/T as a function of morphological type

faint bulges

B/T

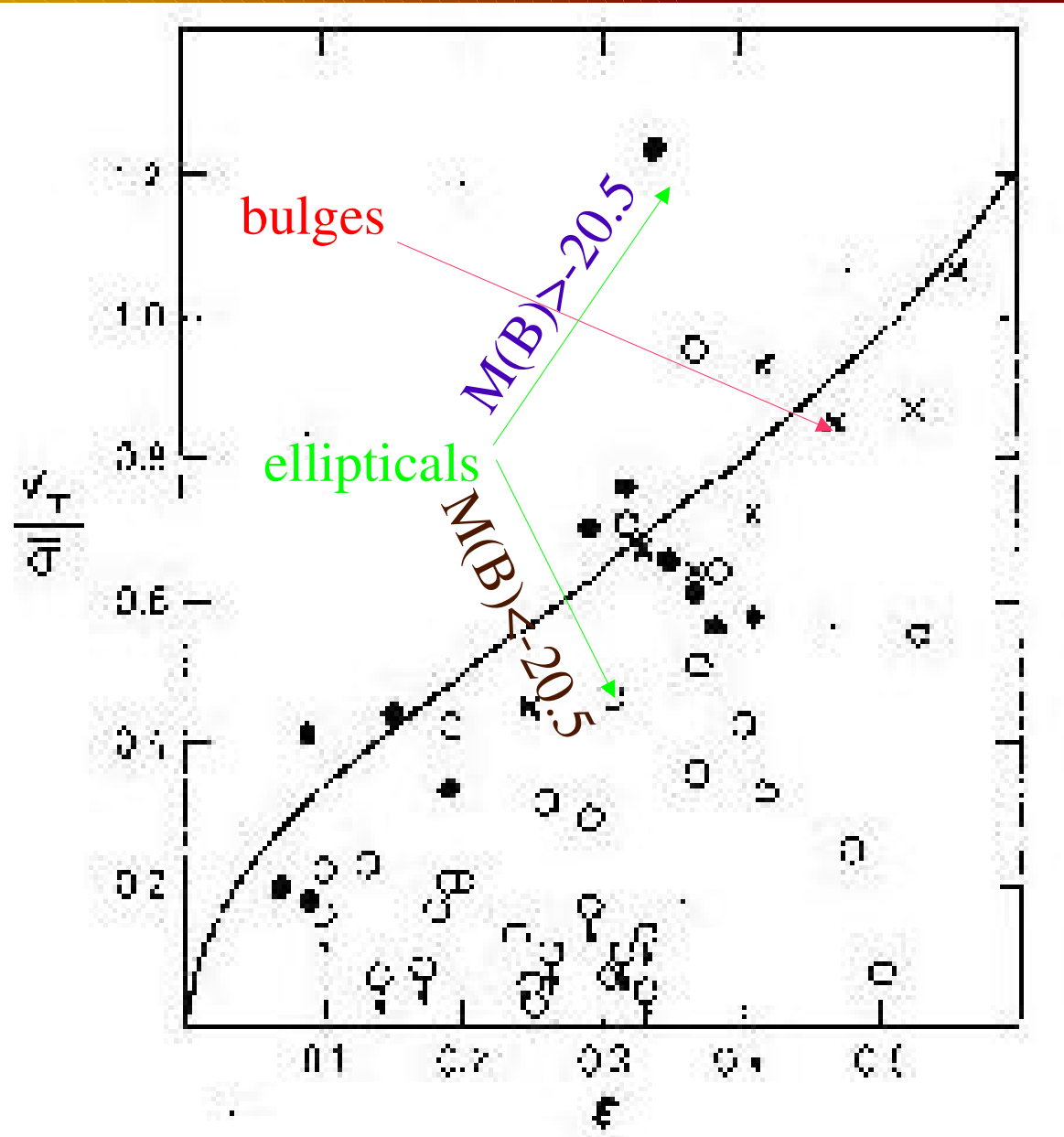
bright bulges

(Kent 1985)

Are bulges supported by rotation?

Max rot vel/mean vel disp

(Solid line is for oblate galaxies with isotropic vel disp)

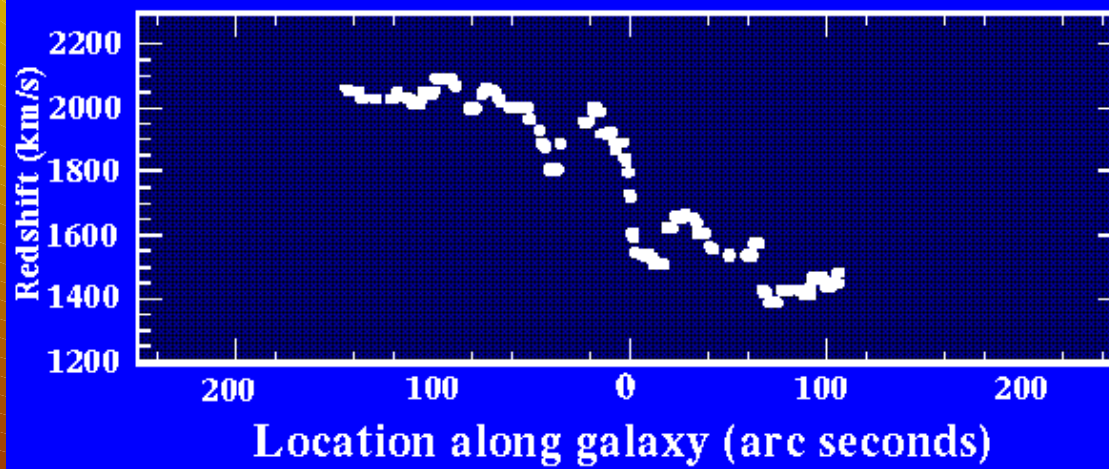
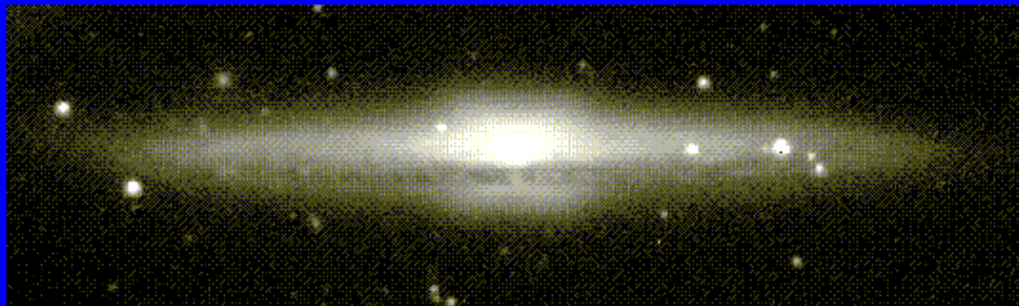


(Davis et al. 1983)

Increasing Ellipticity ->

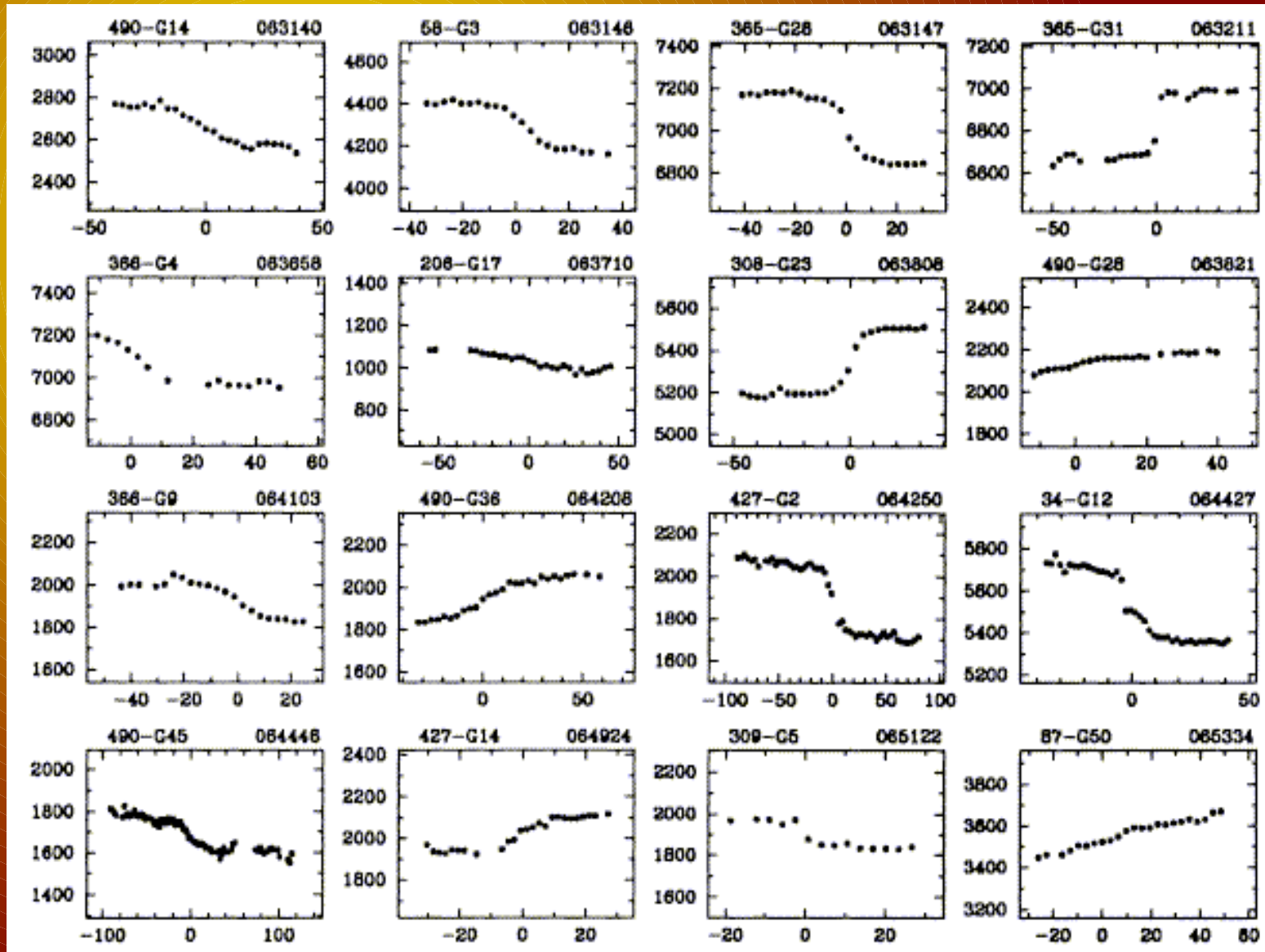
ROTATION CURVES

NGC 5746



ROTATION CURVES ARE NOT ALWAYS FLAT!

km/s



kpc

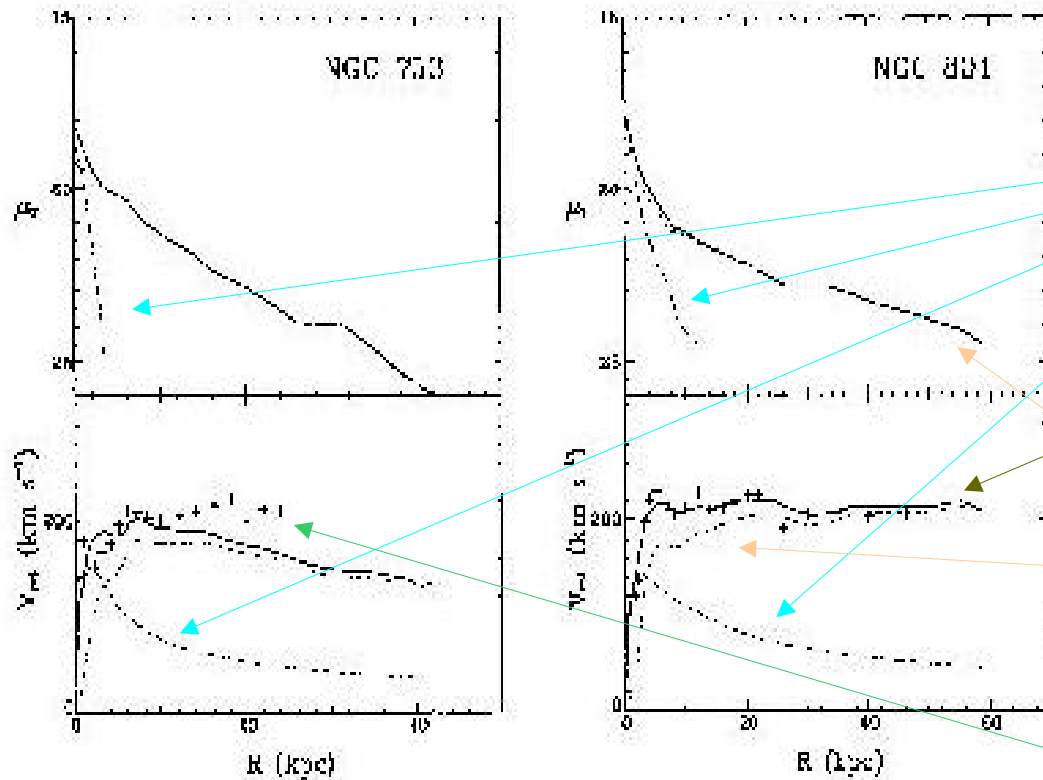
(Mathewson, Ford & Buchhorn 1992)

LUMINOUS OR DARK MATTER?

Bad fit

Good fit

Rot. vel. SB



Bulge

Total

Disk

Data

FIG. 2. Top panels: Major axis luminosity profiles for 37 spiral galaxies. The profile is decomposed into bulge (solid red long-dashed) and disk (dashed red) components. Lower panels: Observed rotation curves (crosses) and the best-fitting exponential disk rotation (solid line). The separate contributions of the bulge and disk components are also shown.

THE TULLY-FISHER RELATION

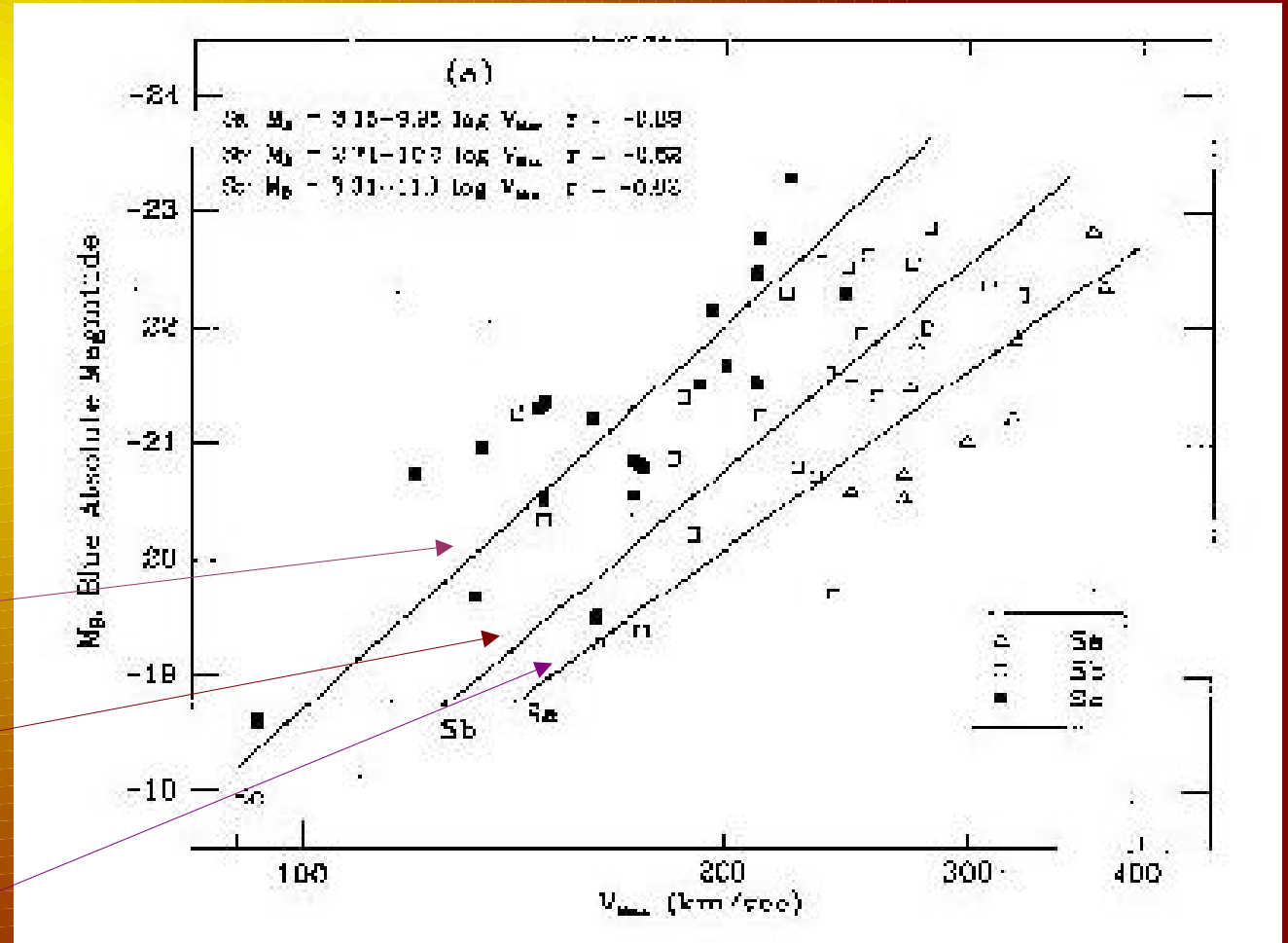
$$M = a - b \log(V_{\text{rot}})$$

$M(B)$

Sc

Sb

Sa



Max rot. vel. (km/s)

(Rubin et al 1985)

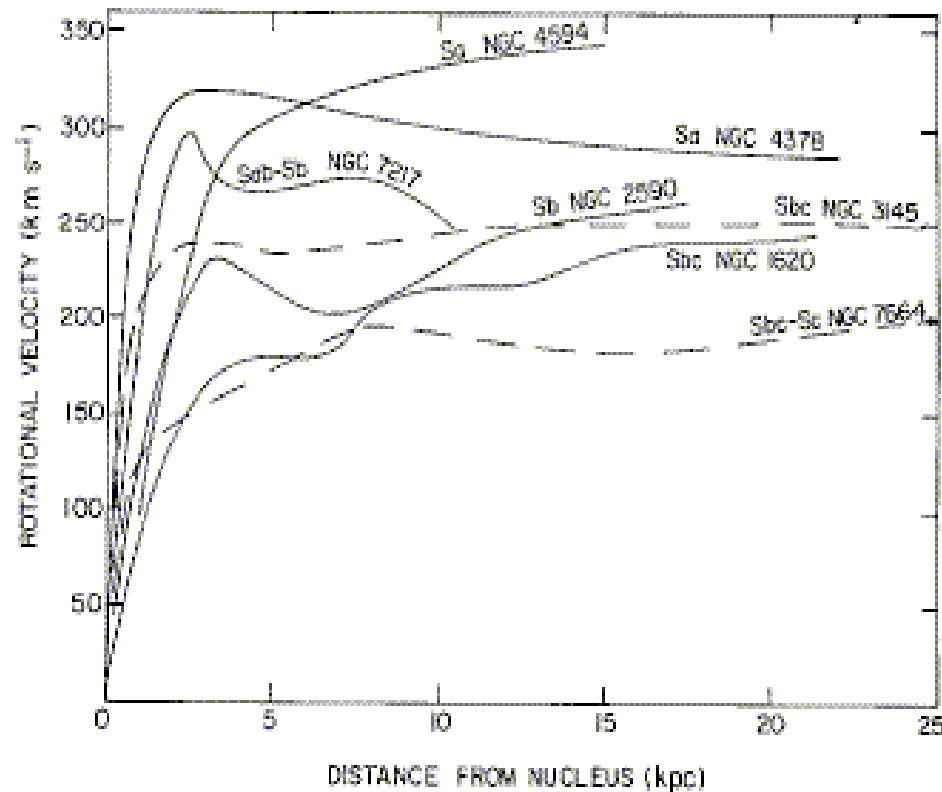


FIG. 3.—Rotational velocities for seven galaxies, as a function of distance from nucleus. Curves have been smoothed to remove velocity undulations across arms and small differences between major-axis velocities on each side of nucleus. Early-type galaxies consistently have higher peak velocities than later types.

(Rubin, Ford & Thonnard 1978)

SPIRAL ARMS IN GRAND-DESIGN SPIRALS

example: HST images of the center of M51



NICMOS filters (NIR: K,J)



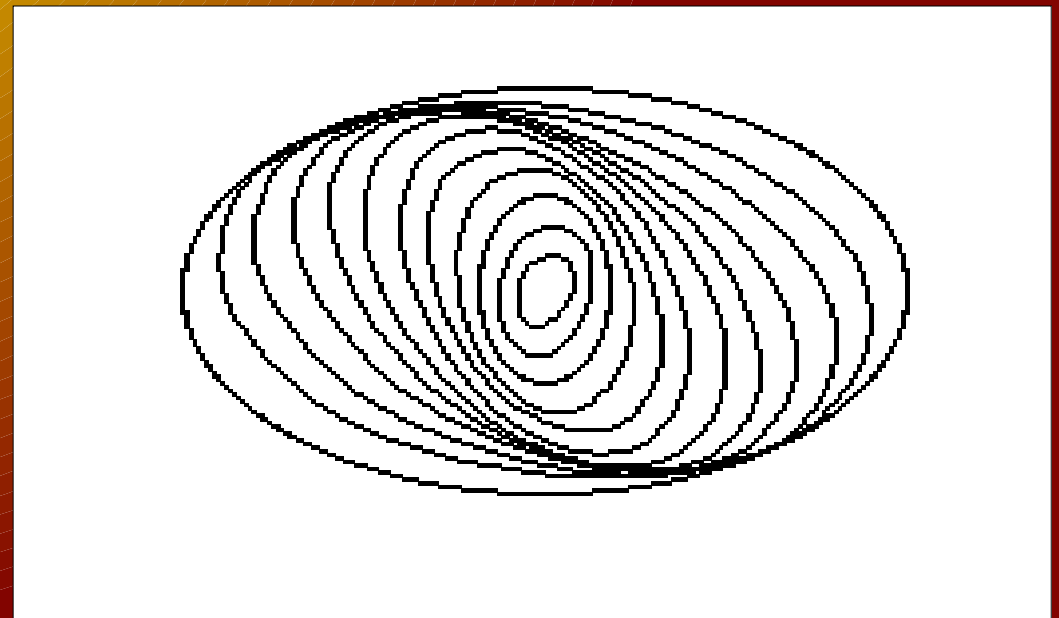
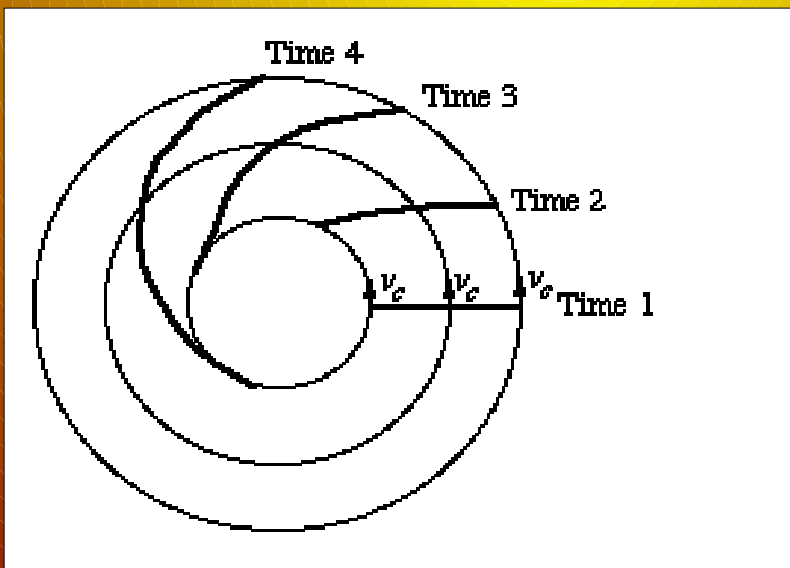
WFPC2 filters (I,V,B)

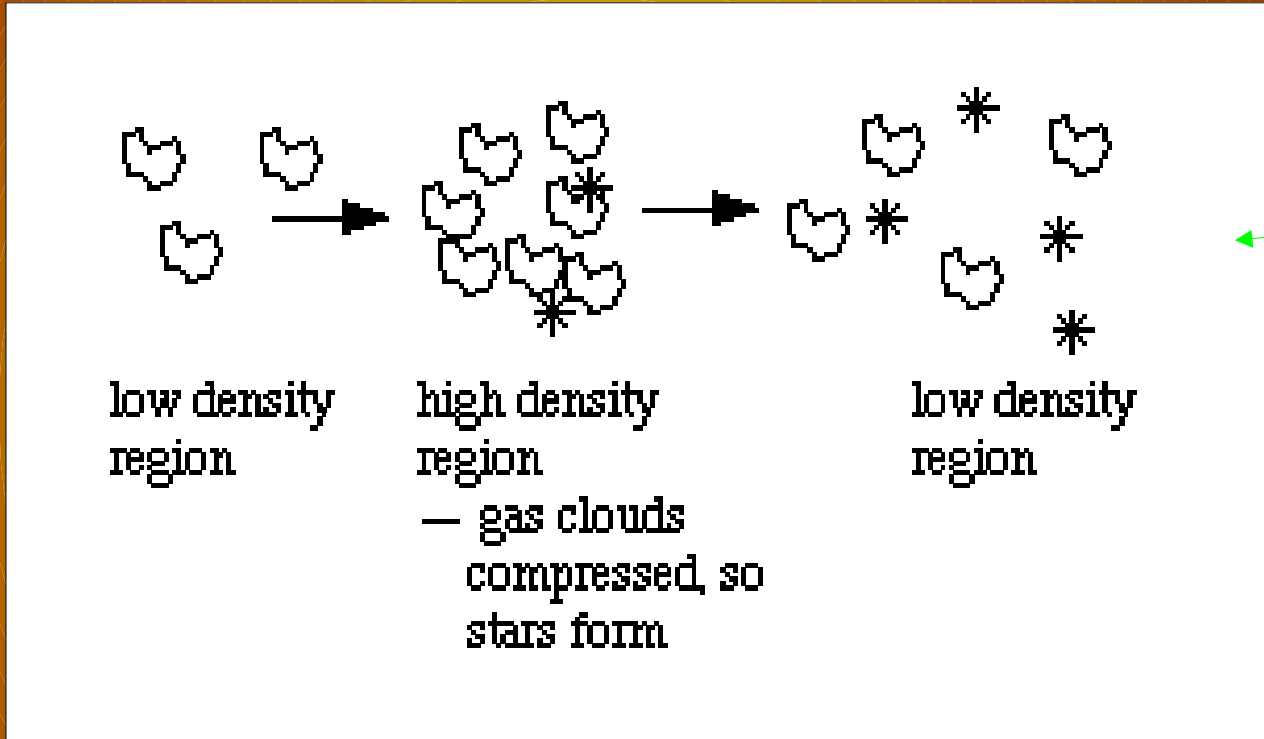
THE ORIGIN OF SPIRAL ARMS

The winding dilemma:
differential rotation rapidly
winds up spiral arms

The Lin & Shu solution:
the spiral density wave

- the stars are on elliptical orbits
- the orbits are correlated

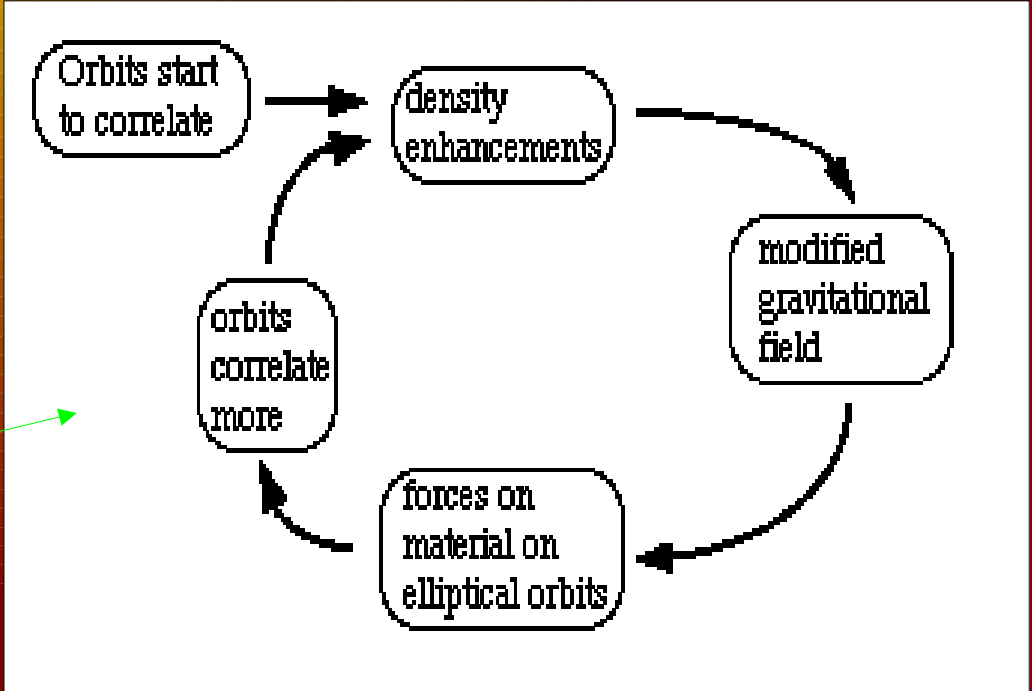




when many orbits come together, the density increases

Star formation

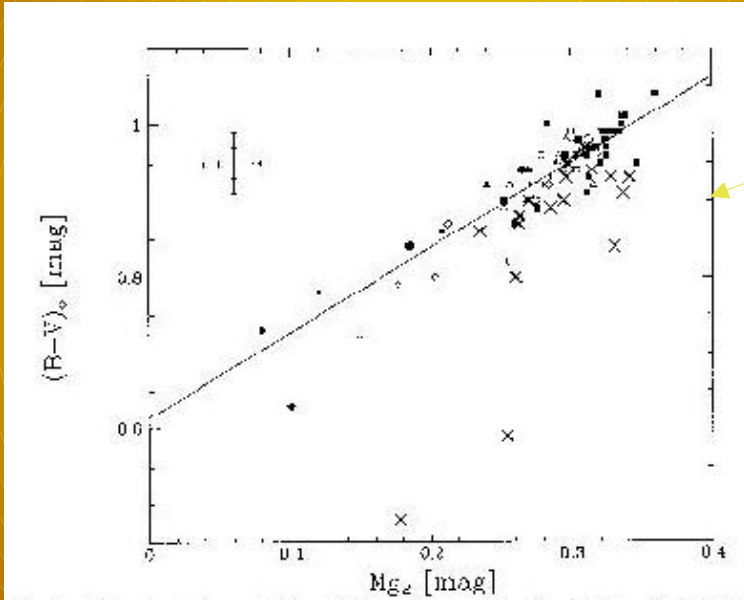
orbits correlates with a feedback loop



SPECTRAL INDEXES AND COLOUR GRADIENTS

ELLIPTICALS

Global B-V



Spectral index Mg2

weak line

strong line

(Bender, Burstein & Faber 1993)

U-B

B-V

V-R

(Walterbos & Kennicutt 1987)

M31 (Spiral)

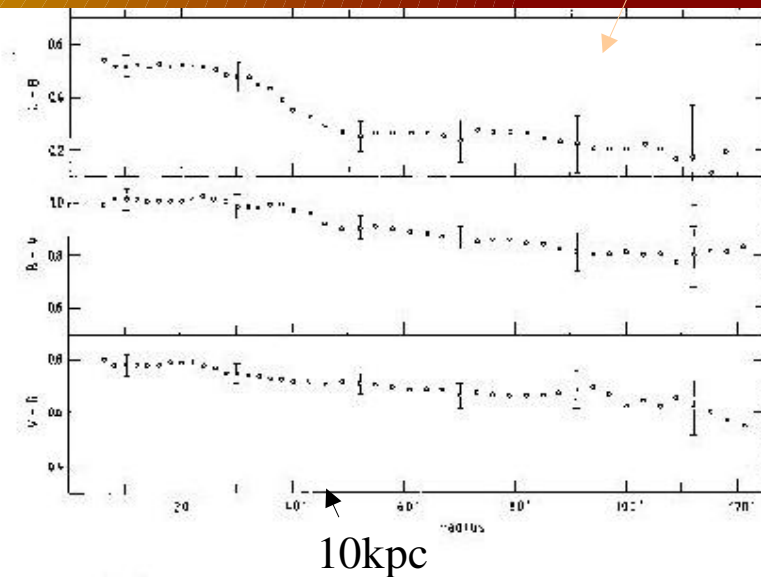


FIGURE 12. The global light and color profiles of M31 obtained from the data by averaging the intensity distributions in ellipses centred on the nucleus of the galaxy. Foreground stars were removed from the data beforehand. The uncertainties were estimated from comparisons of the global profiles derived from different planes in the same color band.

Radial distance (averaged over ellipses)