

Problem 1.1

	<u>ELLIPTICAL</u>	<u>Sa</u>	<u>Sc</u>
Morphology	Smooth Featureless Elliptical isophotes	Central bulge Thin disk Tightly-wound spiral arms	As Sa except Bulge less prominent, Spiral arms more open
Colour	Red	Bluer than elliptical (especially in spiral arms)	Bluer than Sa
Spectra	Absorption lines from stars No emission lines Spectra similar to K giants	Absorption and emission lines Similar to F, G type	More emission than Sa
Gas content	Very low	Significant (especially in disk)	More than Sa
Stellar population	Old K giants typical	Old in bulge Younger in disk Youngest in spiral arms	As Sa

(NB precise details not required, as long as broad features are given for each category)

## Problem 1.2

Use subscript 1 and 2 to refer to Virgo and Coma galaxies respectively,

$$\text{Virgo: } v_{\text{rot}1} = 175 \text{ km s}^{-1}, \quad M_{V1} = 11.87$$

$$\text{Coma: } v_{\text{rot}2} = 245 \text{ km s}^{-1}, \quad M_{V2} = 14.63$$

So,  $F_1 = \frac{L_1}{4\pi D_1^2}$ ,  $F_2 = \frac{L_2}{4\pi D_2^2}$  where  $\begin{cases} F & \text{flux} \\ L & \text{luminosity} \\ D & \text{distance} \end{cases}$

So ratio of fluxes is

$$\frac{F_1}{F_2} = \frac{L_1}{L_2} \cdot \frac{D_2^2}{D_1^2} \quad \therefore \frac{D_2}{D_1} = \left( \frac{F_1}{F_2} \cdot \frac{L_2}{L_1} \right)^{\frac{1}{2}}$$

and using Tully-Fisher,  $L \propto v_{\text{rot}}^4$

$$\text{so } \frac{L_2}{L_1} = \left( \frac{v_{\text{rot}2}}{v_{\text{rot}1}} \right)^4 \quad \text{and} \quad \frac{D_2}{D_1} = \left( \frac{F_1}{F_2} \cdot \frac{v_{\text{rot}2}^4}{v_{\text{rot}1}^4} \right)^{\frac{1}{2}}$$

$$\text{also, } \frac{F_1}{F_2} = 10^{-0.4(M_{V1} - M_{V2})} \quad (\text{from definition})$$

$$\therefore \frac{D_2}{D_1} = \left( 10^{-0.4(M_{V1} - M_{V2})} \cdot \frac{v_{\text{rot}2}^4}{v_{\text{rot}1}^4} \right)^{\frac{1}{2}}$$

$$= \left( 10^{-0.4(11.87 - 14.63)} \times \frac{(245)^4}{(175)^4} \right)^{\frac{1}{2}}$$

$$\therefore \frac{D_2}{D_1} = (12.7057 \times 3.8416)^{\frac{1}{2}} = \underline{6.9864}$$

$$\left( \text{or } \frac{D_1}{D_2} = 0.1431 \right)$$

