

SPA7010U/SPA7010P Example Problems 1
(30 Jan 2020)

Problem 1.1

Compare and contrast, in list form, the observed properties of elliptical, Sa and Sc type galaxies, referring to their morphologies, colours, spectra, gas content, and stellar populations.

Problem 1.2

The Tully-Fisher relation for spiral galaxies states that $L \simeq k v_{\text{rot}}^4$, where L is luminosity, v_{rot} is the peak rotational velocity and k is a constant.

A spiral galaxy in the Virgo cluster is observed with $v_{\text{rot}} = 175 \text{ km s}^{-1}$ and apparent magnitude $m_V = 11.87$. Another galaxy, in the Coma cluster, is observed with $v_{\text{rot}} = 245 \text{ km s}^{-1}$ and $m_V = 14.63$. Using the expression given above, estimate the ratio of the distances to the two clusters, assuming galactic extinction is negligible.

Problem 1.3

The fundamental plane for elliptical galaxies has the form

$$R_0 I_0^{0.8} \sigma_0^{-1.3} = \text{constant} ,$$

where R_0 is a characteristic radius, I_0 is the central surface brightness and σ_0 is the line-of-sight velocity dispersion. Show that this implies luminosity $L \propto \sigma_0^{2.6} / I_0^{0.6}$.

Explain briefly how R_0 , I_0 and σ_0 could be determined from observation. How could these quantities be used to measure the relative distances to galaxy clusters.