Einführung in die Astronomie und Astrophysik 2

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Estimating Galaxy Properties — Hand in on June 9, 2011

7.1 The Andromeda Galaxy

Andromeda (M31) has a angular diameter of about $3°$. The central core has a angular diameter of only $2''$ with an apparent (bolometric) magnitude of $12.5^{\rm m}$ and a mass of $1.3 \times 10^7 \, {\rm M}_\odot$, as determined from the rotation curve.

a) Determine distance and size of M31, by using the luminosity-period relation for Cepheid stars (Feast & Catchpole, 1997, MNRAS, 286, L1)

$$M_V = -2.81^{\rm m} \cdot \log_{10}\left(\frac{P}{1\,{\rm day}}\right) - 1.43^{\rm m}. \tag{1}$$

Assume you measure a Cepheid star with a period P of 40 days and a mean apparent magnitude $m_V = 18.04^{\rm m}$. What is the distance to Andromeda and what is the diameter of the galaxy.

b) Compute the luminosity of the galaxy core.

c) If you assume for simplicity that the core of M31 consists of main-sequence stars of equal mass, use the mass-luminosity relation to determine the number of stars in the core. Also compute the average stellar density of the core.   (5 points)

7.2 HI Observation of a Distant Galaxy

When you point a radio telescope the center of a distant spiral galaxy, you find the emission line of neutral hydrogen at a wavelength of $21.4918\,{\rm cm}$. You detect HI out to a radius of about $0.5'$ and you notice that the disk of the galaxy is inclined by $60°$ with respect to the line of sight. At the outer edges of the galaxy, the wavelengths of the HI emission line differ by $\pm 0.01135\,{\rm cm}$.

a) What is the distance to the galaxy assuming a Hubble parameter $H_0 = 75\,{\rm km\,s^{-1}\,Mpc^{-1}}$?

b) What is the mass of the galaxy assuming the gas moves on circular orbits?

c) What is the true diameter?

b) What are possible uncertainties and errors in the above estimates?   (5 points)