PHYS2160 Part I – Semester 2, 2015 – Assignment
Chris Tinney

Date Handed Out: Tuesday, August 12, 2015 (Lecture 5)
Due Date: Tuesday, August 25, 2015 (Day of Lecture 9)

This assignment counts towards 15% of your final mark.

Completed assignments should be handed in at the lecture on the due date, or to the School of
Physics office before 4pm.

Assignments will be docked 10% of the grade if handed in up until 4pm on the next day, 20%
on the Friday, 40% on the next Monday, and an additional 10% each day thereafter.

Question 1

a. By how much brighter is one star than another if their magnitude difference is 0.075
   mag, 0.75 mag, 14.5 mag?
   b. The apparent magnitude of the galaxy M82 in the V band is $m_v=8.2$. M82 is 3.0±0.5
      Mpc from the Earth. If the absolute magnitude of the Sun in the V band is $M_v=-4.82$,
      calculate the V band luminosity (and the uncertainty in that luminosity) of M82 in solar
      luminosities.
   c. Calculate the expected recession velocity of M82, clearly stating any assumptions you
      make.
   d. You make photometric observations of two galaxies in the Perseus cluster of galaxies
      (which is known to have a recession velocity of 5400 km/s), and find them to be $m_1 =
      21.5$ and $m_2 = 13.8$. The absolute magnitudes of elliptical galaxies generally lie in the
      range $-9$ to $-23$ and the absolute magnitudes of spiral galaxies lies in the range $-15$ to
      $-23$. For each of these two galaxies, deduce whether it is likely to be an elliptical, a
      spiral, or whether the identification is not possible from the data.

Question 2

a. Sketch Hubble’s Tuning Fork diagram, and describe the galaxy classification scheme it
   illustrates. Include a discussion of how the physical parameters of these galaxies vary
   across the diagram. (NB: “Sketch” does not mean cut-and-paste an image.)
   b. What type (or types) of galaxy are unrepresented on the Tuning Fork?

Question 3

a. Briefly explain what a HII region is.
   b. How is the gas in a HII region different from the gas in a H$_2$ cloud?
   c. What sort of observation is most commonly used to detect HI gas?
   d. The Kepler satellite detects planets by the dimming produced when they transit across
      stars in Kepler’s field of view.
      i. By how much will the flux from a 1.1 solar mass star decrease when a planet
         the 1.5 times the size as the Earth transits its disk?
      ii. Assuming assume the Earth has a circular orbit, estimate how long the transit of
          an Earth-like planet in a Earth-like orbit across the centre of the disk of a Sun-
          like star, as seen by Kepler, will last. Show your reasoning using suitable figures.
The galaxy NGC2639 is an SBa galaxy with an observed rotation velocity of 280km/s at its ‘standard’ radius of $R_{25}=27.3\text{kpc}$, an apparent B magnitude of 12.22 and its disk appears on the sky to be elliptical in shape, with a major-to-minor axis ratio of 2:1.

a. The B-band “Tully-Fisher” relation for spiral galaxies in its absolute magnitude form is

$$M_B = -9.95 \log(V_{\text{max}}) + 3.15$$

Explain the terms in this equation.

b. Using this equation calculate the absolute magnitude $M_B$ for NGC2639.

c. Then calculate the distance to NGC2639 explaining your reasoning.

d. What additional observation would be required to use this data to obtain an estimate of Hubble’s constant $H_0$. 

Question 4