Physics of Galaxies HW: Set 3
Issue Date: 19/10/17 Hand-In Date: 26/10/17
Students should hand in their exercises by **4.00pm** on the date given above; exercises
will not be accepted for marking later than this. The **Course Title**, the exercise **Set
Number** and the **Student's Name** should be stated clearly.

1. Describe how the *photometric* method for the determination of masses of Galaxies
works. In your answer you should refer to Salpeter *initial mass function*. **[4 marks]**
Describe how the *virial theorem* is used to estimate the masses of *elliptical* galaxies.
[4 marks] Describe how Newtonian dynamics is used to estimate the masses of *spiral*
galaxies. **[2 marks]** What is (i) the name of the method and (ii) physical effect, on
which it is based, for the determination of masses of Galaxies for the above virial
theorem and Newtonian dynamics cases. **[2 marks]**

2. Look up (i) Salpeter initial mass function expression and (ii) mass-luminosity
relation in the lecture notes, then derive the relation for the total luminosity in the
Galaxy as

$$L_{tot} = \frac{\phi_* M_* L_*}{4.3 - \alpha} \left(\frac{M_h}{M_*} \right)^{4.3 - \alpha}.$$

Show each step of the calculation explicitly **[4 marks]**. Explain, without invoking
mathematics, why the total mass of the galaxy is prescribed by low mass stars with
mass M_l, whereas the total luminosity is prescribed by high mass stars with mass M_h.
[2 marks].

3. What are the ranges of values, in solar units, of the mass-luminosity ratios of (a)
elliptical and (b) spiral galaxies using *spectroscopic* methods? What results does
photometric method yield? Comment on the discrepancy **[4 marks]**.

4. Use empirical Mass-Luminosity relation $L/L_{sun} = (M/M_{sun})^{3.3}$ to the estimate mass-
luminosity ratio, in solar units, for an O-type star with mass $M = 50 M_{sun}$ **[1 mark]**.
Compare that to an average human who weighs 70 kg and eats 2400 kcal per day
[4 marks].
Human brain power output is 20% of the total, mass of the brain is 2% of total body
mass. What mass star has the same mass-luminosity ratio, in solar units, as an average
human brain? **[2 marks]**.

29 marks in total