

Exercise Sheet #3

Submit by Tuesday 23-03-2021

Exercise 1. - The Stellar Initial Mass Function

A simplified spiral galaxy consists of a bulge composed only of an old stellar population, and a disk composed of 50 % old (greater than or equal to 10 Gyr) and 50 % young stellar populations. An old stellar population consists only of low-mass stars, whereas a young stellar population consists of stars over the whole mass range. Let bulge and disk contain the same total number of stars each. For simplicity, we separate ‘low-mass’ and ‘high-mass’ stars at $1 M_{\odot}$.

- (a) Consider the Salpeter Initial Mass Function:

$$\xi(M) = \frac{dN}{dM} \Big|_M = \xi_0 M^{-2.35} \quad (1)$$

where $\xi(M)$ is the number of stars within the mass interval $[M, M + dM]$. Assume the lower mass limit to be $0.2 M_{\odot}$ and the upper mass limit to be $100 M_{\odot}$. What fraction of all stars are high-mass stars? (10 points)

Exercise 2. - Flux ratios

From now on, we adopt the highly simplified assumption that all low-mass stars are identical, have $0.5 M_{\odot}$, and that the peak of their emission is at $\lambda = 7500 \text{ \AA}$ (optical *i*-band). Furthermore, let us assume that all high-mass stars are identical, have $3.0 M_{\odot}$, and that the peak of their emission is at $\lambda = 2500 \text{ \AA}$ (near-UV band).

- (a) Determine the effective temperature of a low-mass star, T_{low} , and a high-mass star, T_{high} , assuming that they are black bodies. (10 points)
- (b) For two black bodies of equal sizes that have T_{low} and T_{high} as their temperatures, calculate their flux ratio. (10 points)
- (c) Different from the situation in the previous point, the low-mass and high-mass stars do not have equal sizes, which you can see from the mass-radius relation in Fig. 1. Based on that figure (or the relation from the Lecture 3), and hence on their different surface areas, what is their actual flux ratio at $\lambda = 2500 \text{ \AA}$ and at $\lambda = 7500 \text{ \AA}$? (10 points)
- (d) Using the values from 1(a) and 2(c), what bulge-to-disk luminosity ratio would you measure for this galaxy when observing it with GALEX in the NUV band, and with SDSS in the optical *i*-band? (If you did not succeed in solving 1(a) and/or 2(c), simply provide an equation containing the respective quantities.) (10 points)

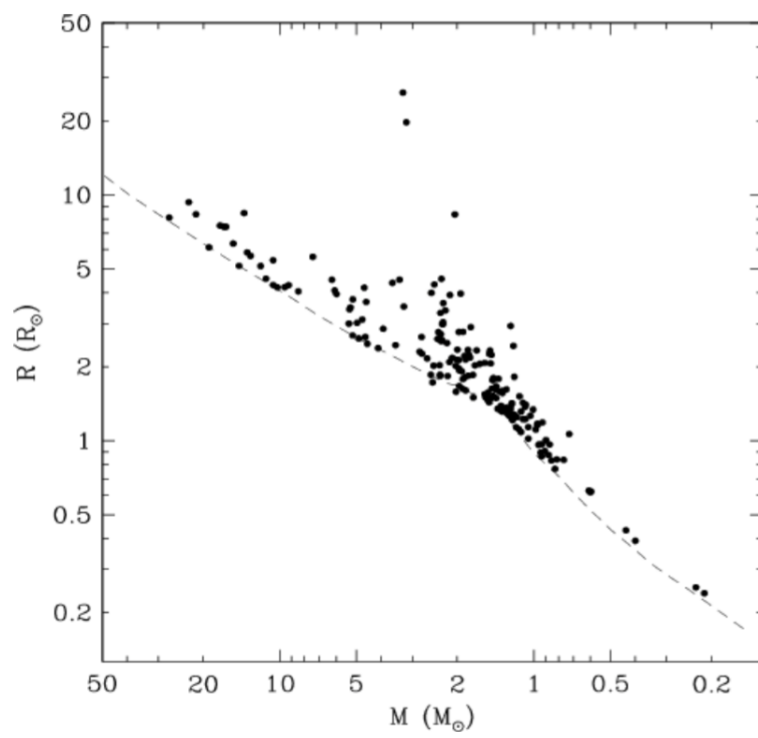


Figure 1: Stellar mass-radius relation.