PHY2029 – Assignment 2
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Question 1:

1a:
The expected probability distribution function (PDF) of a single throw of a 10-faced dice is a uniform distribution, where each face has an equal probability of 0.1 of being rolled.

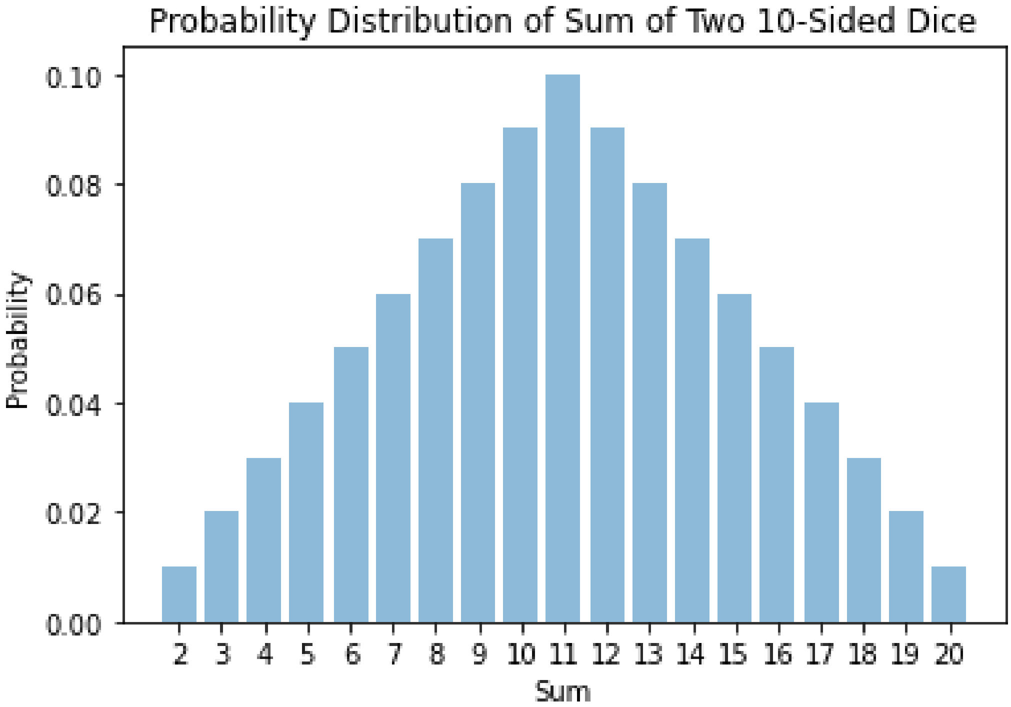
The mean of the distribution can be calculated using $\mu = \frac{a+b}{2}$, (a=minimum value, b=maximum value). The mean is therefore 5.5.

The standard deviation of this distribution can be calculated using $\sigma = \sqrt{\frac{\sum(x_i - \bar{x})^2}{N-1}}$. The standard deviation is calculated to be $\sqrt{8.25}$ = 2.87228 (to 5 decimal places).

1b:
The expected PDF would be a discrete distribution, since the possible outcomes are integers. It would have a peak at the most probable sum (in this case, 11), and would be symmetric around that peak, since the dice are fair and the probabilities are the same for each sum.

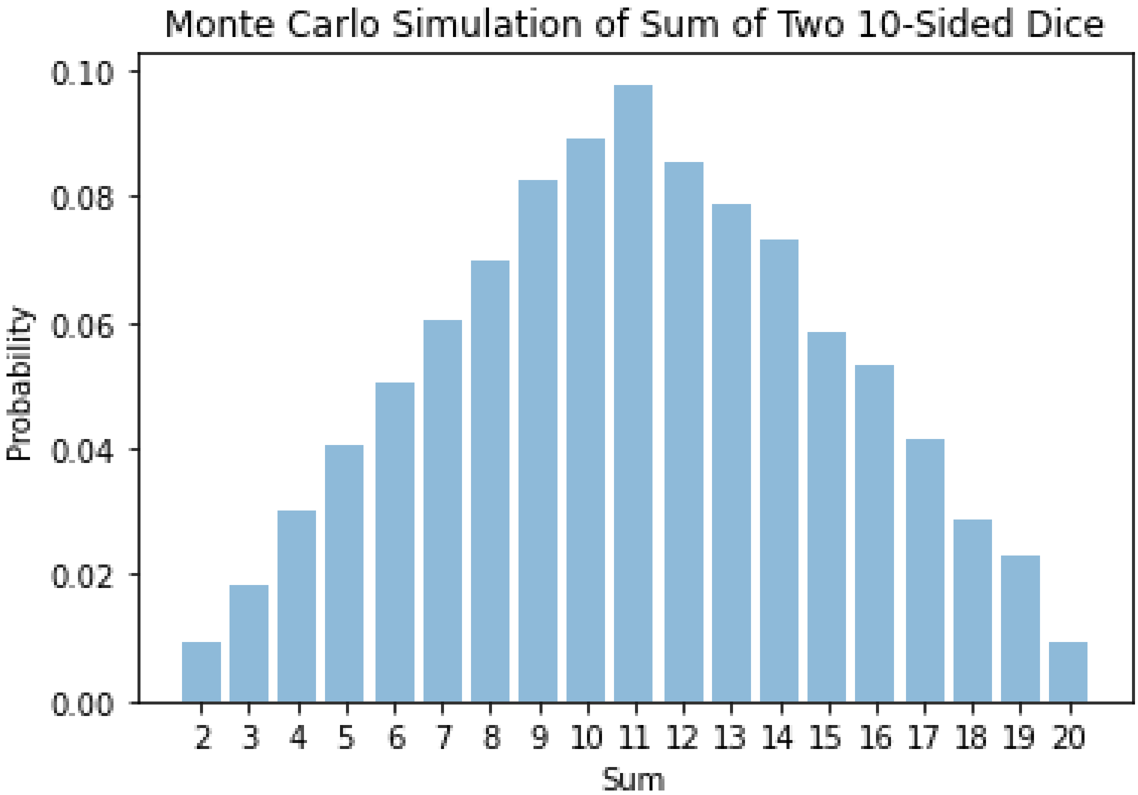
Possible outcomes of the sum of two rolls of a 10-sided dice.

	1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10	11
2	3	4	5	6	7	8	9	10	11	12
3	4	5	6	7	8	9	10	11	12	13
4	5	6	7	8	9	10	11	12	13	14
5	6	7	8	9	10	11	12	13	14	15
6	7	8	9	10	11	12	13	14	15	16
7	8	9	10	11	12	13	14	15	16	17
8	9	10	11	12	13	14	15	16	17	18
9	10	11	12	13	14	15	16	17	18	19
10	11	12	13	14	15	16	17	18	19	20



The mean of the distribution is 11.
The standard deviation of this distribution is $\sqrt{16.5}$ = 4.06202 (to 5 decimal places)

<u>1c:</u>



The Monte Carlo mean from this simulation is 11.0352.
The expected mean from 1b was 11.
The Monte Carlo standard deviation from this simulation was 4.07133 (to 5dp).
The expected standard deviation from 1b was 4.06202 (to 5dp).

The Monte Carlo result for the mean and the standard deviation are very close to the predicted values which confirms the accuracy of the earlier analysis.

1d:

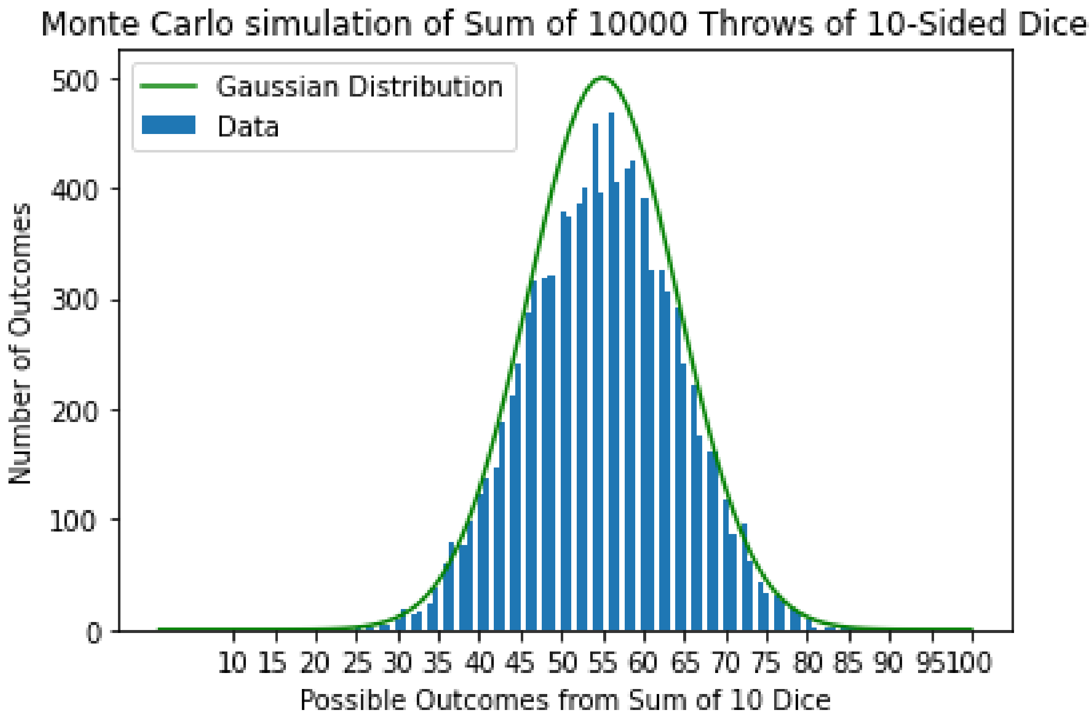


Figure 1d: Monte Carlo simulation of the sum of 10000 throws of 10-sided dice with a gaussian distribution over plotted.

The Gaussian PDF is a good approximation. It manages to fit well to the central mean, but the mean height is slightly too tall for the simulated value. It demonstrates the width of the distribution. This is a fairly accurate to the Monte Carlo PDF.

1e:

The empirical relation between the number of 10-faced dice per throw and the mean and width of the approximate Gaussian is that the greater the number of 10-faced dice the closer the mean of the approximate Gaussian is to the expected mean of 11. The width of the Gaussian is more symmetrical about the mean, and resembles more so the Monte Carlo PDF. As well as this the width of the approximate Gaussian gets closer to the Monte Carlo PDF width.

Question 2:

2a:

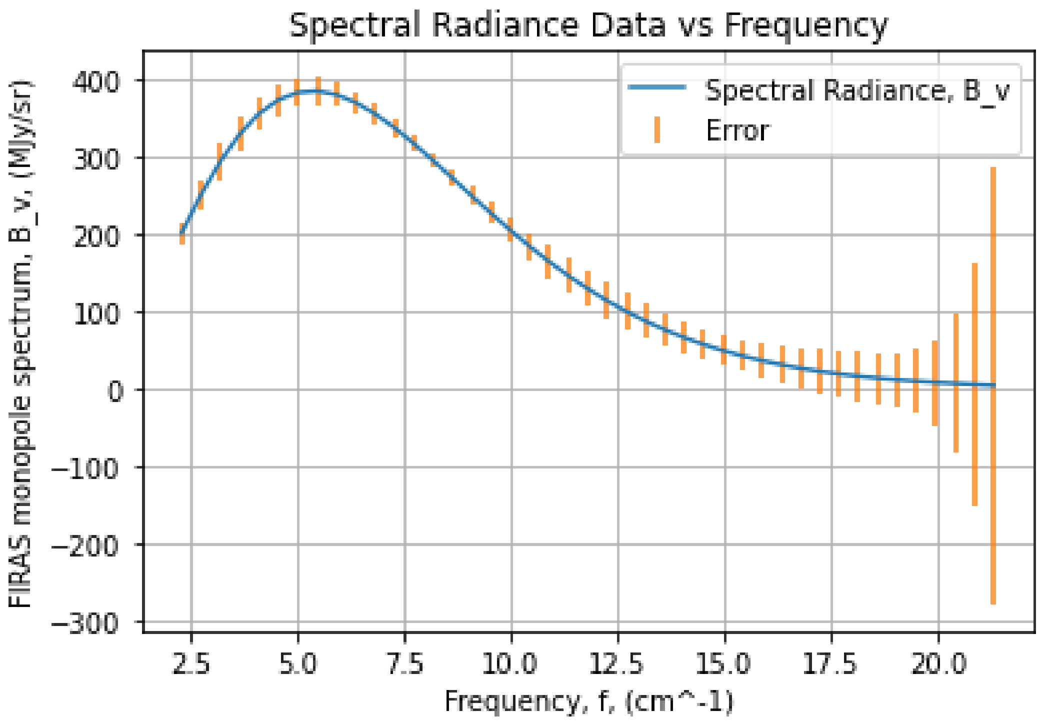


Figure 2a: Plot of spectral radiance against frequency.

The mean of B_v was calculated to be 162.45460 (to 5dp).
The standard deviation of B_v was calculated to be 136.46455 (to 5dp).

A Gaussian function with these parameters cannot approximate the measurements of B_v. Because the plotted graph is not symmetric around a point. The plotted graph is closer to a Poisson distribution, as it is skewed to one side with a long tail.

2b:

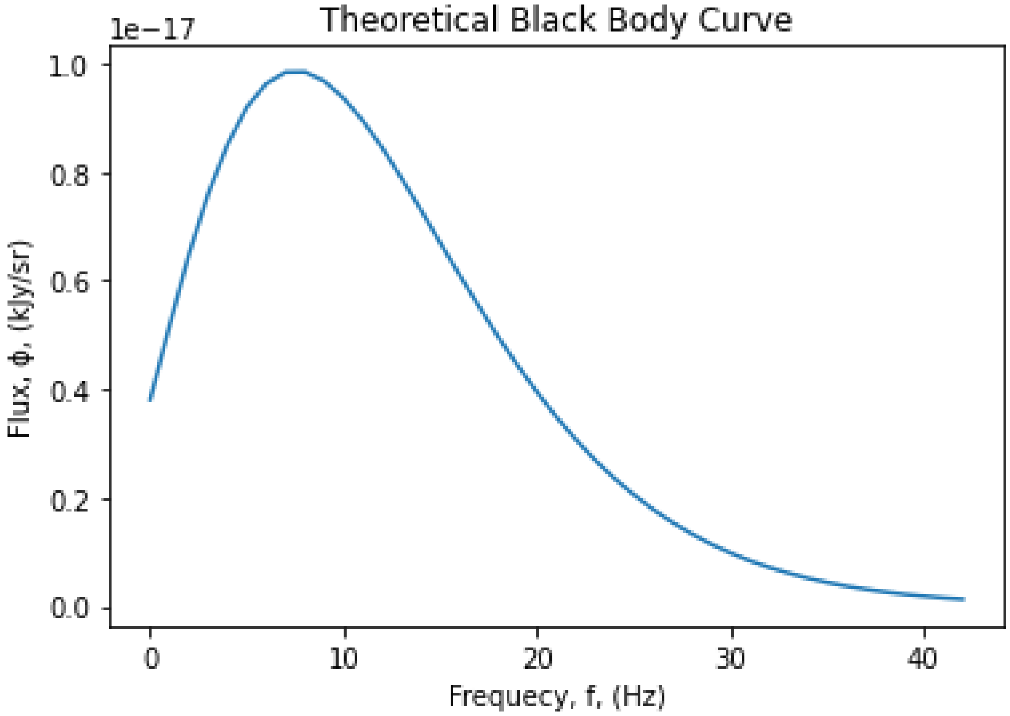


Figure 2b.2: Figure of a theoreticl black body curve at the best fit temerature (2.725K).

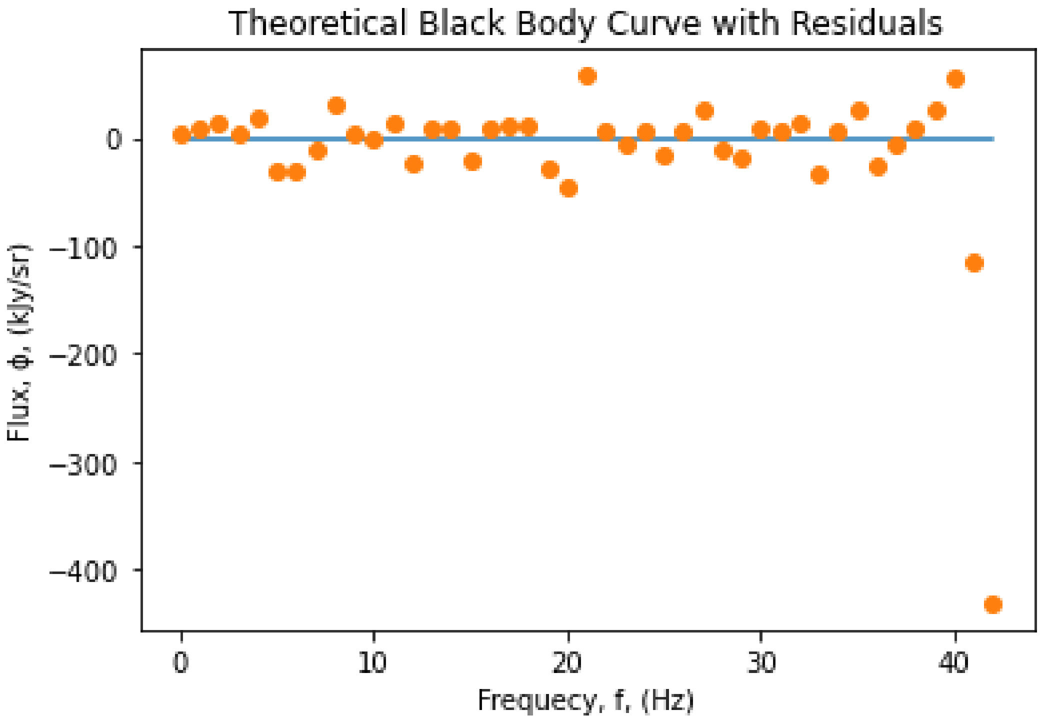


Figure 2b.1: Figure of theoreticl black body curve with overplotted residuals at the best fit temperature (2.725K)

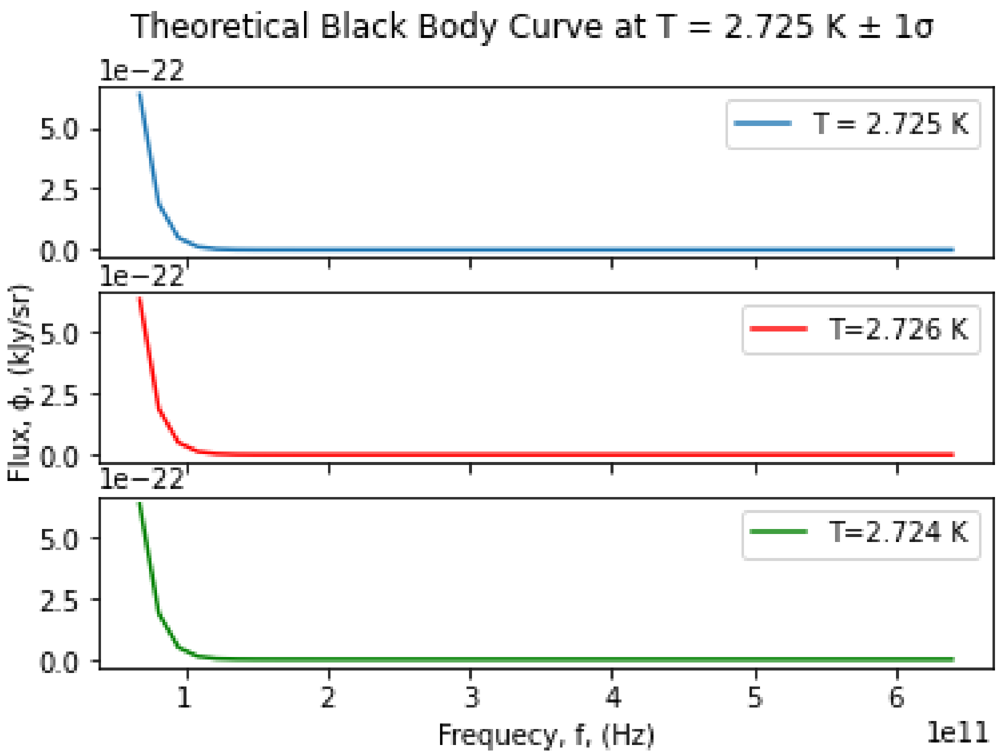


Figure 2b.3: (Top), Plot of theoretical black body curve at best fit temperature (2.725K). (Middle), Plot of theoretical black body curve at +1σ temperature. (Bottom), Plot of theoretical black body curve at -1σ temperature.

I would expect both the ±1σ to have the same ratio when compared to the best-fit temperature.

2c:

Best-fitting temperature = 2.725K
Minimum chi-squared = 103244.516093

2d:

As chi-squared is significantly bigger than one you would expect the fit to be poor

Question 3:

3a:

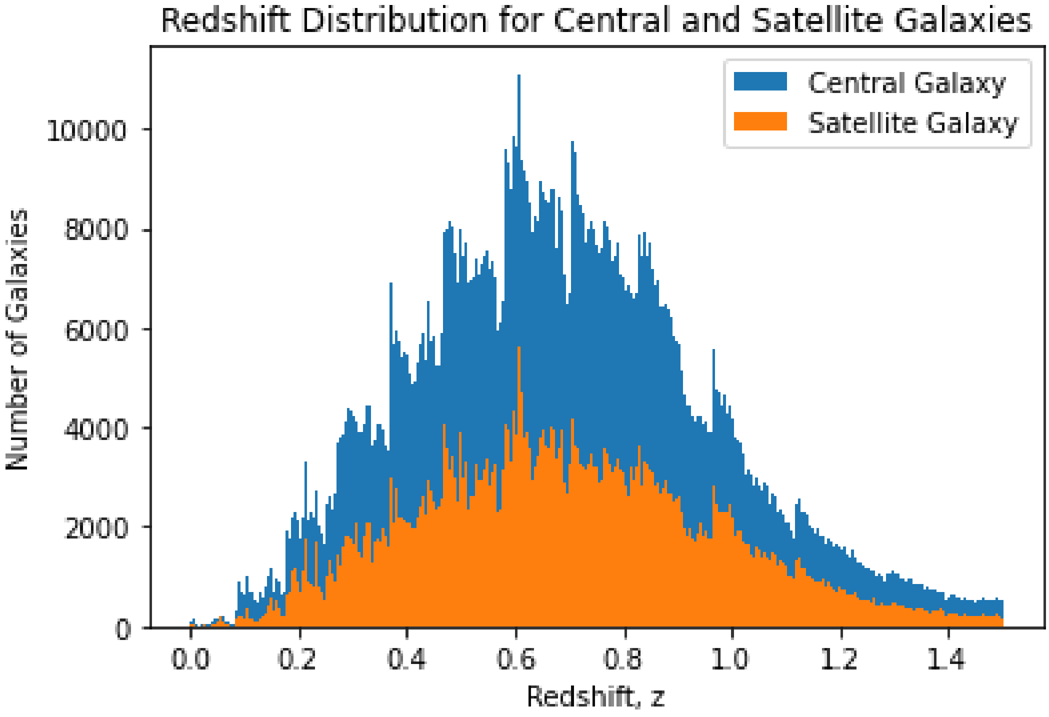


Figure 3a.1: Plot of the redshift distribution for both central and satellite galaxies.

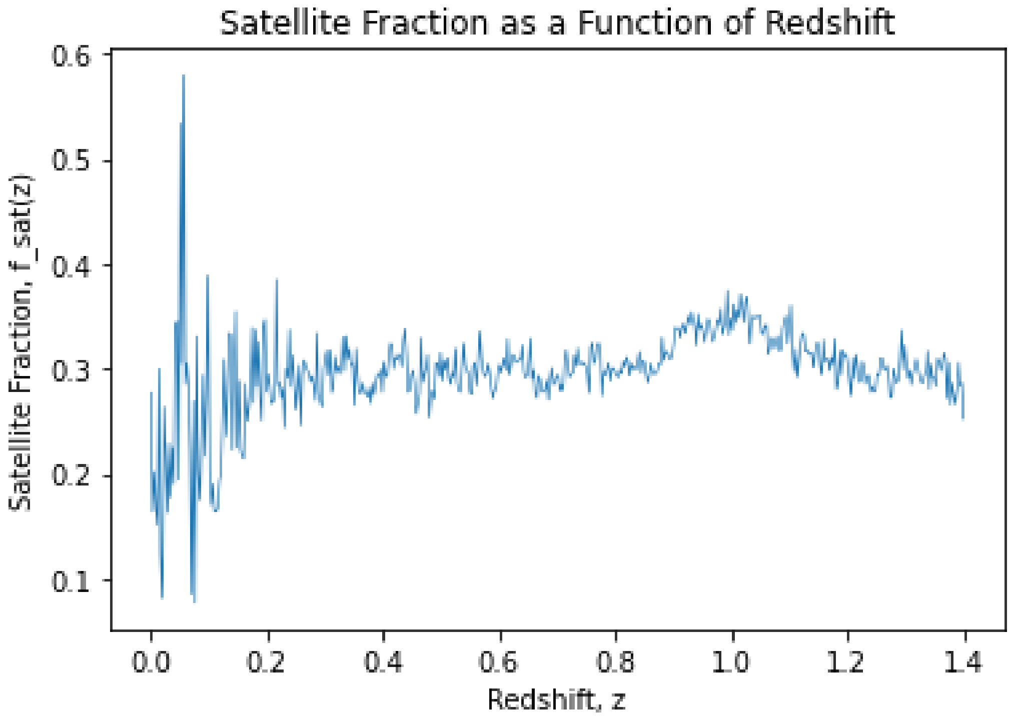


Figure 3a.2: Plot of the satellite fraction of the galaxies as a function of redshift.

3b:

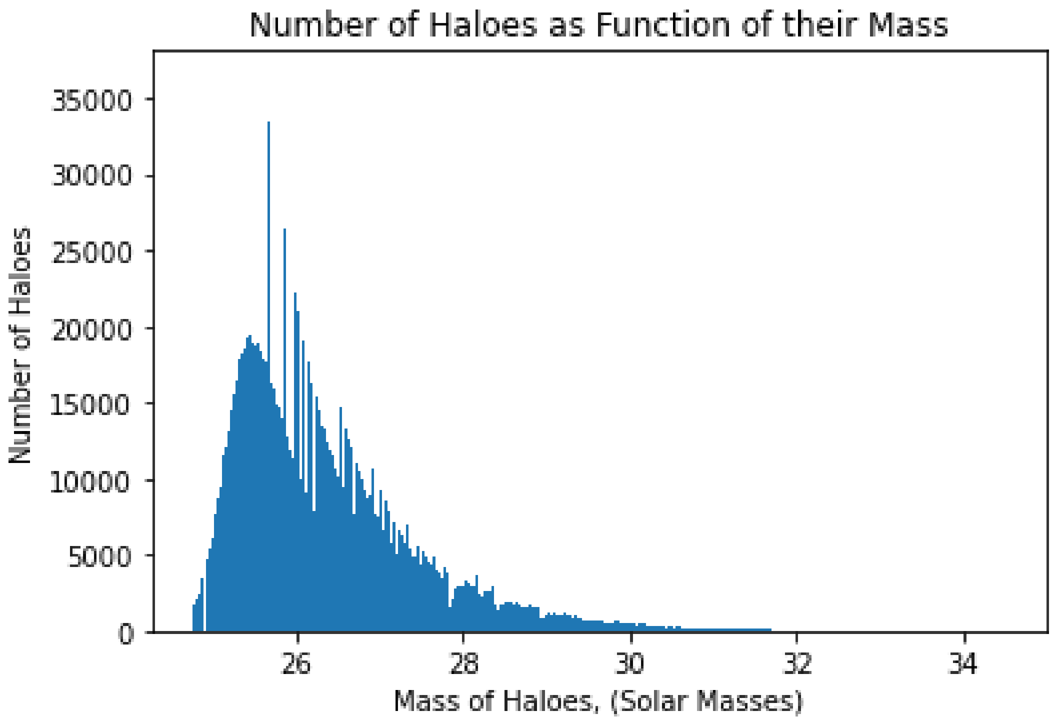


Figure 3b: Plot of the number of haloes as a function of mass.

The most abundant haloes are around the 25-26 solar masses region. And the rarest haloes are at the far region of the graph between 30 solar masses and 32 solar masses.

The reason for this distribution of number of haloes as a function of mass, is related to the way structures form in the universe. Haloes grow though gravitational attraction. However, as the haloes get more massive, their growth slows because the matter density in the universe is not uniform. Large haloes have to wait for rare, massive density fluctuations to accumulate enough matter to grow, while smaller haloes can form more easily.

3c:

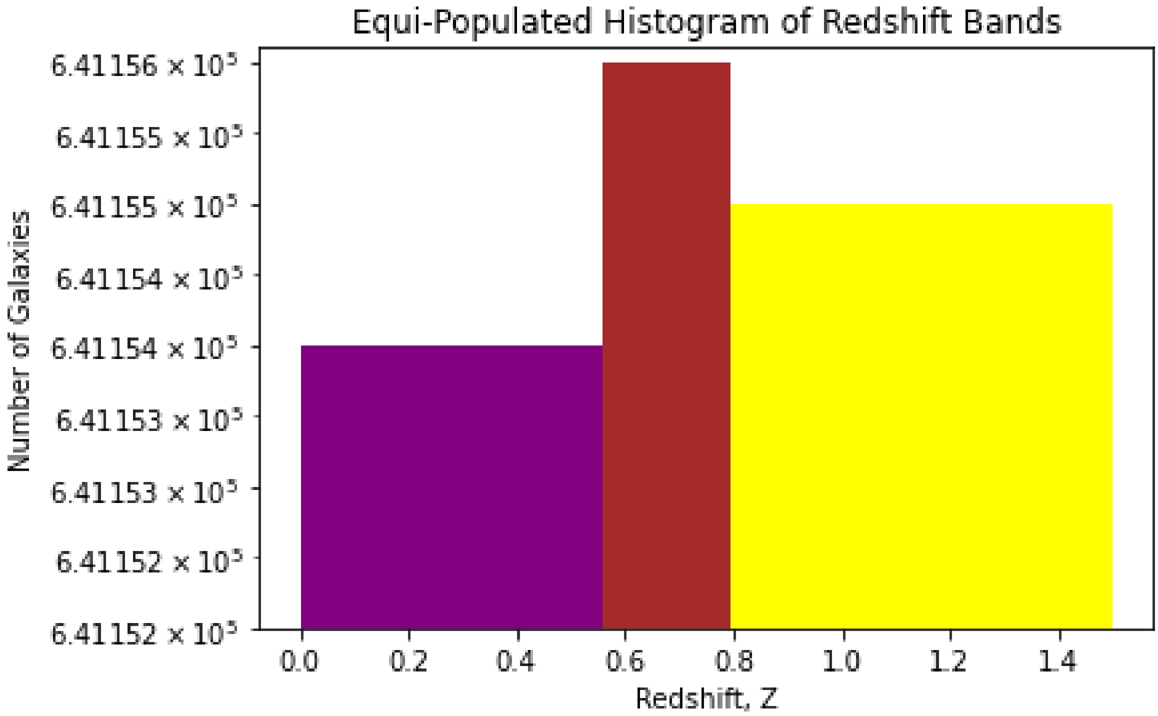


Figure 3c: Plot of the ranking of central galaxies with respect to redshift, split into equi-populated samples of low, medium and high redshift.

The halo mass function is higher at greater redshift. This makes sense because the universe was denser and had a greater rate of structure formation in the past. There is an abundance of massive halos increasing at higher redshifts and decreasing at lower redshifts. Therefore, there is redshift evolution.

3d:

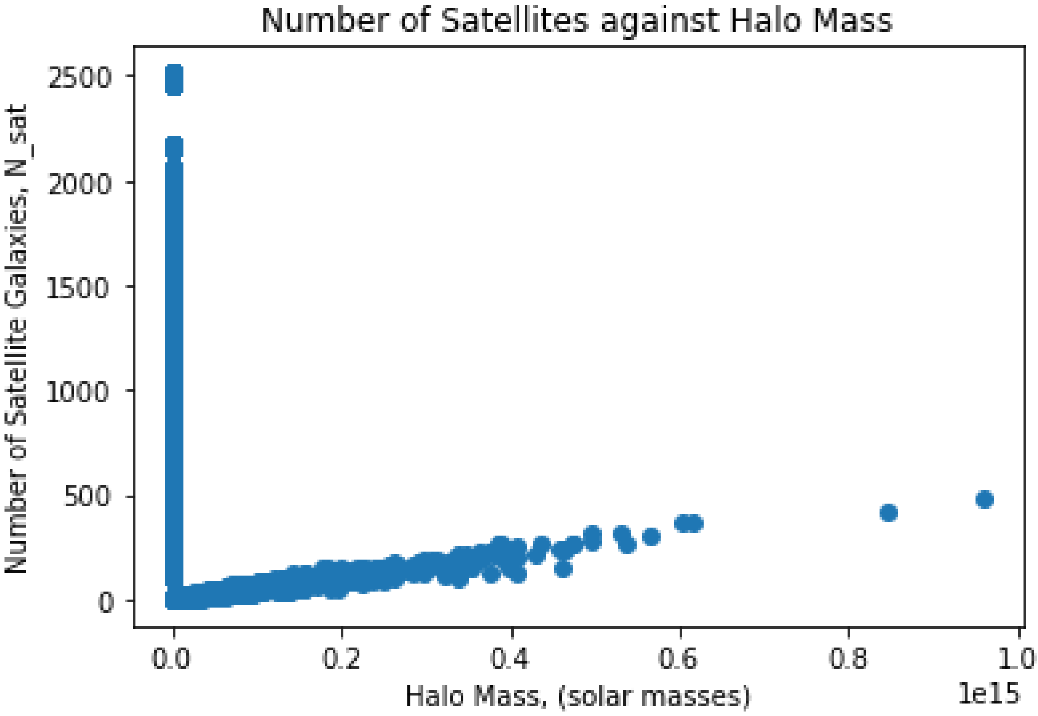


Figure 3d: Plot of the number of satellite galaxies against halo mass.

The mean number of satellites is not increasing with mass. The scatter does increase with mass. There is not a low mass cut off, except for the natural limit of 0. This tells us that the number of galaxes with a low mass halo is much greater than the number of galaxies with a high mass halo. Also, that there is a linear correlation after the initial low mass spike.

Question 4

4a:

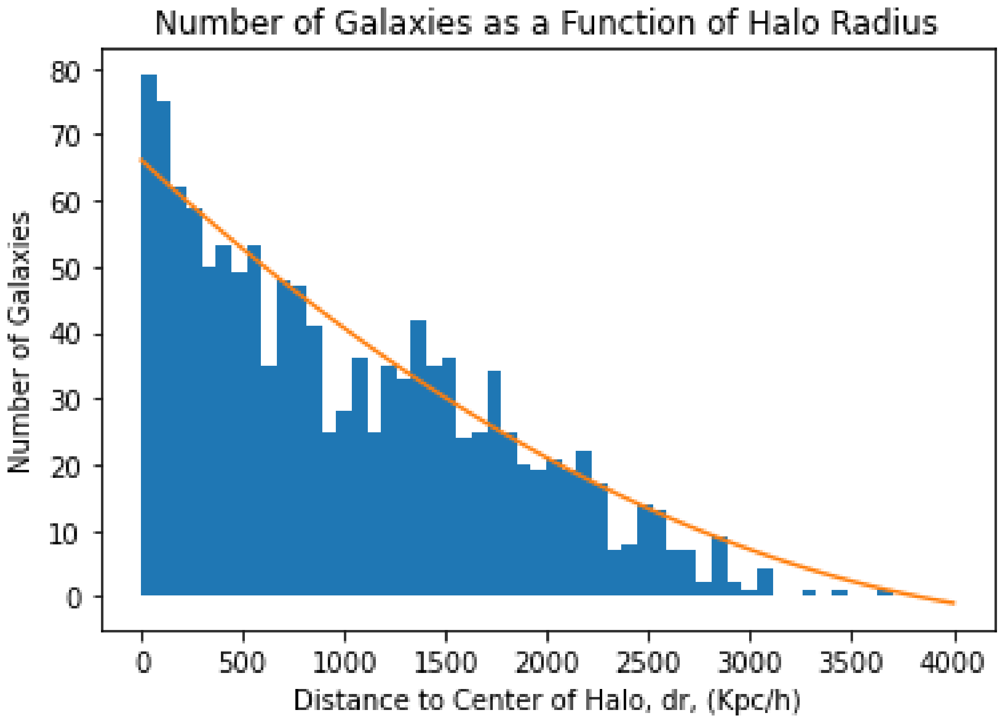


Figure 4a: Plot of the number of satellite galaxies as a function of halo radius.

The profile was fitted with a power law seen in orange.
It has the form: $PDF(dr) \propto dr^{\alpha}$. Where α = -0.6

4c:

I have decided to opt out of question 4c.