ASTP-720 Homework 8

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Github Link: `https://github.com/zrd7527/ASTP720.git`

1 Problem 1

I started this homework by plotting the strain as a function of time data. The plot can be seen in Figure 1 and matches the data plot in the homework description. Next I created a DFT function which takes an array of data and multiplies it by the w coefficient described in class and written in Equation 1. I then wrote a Cooley-Tukey function which recursively breaks up the data into odd and even indices until the threshold value of 32 separate data arrays is reached. Once the threshold is passed, a DFT is performed on each data array. I used the algorithm described in the website at the first link to make my Cooley-Tukey function. I used the second link to order and correctly plot the output of my Cooley-Tukey function. Once I completed those steps my Fourier Transform plot appeared the same as the plot in the homework description. However it was 12 orders of magnitude too large in the amplitude spectrum. I manually offset the output of the Fourier Transform to match the plot in the description. Next I used Equations 2 and 3 to solve for the total binary mass in terms of the separation radius, shown in Equation 4. Plugging the result back into Equation 3 and using the given distance of 12 parsecs allowed me to solve for the separation radius in Equation 5. I found the binary separation to be 0.85 AU. Finally I put that answer into Equation 2 and solved for the binary mass in Equation 6. The mass I found is 23164 solar masses which is too large. This large mass may be due to the strange offset I put into my Fourier Transform.

The links I used: `https://jakevdp.github.io/blog/2013/08/28/understanding-the-fft/` `https://www.mathworks.com/matlabcentral/answers/479730-convert-time-to-frequency-domain`

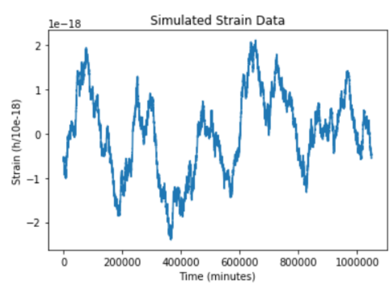

Figure 1

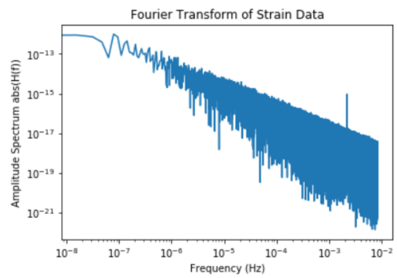

Figure 2

$$w = e^{-2\pi i k \frac{n}{N}} \tag{1}$$

$$h \approx 2.6 \times 10^{-21} (\frac{M}{M\odot})^2 (\frac{D}{pc})^{-1} (\frac{R}{R\odot})^{-1} \tag{2}$$

$$f_{gw} \approx 10^{-4} Hz (\frac{M}{M\odot})^{1/2} (\frac{R}{R\odot})^{-3/2} \tag{3}$$

$$(\frac{M}{M\odot}) \approx [3.8 \times 10^{16} Hz (\frac{h}{f_{gw}}) (\frac{D}{pc}) (\frac{R}{R\odot})^{-1/2}]^{2/3} \tag{4}$$

$$(\frac{R}{R\odot}) \approx [\frac{f_{gw}^2}{(3.8 \times 10^{12} Hz^2) h} (\frac{D}{pc})^{-1}]^{-3/5} \tag{5}$$

$$(\frac{M}{M\odot}) \approx [\frac{h}{2.6 \times 10^{-21}} (\frac{D}{pc}) (\frac{R}{R\odot})]^{1/2} \tag{6}$$