

Week Two Update

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Gravitational Wave Modeling of the Galactic White Dwarf Confusion Noise

- Developed an intuitive physical understanding of these systems

- Developed an understanding of the $G=c=1$ convention

- Calculated some characteristic timescales on which the system evolves

- Wrote a program to evolve the orbital frequency and eccentricity of the systems

- Determined the need for relativistic PN terms in our differential equations

- Wrote a program to calculate the relative power radiated at each orbital harmonic

Goal :

Model the gravitational waves put off by the galactic population of binary white dwarf systems, and determine their effect on future Laser Interferometer Space Antenna (LISA) observations.

1) $\nu/d\nu dt$

Time it takes (in seconds) for the GW radiation to change the orbital frequency significantly

A Characteristic Time Scale

Given different values of eccentricity

```
▶ print( $\nu/d\nu dt(0.01)$ )  
print( $\nu/d\nu dt(0.1)$ )  
print( $\nu/d\nu dt(0.5)$ )  
print( $\nu/d\nu dt(0.9)$ )  
print( $\nu/d\nu dt(0.99)$ )
```

```
233880835385.31375  
219266754790.89542  
47915423232.904106  
188264290.17771202  
59791.405036493954
```

```
In [13]: ▶ def delta_nu(dnu_dt, delta_t):  
           delta_nu = dnu_dt * delta_t  
           return delta_nu
```

```
In [14]: ▶ v1 = delta_nu(dnu_dt0, tf)
```

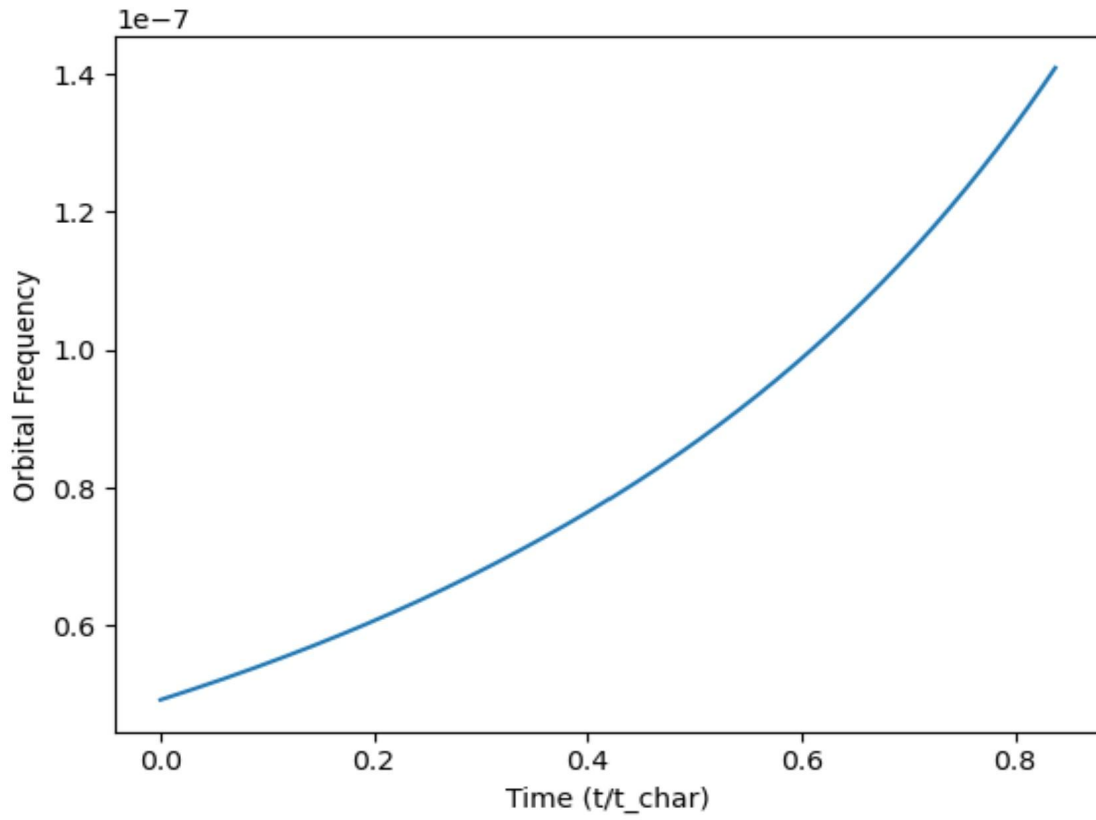
```
In [15]: ▶ def delta_e(dedt, delta_t):  
           delta_e = dedt * delta_t  
           return delta_e
```

```
In [16]: ▶ v2 = delta_e(dedt0, tf)
```

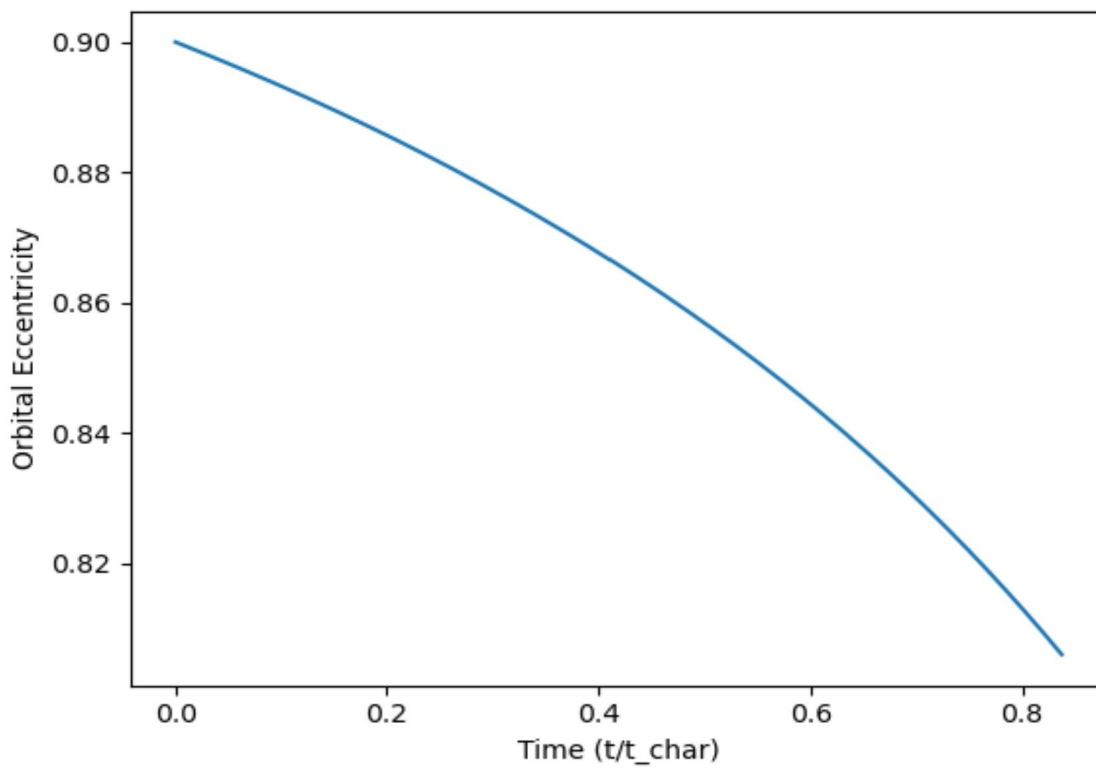
```
In [18]: ▶ print(v1*t_M*t_char) #Estimated change in  $\nu$  *  $t_M$  over 5 years  
           print(v1*t_char) #Estimated change in  $\nu$  over 5 years  
           print(v2*t_char) #Estimated change in eccentricity over 5 years
```

```
4.1267569592717434e-08  
0.008375459831025736  
-0.053789902899678256
```

Evolution of Orbital Frequency



Evolution of Orbital Eccentricity



Comparison between non-PN and PN values

Given different values of eccentricity

It appears the PN values do not contribute significantly

```
In [86]: # e = 0.01
print(dnudt2(0.01))
print(dnudt(0.01))
print(dnudt2(0.01)/dnudt(0.01))

print(dedt2(0.01))
print(dedt(0.01))
print(dedt2(0.01)/dedt(0.01))

4.276420612080573e-14
4.275681666488496e-14
1.0001728252123792
-4.512427429687934e-14
-4.511575546662131e-14
1.0001888216249495
```

