

# CITA computing project

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The goal of this project is to simulate two double white dwarf populations with COSMIC<sup>1</sup>, a binary population synthesis suite and compare their output.

## 1 Getting familiar with COSMIC

1. Install COSMIC by cloning from the Github repository
2. Simulate 3 binaries that produce a WD + WD, NS + NS, and BH + BH system and plot the time evolution of their masses, orbital period, and eccentricity from Zero Age Main Sequence to the formation of the second remnant (WD/NS/BH). This will take some trial and error with the initial conditions.
3. Simulate a grid of binaries with an initial orbital period of 50 days, initial eccentricity of 0.5, primary masses ranging from 10 to 100  $M_{\odot}$  in 10  $M_{\odot}$  increments, and 10 secondary masses for each primary mass with a mass ratio ranging from 0.1 to 1.0. Plot the orbital period at the formation of the second stellar remnant as a function of mass ratio for each primary mass.

## 2 Simulating double white dwarf populations

1. Initialize 1,000,000 binaries with the independent initial condition sampler using the following models: primary masses following kroupa01, eccentricity following a uniform distribution, orbital periods following sana12, a burst of star formation 13.7 Gyr in the past with a duration 0.0 yr, all with solar metallicity:  $Z=0.017$ .
2. Evolve all of these with the standard BSEDict from the COSMIC documentation.
3. Select all WD + WD binaries at the formation of the second WD and plot a histogram of their ages, masses, and orbital periods.
4. Write two functions based on the equations in Peters (1964) for circular binaries: one to evolve the WD + WD binary semimajor axis as a function of time due to GW emission; and one which calculates the merger time.
5. Calculate the time between the ZAMS formation of the WD + WD binaries and their merger times (also called a delay time), and plot a histogram of the delay time distribution for the population.
6. Repeat the process above but change the alpha parameter in the BSEDict from 1 to 0.25.
7. Compare the delay time distributions and WD + WD formation distributions to describe how this change affects the population

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<sup>1</sup><https://github.com/COSMIC-PopSynth/COSMIC>