

This past summer, I was a research intern at the Center for Interdisciplinary Exploration and Research in Astrophysics at Northwestern University. I worked under the guidance of a graduate student, Katie Breivik, and Professor Vicky Kalogera. My task was to create a database of neutron star and black hole binaries from different binary evolution models; the database was to be used to investigate how different models influence the number and properties of these binaries observable by LIGO. Under their instruction, I used a computer program called COSMIC (Compact Object Synthesis and Monte-Carlo Investigation Code), which in turn utilized BSE (Binary Star Evolution code), to simulate binary star evolutions and record the occurrences of three outcomes (neutron star-neutron star binaries, neutron star-black hole binaries, and black hole-black hole binaries). COSMIC is designed to supply a population of binaries to be evolved by BSE and selects only binaries that match user-inputted conditions, thus allowing for more concentration on the formation and evolution of specific binary populations. Through remote access of Northwestern's supercomputer, Quest, I used COSMIC to simulate 18 different models for each of the three binary types aforementioned. Within each model, I tested 10 different metallicities, a condition in star environments describing the amount of non-hydrogen particles in the surrounding atmosphere. Each program ran on 20 cores, and each core sampled 10,000 binary star systems resulting in 200,000 simulated binaries. We evolved each binary for 13.82 billion years to investigate the total evolution possible over the age of the Universe. Each model changed one or two aspects of a fiducial model to investigate the effects of each model separately. We investigated different models for mass transfer between the binary components, common envelope evolution, and natal kicks from the formation of neutrons stars and black holes. Aside

from inputting the parameters and running, saving, and organizing the results for each program, I debugged COSMIC and BSE and coded in Python to graph my initial results, gaining experience with both FORTRAN and Python.