Large-Scale Multi-Messenger Simulation of White Dwarfs in the LISA Era

Shotton, Anabelle (School: Dobbs Ferry High School)

The discovery of gravitational waves (GW) has brought about the development of new detectors, including the Laser Interferometer Space Antenna (LISA), which will detect white dwarf (WD) binaries (Hughes, 2006). Previous research has found that multi-messenger (MM) data, or analysis combining both GW and electromagnetic radiation (EMR) data, can more precisely measure WD qualities than individual data types alone (Johnson et al., 2021; Shah et al., 2012). This study utilized the COSMIC software, created by Breivik et al. (2020), which simulates data of Milky Way-like galaxies. Analyses were performed on this data to determine the percent confidence of accurate WD composition predictions when using GW, EMR, or MM data. One galaxy's worth of WD data from COSMIC, containing 12182 WD binaries, was split into two halves, one used as a 'known' set and the other as a 'detected' set. Random error was added to the mass values of WD binaries in the 'detected' set, as well as a filter for EMR detectability, and their compositions were predicted based on the 'known' data. It was found that predictions based on MM data were typically more accurate than on GW data, and sometimes more accurate than on EMR data. When MM predictions were more accurate than EMR predictions, it was by a large factor, indicating the value of MM analysis in mitigating the random error in GW and EMR detections alone. However, only 4.5% of LISA-detectable data was EMR-detectable, indicating a limitation of MM analysis. These findings may be confirmed and built upon with observational data when LISA launches in 2035, and they highlight the need for LISA and EMR astronomers to collaborate when that time comes.

Awards Won: