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Building a Complete Analytic Model for Gravitational Waves[1]

DILLON BUSKIRK, Marshall Univ — With the recent discovery of gravitational waves and electromagnetic counterparts, the era of multi-messenger gravitational wave astronomy has begun. Crucial to the success of this new science is the need for accurate and efficient templates for modeling gravitational waves emitted by a large class of compact binaries. This work presents the analytical calculation of gravitational waveforms in the detected range, using tools easily accessible to undergraduate research students, such as Mathematica and Python. The inspiral case is described with the 3^{rd} order post-Newtonian method, and the merger phase employs the Implicit Rotating Source model. With these inspiral and merger models, we calculated the real and imaginary waveforms for a range of five different mass parameters corresponding to each the LIGO-Virgo signals detected since September 14, 2015. We explore new techniques of matching the waveforms for each phase, to determine the best suited method to analytically build a complete gravitational waveform. Next we compare our results with the filtered waveforms provided by LIGO, and with numerical simulations. Further work will allow for a model with less limitations, such as nonzero eccentricity.

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Dillon Buskirk
Marshall Univ

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