DL11349/Kumar – Summary of changes

Prayush Kumar, Ilana MacDonald, Duncan A. Brown,
Harald P. Pfeiffer, Kipp Cannon, Michael Boyle,
Lawrence E. Kidder, Abdul H. Mroué, Mark A. Scheel,
Béla Szilágyi and Anıl Zenginoğlu

January 6, 2014

We summarize the changes that have been made to the manuscript, in response to the referee's comments and suggestions. We would like to the thank the referee for carefully reading through the manuscript and their constructive suggestions.

As suggested by the referee:

1. We use the manifold of Effective-One-Body (EOBNRv2) waveforms for the construction of template banks. In the first version of the manuscript, this was justified in Section III, where we describe the method for quantification of template bank effectualness (above Eq. 18). To clarify this reasoning earlier to the reader, the following text has been added to the Introduction:
"The bank placement algorithm uses the EOB model from Ref. [53] (EOBNRv2). As this model was calibrated against NR for most of these mass-ratios, we expect the manifold of EOBNRv2 to be a reasonable approximation for the NR manifold. In Sec. V, we demonstrate that this approximation holds well for NR-PN hybrids as well."

2. In Section II A, a typographical error has been rectified, changing
"... Einsteins equations." to *"... Einstein's equations."*

3. A column has been added to Table I, which includes information about the starting frequency of each of the listed Numerical Relativity simulation. This information is presented in the form of the value of the binary mass for which the gravitational-waves extracted from the (respective) simulation start at 15 Hz. This particular frequency is significant because it is expected to be the lower bound on the sensitive frequency band of the Advanced LIGO-Virgo detectors.

4. In Section IV, we describe the stochastic construction of template banks. As the fraction of accepted proposals decreases, the fraction of the total parameter space, that is covered at the desired density increases. Both asymptotically approach 0 and 1, respectively, as the bank construction algorithm converges. We terminate the Monte Carlo sampling process when the fraction of the parameter space covered is $\gtrsim 0.99$. In the first version of the manuscript, this was described as: *"And the coverage fraction of the bank is 99%."* This has been re-phrased as: *"The process is repeated till the fraction of proposals being accepted falls below* $\sim 10^{-4}$*, and* $\gtrsim 99\%$ *of the parameter space is covered effectually."*

5. In Section IV, we have clarified that while completing the coverage of the stochastically constructed bank, we push the points sampled in the under-covered regions of the parameter space to the closest allowed values of the mass-ratio – along lines of constant chirp mass. We have changed *"... pushing their mass-ratios to the two neighboring mass-ratio from* $\mathcal{S}_q$*"* to *"... pushing their mass-ratios to the two neighboring mass-ratios from* $\mathcal{S}_q$ *along lines of constant chirp mass"*.

6. In Section V, the following statement about the sensitivity of the Advanced LIGO-Virgo detectors, *"The detectors will be relatively very sensitive to a relatively short frequency band."*, has been rephrased as: *"The detectors will be most sensitive in a comparatively narrow frequency band."*

7. In Section V, we describe two independent methods of constructing hybrid waveform template banks. For the second method, the spacing between neighboring templates is obtained by requiring a fixed value of inner product between them. We have added a description of how the first template (for each unique value of mass-ratio) is chosen. We replaced the following text, *"The spacing between neighboring templates is given by requiring that the overlap between them be 97%. We take the union of these banks as the final two-dimensional bank."*, with *"The template with the lowest total mass is chosen by requiring the hybrid mismatch to be* 3% *at that point. The spacing between neighboring templates is given by requiring that the overlap between them be* 97%*. We take the union of these banks as the final two-dimensional bank."*

Other changes:

1. The second paragraph in Section V (describing Figure 5) gives the orbital frequencies at which the post-Newtonian waveforms were stitched to the Numerical Relativity waveforms to obtain the hybrids that we use in this work. Also given is the number of orbits – *before merger* – that these frequencies correspond to. We discovered that, due to the inclusion of ringdown cycles, the numbers of orbits stated were artificially elevated. These have been re-computed, and corrected in the manuscript, making sure that the number of orbits stated in the updated version include only the inspiral and merger portions of the waveform (and not the *ringdown*). The following text, *"In terms of number of orbits before merger, this is 31.9 orbits for* $q = 1$*, 17.8 orbits for* $q = 2$*, 16.9 orbits for* $q = 3$*, 18.4 orbits for* $q = 4$*, 21.6 orbits for* $q = 6$*, and 25.1 orbits for* $q = 8$*."*, has been changed to *"In terms of number of orbits before merger, this is 26.9 orbits for* $q = 1$*, 13.6 orbits for* $q = 2$*, 12.6 orbits for* $q = 3$*, 14.3 orbits for* $q = 4$*, 17.8 orbits for* $q = 6$*, and 21.4 orbits for* $q = 8$*."*. The updated information is consistent with Table I.

2. In Figure 5 and its inset figure, the black circles indicate the lowest binary total masses for which the Numerical Relativity waveforms start at 15 Hz. We discovered a problem with the formula used to compute these masses (only for the "NR-only" points). This figure has been updated with the correct values for all mass-ratios. The updated information is consistent with Table I.