Third RIT binary black hole simulations catalog

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The third release of the RIT public catalog of numerical relativity black-hole-binary waveforms http://ccrg.rit.edu/~RITCatalog consists of 777 accurate simulations that include 300 precessing and 477 nonprecessing binary systems with mass ratios $q = m_1/m_2$ in the range $1/15 \leq q \leq 1$ and individual spins up to $s/m^2 = 0.95$. The catalog also provides initial parameters of the binary, trajectory information, peak radiation, and final remnant black hole properties. The waveforms are corrected for the center-of-mass drifting and are extrapolated to future null infinity. We successfully test this correction comparing with simulations of low radiation content initial data. As an initial application of this waveform catalog we reanalyze all the peak radiation and remnant properties to find new, simple, correlations among them for practical astrophysical usage.

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I. INTRODUCTION

Since the breakthroughs [1–3] in numerical relativity that solved the binary black hole problem, those techniques have been used to explore the late dynamics of spinning black-hole binaries beyond the post-Newtonian regime for several years. The first generic, long-term precessing black-hole binary evolutions (i.e., without any symmetry) were performed in Ref. [4], where a detailed comparison with post-Newtonian $\ell = 2, 3$ waveforms was made. Numerical simulations have then started to explore the corners of parameter space, and these include near extremal [5] with $\chi = 0.99$ spinning black-hole binaries in Refs. [6,7], mass ratios as small as $q = 1/128$ in Ref. [8], and large initial separations, $R = 100m$, in Ref. [9], as well as very long waveforms starting at proper separations of $25m$ for a precessing binary in [10] and for a nonspinning binary with 176 orbits in Ref. [11].

Other important studies include the exploration of the *hang-up* effect, i.e., the role individual black-hole spins play to delay or accelerate their merger [12–15], the determination of the magnitude and direction of the *recoil* velocity of the final merged black hole [16–23], and the *flip flop* of individual spins during the orbital phase [10,24,25], as well as precession dynamics [26–30] and the inclusion of those dynamics to construct surrogate models for gravitational waveforms [31–33].

Numerical relativity breakthroughs [1–3] led to detailed predictions of the gravitational waves from the late inspiral, plunge, merger, and ringdown of black-hole-binary systems (BHB). These predictions helped to accurately identify the first direct detection [34] of gravitational waves with such binary black hole systems [35–38] and match them to targeted supercomputer simulations [39–41].

There have been several significant efforts to coordinate numerical relativity simulations to support gravitational wave observations. These include the numerical injection analysis (NINJA) project [42–45], the numerical relativity and analytical relativity (NRAR) collaboration [46], and the waveform catalogs released by the SXS collaboration [47–50], Georgia Tech. [51], and RIT [52,53].

In this paper we describe a new release of the public waveform catalog by the RIT numerical relativity group that total 777 simulations by adding a new set of 457 waveforms, with 203 aligned spins and 254 precessing binaries. The catalog includes all waveform modes $\ell \leq 4$ modes of ψ_4 and the strain h (both extrapolated to null infinity) and is updated to correct for the center-of-mass displacement during inspiral and after merger. The catalog can be accessed from http://ccrg.rit.edu/~RITCatalog.

This paper is organized as follows. In Sec. II we briefly describe the methods and criteria for producing the numerical simulations, the new center-of-mass correction and evaluation of their errors in order to be included in the RIT catalog. In Sec. III we describe the relevant BHB parameters, the file format, and the content of the data in the catalog. A more detailed set of the results is given in Sec. III A and in the Appendix A. We conclude in Sec. IV with a discussion of the future use of this catalog for parameter inference of new gravitational wave events and the extensions to this work to longer, more generic precessing binaries.

II. FULL NUMERICAL EVOLUTIONS

The simulations in the RIT Catalog were evolved using the LAZEV code [54] implementation of the moving

puncture approach [2] (with the modifications suggested by Ref. [55]). In all cases (except the very high spin where we use CCZ4 [56]) we use the BSSNOK (Baumgarte-Shapiro-Shibata-Nakamura-Oohara-Kojima) family of evolutions systems [57–59]. For the runs in the catalog, we used a variety of finite-difference orders, Kreiss-Oliger dissipation orders, and Courant factors [60–62]. All of these are given in the metadata included in the catalog and the references associated with each run (where detailed studies have been performed).

The LAZEV code uses the CACTUS [63] / CARPET [64] / EINSTEINTOOLKIT [65,66] infrastructure. The CARPET mesh refinement driver provides a "moving boxes" style of mesh refinement. In this approach, refined grids of fixed size are arranged about the coordinate centers of both holes. The code then moves these fine grids about the computational domain by following the trajectories of the two black holes (BHs).

We use AHFINDERDIRECT [67] to locate apparent horizons. We first measure the magnitude of the horizon spin using the *isolated horizon* (IH) algorithm detailed in Ref. [68] (as implemented in Ref. [69]). Once we have the horizon spin, we can calculate the horizon mass via the Christodoulou formula $m_H = \sqrt{m_{\rm irr}^2 + S_H^2/(4m_{\rm irr}^2)}$, where $m_{\rm irr} = \sqrt{A/(16\pi)}$ and A is the surface area of the horizon.

To compute the numerical (Bowen-York) initial data, we use the puncture approach [70] along with the TWOPUNCTURES [71] code. To compute initial low eccentricity orbital parameters, we use the third. post-Newtonian techniques described in [72] to determine quasicircular orbits. We then evaluate the residual eccentricity during evolution via the simple formula, as a function of the separation of the holes, d, $e_d = d^2\ddot{d}/m$, as given in [4]. If needed, an iterative method for eccentricity reduction can be applied [73,74].

To generate more realistic initial data with reduced spurious gravitational wave content, in Ref. [75] we have chosen a background ansatz as a conformal superposition of (possibly boosted) Kerr spatial metrics. These new initial data, labeled as HiSpID when compared with the well-known Bowen-York solutions, produce up to an order of magnitude reduction in the initial unphysical gravitational radiation signature. Those HiSpID data are relevant for nonspinning as well as very highly spinning black holes in a binary [7] and high energy collisions [76]. To generate those data we generalize the TWOPUNCTURES code [71] to solve a coupled system of the Hamiltonian and momentum constraints. We can thus evolve arbitrarily highly spinning black holes in quasicircular orbits with unequal masses and different spin orientations [77]. We will use these data for evolving highly spinning binaries with intrinsic spins $\alpha_i = S_i/m_i^2 > 0.9$.

As discussed in Ref. [52] the main sources of numerical errors in this catalog are due to finite difference truncation, finite extraction radii, use of finite number of modes, the nonzero residual initial eccentricities, and displacement of the center of mass. During the early inspiral, the irreducible masses and intrinsic spins of each black hole should be nearly constant because the levels of gravitational wave energy and momentum absorbed by the holes is 4–5 orders of magnitude smaller [78] than those emitted to infinity. During a simulation, the masses and spins variations are dominated by numerical truncation error. We then use these variations on the horizon masses and spins as a measure of the size of the truncation error. For our current simulations we monitor accuracy by measuring the conservation of the individual horizon masses and spins during evolution, as well as the level of satisfaction of the Hamiltonian and momentum constraints, to ensure reaching an accuracy consistent with our main applications. Those measurements are seen to be preserved during evolution to at least one part in 10^4 in the cases of the masses and one part in 10^3 in the cases of the spins (see for instance Fig. 6 in Ref. [30]).

We measure radiated energy, linear momentum, and angular momentum, in terms of the radiative Weyl scalar ψ_4, using the formulas provided in Refs. [79,80]. These formulas are strictly speaking only valid at future null-infinity ($\mathcal{I}^+$). We therefore measure the radiated energy momentum on a series of timelike world tubes of finite radius and then extrapolate to $r = \infty$ using both linear and quadratic extrapolations. The difference between these two extrapolations give us an estimate for the uncertainty.

Unlike the radiated energy momentum, more care is needed to properly extrapolate the waveform itself to $\mathcal{I}^+$. As described in Ref. [81], we use the Teukolsky equation to obtain expressions for $r\psi_4$ at $\mathcal{I}^+$ based on its values on a timelike world tube traced out by a fixed sphere of constant (large) areal radius r [see Eq. (29), there]. The expressions there contain the corrections of order $\mathcal{O}(1/r)$ and $\mathcal{O}(1/r^2)$ to $r\psi_4$. As shown in Ref. [81], this extrapolation is consistent with both the waveform and the radiated energy-momentum extrapolated using a least squares fit to a polynomial in $1/r$ powers. Additionally, the $\mathcal{O}(1/r)$ perturbative corrections were shown to be consistent with a Cauchy-characteristic extraction for an equal-mass binary in [82].

Various simulations in this catalog were studied in detail in previous papers. In Appendix A of Ref. [83], we performed a detailed error analysis of configurations with equal mass and spins aligned/antialigned with respect to the orbital angular momentum; in Appendix B of Ref. [62], we performed convergence studies for runs with mass ratios $(q = 1, 3/4, 1/2, 1/3)$ and measured errors due to finite observer locations; and in Ref. [84], we performed convergence studies for $q \geq 1/10$ nonspinning binaries. In Ref. [85] we make detailed convergence and gauge studies on nonspinning $(q = 1/2, 1/3, 1/5, 1/3)$ and spinning $q = 1$ binaries.

Finally, in addition to all the internal consistency analysis and error estimates, in Ref. [41] we showed that

for the parameter estimated for GW150914 ($q = m_1/m_2 = 0.82$ and spins for the small/large holes of $\chi_1 = -0.44$ and $\chi_2 = +0.33$), the RIT waveforms and those produced completely independently by the SXS collaboration have an excellent match [86] of $\gtrsim 0.99$ overall for modes up to $\ell = 5$. In Ref. [87] a similar agreement between approaches has been found for other five targeted precessing and nonprecessing simulations of GW170104, displaying a fourth order convergence with finite difference resolution. The comparisons were also carried up to $\ell = 5$ modes. For all modes up to $l \leq 4$ we found a match of $\gtrsim 0.99$ and $\gtrsim 0.97$ for the $l = 5$ modes.

In all our studies we concluded that the waveforms at the resolutions provided in this catalog are well into the convergence regime (roughly converging at fourth order with resolution), that the horizon evaluated quantities such as the remnant final mass and spins have errors of the order of 0.1%, and that the radiatively computed quantities such as the recoil velocities and peak luminosities are evaluated at a typical error of 5%.

A. Center-of-mass displacement

Since full numerical simulations of binary black hole are started at a finite separation, they include nonphysical initial data effects, such as radiation content absorbed by the holes adding to their masses and spins (see Tables I–III, for initial versus settled values), and an initial kick due to the net linear momentum of the initial radiation content. Corrections by this effect are normally performed in the simulation coordinates, and hence depend on the gauge chosen. The choice itself of the center of mass and its gauge dependence has been studied in full general relativity (see for instance the recent paper [88] and references therein) and in the post-Newtonian approximation (see for instance the recent papers [89,90] and references therein). In [91] a detailed characterization and study has been performed to evaluate the impact of a shifting center or mass during full numerical evolutions has on the mode decomposition of the gravitational waveforms, even if extrapolated to infinite resolution and infinite observer location.

The center of mass shows two notable features when displayed in the simulations coordinates: A wobbling of increasing radius due to the physical radiation of momenta during the inspiral motion and a displacement of the center of this wobbling away from the origin of coordinates (chosen formally at the initial center-of-mass location). See Figs. 1 and 3, and note that both trajectories begin at the origin of coordinates $(x, y) = (0, 0)$. A practical implementation of the center-of-mass correction is to account for a linear shift in time of the origin of coordinates for the multipole decomposition of the waveform as in Appendix E of Ref. [92]. The center-of-mass offset and linear drift determined by this fitting are then used to shift the waveform modes. This shift can be performed *a posteriori* by demixing modes at each time step from a center of coordinates that is linearly moving [93]. This linear correction is determined from the premerger motion of the center of mass, but is being applied as an extrapolation postmerger, since the postmerger final black hole acquires a physical recoil velocity due to a net radiation of linear momentum carried in the form of gravitational waves to infinity.

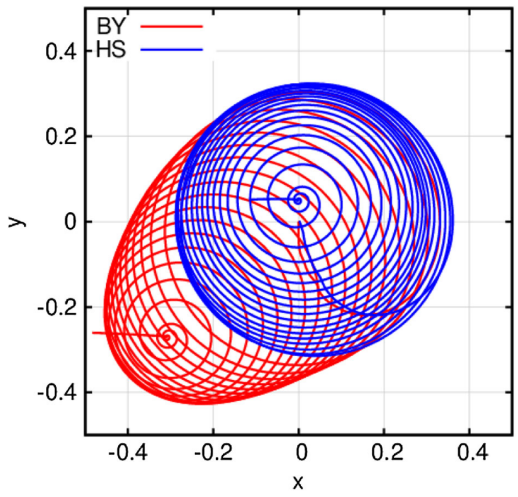

FIG. 1. Wobbling and displacement of the center of mass for a binary with mass ratio $q = 0.4142$ and spins $a_1 = -0.50$ and $a_2 = 0.85$ for Bowen-York (BY) and HiSpID (HS) initial data.

We have applied this correction to all the 777 waveforms released in this catalog. In order to exemplify its effectiveness, we have considered the evolution of binary black holes with the usual Bowen-York initial data [94] and compared the corresponding evolution of the HiSpID data [75] with much lower radiation content. We then applied the above correction to the former simulation to see if this brings the mode contents toward those of the later simulation as a test of effectiveness of the shift of the center-of-mass correction.

In Fig. 1 we display the wobbling and displacement of the center of mass for a nonprecessing binary with mass ratio $q = 0.4142$ and spins $a_1 = -0.50$ and $a_2 = 0.85$ for evolutions from Bowen-York (BY) and HiSpID (HS) initial data. Those show the much larger displacement of the BY data (roughly an order of magnitude) than for the HS data. Thus we expect the latter showing a much reduced mode mixing effect and providing a reference and measure of the benefits of applying the center-of-mass shift correction to the BY data. This is indeed clearly the fact when as shown in Fig. 2 where we display a few selected modes of our $\ell_{\max} = 6$ analysis. The corrections to the BY data show a rectified amplitude to the most affected modes during the inspiral $(\ell, m) = (2, 1), (3, 1)$ and postmerger $(\ell, m) = (4, 4)$ while $(\ell, m) = (2, 2)$ appears mostly unaffected at larger scale. The rest of the modes, not displayed here, fall into one of the above categories. A further correction of the center-of-mass shift can then be applied to the HS, thus achieving even higher accuracy.

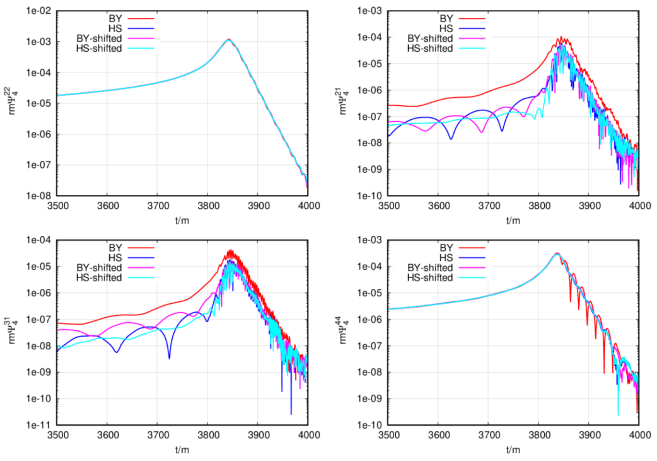

FIG. 2. Amplitude of the modes $(\ell, m) = (2,2), (2,1), (3,1), (4,4)$ of the Weyl scalar ψ_4 decomposition at the extraction radius $R = 75m$. Displayed are the evolution of BY and HS data amplitudes, and the correction to the center of mass shifts to the BY and HS data evolutions.

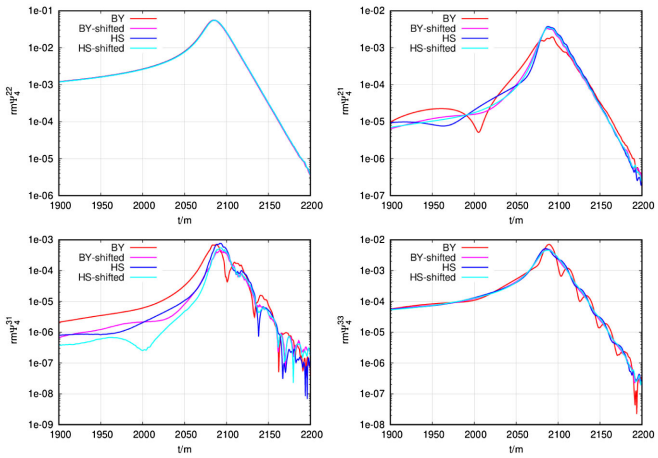

FIG. 4. Amplitude of the modes $(\ell, m) = (2,2), (2,1), (3,1), (3,3)$ of the Weyl scalar ψ_4 decomposition at the extraction radius $R = 113m$. Displayed are the evolution of BY and HS data amplitudes, and the correction to the center-of-mass shift to the BY and HS data evolutions.

In order to further cross-check our results we have studied a second case displayed in Fig. 3 showing the wobbling and displacement of the center of mass for a nonprecessing binary with mass ratio $q = 0.85$ and spins $a_1 = -0.50$ and $a_2 = -0.85$ for evolutions from BY and HS initial data. Those show the larger displacement of the BY data (roughly a factor of 3) than for the HS data. Figure 4 displays similar results as the first simulation.

III. THE CATALOG

The RIT Catalog can be found at http://ccrg.rit.edu/~RITCatalog. Figure 5 shows the distribution of the

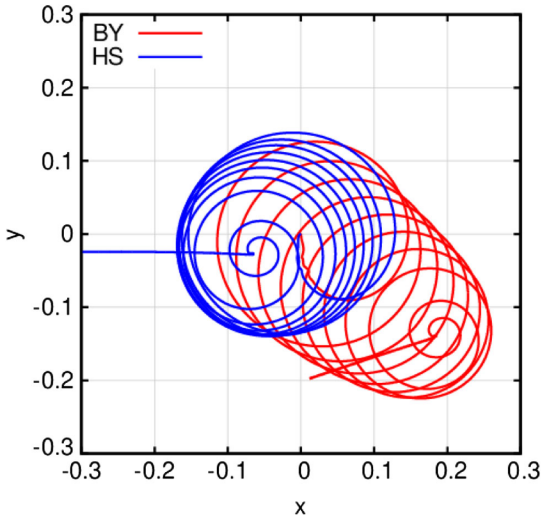

FIG. 3. Wobbling and displacement of the center of mass for a binary with mass ratio $q = 0.85$ and spins $a_1 = -0.50$ and $a_2 = -0.85$ for BY and HS initial data.

nonprecessing runs in the catalog in terms of $\chi_{1,2}$ and q (where χ_i is the component of the dimensionless spins of BH i along the direction of the orbital angular momentum). The information currently in the catalog consists of the metadata describing the runs and all modes up through the $\ell = 4$ modes (enough for most applications) of $mr\psi_4$ extrapolated to $\mathcal{I}^+$ via the perturbative approach of [81]. The associated metadata include the initial orbital frequencies, Arnowitt-Deser-Misner (ADM) masses, initial waveform frequencies from the (2,2) mode, black-hole masses, momenta, spins, separations, and eccentricities, as well the black-hole masses and spins once the initial burst of radiation has left the region around the binary. Note that we normalize our data such that the sum of the two initial horizon masses is $1m$. These *relaxed* quantities (at $t_{\rm relax} = 200m$ after the initial burst of radiation has mostly dissipated) are more accurate and physically relevant for modeling purposes. In addition, we also include the final remnant black-hole masses, spins, and recoil velocity.

The catalog is organized using an interactive table [95] that includes an identification number, resolution, type of run (nonspinning, aligned spins, precessing), the initial proper length of the coordinate line joining the two BH centroids that is outside both horizons [9], the coordinate separation of the two centroids, the mass ratio of the two black holes, the components of the dimensionless spins of the two black holes, the starting waveform frequency, $mf_{22,\rm relax}$, time to merger, number of gravitational wave cycles calculated from the (2,2) modes from the beginning of the inspiral signal to the amplitude peak, remnant mass, remnant spin, recoil velocity, peak luminosity, amplitude,

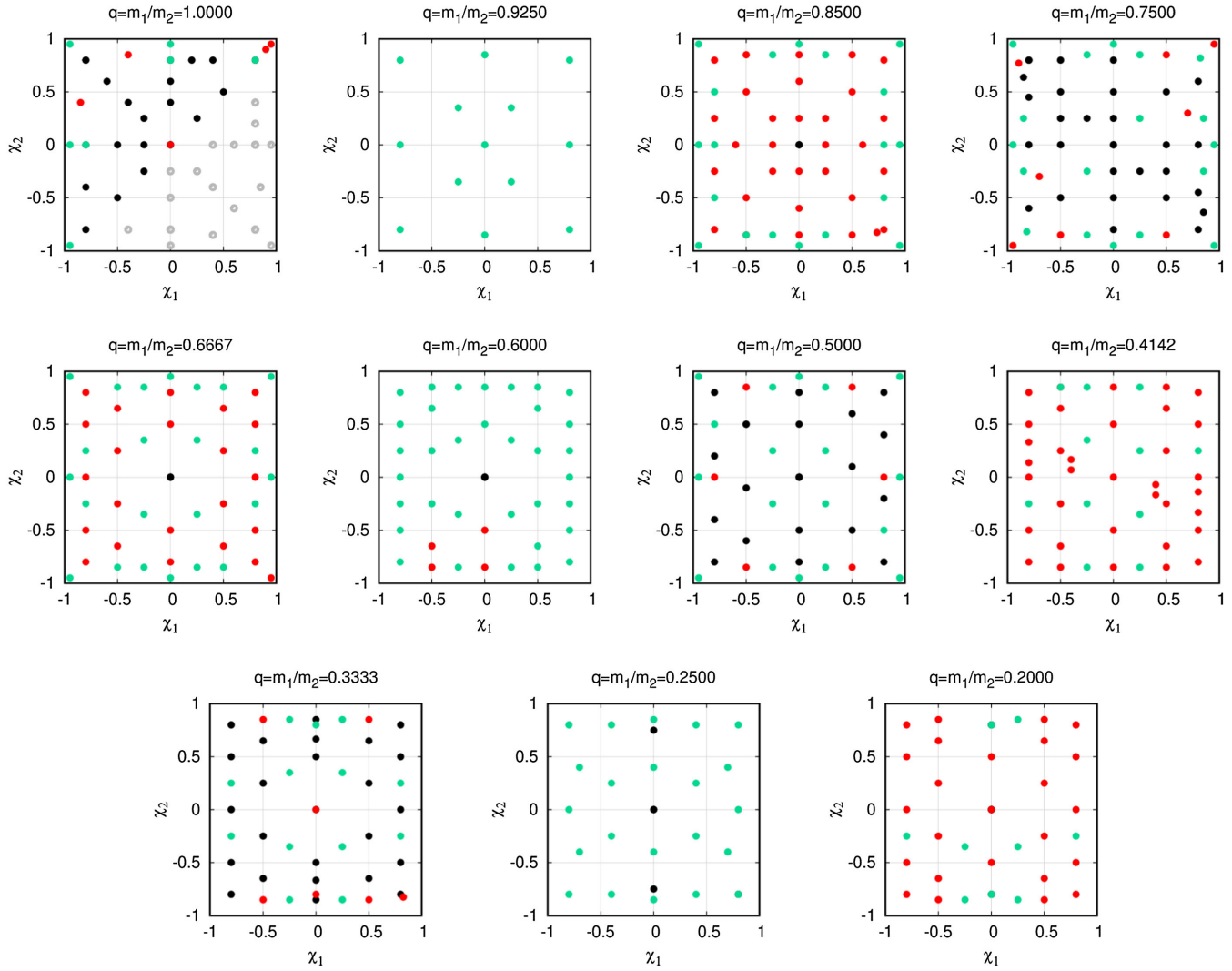

FIG. 5. Initial parameters in the (q,χ_1,χ_2) space for the 477 nonprecessing binaries. Note that χ_i denotes the component of the dimensionless spin of BH i along the orbital angular momentum. Each panel corresponds to a given mass ratio that covers the comparable masses binary range from $q=1$ to $q=1/5$. The dots in black denote the simulations of the catalog first release, the dots in red are those of the second release, and the dots in green are those of this third release.

and frequency. The final column gives the appropriate bibtex keys for the relevant publications where the waveforms were first presented. The table can be sorted (ascending or descending) by any of these columns. And there is a direct search feature that runs over all table elements.

Resolutions are given in terms of the grid spacing of the refinement level where the waveform is extracted (which is typically two refinement levels below the coarsest grid) with $R_{\rm obs}\sim 100m$. We use the notation nXYY, where the grid spacing in the wave zone is given by $h=m/X.YY$, e.g., n120 corresponds to $h=m/1.2$.

For each simulation in the catalog there are three files: one contains the metadata information in ASCII format, and the other two are tar.gz files containing ASCII files with up to and including $\ell=4$ modes of $mr\psi_4$ and h. In the near future, data will be available in the numerical relativity injection format [96]. Note that the primary data in our catalog is the Weyl scalar $mr\psi_4$ extrapolated to $\mathcal{I}^+$ [using Eq. (29) of Ref. [81]], rather than the strain $(r/m)h$. We provide the strain but also leave it to the user to convert $mr\psi_4$ to strain for most modes since this is still a sensitive process and is best handled on a mode-by-mode basis. The subtleties associated with transforming ψ_4 to h arise from the two integrations required [4,97]. One of the standard techniques, developed in Ref. [98], performs this integration in Fourier space with a windowing function and a low-frequency cutoff. Both of these require fine-tuning of parameters. The codes to do this are open source and publicly available from https://svn.einsteintoolkit.org/pyGWAnalysis/trunk.

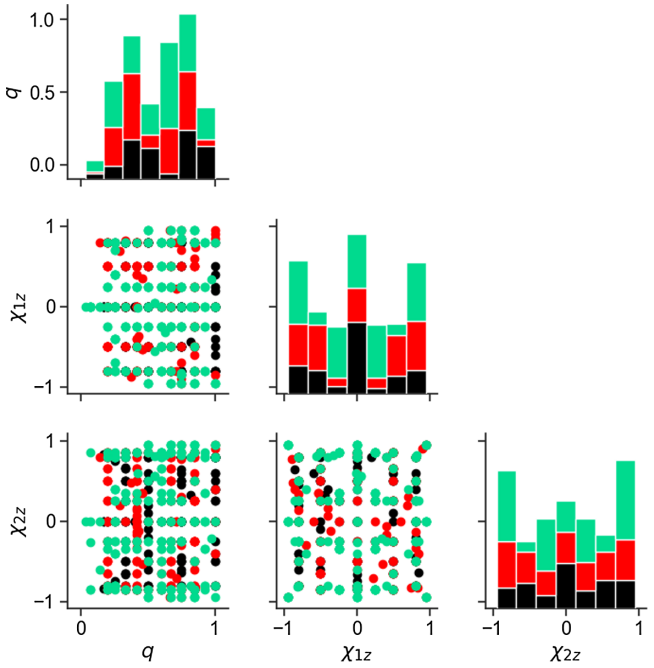

FIG. 6. Counting simulations in the (q,χ_1,χ_2) planes (faces of the cube) for the 477 nonprecessing binaries. The 120 release 1 simulations are black, the 154 release 2 simulations are red, and the 203 release 3 are in green.

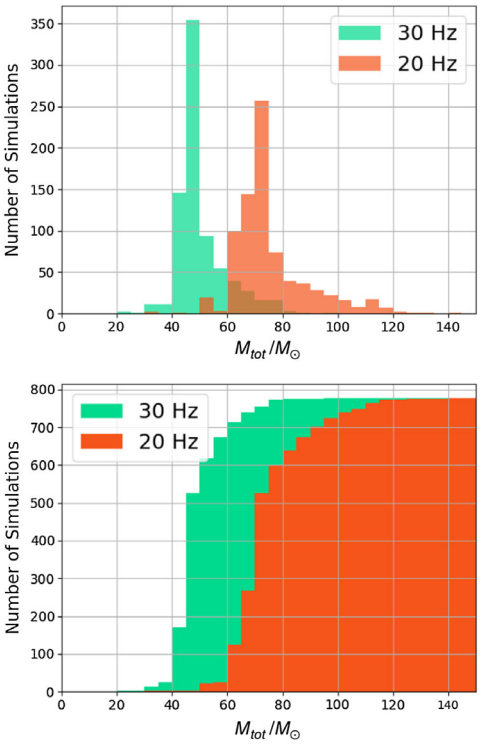

FIG. 7. Top: Distributions of the total mass of BHB systems in the RIT catalog corresponding to a starting gravitational wave frequency of 20 Hz (green) and 30 Hz (red) in bins of 5 $M_\odot$. Bottom: The cumulative version of the above plot also in bins of 5 $M_\odot$ for the 777 simulations in this catalog.

Figure 6 shows the distribution of the 477 nonprecessing runs in the catalog in terms of $\chi_{1,2}$ and q. Those runs were motivated by systematic studies to produce a set of accurate remnant formulas to represent the final mass, spin, and recoil of a merged binary black-hole system and the peak luminosity, amplitude, and frequency, as a function of the parameters of the precursor binary, as reported in [15,62,83,99–101]. A second important motivation was to provide a grid of simulations for parameter estimation of gravitational wave signals detected by LIGO using the methods described in [39].

The precessing runs in the catalog were motivated to study particular spin dynamics of merging BHB, such as the study of unstable spin flip flop, as reported in [25] and the targeted follow-ups of the gravitational wave signals from the first and second LIGO observing runs [41,87]. We have also paid special attention to the systematic study of simulations covering a four-dimensional parameter space involving a spinning and a nonspinning black-hole binary as a function of the mass ratio (see Fig. 8). Those simulations were originally performed to study remnant recoil and final masses and spins [102]. We have supplemented them here with additional simulations to have a coverage of spin orientations (see Fig. 8 and Table I) that allows an estimation of precession.

Figure 7 shows the distributions of the minimal total mass of the BHB systems in the catalog given a starting gravitational wave frequency of 20 or 30 Hz in the source frame. This provides a coverage for the current events observed by LIGO (redshift effects improve this coverage by a factor of $1+z$, where z is the redshift). Coverage of even lower total masses would require longer simulations or hybridization of the current waveforms with post-Newtonian methods [44].

A. Nonprecessing merging binaries correlations

Detailed and higher order formulas relating the binary parameters to the postmerger properties of the final remnant black-hole and merger waveform have been studied in Refs. [15,62,83] using the aligned spin simulations of previous releases of the RIT catalog.

Foreseeing astrophysical applications and use in the future of massive catalogs of binary black holes, we display in Fig. 9 simple scaling phenomenological correlations between remnant parameters and merger waveforms.

Fitting formulas for the simple correlations and estimated errors in their coefficient are

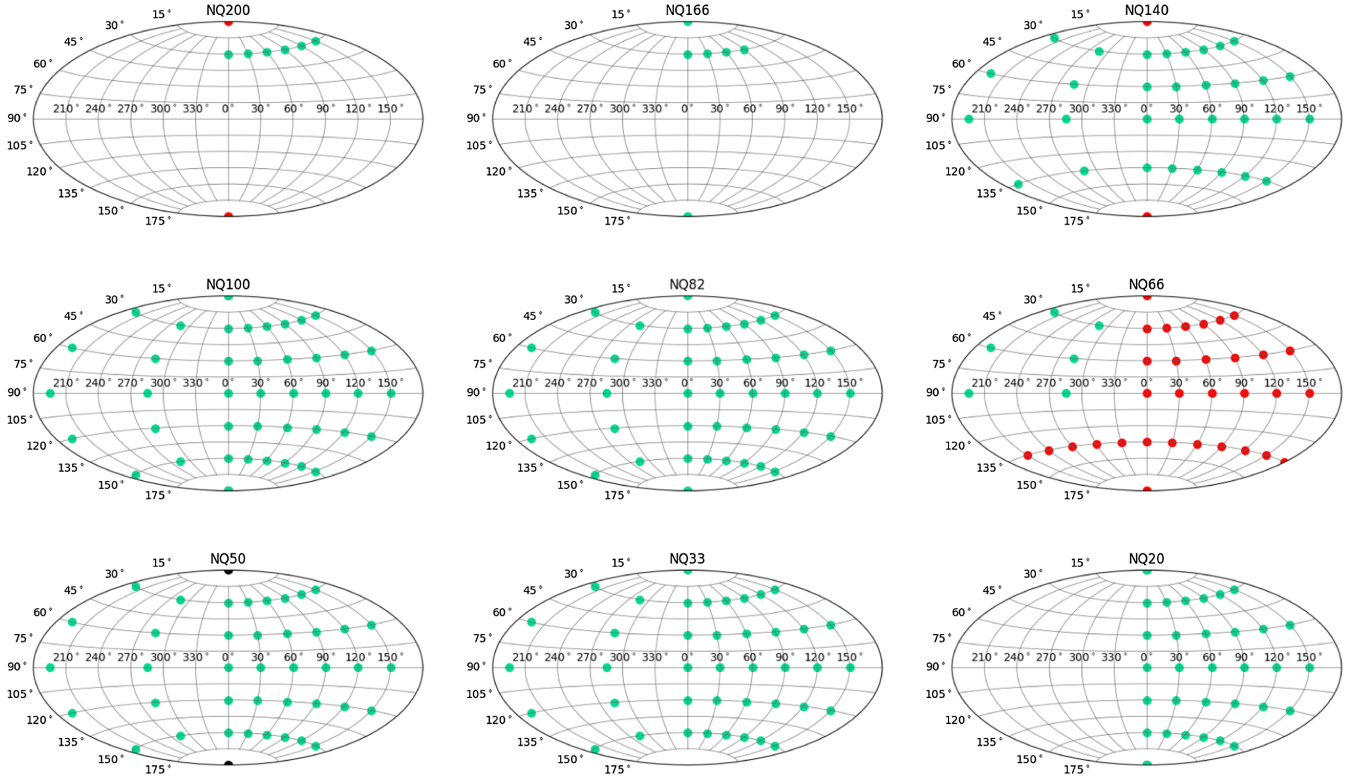

FIG. 8. Initial parameters in the (q, θ_2, ϕ_2) space for the precessing binaries. Note that $(\chi_2 = 0.8, \theta_2, \phi_2)$ denotes the component of the dimensionless spin of the BH $i = 2$ from the direction of the orbital angular momentum. Each panel corresponds to a given mass ratio that covers the comparable masses binary range $q = 1, 0.82, 2/3, 1/3, 1/5$, and $q = 2, 5/3, 1.4$, where $q > 1$ means it is the smaller hole that is spinning. The dots in black denote the simulations of the catalog first release, the dots in red are those of the second release, and the dots in green are those of this third release.

$$\begin{aligned}
\alpha_f &= 1.044 \pm 0.008 - (27.76 \pm 1.37)\mathrm{e}^{(-12.17\pm0.20)m\omega_{22}},\\
\alpha_f &= 1.037 \pm 0.011 - (2.54 \pm 0.04)\mathrm{e}^{(-242.69\pm5.90)\mathcal{L}/\eta^{1.5}},\\
\alpha_f &= 0.940 \pm 0.005 - (2.96 \pm 0.05)\mathrm{e}^{(-12.84\pm0.19)E_{\mathrm{rad}}/\eta},
\end{aligned} \tag{1}$$

for the final spin α_f as a function of the peak frequency $m\omega_{22}$ of the (2,2) mode, the peak Luminosity $\mathcal{L}$, and the total radiated energy during merger E_{rad} [normalized by the symmetric mass ratio $\eta = q/(1+q)$].

Similar correlations among those quantities can be found,

$$\begin{aligned}
m\omega_{22} &= 0.705 \pm 0.045 - (0.53 \pm 0.04)\mathrm{e}^{(-53.00\pm6.93)\mathcal{L}/\eta^{1.5}},\\
m\omega_{22} &= 0.534 \pm 0.010 - (0.38 \pm 0.01)\mathrm{e}^{(-3.97\pm0.23)E_{\mathrm{rad}}/\eta},\\
\mathcal{L}/\eta^{1.5} &= 0.030 \pm 0.001 - (0.030 \pm 0.001)\mathrm{e}^{(-1.72\pm0.09)E_{\mathrm{rad}}/\eta}.
\end{aligned} \tag{2}$$

The fittings take the leading behavior and scaling of the correlations without attempting higher order corrections to be used in astrophysical estimates and control of more sophisticated implementations in large catalogs of binary black-hole gravitational wave signals and its modeling, as well as tests of gravity.

IV. CONCLUSIONS AND DISCUSSION

The breakthroughs [1–3] in numerical relativity were instrumental in identifying the first detection of gravitational waves [34] with the merger of two black holes. The comparison of different approaches to solve the binary black-hole problem has produced an excellent agreement for GW150914 [41] and GW170104 [87], including higher (up to $\ell = 5$) modes. The use of numerical relativity waveform catalogs (see also Refs. [39,103,104]) allows the application of a consistent method for parameter estimation (of merging binary black holes) of the observed gravitational waves in the observational runs O1/O2. With the current aligned spin coverage one can successfully carry out parameter estimations with results at least as good as with the phenomenological models [34]. In particular, in this third RIT Catalog release we included coverage of spins above 0.95 in magnitude up to mass ratios 2:1.

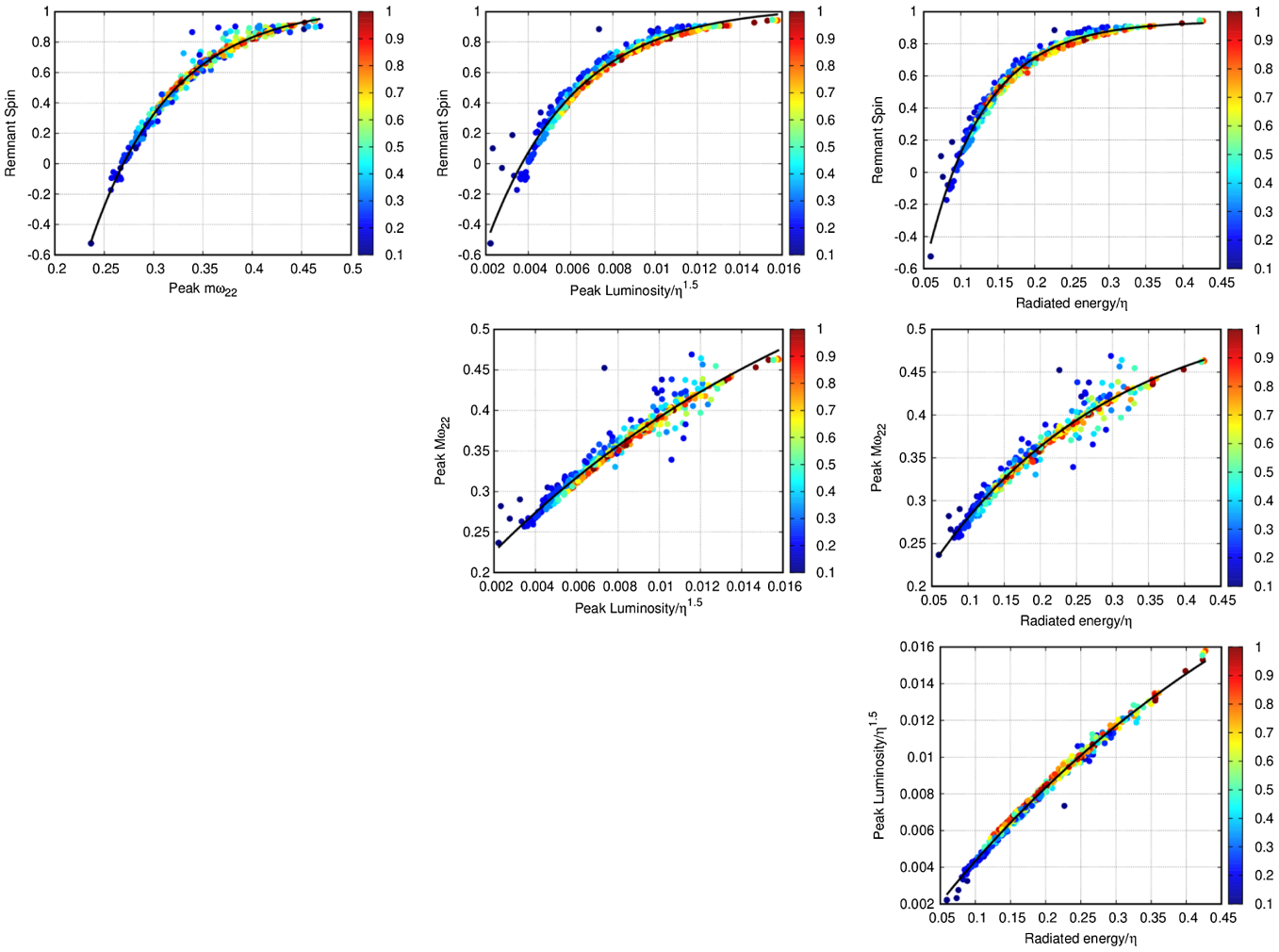

FIG. 9. Correlations between the radiated energy, peak luminosity, peak frequency at merger, and spin remnant with the corresponding scaling by the symmetric mass ratio to obtain the leading mass dependence.

New forthcoming simulation produced (for instance targeted to follow up any new detection or catalog expansions) will contribute to improve the binary parameter coverage, thus reducing the interpolation error. The next step will be to reduce the extrapolation error at very high spins by adding more simulations with spin magnitudes above 0.95, and also the extension of the family of simulations displayed in Fig. 8 to smaller mass ratios, i.e., $q \leq 1/3$. Coverage for low total binary masses (below 20 $M_{\odot}$), in turn, would require longer full numerical simulations or hybridization of the current NR waveforms with post-Newtonian waveforms [105].

The next area of development for the numerical relativity waveform catalogs is the coverage of precessing binaries. Those require expansion of the parameter space to seven dimensions (assuming negligible eccentricity), and are being carried out in a hierarchical approach by first neglecting the effects of the spin of the secondary black holes, which is a good assumption for small mass ratios. This approach has proven successful also when applied to all O1/O2 events [106]. It required an homogeneous set of simulations since the differences in $\ln \mathcal{L}$ are subtle; hence the need to expand the current RIT catalog. In a second stage, a follow-up of the first determined spin orientations can be performed with a two spin search. Another line of extension of the use of NR waveforms is its use in searches of gravitational waves (in addition to that of parameter estimation) a first implementation of the nonspinning waveforms (using for instance the simulations reported in [84] would produce a prototype of this search analysis and for each of the recoil effects [107]).

The simulations of orbiting black-hole binaries produce also information about the final remnant of the merger of the two holes. Numerous empirical formulas relating the initial parameters $(q, \vec{\chi}_1, \vec{\chi}_2)$ (individual masses and spins) of the binary to those of the final remnant $(m_f, \vec{\chi}_f, \vec{V}_f)$ have been proposed. These include formulas for the final mass, spin, and recoil velocity

TABLE I. Initial data parameters for the quasicircular configurations with a smaller mass black hole (labeled 1), and a larger mass spinning black hole (labeled 2). The punctures are located at $\vec{r}_1 = (x_1, 0, 0)$ and $\vec{r}_2 = (x_2, 0, 0)$, with individual linear momenta $P = \pm(P_r, P_t, 0)$, spin magnitudes $|S_i|$, puncture mass parameters m^p/m, horizon (Christodoulou) masses m^H/m, total ADM mass $M_{\rm ADM}$, and dimensionless spins $|a/m_H| = |S/m_H^2|$. The spin directions for the precessing simulations are given in the catalog and in Table III.

Run	x_1/m	x_2/m	P_r/m	P_t/m	m_1^p/m	m_2^p/m	$\lvert S_1/m^2\rvert$	$\lvert S_2/m^2\rvert$	m_1^H/m	m_2^H/m	$M_{\rm ADM}/m$	$\lvert a_1/m_1^H\rvert$	$\lvert a_2/m_2^H\rvert$
RIT:BBH:0275	−11.59	1.66	-8.72×10^{-5}	0.03601	0.1199	0.4593	0	0.6508	0.125	0.875	0.9966	0	0.85
RIT:BBH:0282	−9.38	0.625	-6.03×10^{-5}	0.02301	0.0589	0.4929	0	0.7471	0.0625	0.9375	0.9977	0	0.85
RIT:BBH:0310	−6.73	4.80	-5.42×10^{-4}	0.08356	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9911	0.8	0
RIT:BBH:0313	−6.73	4.80	-5.43×10^{-4}	0.08358	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9911	0.8	0
RIT:BBH:0315	−6.73	4.80	-5.43×10^{-4}	0.08356	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9911	0.8	0
RIT:BBH:0320	−6.73	4.80	-5.43×10^{-4}	0.08359	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9911	0.8	0
RIT:BBH:0323	−4.50	4.50	-1.18×10^{-3}	0.103	0.5	0.5	0.2425	0.2425	0.5	0.5	0.988	0.97	0.97
RIT:BBH:0325	−6.73	4.80	-5.42×10^{-4}	0.08356	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9911	0.8	0
RIT:BBH:0327	−6.73	4.80	-5.43×10^{-4}	0.08358	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9911	0.8	0
RIT:BBH:0328	−6.74	4.81	-5.53×10^{-4}	0.084	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9912	0.8	0
RIT:BBH:0329	−6.74	4.81	-5.54×10^{-4}	0.08402	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9912	0.8	0
RIT:BBH:0330	−6.74	4.81	-5.57×10^{-4}	0.08409	0.2515	0.5717	0.1389	0	0.4167	0.5833	0.9913	0.8	0
RIT:BBH:0331	−4.50	4.50	-1.18×10^{-3}	0.1046	0.5	0.5	0.2475	0.2475	0.5	0.5	0.9881	0.99	0.99
RIT:BBH:0332	−6.74	4.81	-5.56×10^{-4}	0.08406	0.2515	0.5717	0.1389	0	0.4167	0.5833	0.9913	0.8	0
RIT:BBH:0333	−6.77	4.84	-6.05×10^{-4}	0.08572	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9914	0.8	0
RIT:BBH:0334	−6.77	4.84	-6.06×10^{-4}	0.08573	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9914	0.8	0
RIT:BBH:0335	−6.77	4.84	-6.07×10^{-4}	0.08576	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9915	0.8	0
RIT:BBH:0340	−9.07	3.02	-2.92×10^{-4}	0.06338	0.2408	0.513	0	0.4219	0.25	0.75	0.9934	0	0.75
RIT:BBH:0341	−6.74	4.81	-5.53×10^{-4}	0.08402	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9912	0.8	0
RIT:BBH:0342	−6.77	4.84	-6.08×10^{-4}	0.08578	0.2515	0.5717	0.1389	0	0.4167	0.5833	0.9915	0.8	0
RIT:BBH:0343	−6.75	4.82	-5.72×10^{-4}	0.08469	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9913	0.8	0
RIT:BBH:0346	−6.75	4.82	-5.74×10^{-4}	0.08472	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9913	0.8	0
RIT:BBH:0347	−6.74	4.81	-5.55×10^{-4}	0.08406	0.2515	0.5717	0.1389	0	0.4167	0.5833	0.9913	0.8	0
RIT:BBH:0349	−6.75	4.82	-5.77×10^{-4}	0.08478	0.2515	0.5717	0.1389	0	0.4167	0.5833	0.9914	0.8	0
RIT:BBH:0351	−6.30	6.30	-4.98×10^{-4}	0.0839	0.4888	0.304	0	0.2	0.5	0.5	0.9918	0	0.8
RIT:BBH:0353	−6.30	6.30	-4.98×10^{-4}	0.08391	0.4888	0.304	0	0.2	0.5	0.5	0.9918	0	0.8
RIT:BBH:0354	−6.30	6.30	-4.99×10^{-4}	0.08394	0.4888	0.304	0	0.2	0.5	0.5	0.9918	0	0.8
RIT:BBH:0355	−6.77	4.84	-6.07×10^{-4}	0.08576	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9915	0.8	0
RIT:BBH:0356	−6.30	6.30	-4.99×10^{-4}	0.08393	0.4888	0.304	0	0.2	0.5	0.5	0.9918	0	0.8
RIT:BBH:0357	−7.81	4.69	-4.58×10^{-4}	0.07931	0.3233	0.3242	0.07031	0.332	0.375	0.625	0.9923	0.5	0.85
RIT:BBH:0358	−7.81	4.69	-4.43×10^{-4}	0.07874	0.3233	0.4864	0.07031	0.2539	0.375	0.625	0.9922	0.5	0.65
RIT:BBH:0359	−6.30	6.30	-4.99×10^{-4}	0.08393	0.4888	0.304	0	0.2	0.5	0.5	0.9918	0	0.8
RIT:BBH:0360	−6.77	4.84	-6.05×10^{-4}	0.08573	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9914	0.8	0
RIT:BBH:0361	−6.30	6.30	-4.98×10^{-4}	0.08391	0.4888	0.304	0	0.2	0.5	0.5	0.9918	0	0.8
RIT:BBH:0362	−6.29	6.29	-4.82×10^{-4}	0.08333	0.4888	0.304	0	0.2	0.5	0.5	0.9917	0	0.8
RIT:BBH:0363	−4.50	4.50	-1.19×10^{-3}	0.1049	0.5	0.5	0.2425	0.2425	0.5	0.5	0.9884	0.97	0.97
RIT:BBH:0364	−6.29	6.29	-4.81×10^{-4}	0.08331	0.4888	0.304	0	0.2	0.5	0.5	0.9917	0	0.8

(Table continued)

TABLE I. *(Continued)*

Run	x_1/m	x_2/m	P_r/m	P_t/m	m_1^p/m	m_2^p/m	$\lvert S_1/m^2\rvert$	$\lvert S_2/m^2\rvert$	m_1^H/m	m_2^H/m	$M_{\rm ADM}/m$	$\lvert a_1/m_1^H\rvert$	$\lvert a_2/m_2^H\rvert$
RIT:BBH:0365	−9.00	3.00	-2.62×10^{-4}	0.06166	0.2409	0.4614	0	0.45	0.25	0.75	0.9932	0	0.8
RIT:BBH:0366	−6.50	6.50	-4.56×10^{-4}	0.08245	0.4891	0.3042	0	0.2	0.5	0.5	0.992	0	0.8
RIT:BBH:0367	−6.29	6.29	-4.84×10^{-4}	0.08339	0.4888	0.3039	0	0.2	0.5	0.5	0.9918	0	0.8
RIT:BBH:0368	−6.29	6.29	-4.82×10^{-4}	0.08333	0.4888	0.304	0	0.2	0.5	0.5	0.9917	0	0.8
RIT:BBH:0369	−6.29	6.29	-4.85×10^{-4}	0.08342	0.4888	0.3039	0	0.2	0.5	0.5	0.9918	0	0.8
RIT:BBH:0370	−7.20	4.80	-6.14×10^{-4}	0.08529	0.3449	0.3105	0.08	0.306	0.4	0.6	0.9921	0.5	0.85
RIT:BBH:0371	−7.20	4.80	-4.24×10^{-4}	0.07857	0.3451	0.3106	0.08	0.306	0.4	0.6	0.9913	0.5	0.85
RIT:BBH:0372	−6.29	6.29	-4.84×10^{-4}	0.08339	0.4888	0.3039	0	0.2	0.5	0.5	0.9918	0	0.8
RIT:BBH:0373	−9.38	0.625	-5.77×10^{-5}	0.02274	0.05891	0.9345	0	0	0.0625	0.9375	0.9976	0	0
RIT:BBH:0374	−7.81	4.69	-3.84×10^{-4}	0.07636	0.3642	0.546	0	0.1953	0.375	0.625	0.9919	0	0.5
RIT:BBH:0375	−6.75	4.82	-5.77×10^{-4}	0.08481	0.2514	0.5717	0.1389	0	0.4167	0.5833	0.9914	0.8	0
RIT:BBH:0376	−6.28	6.28	-4.62×10^{-4}	0.08255	0.4888	0.304	0	0.2	0.5	0.5	0.9916	0	0.8
RIT:BBH:0377	−6.28	6.28	-4.60×10^{-4}	0.08251	0.4888	0.304	0	0.2	0.5	0.5	0.9916	0	0.8
RIT:BBH:0378	−6.75	4.82	-5.76×10^{-4}	0.08478	0.2515	0.5717	0.1389	0	0.4167	0.5833	0.9914	0.8	0
RIT:BBH:0379	−6.75	4.82	-5.73×10^{-4}	0.08472	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9913	0.8	0
RIT:BBH:0380	−7.81	4.69	-3.91×10^{-4}	0.07667	0.3235	0.4864	0.07031	0.2539	0.375	0.625	0.992	0.5	0.65
RIT:BBH:0381	−6.28	6.28	-4.64×10^{-4}	0.08262	0.4888	0.3039	0	0.2	0.5	0.5	0.9917	0	0.8
RIT:BBH:0382	−6.28	6.28	-4.65×10^{-4}	0.08266	0.4888	0.3039	0	0.2	0.5	0.5	0.9917	0	0.8
RIT:BBH:0383	−6.28	6.28	-4.64×10^{-4}	0.08262	0.4888	0.3039	0	0.2	0.5	0.5	0.9917	0	0.8
RIT:BBH:0384	−7.03	5.97	-4.01×10^{-4}	0.07986	0.279	0.4706	0.1689	0.1461	0.4595	0.5405	0.9919	0.8	0.5
RIT:BBH:0385	−6.50	6.50	-3.80×10^{-4}	0.07915	0.4893	0.3043	0	0.2	0.5	0.5	0.9917	0	0.8
RIT:BBH:0386	−7.20	4.80	-4.57×10^{-4}	0.08018	0.3451	0.3106	0.08	0.306	0.4	0.6	0.9915	0.5	0.85
RIT:BBH:0387	−7.20	4.80	-5.17×10^{-4}	0.08243	0.2416	0.5738	0.128	0.09	0.4	0.6	0.9917	0.8	0.25
RIT:BBH:0388	−7.20	4.80	-5.47×10^{-4}	0.08332	0.3449	0.3106	0.08	0.306	0.4	0.6	0.9918	0.5	0.85
RIT:BBH:0389	−6.28	6.28	-4.61×10^{-4}	0.08255	0.4888	0.304	0	0.2	0.5	0.5	0.9916	0	0.8
RIT:BBH:0390	−7.03	5.97	-4.79×10^{-4}	0.08296	0.2789	0.4705	0.1689	0.1461	0.4595	0.5405	0.9922	0.8	0.5
RIT:BBH:0391	−7.20	4.80	-5.66×10^{-4}	0.08397	0.2415	0.5738	0.128	0.09	0.4	0.6	0.9919	0.8	0.25
RIT:BBH:0392	−7.81	4.69	-4.46×10^{-4}	0.07892	0.2264	0.6147	0.1125	0	0.375	0.625	0.9922	0.8	0
RIT:BBH:0393	−4.50	4.50	-1.19×10^{-3}	0.1036	0.5	0.5	0.2425	0.2425	0.5	0.5	0.9881	0.97	0.97
RIT:BBH:0394	−4.50	4.50	-1.18×10^{-3}	0.1036	0.5	0.5	0.2425	0.2425	0.5	0.5	0.9881	0.97	0.97
RIT:BBH:0395	−6.86	5.14	-5.54×10^{-4}	0.08459	0.4062	0.5457	0.04592	0.08163	0.4286	0.5714	0.9915	0.25	0.25
RIT:BBH:0396	−7.81	4.69	-3.79×10^{-4}	0.07615	0.3235	0.3242	0.07031	0.332	0.375	0.625	0.992	0.5	0.85
RIT:BBH:0397	−7.81	4.69	-4.53×10^{-4}	0.07917	0.3234	0.5989	0.07031	0.09766	0.375	0.625	0.9922	0.5	0.25
RIT:BBH:0398	−7.81	4.69	-3.67×10^{-4}	0.07547	0.3643	0.3242	0	0.332	0.375	0.625	0.9919	0	0.85
RIT:BBH:0399	−6.86	5.14	-4.87×10^{-4}	0.0822	0.4063	0.5458	0.04592	0.08163	0.4286	0.5714	0.9912	0.25	0.25
RIT:BBH:0400	−7.81	4.69	-3.89×10^{-4}	0.07652	0.2265	0.6148	0.1125	0	0.375	0.625	0.992	0.8	0
RIT:BBH:0401	−7.20	4.80	-4.31×10^{-4}	0.07896	0.3787	0.3106	0.04	0.306	0.4	0.6	0.9914	0.25	0.85
RIT:BBH:0402	−7.81	4.69	-3.64×10^{-4}	0.07529	0.3235	0.4864	0.07031	0.2539	0.375	0.625	0.9918	0.5	0.65

(Table continued)

TABLE I. *(Continued)*

Run	x_1/m	x_2/m	P_r/m	P_t/m	m_1^p/m	m_2^p/m	$\lvert S_1/m^2\rvert$	$\lvert S_2/m^2\rvert$	m_1^H/m	m_2^H/m	$M_{\rm ADM}/m$	$\lvert a_1/m_1^H\rvert$	$\lvert a_2/m_2^H\rvert$
RIT:BBH:0403	−7.03	5.97	-4.45×10^{-4}	0.08174	0.279	0.5298	0.1689	0	0.4595	0.5405	0.992	0.8	0
RIT:BBH:0404	−7.20	4.80	-4.61×10^{-4}	0.08029	0.3786	0.5586	0.04	0.126	0.4	0.6	0.9914	0.25	0.35
RIT:BBH:0405	−7.20	4.80	-5.96×10^{-4}	0.08479	0.3784	0.3105	0.04	0.306	0.4	0.6	0.992	0.25	0.85
RIT:BBH:0406	−7.20	4.80	-5.62×10^{-4}	0.0838	0.3784	0.3105	0.04	0.306	0.4	0.6	0.9919	0.25	0.85
RIT:BBH:0407	−7.20	4.80	-4.80×10^{-4}	0.08101	0.2416	0.5739	0.128	0.09	0.4	0.6	0.9916	0.8	0.25
RIT:BBH:0408	−7.03	5.97	-4.16×10^{-4}	0.08057	0.279	0.4706	0.1689	0.1461	0.4595	0.5405	0.992	0.8	0.5
RIT:BBH:0409	−7.20	4.80	-5.42×10^{-4}	0.08322	0.3785	0.5585	0.04	0.126	0.4	0.6	0.9917	0.25	0.35
RIT:BBH:0410	−4.50	4.50	-1.19×10^{-3}	0.1056	0.5	0.5	0.2425	0.2425	0.5	0.5	0.9885	0.97	0.97
RIT:BBH:0411	−7.20	4.80	-4.47×10^{-4}	0.07964	0.2416	0.5739	0.128	0.09	0.4	0.6	0.9914	0.8	0.25
RIT:BBH:0412	−7.20	4.80	-4.48×10^{-4}	0.07976	0.3786	0.3106	0.04	0.306	0.4	0.6	0.9914	0.25	0.85
RIT:BBH:0413	−7.81	4.69	-3.56×10^{-4}	0.07481	0.3235	0.3242	0.07031	0.332	0.375	0.625	0.9918	0.5	0.85
RIT:BBH:0414	−7.20	4.80	-5.14×10^{-4}	0.08228	0.3785	0.5586	0.04	0.126	0.4	0.6	0.9916	0.25	0.35
RIT:BBH:0415	−7.20	4.80	-4.82×10^{-4}	0.08115	0.3786	0.5586	0.04	0.126	0.4	0.6	0.9915	0.25	0.35
RIT:BBH:0416	−9.62	1.38	-1.43×10^{-4}	0.03964	0.119	0.8698	0	0	0.125	0.875	0.9959	0	0
RIT:BBH:0417	−9.19	3.81	-3.04×10^{-4}	0.06786	0.2762	0.6806	0.02145	0.125	0.2929	0.7071	0.9932	0.25	0.25
RIT:BBH:0418	−7.03	5.97	-3.78×10^{-4}	0.07878	0.279	0.5299	0.1689	0	0.4595	0.5405	0.9917	0.8	0
RIT:BBH:0419	−4.50	4.50	-1.18×10^{-3}	0.1049	0.5	0.5	0.2425	0.2425	0.5	0.5	0.9884	0.97	0.97
RIT:BBH:0420	−7.03	5.97	-3.60×10^{-4}	0.07776	0.2791	0.4707	0.1689	0.1461	0.4595	0.5405	0.9917	0.8	0.5
RIT:BBH:0421	−7.81	4.69	-4.16×10^{-4}	0.07775	0.3234	0.5989	0.07031	0.09766	0.375	0.625	0.992	0.5	0.25
RIT:BBH:0422	−7.81	4.69	-4.14×10^{-4}	0.07762	0.3234	0.599	0.07031	0.09766	0.375	0.625	0.992	0.5	0.25
RIT:BBH:0423	−9.19	3.81	-3.00×10^{-4}	0.06764	0.2762	0.6625	0.02145	0.175	0.2929	0.7071	0.9932	0.25	0.35
RIT:BBH:0424	−6.26	6.26	-4.46×10^{-4}	0.08188	0.4888	0.3039	0	0.2	0.5	0.5	0.9916	0	0.8
RIT:BBH:0425	−6.26	6.26	-4.44×10^{-4}	0.08182	0.4888	0.304	0	0.2	0.5	0.5	0.9915	0	0.8
RIT:BBH:0426	−6.26	6.26	-4.44×10^{-4}	0.08179	0.4888	0.304	0	0.2	0.5	0.5	0.9915	0	0.8
RIT:BBH:0427	−6.26	6.26	-4.45×10^{-4}	0.08182	0.4888	0.304	0	0.2	0.5	0.5	0.9915	0	0.8
RIT:BBH:0428	−6.26	6.26	-4.47×10^{-4}	0.08188	0.4888	0.3039	0	0.2	0.5	0.5	0.9915	0	0.8
RIT:BBH:0430	−7.81	4.69	-3.84×10^{-4}	0.0763	0.3235	0.599	0.07031	0.09766	0.375	0.625	0.9919	0.5	0.25
RIT:BBH:0431	−9.19	3.81	-2.70×10^{-4}	0.06609	0.2763	0.6806	0.02145	0.125	0.2929	0.7071	0.9931	0.25	0.25
RIT:BBH:0432	−7.03	5.97	-4.45×10^{-4}	0.0817	0.437	0.2794	0.05278	0.2484	0.4595	0.5405	0.992	0.25	0.85
RIT:BBH:0433	−6.26	6.26	-4.48×10^{-4}	0.08191	0.4888	0.3039	0	0.2	0.5	0.5	0.9916	0	0.8
RIT:BBH:0434	−9.19	3.81	-2.73×10^{-4}	0.06629	0.2763	0.6625	0.02145	0.175	0.2929	0.7071	0.9931	0.25	0.35
RIT:BBH:0435	−9.19	3.81	-2.47×10^{-4}	0.06465	0.2764	0.3684	0.02145	0.425	0.2929	0.7071	0.993	0.25	0.85
RIT:BBH:0436	−9.19	3.81	-3.16×10^{-4}	0.0684	0.1762	0.6806	0.06863	0.125	0.2929	0.7071	0.9934	0.8	0.25
RIT:BBH:0437	−7.03	5.97	-4.72×10^{-4}	0.0827	0.437	0.2793	0.05278	0.2484	0.4595	0.5405	0.9922	0.25	0.85
RIT:BBH:0438	−9.19	3.81	-2.52×10^{-4}	0.06506	0.2764	0.3684	0.02145	0.425	0.2929	0.7071	0.993	0.25	0.85
RIT:BBH:0439	−6.25	6.25	-4.35×10^{-4}	0.08134	0.4888	0.304	0	0.2	0.5	0.5	0.9914	0	0.8
RIT:BBH:0440	−6.25	6.25	-4.34×10^{-4}	0.08132	0.4888	0.304	0	0.2	0.5	0.5	0.9914	0	0.8
RIT:BBH:0441	−6.25	6.25	-4.34×10^{-4}	0.08131	0.4888	0.304	0	0.2	0.5	0.5	0.9914	0	0.8

(Table continued)

TABLE I. *(Continued)*

Run	x_1/m	x_2/m	P_r/m	P_t/m	m_1^p/m	m_2^p/m	$\lvert S_1/m^2\rvert$	$\lvert S_2/m^2\rvert$	m_1^H/m	m_2^H/m	$M_{\rm ADM}/m$	$\lvert a_1/m_1^H\rvert$	$\lvert a_2/m_2^H\rvert$
RIT:BBH:0442	−9.38	0.625	-8.43×10^{-5}	0.02444	0.05879	0.4929	0	0.7471	0.0625	0.9375	0.9979	0	0.85
RIT:BBH:0443	−6.25	6.25	-4.35×10^{-4}	0.08135	0.4888	0.304	0	0.2	0.5	0.5	0.9914	0	0.8
RIT:BBH:0444	−6.25	6.25	-4.34×10^{-4}	0.08131	0.4888	0.304	0	0.2	0.5	0.5	0.9914	0	0.8
RIT:BBH:0445	−6.25	6.25	-4.35×10^{-4}	0.08135	0.4888	0.304	0	0.2	0.5	0.5	0.9914	0	0.8
RIT:BBH:0446	−8.67	4.33	-3.19×10^{-4}	0.07144	0.2011	0.5838	0.08889	0.2222	0.3333	0.6667	0.9928	0.8	0.5
RIT:BBH:0447	−8.67	4.33	-3.49×10^{-4}	0.07277	0.315	0.6405	0.02778	0.1111	0.3333	0.6667	0.9927	0.25	0.25
RIT:BBH:0448	−6.25	6.25	-4.35×10^{-4}	0.08134	0.4888	0.304	0	0.2	0.5	0.5	0.9914	0	0.8
RIT:BBH:0449	−9.19	3.81	-2.62×10^{-4}	0.06561	0.1763	0.6807	0.06863	0.125	0.2929	0.7071	0.9931	0.8	0.25
RIT:BBH:0450	−8.83	2.94	-3.20×10^{-4}	0.06455	0.2406	0.5128	0	0.4219	0.25	0.75	0.9933	0	0.75
RIT:BBH:0451	−8.67	4.33	-3.37×10^{-4}	0.0722	0.201	0.5839	0.08889	0.2222	0.3333	0.6667	0.9928	0.8	0.5
RIT:BBH:0452	−8.67	4.33	-3.21×10^{-4}	0.07146	0.3151	0.6405	0.02778	0.1111	0.3333	0.6667	0.9926	0.25	0.25
RIT:BBH:0453	−6.25	6.25	-4.35×10^{-4}	0.08132	0.4888	0.304	0	0.2	0.5	0.5	0.9914	0	0.8
RIT:BBH:0454	−8.67	4.33	-3.36×10^{-4}	0.07218	0.3151	0.6405	0.02778	0.1111	0.3333	0.6667	0.9927	0.25	0.25
RIT:BBH:0455	−6.87	5.63	-5.19×10^{-4}	0.08407	0.4386	0.3352	0	0.242	0.45	0.55	0.9918	0	0.8
RIT:BBH:0456	−7.03	5.97	-3.63×10^{-4}	0.07796	0.4372	0.2794	0.05278	0.2484	0.4595	0.5405	0.9917	0.25	0.85
RIT:BBH:0457	−8.67	4.33	-3.10×10^{-4}	0.0709	0.3151	0.6405	0.02778	0.1111	0.3333	0.6667	0.9926	0.25	0.25
RIT:BBH:0458	−6.49	6.01	-4.69×10^{-4}	0.08271	0.4692	0.5083	0	0	0.4805	0.5195	0.9914	0	0
RIT:BBH:0459	−6.87	5.63	-4.17×10^{-4}	0.08011	0.4388	0.3353	0	0.242	0.45	0.55	0.9914	0	0.8
RIT:BBH:0460	−7.03	5.97	-3.78×10^{-4}	0.07881	0.4372	0.2794	0.05278	0.2484	0.4595	0.5405	0.9918	0.25	0.85
RIT:BBH:0461	−9.19	3.81	-3.32×10^{-4}	0.06902	0.2761	0.3684	0.02145	0.425	0.2929	0.7071	0.9934	0.25	0.85
RIT:BBH:0462	−8.67	4.33	-2.93×10^{-4}	0.06998	0.3152	0.3467	0.02778	0.3778	0.3333	0.6667	0.9926	0.25	0.85
RIT:BBH:0463	−7.81	4.69	-5.19×10^{-4}	0.08132	0.2263	0.3823	0.1125	0.3125	0.375	0.625	0.9926	0.8	0.8
RIT:BBH:0464	−7.81	4.69	-4.89×10^{-4}	0.0804	0.2264	0.5459	0.1125	0.1953	0.375	0.625	0.9924	0.8	0.5
RIT:BBH:0465	−8.67	4.33	-3.91×10^{-4}	0.07445	0.3149	0.3467	0.02778	0.3778	0.3333	0.6667	0.993	0.25	0.85
RIT:BBH:0466	−8.67	4.33	-3.75×10^{-4}	0.07381	0.315	0.3467	0.02778	0.3778	0.3333	0.6667	0.9929	0.25	0.85
RIT:BBH:0467	−9.38	0.625	-4.34×10^{-5}	0.0213	0.05901	0.493	0	0.7471	0.0625	0.9375	0.9975	0	0.85
RIT:BBH:0468	−5.75	5.75	-8.41×10^{-4}	0.09746	0.5	0.5	0.2375	0.2375	0.5	0.5	0	0.95	0.95
RIT:BBH:0469	−9.19	3.81	-3.44×10^{-4}	0.06954	0.2761	0.3684	0.02145	0.425	0.2929	0.7071	0.9935	0.25	0.85
RIT:BBH:0470	−7.81	4.69	-4.94×10^{-4}	0.08054	0.3547	0.3241	0.03516	0.332	0.375	0.625	0.9924	0.25	0.85
RIT:BBH:0471	−7.81	4.69	-4.20×10^{-4}	0.07786	0.2264	0.546	0.1125	0.1953	0.375	0.625	0.9922	0.8	0.5
RIT:BBH:0472	−6.00	6.00	-4.54×10^{-4}	0.0815	0.3038	0.3038	0.2	0.2	0.5	0.5	0.991	0.8	0.8
RIT:BBH:0473	−6.10	3.37	-8.92×10^{-4}	0.08893	0.3417	0.5374	0.006054	0.2344	0.3559	0.6441	0.99	0.0478	0.565
RIT:BBH:0474	−7.81	4.69	-4.70×10^{-4}	0.07972	0.3547	0.3241	0.03516	0.332	0.375	0.625	0.9923	0.25	0.85
RIT:BBH:0475	−7.81	4.69	-4.09×10^{-4}	0.07751	0.2265	0.5459	0.1125	0.1953	0.375	0.625	0.9921	0.8	0.5
RIT:BBH:0476	−7.81	4.69	-4.50×10^{-4}	0.07906	0.3548	0.583	0.03516	0.1367	0.375	0.625	0.9921	0.25	0.35
RIT:BBH:0477	−8.67	4.33	-2.86×10^{-4}	0.06947	0.3152	0.3467	0.02778	0.3778	0.3333	0.6667	0.9925	0.25	0.85
RIT:BBH:0478	−7.81	4.69	-4.42×10^{-4}	0.07869	0.2264	0.3824	0.1125	0.3125	0.375	0.625	0.9923	0.8	0.8
RIT:BBH:0479	−4.47	3.36	-1.96×10^{-3}	0.108	0.3098	0.392	0.1276	0.2397	0.4292	0.5708	0.9877	0.6929	0.7357

(Table continued)

TABLE I. *(Continued)*

Run	x_1/m	x_2/m	P_r/m	P_t/m	m_1^p/m	m_2^p/m	$\lvert S_1/m^2\rvert$	$\lvert S_2/m^2\rvert$	m_1^H/m	m_2^H/m	$M_{\rm ADM}/m$	$\lvert a_1/m_1^H\rvert$	$\lvert a_2/m_2^H\rvert$
RIT:BBH:0480	−7.81	4.69	-3.61×10^{-4}	0.07514	0.3549	0.3242	0.03516	0.332	0.375	0.625	0.9918	0.25	0.85
RIT:BBH:0481	−7.81	4.69	-3.64×10^{-4}	0.07526	0.2265	0.546	0.1125	0.1953	0.375	0.625	0.9919	0.8	0.5
RIT:BBH:0482	−7.81	4.69	-3.52×10^{-4}	0.07454	0.2265	0.3825	0.1125	0.3125	0.375	0.625	0.9919	0.8	0.8
RIT:BBH:0483	−7.81	4.69	-4.30×10^{-4}	0.07828	0.3548	0.583	0.03516	0.1367	0.375	0.625	0.9921	0.25	0.35
RIT:BBH:0484	−11.59	1.66	-8.87×10^{-5}	0.03609	0.1199	0.7201	0	0.4615	0.125	0.875	0.9966	0	0.6028
RIT:BBH:0485	−7.81	4.69	-4.01×10^{-4}	0.07711	0.3549	0.583	0.03516	0.1367	0.375	0.625	0.9919	0.25	0.35
RIT:BBH:0486	−7.81	4.69	-3.73×10^{-4}	0.07581	0.3549	0.3242	0.03516	0.332	0.375	0.625	0.9919	0.25	0.85
RIT:BBH:0487	−7.81	4.69	-3.85×10^{-4}	0.07639	0.3549	0.583	0.03516	0.1367	0.375	0.625	0.9919	0.25	0.35
RIT:BBH:0488	−7.81	4.69	-3.91×10^{-4}	0.07671	0.2265	0.3824	0.1125	0.3125	0.375	0.625	0.9921	0.8	0.8
RIT:BBH:0489	−7.81	4.69	-3.76×10^{-4}	0.07588	0.2265	0.599	0.1125	0.09766	0.375	0.625	0.9919	0.8	0.25
RIT:BBH:0490	−6.60	5.40	-4.80×10^{-4}	0.08241	0.4384	0.335	0	0.242	0.45	0.55	0.9912	0	0.8
RIT:BBH:0491	−6.60	5.40	-4.80×10^{-4}	0.08242	0.4384	0.335	0	0.242	0.45	0.55	0.9912	0	0.8
RIT:BBH:0492	−8.85	4.89	-2.69×10^{-4}	0.07017	0.346	0.5409	0.006054	0.2344	0.3559	0.6441	0.9927	0.0478	0.565
RIT:BBH:0493	−6.60	5.40	-4.81×10^{-4}	0.08245	0.4384	0.335	0	0.242	0.45	0.55	0.9912	0	0.8
RIT:BBH:0494	−9.75	3.25	-2.23×10^{-4}	0.05994	0.2353	0.704	0.01562	0.1969	0.25	0.75	0.9938	0.25	0.35
RIT:BBH:0495	−9.38	0.625	-6.44×10^{-5}	0.02323	0.05888	0.9084	0	0.2289	0.0625	0.9375	0.9977	0	0.2604
RIT:BBH:0496	−6.60	5.40	-4.82×10^{-4}	0.08246	0.4384	0.3349	0	0.242	0.45	0.55	0.9912	0	0.8
RIT:BBH:0497	−7.81	4.69	-4.27×10^{-4}	0.07821	0.2265	0.5989	0.1125	0.09766	0.375	0.625	0.9922	0.8	0.25
RIT:BBH:0498	−6.60	5.40	-4.81×10^{-4}	0.08245	0.4384	0.335	0	0.242	0.45	0.55	0.9912	0	0.8
RIT:BBH:0499	−5.25	5.25	-8.45×10^{-4}	0.0968	0.5	0.5	0.2375	0.2375	0.5	0.5	0	0.95	0.95
RIT:BBH:0500	−6.60	5.40	-4.80×10^{-4}	0.08242	0.4384	0.335	0	0.242	0.45	0.55	0.9912	0	0.8
RIT:BBH:0501	−7.81	4.69	-4.66×10^{-4}	0.07965	0.2264	0.5989	0.1125	0.09766	0.375	0.625	0.9923	0.8	0.25
RIT:BBH:0502	−7.81	4.69	-4.04×10^{-4}	0.07718	0.2265	0.599	0.1125	0.09766	0.375	0.625	0.9921	0.8	0.25
RIT:BBH:0503	−4.50	4.50	-1.19×10^{-3}	0.1053	0.5	0.5	0.2425	0.2425	0.5	0.5	0	0.97	0.97
RIT:BBH:0504	−4.50	4.50	-1.19×10^{-3}	0.1033	0.5	0.5	0.2425	0.2425	0.5	0.5	0	0.97	0.97
RIT:BBH:0505	−6.60	5.40	-4.95×10^{-4}	0.08308	0.4383	0.335	0	0.242	0.45	0.55	0.9912	0	0.8
RIT:BBH:0506	−6.60	5.40	-4.99×10^{-4}	0.0832	0.4383	0.3349	0	0.242	0.45	0.55	0.9913	0	0.8
RIT:BBH:0507	−9.07	3.02	-2.92×10^{-4}	0.06337	0.2408	0.513	0	0.4219	0.25	0.75	0.9934	0	0.75
RIT:BBH:0508	−6.60	5.40	-4.97×10^{-4}	0.08312	0.4383	0.3349	0	0.242	0.45	0.55	0.9912	0	0.8
RIT:BBH:0509	−7.43	5.57	-4.92×10^{-4}	0.08266	0.2456	0.3299	0.1506	0.2678	0.4286	0.5714	0.9925	0.82	0.82
RIT:BBH:0510	−6.60	5.40	-5.00×10^{-4}	0.0832	0.4383	0.3349	0	0.242	0.45	0.55	0.9913	0	0.8
RIT:BBH:0511	−6.60	5.40	-5.01×10^{-4}	0.08323	0.4383	0.3349	0	0.242	0.45	0.55	0.9913	0	0.8
RIT:BBH:0512	−6.60	5.40	-4.96×10^{-4}	0.08312	0.4383	0.3349	0	0.242	0.45	0.55	0.9912	0	0.8
RIT:BBH:0513	−6.86	5.14	-4.34×10^{-4}	0.07975	0.2452	0.3295	0.1506	0.2678	0.4286	0.5714	0.9912	0.82	0.82
RIT:BBH:0514	−9.19	3.81	-2.71×10^{-4}	0.06738	0.2875	0.7073	0.04285	0.425	0.2977	0.7074	0.9925	0.4995	0.85
RIT:BBH:0515	−9.60	2.40	-2.44×10^{-4}	0.05553	0.1788	0.7726	0.016	0.16	0.2	0.8	0.9945	0.4	0.25
RIT:BBH:0516	−9.60	2.40	-2.90×10^{-4}	0.05746	0.1192	0.4933	0.032	0.512	0.2	0.8	0.9948	0.8	0.8
RIT:BBH:0517	−9.60	2.40	-2.15×10^{-4}	0.05412	0.1789	0.7726	0.016	0.16	0.2	0.8	0.9943	0.4	0.25

(Table continued)

TABLE I. *(Continued)*

Run	x_1/m	x_2/m	P_r/m	P_t/m	m_1^p/m	m_2^p/m	$\lvert S_1/m^2\rvert$	$\lvert S_2/m^2\rvert$	m_1^H/m	m_2^H/m	$M_{\rm ADM}/m$	$\lvert a_1/m_1^H\rvert$	$\lvert a_2/m_2^H\rvert$
RIT:BBH:0518	−9.60	2.40	-2.66×10^{-4}	0.05645	0.1193	0.4933	0.032	0.512	0.2	0.8	0.9947	0.8	0.8
RIT:BBH:0519	−6.63	5.42	-5.14×10^{-4}	0.08387	0.4383	0.335	0	0.242	0.45	0.55	0.9913	0	0.8
RIT:BBH:0520	−6.65	5.45	-5.42×10^{-4}	0.08479	0.4383	0.335	0	0.242	0.45	0.55	0.9915	0	0.8
RIT:BBH:0521	−6.65	5.45	-5.46×10^{-4}	0.08487	0.4383	0.3349	0	0.242	0.45	0.55	0.9916	0	0.8
RIT:BBH:0522	−6.65	5.45	-5.47×10^{-4}	0.08491	0.4383	0.3349	0	0.242	0.45	0.55	0.9916	0	0.8
RIT:BBH:0523	−6.65	5.45	-5.45×10^{-4}	0.08487	0.4383	0.3349	0	0.242	0.45	0.55	0.9916	0	0.8
RIT:BBH:0524	−6.65	5.45	-5.42×10^{-4}	0.08479	0.4383	0.335	0	0.242	0.45	0.55	0.9915	0	0.8
RIT:BBH:0525	−6.65	5.45	-5.41×10^{-4}	0.08476	0.4383	0.335	0	0.242	0.45	0.55	0.9915	0	0.8
RIT:BBH:0526	−9.60	2.40	-2.49×10^{-4}	0.05574	0.192	0.7386	0	0.256	0.2	0.8	0.9945	0	0.4
RIT:BBH:0527	−6.63	5.42	-5.17×10^{-4}	0.08392	0.4383	0.3349	0	0.242	0.45	0.55	0.9914	0	0.8
RIT:BBH:0528	−5.95	5.05	-9.84×10^{-4}	0.1005	0.4595	0.5405	0.2005	0.2776	0.4595	0.5405	0	0.95	0.95
RIT:BBH:0529	−6.49	6.01	-5.27×10^{-4}	0.08477	0.4691	0.268	0	0.2294	0.4805	0.5195	0.9918	0	0.85
RIT:BBH:0530	−6.86	5.14	-4.70×10^{-4}	0.08155	0.4063	0.2954	0.04592	0.2776	0.4286	0.5714	0.9913	0.25	0.85
RIT:BBH:0531	−6.49	6.01	-4.25×10^{-4}	0.08081	0.4693	0.268	0	0.2294	0.4805	0.5195	0.9914	0	0.85
RIT:BBH:0532	−9.60	2.40	-2.05×10^{-4}	0.05351	0.1921	0.7386	0	0.256	0.2	0.8	0.9943	0	0.4
RIT:BBH:0533	−9.60	2.40	-2.17×10^{-4}	0.05415	0.1194	0.793	0.032	0	0.2	0.8	0.9944	0.8	0
RIT:BBH:0534	−6.49	6.01	-4.77×10^{-4}	0.083	0.4572	0.4821	0.05772	0.09445	0.4805	0.5195	0.9915	0.25	0.35
RIT:BBH:0535	−9.60	2.40	-1.87×10^{-4}	0.05231	0.179	0.4934	0.016	0.512	0.2	0.8	0.9942	0.4	0.8
RIT:BBH:0536	−6.49	6.01	-5.18×10^{-4}	0.08447	0.2918	0.5082	0.1847	0	0.4805	0.5195	0.9917	0.8	0
RIT:BBH:0537	−6.86	5.14	-4.51×10^{-4}	0.08065	0.4063	0.2954	0.04592	0.2776	0.4286	0.5714	0.9912	0.25	0.85
RIT:BBH:0538	−9.60	2.40	-2.84×10^{-4}	0.0572	0.1787	0.4933	0.016	0.512	0.2	0.8	0.9947	0.4	0.8
RIT:BBH:0539	−6.49	6.01	-4.38×10^{-4}	0.0814	0.4572	0.4821	0.05772	0.09445	0.4805	0.5195	0.9913	0.25	0.35
RIT:BBH:0540	−6.67	5.46	-5.66×10^{-4}	0.08551	0.4383	0.335	0	0.242	0.45	0.55	0.9916	0	0.8
RIT:BBH:0541	−6.67	5.46	-5.67×10^{-4}	0.08554	0.4383	0.335	0	0.242	0.45	0.55	0.9916	0	0.8
RIT:BBH:0542	−6.67	5.46	-5.67×10^{-4}	0.08555	0.4383	0.335	0	0.242	0.45	0.55	0.9917	0	0.8
RIT:BBH:0543	−6.67	5.46	-5.67×10^{-4}	0.08554	0.4383	0.335	0	0.242	0.45	0.55	0.9916	0	0.8
RIT:BBH:0544	−6.67	5.46	-5.65×10^{-4}	0.08551	0.4383	0.335	0	0.242	0.45	0.55	0.9916	0	0.8
RIT:BBH:0545	−6.60	4.40	-9.20×10^{-4}	0.09732	0.4	0.6	0.152	0.342	0.4	0.6	0	0.95	0.95
RIT:BBH:0546	−9.60	2.40	-2.09×10^{-4}	0.0537	0.1789	0.7726	0.016	0.16	0.2	0.8	0.9943	0.4	0.25
RIT:BBH:0547	−6.67	5.46	-5.65×10^{-4}	0.0855	0.4383	0.335	0	0.242	0.45	0.55	0.9916	0	0.8
RIT:BBH:0548	−6.49	6.01	-5.85×10^{-4}	0.08653	0.2917	0.316	0.1847	0.2159	0.4805	0.5195	0.9921	0.8	0.8
RIT:BBH:0549	−9.60	2.40	-1.92×10^{-4}	0.05269	0.179	0.4934	0.016	0.512	0.2	0.8	0.9942	0.4	0.8
RIT:BBH:0550	−9.60	2.40	-2.33×10^{-4}	0.05504	0.1194	0.7929	0.032	0	0.2	0.8	0.9945	0.8	0
RIT:BBH:0551	−6.63	5.42	-5.16×10^{-4}	0.08392	0.4383	0.3349	0	0.242	0.45	0.55	0.9914	0	0.8
RIT:BBH:0552	−6.49	6.01	-5.07×10^{-4}	0.0841	0.4571	0.482	0.05772	0.09445	0.4805	0.5195	0.9916	0.25	0.35
RIT:BBH:0553	−6.63	5.42	-5.23×10^{-4}	0.08407	0.4383	0.3348	0	0.242	0.45	0.55	0.9915	0	0.8
RIT:BBH:0554	−6.63	5.42	-5.21×10^{-4}	0.08402	0.4383	0.3349	0	0.242	0.45	0.55	0.9915	0	0.8
RIT:BBH:0555	−6.49	6.01	-4.62×10^{-4}	0.08243	0.4572	0.482	0.05772	0.09445	0.4805	0.5195	0.9914	0.25	0.35

(Table continued)

TABLE I. *(Continued)*

Run	x_1/m	x_2/m	P_r/m	P_t/m	m_1^p/m	m_2^p/m	$\lvert S_1/m^2\rvert$	$\lvert S_2/m^2\rvert$	m_1^H/m	m_2^H/m	$M_{\rm ADM}/m$	$\lvert a_1/m_1^H\rvert$	$\lvert a_2/m_2^H\rvert$
RIT:BBH:0556	−7.00	3.50	-9.53×10^{-4}	0.0941	0.3333	0.6667	0.1056	0.4222	0.3333	0.6667	0	0.95	0.95
RIT:BBH:0557	−6.49	6.01	-4.65×10^{-4}	0.08254	0.2919	0.3161	0.1847	0.2159	0.4805	0.5195	0.9917	0.8	0.8
RIT:BBH:0558	−6.49	6.01	-3.99×10^{-4}	0.0794	0.2919	0.3162	0.1847	0.2159	0.4805	0.5195	0.9913	0.8	0.8
RIT:BBH:0559	−6.49	6.01	-4.31×10^{-4}	0.08107	0.2919	0.5084	0.1847	0	0.4805	0.5195	0.9914	0.8	0
RIT:BBH:0560	−6.63	5.42	-5.20×10^{-4}	0.08402	0.4383	0.3349	0	0.242	0.45	0.55	0.9915	0	0.8
RIT:BBH:0561	−6.67	3.33	-9.12×10^{-4}	0.09271	0.3333	0.6667	0.1056	0.4222	0.3333	0.6667	0	0.95	0.95
RIT:BBH:0562	−9.60	2.40	-2.35×10^{-4}	0.05507	0.1788	0.7726	0.016	0.16	0.2	0.8	0.9944	0.4	0.25
RIT:BBH:0563	−6.49	6.01	-4.74×10^{-4}	0.08287	0.2918	0.3162	0.1847	0.2159	0.4805	0.5195	0.9917	0.8	0.8
RIT:BBH:0564	−7.03	5.97	-4.99×10^{-4}	0.0854	0.4538	0.5397	0.1055	0.2483	0.4662	0.5452	0.9918	0.4999	0.85
RIT:BBH:0565	−6.86	5.14	-6.15×10^{-4}	0.08639	0.4061	0.2953	0.04592	0.2776	0.4286	0.5714	0.9918	0.25	0.85
RIT:BBH:0566	−6.00	4.50	-8.57×10^{-4}	0.09634	0.4286	0.5714	0.1745	0.3102	0.4286	0.5714	0	0.95	0.95
RIT:BBH:0567	−9.75	3.25	-2.01×10^{-4}	0.05845	0.2354	0.3915	0.01562	0.4781	0.25	0.75	0.9937	0.25	0.85
RIT:BBH:0568	−6.86	5.14	-5.78×10^{-4}	0.0853	0.4061	0.2953	0.04592	0.2776	0.4286	0.5714	0.9917	0.25	0.85
RIT:BBH:0569	−7.71	3.28	-4.52×10^{-4}	0.07354	0.2871	0.5733	0.0008892	0.2955	0.2982	0.7018	0.9919	0.01	0.6
RIT:BBH:0570	−9.60	2.40	-2.72×10^{-4}	0.0567	0.1787	0.4933	0.016	0.512	0.2	0.8	0.9947	0.4	0.8
RIT:BBH:0571	−5.68	4.82	-8.61×10^{-4}	0.09713	0.4595	0.5405	0.2005	0.2776	0.4595	0.5405	0	0.95	0.95
RIT:BBH:0572	−9.75	3.25	-2.56×10^{-4}	0.06174	0.2352	0.704	0.01562	0.1969	0.25	0.75	0.9939	0.25	0.35
RIT:BBH:0573	−5.00	5.00	-9.13×10^{-4}	0.09618	0.4875	0.5	0	0.2375	0.5	0.5	0	0	0.95
RIT:BBH:0574	−9.60	2.40	-2.82×10^{-4}	0.0571	0.1919	0.4182	0	0.544	0.2	0.8	0.9947	0	0.85
RIT:BBH:0575	−9.75	3.25	-2.49×10^{-4}	0.06137	0.2352	0.704	0.01562	0.1969	0.25	0.75	0.9939	0.25	0.35
RIT:BBH:0576	−9.75	3.25	-2.18×10^{-4}	0.05961	0.2353	0.704	0.01562	0.1969	0.25	0.75	0.9937	0.25	0.35
RIT:BBH:0577	−5.68	4.82	-8.07×10^{-4}	0.09558	0.4595	0.5405	0.2005	0.2776	0.4595	0.5405	0	0.95	0.95
RIT:BBH:0578	−9.60	2.40	-1.94×10^{-4}	0.05289	0.1194	0.4934	0.032	0.512	0.2	0.8	0.9943	0.8	0.8
RIT:BBH:0579	−9.75	3.25	-2.05×10^{-4}	0.05876	0.2354	0.3915	0.01562	0.4781	0.25	0.75	0.9937	0.25	0.85
RIT:BBH:0580	−9.60	2.40	-1.85×10^{-4}	0.05212	0.1195	0.4934	0.032	0.512	0.2	0.8	0.9943	0.8	0.8
RIT:BBH:0581	−6.00	4.50	-7.67×10^{-4}	0.09386	0.4286	0.5714	0.1745	0.3102	0.4286	0.5714	0	0.95	0.95
RIT:BBH:0582	−5.04	4.62	-1.25×10^{-3}	0.09779	0.4698	0.517	0.09646	0.1759	0.4834	0.5263	0.989	0.4211	0.647
RIT:BBH:0583	−6.86	5.14	-4.92×10^{-4}	0.0824	0.2198	0.5458	0.1561	0.08163	0.4286	0.5714	0.9914	0.85	0.25
RIT:BBH:0584	−6.86	5.14	-5.96×10^{-4}	0.08586	0.2197	0.5456	0.1561	0.08163	0.4286	0.5714	0.9918	0.85	0.25
RIT:BBH:0585	−9.75	3.25	-2.86×10^{-4}	0.06312	0.2351	0.3915	0.01562	0.4781	0.25	0.75	0.9941	0.25	0.85
RIT:BBH:0586	−7.92	3.94	-3.93×10^{-4}	0.07416	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9919	0	0.8
RIT:BBH:0587	−7.92	3.94	-3.93×10^{-4}	0.07417	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9919	0	0.8
RIT:BBH:0588	−7.92	3.94	-3.94×10^{-4}	0.0742	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.992	0	0.8
RIT:BBH:0589	−7.93	3.94	-3.95×10^{-4}	0.07421	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.992	0	0.8
RIT:BBH:0590	−7.92	3.94	-3.94×10^{-4}	0.0742	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.992	0	0.8
RIT:BBH:0591	−7.92	3.94	-3.93×10^{-4}	0.07417	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9919	0	0.8
RIT:BBH:0592	−7.92	3.95	-4.06×10^{-4}	0.07484	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.992	0	0.8
RIT:BBH:0593	−7.93	3.95	-4.08×10^{-4}	0.07487	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.992	0	0.8

(Table continued)

TABLE I. *(Continued)*

Run	x_1/m	x_2/m	P_r/m	P_t/m	m_1^p/m	m_2^p/m	$\lvert S_1/m^2\rvert$	$\lvert S_2/m^2\rvert$	m_1^H/m	m_2^H/m	$M_{\rm ADM}/m$	$\lvert a_1/m_1^H\rvert$	$\lvert a_2/m_2^H\rvert$
RIT:BBH:0594	−7.93	3.96	-4.10×10^{-4}	0.07494	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9921	0	0.8
RIT:BBH:0595	−7.94	3.96	-4.11×10^{-4}	0.07497	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9921	0	0.8
RIT:BBH:0596	−7.93	3.96	-4.10×10^{-4}	0.07494	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9921	0	0.8
RIT:BBH:0597	−7.93	3.95	-4.07×10^{-4}	0.07487	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.992	0	0.8
RIT:BBH:0598	−7.98	4.03	-4.88×10^{-4}	0.07777	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9925	0	0.8
RIT:BBH:0599	−7.98	4.04	-4.88×10^{-4}	0.07778	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9925	0	0.8
RIT:BBH:0600	−7.99	4.04	-4.89×10^{-4}	0.0778	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9925	0	0.8
RIT:BBH:0601	−7.99	4.04	-4.89×10^{-4}	0.07781	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9925	0	0.8
RIT:BBH:0602	−7.99	4.04	-4.89×10^{-4}	0.0778	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9925	0	0.8
RIT:BBH:0603	−7.98	4.04	-4.88×10^{-4}	0.07778	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9925	0	0.8
RIT:BBH:0604	−6.86	5.14	-4.61×10^{-4}	0.0811	0.2198	0.5458	0.1561	0.08163	0.4286	0.5714	0.9913	0.85	0.25
RIT:BBH:0605	−9.75	3.25	-2.78×10^{-4}	0.06272	0.2351	0.3915	0.01562	0.4781	0.25	0.75	0.9941	0.25	0.85
RIT:BBH:0606	−7.94	3.98	-4.30×10^{-4}	0.07585	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9921	0	0.8
RIT:BBH:0607	−7.94	3.98	-4.32×10^{-4}	0.07589	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9922	0	0.8
RIT:BBH:0608	−7.95	3.98	-4.36×10^{-4}	0.07597	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9923	0	0.8
RIT:BBH:0609	−7.96	3.99	-4.37×10^{-4}	0.07602	0.3225	0.4083	0	0.3556	0.3333	0.6667	0.9923	0	0.8
RIT:BBH:0610	−7.95	3.98	-4.35×10^{-4}	0.07597	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9923	0	0.8
RIT:BBH:0611	−7.94	3.98	-4.31×10^{-4}	0.07589	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9922	0	0.8
RIT:BBH:0612	−6.86	5.14	-5.47×10^{-4}	0.08437	0.2198	0.5457	0.1561	0.08163	0.4286	0.5714	0.9916	0.85	0.25
RIT:BBH:0613	−9.60	2.40	-1.88×10^{-4}	0.05237	0.1922	0.4183	0	0.544	0.2	0.8	0.9942	0	0.85
RIT:BBH:0614	−10.83	2.17	-1.62×10^{-4}	0.04701	0.156	0.4366	0.006944	0.5903	0.1667	0.8333	0.9957	0.25	0.85
RIT:BBH:0615	−5.68	4.82	-9.28×10^{-4}	0.09259	0.4595	0.5288	0.2005	0	0.4595	0.5405	0	0.95	0
RIT:BBH:0616	−6.30	4.20	-7.21×10^{-4}	0.09165	0.4	0.6	0.152	0.342	0.4	0.6	0	0.95	0.95
RIT:BBH:0617	−5.65	3.49	-1.13×10^{-3}	0.09634	0.3743	0.6134	0.04746	0.3101	0.3876	0.6162	0.9889	0.3199	0.8204
RIT:BBH:0618	−7.96	4.01	-4.60×10^{-4}	0.07693	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9923	0	0.8
RIT:BBH:0619	−7.96	4.01	-4.62×10^{-4}	0.07696	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9923	0	0.8
RIT:BBH:0620	−7.97	4.01	-4.65×10^{-4}	0.07702	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9924	0	0.8
RIT:BBH:0621	−7.97	4.02	-4.66×10^{-4}	0.07705	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9924	0	0.8
RIT:BBH:0622	−7.97	4.01	-4.64×10^{-4}	0.07702	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9924	0	0.8
RIT:BBH:0623	−7.96	4.01	-4.62×10^{-4}	0.07696	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9923	0	0.8
RIT:BBH:0624	−6.71	4.44	-5.65×10^{-4}	0.08352	0.3878	0.3659	0	0.288	0.4	0.6	0.9908	0	0.8
RIT:BBH:0625	−6.71	4.44	-5.68×10^{-4}	0.08358	0.3878	0.3658	0	0.288	0.4	0.6	0.9909	0	0.8
RIT:BBH:0626	−6.85	4.55	-5.46×10^{-4}	0.08315	0.388	0.366	0	0.288	0.4	0.6	0.9911	0	0.8
RIT:BBH:0627	−6.85	4.55	-5.53×10^{-4}	0.08333	0.388	0.3659	0	0.288	0.4	0.6	0.9912	0	0.8
RIT:BBH:0628	−7.05	4.70	-5.26×10^{-4}	0.08269	0.3883	0.3662	0	0.288	0.4	0.6	0.9914	0	0.8
RIT:BBH:0629	−7.05	4.70	-5.35×10^{-4}	0.08291	0.3883	0.3661	0	0.288	0.4	0.6	0.9916	0	0.8
RIT:BBH:0630	−5.20	5.10	-8.85×10^{-4}	0.08916	0.484	0.4952	0.08286	0.0564	0.4988	0.5112	0.9896	0.34	0.22
RIT:BBH:0631	−7.96	4.01	-4.61×10^{-4}	0.07694	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9923	0	0.8

(Table continued)

TABLE I. *(Continued)*

Run	x_1/m	x_2/m	P_r/m	P_t/m	m_1^p/m	m_2^p/m	$\lvert S_1/m^2\rvert$	$\lvert S_2/m^2\rvert$	m_1^H/m	m_2^H/m	$M_{\rm ADM}/m$	$\lvert a_1/m_1^H\rvert$	$\lvert a_2/m_2^H\rvert$
RIT:BBH:0632	−7.97	4.02	-4.66×10^{-4}	0.07704	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9924	0	0.8
RIT:BBH:0633	−7.98	4.04	-4.88×10^{-4}	0.07777	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9925	0	0.8
RIT:BBH:0634	−7.99	4.04	-4.89×10^{-4}	0.07781	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9925	0	0.8
RIT:BBH:0635	−7.94	3.98	-4.30×10^{-4}	0.07586	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9921	0	0.8
RIT:BBH:0636	−7.95	3.99	-4.36×10^{-4}	0.076	0.3225	0.4083	0	0.3556	0.3333	0.6667	0.9923	0	0.8
RIT:BBH:0637	−10.00	2.04	-2.10×10^{-4}	0.04946	0.1596	0.5147	0	0.5556	0.1667	0.8333	0.9954	0	0.8
RIT:BBH:0638	−7.92	3.95	-4.06×10^{-4}	0.07485	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.992	0	0.8
RIT:BBH:0639	−7.94	3.96	-4.11×10^{-4}	0.07496	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9921	0	0.8
RIT:BBH:0640	−7.92	3.94	-3.93×10^{-4}	0.07416	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.9919	0	0.8
RIT:BBH:0641	−7.93	3.94	-3.95×10^{-4}	0.0742	0.3225	0.4084	0	0.3556	0.3333	0.6667	0.992	0	0.8
RIT:BBH:0642	−5.41	4.59	-7.71×10^{-4}	0.09263	0.4595	0.5405	0.2005	0.2776	0.4595	0.5405	0	0.95	0.95
RIT:BBH:0643	−5.95	5.05	-8.80×10^{-4}	0.09667	0.4477	0.5405	0	0.2776	0.4595	0.5405	0	0	0.95
RIT:BBH:0644	−6.00	4.50	-8.93×10^{-4}	0.0917	0.4286	0.5599	0.1745	0	0.4286	0.5714	0	0.95	0
RIT:BBH:0645	−6.65	5.48	-5.65×10^{-4}	0.0855	0.4383	0.335	0	0.242	0.45	0.55	0.9916	0	0.8
RIT:BBH:0646	−6.65	5.48	-5.67×10^{-4}	0.08555	0.4383	0.335	0	0.242	0.45	0.55	0.9916	0	0.8
RIT:BBH:0647	−6.64	5.46	-5.41×10^{-4}	0.08477	0.4383	0.335	0	0.242	0.45	0.55	0.9915	0	0.8
RIT:BBH:0648	−6.64	5.46	-5.46×10^{-4}	0.0849	0.4383	0.3349	0	0.242	0.45	0.55	0.9916	0	0.8
RIT:BBH:0649	−6.63	5.42	-5.15×10^{-4}	0.08388	0.4383	0.335	0	0.242	0.45	0.55	0.9914	0	0.8
RIT:BBH:0650	−6.63	5.42	-5.22×10^{-4}	0.08406	0.4383	0.3348	0	0.242	0.45	0.55	0.9915	0	0.8
RIT:BBH:0651	−6.61	5.39	-4.95×10^{-4}	0.08309	0.4383	0.335	0	0.242	0.45	0.55	0.9912	0	0.8
RIT:BBH:0652	−6.61	5.39	-5.00×10^{-4}	0.08322	0.4383	0.3349	0	0.242	0.45	0.55	0.9913	0	0.8
RIT:BBH:0653	−6.62	5.38	-4.80×10^{-4}	0.08241	0.4384	0.335	0	0.242	0.45	0.55	0.9912	0	0.8
RIT:BBH:0654	−6.62	5.38	-4.82×10^{-4}	0.08246	0.4384	0.3349	0	0.242	0.45	0.55	0.9912	0	0.8
RIT:BBH:0655	−6.30	4.20	-8.49×10^{-4}	0.09023	0.4	0.5887	0.152	0	0.4	0.6	0	0.95	0
RIT:BBH:0656	−8.89	2.94	-2.77×10^{-4}	0.06243	0.2407	0.4614	0	0.45	0.25	0.75	0.9931	0	0.8
RIT:BBH:0657	−6.02	3.26	-9.97×10^{-4}	0.09289	0.3483	0.6435	0.06933	0.337	0.3587	0.646	0.9894	0.5497	0.8104
RIT:BBH:0658	−6.29	4.71	-8.69×10^{-4}	0.09562	0.4169	0.5714	0	0.3102	0.4286	0.5714	0	0	0.95
RIT:BBH:0659	−5.50	5.50	-8.00×10^{-4}	0.0882	0.5	0.4875	0.2375	0	0.5	0.5	0	0.95	0
RIT:BBH:0660	−10.83	2.17	-1.43×10^{-4}	0.04583	0.1561	0.785	0.006944	0.2431	0.1667	0.8333	0.9955	0.25	0.35
RIT:BBH:0661	−6.28	6.28	-4.61×10^{-4}	0.08252	0.4888	0.304	0	0.2	0.5	0.5	0.9916	0	0.8
RIT:BBH:0662	−6.28	6.28	-4.65×10^{-4}	0.08265	0.4888	0.3039	0	0.2	0.5	0.5	0.9917	0	0.8
RIT:BBH:0663	−6.29	6.29	-4.81×10^{-4}	0.08331	0.4888	0.304	0	0.2	0.5	0.5	0.9917	0	0.8
RIT:BBH:0664	−6.29	6.29	-4.85×10^{-4}	0.08341	0.4888	0.3039	0	0.2	0.5	0.5	0.9918	0	0.8
RIT:BBH:0665	−6.30	6.30	-4.98×10^{-4}	0.0839	0.4888	0.304	0	0.2	0.5	0.5	0.9918	0	0.8
RIT:BBH:0666	−6.30	6.30	-4.99×10^{-4}	0.08393	0.4888	0.304	0	0.2	0.5	0.5	0.9918	0	0.8
RIT:BBH:0667	−6.78	4.83	-6.05×10^{-4}	0.08572	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9914	0.8	0
RIT:BBH:0668	−6.78	4.83	-6.07×10^{-4}	0.08577	0.2515	0.5717	0.1389	0	0.4167	0.5833	0.9915	0.8	0
RIT:BBH:0669	−6.26	6.26	-4.44×10^{-4}	0.0818	0.4888	0.304	0	0.2	0.5	0.5	0.9915	0	0.8

(Table continued)

TABLE I. *(Continued)*

Run	x_1/m	x_2/m	P_r/m	P_t/m	m_1^p/m	m_2^p/m	$\lvert S_1/m^2\rvert$	$\lvert S_2/m^2\rvert$	m_1^H/m	m_2^H/m	$M_{\rm ADM}/m$	$\lvert a_1/m_1^H\rvert$	$\lvert a_2/m_2^H\rvert$
RIT:BBH:0670	−6.26	6.26	-4.47×10^{-4}	0.0819	0.4888	0.3039	0	0.2	0.5	0.5	0.9916	0	0.8
RIT:BBH:0671	−6.75	4.82	-5.73×10^{-4}	0.0847	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9913	0.8	0
RIT:BBH:0672	−6.75	4.82	-5.77×10^{-4}	0.0848	0.2515	0.5717	0.1389	0	0.4167	0.5833	0.9914	0.8	0
RIT:BBH:0673	−6.71	4.82	-5.42×10^{-4}	0.08356	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9911	0.8	0
RIT:BBH:0674	−6.71	4.82	-5.43×10^{-4}	0.08358	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9911	0.8	0
RIT:BBH:0675	−6.73	4.82	-5.53×10^{-4}	0.084	0.2516	0.5717	0.1389	0	0.4167	0.5833	0.9912	0.8	0
RIT:BBH:0676	−6.73	4.82	-5.56×10^{-4}	0.08408	0.2515	0.5717	0.1389	0	0.4167	0.5833	0.9913	0.8	0
RIT:BBH:0677	−8.89	2.94	-2.78×10^{-4}	0.06245	0.2407	0.4614	0	0.45	0.25	0.75	0.9932	0	0.8
RIT:BBH:0678	−9.60	2.40	-2.40×10^{-4}	0.05533	0.1432	0.7386	0.028	0.256	0.2	0.8	0.9945	0.7	0.4
RIT:BBH:0679	−6.67	3.33	-6.91×10^{-4}	0.08713	0.3333	0.6667	0.1056	0.4222	0.3333	0.6667	0	0.95	0.95
RIT:BBH:0681	−6.60	4.40	-8.48×10^{-4}	0.09401	0.3885	0.6	0	0.342	0.4	0.6	0	0	0.95
RIT:BBH:0682	−9.93	2.01	-1.88×10^{-4}	0.04847	0.1596	0.5147	0	0.5556	0.1667	0.8333	0.9952	0	0.8
RIT:BBH:0683	−9.94	2.01	-1.89×10^{-4}	0.0485	0.1596	0.5147	0	0.5556	0.1667	0.8333	0.9952	0	0.8
RIT:BBH:0684	−9.95	2.01	-1.91×10^{-4}	0.04857	0.1596	0.5147	0	0.5556	0.1667	0.8333	0.9953	0	0.8
RIT:BBH:0685	−9.95	2.01	-1.91×10^{-4}	0.04857	0.1596	0.5147	0	0.5556	0.1667	0.8333	0.9953	0	0.8
RIT:BBH:0686	−9.94	2.01	-1.89×10^{-4}	0.0485	0.1596	0.5147	0	0.5556	0.1667	0.8333	0.9952	0	0.8
RIT:BBH:0687	−6.00	4.00	-7.16×10^{-4}	0.08962	0.4	0.6	0.152	0.342	0.4	0.6	0	0.95	0.95
RIT:BBH:0688	−7.33	3.67	-7.58×10^{-4}	0.08774	0.322	0.6667	0	0.4222	0.3333	0.6667	0	0	0.95
RIT:BBH:0689	−7.21	4.32	-5.09×10^{-4}	0.08075	0.2259	0.6139	0.1125	0	0.375	0.625	0.9914	0.8	0
RIT:BBH:0690	−10.83	2.17	-1.10×10^{-4}	0.04318	0.1562	0.4366	0.006944	0.5903	0.1667	0.8333	0.9953	0.25	0.85
RIT:BBH:0691	−9.85	1.95	-1.50×10^{-4}	0.04598	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.9949	0	0.8
RIT:BBH:0692	−8.98	3.04	-3.58×10^{-4}	0.06598	0.2406	0.4614	0	0.45	0.25	0.75	0.9937	0	0.8
RIT:BBH:0693	−8.98	3.04	-3.59×10^{-4}	0.06599	0.2406	0.4614	0	0.45	0.25	0.75	0.9937	0	0.8
RIT:BBH:0694	−8.99	3.04	-3.59×10^{-4}	0.06601	0.2406	0.4614	0	0.45	0.25	0.75	0.9937	0	0.8
RIT:BBH:0695	−8.99	3.04	-3.60×10^{-4}	0.06602	0.2407	0.4614	0	0.45	0.25	0.75	0.9937	0	0.8
RIT:BBH:0696	−8.99	3.04	-3.59×10^{-4}	0.06601	0.2406	0.4614	0	0.45	0.25	0.75	0.9937	0	0.8
RIT:BBH:0697	−8.98	3.04	-3.58×10^{-4}	0.06599	0.2406	0.4614	0	0.45	0.25	0.75	0.9937	0	0.8
RIT:BBH:0698	−8.95	3.01	-3.34×10^{-4}	0.06515	0.2407	0.4614	0	0.45	0.25	0.75	0.9935	0	0.8
RIT:BBH:0699	−8.95	3.01	-3.36×10^{-4}	0.06518	0.2407	0.4614	0	0.45	0.25	0.75	0.9935	0	0.8
RIT:BBH:0700	−8.96	3.02	-3.39×10^{-4}	0.06525	0.2407	0.4614	0	0.45	0.25	0.75	0.9936	0	0.8
RIT:BBH:0701	−8.97	3.02	-3.40×10^{-4}	0.06528	0.2407	0.4613	0	0.45	0.25	0.75	0.9936	0	0.8
RIT:BBH:0702	−8.96	3.02	-3.38×10^{-4}	0.06525	0.2407	0.4614	0	0.45	0.25	0.75	0.9936	0	0.8
RIT:BBH:0703	−8.95	3.01	-3.36×10^{-4}	0.06518	0.2407	0.4614	0	0.45	0.25	0.75	0.9935	0	0.8
RIT:BBH:0704	−8.89	2.94	-2.79×10^{-4}	0.06247	0.2407	0.4614	0	0.45	0.25	0.75	0.9932	0	0.8
RIT:BBH:0705	−9.60	2.40	-2.00×10^{-4}	0.05315	0.1433	0.7387	0.028	0.256	0.2	0.8	0.9943	0.7	0.4
RIT:BBH:0706	−7.00	3.50	-7.15×10^{-4}	0.08435	0.3333	0.6562	0.1056	0	0.3333	0.6667	0	0.95	0
RIT:BBH:0707	−9.88	1.98	-1.70×10^{-4}	0.04754	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.9951	0	0.8
RIT:BBH:0708	−9.89	1.99	-1.72×10^{-4}	0.04759	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.9951	0	0.8

(Table continued)

TABLE I. *(Continued)*

Run	x_1/m	x_2/m	P_r/m	P_t/m	m_1^p/m	m_2^p/m	$\lvert S_1/m^2\rvert$	$\lvert S_2/m^2\rvert$	m_1^H/m	m_2^H/m	$M_{\rm ADM}/m$	$\lvert a_1/m_1^H\rvert$	$\lvert a_2/m_2^H\rvert$
RIT:BBH:0709	−9.91	1.99	-1.74×10^{-4}	0.04768	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.9951	0	0.8
RIT:BBH:0710	−9.92	1.99	-1.76×10^{-4}	0.04773	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.9952	0	0.8
RIT:BBH:0711	−9.91	1.99	-1.74×10^{-4}	0.04768	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.9951	0	0.8
RIT:BBH:0712	−9.89	1.99	-1.72×10^{-4}	0.04759	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.9951	0	0.8
RIT:BBH:0713	−7.21	4.32	-5.10×10^{-4}	0.08075	0.2259	0.6139	0.1125	0	0.375	0.625	0.9915	0.8	0
RIT:BBH:0714	−9.60	2.40	-2.11×10^{-4}	0.05388	0.1433	0.7386	0.028	0.256	0.2	0.8	0.9944	0.7	0.4
RIT:BBH:0715	−8.90	2.95	-2.79×10^{-4}	0.06248	0.2407	0.4614	0	0.45	0.25	0.75	0.9932	0	0.8
RIT:BBH:0716	−8.89	2.94	-2.79×10^{-4}	0.06247	0.2407	0.4614	0	0.45	0.25	0.75	0.9932	0	0.8
RIT:BBH:0717	−8.89	2.94	-2.78×10^{-4}	0.06244	0.2407	0.4614	0	0.45	0.25	0.75	0.9931	0	0.8
RIT:BBH:0718	−8.90	2.95	-2.79×10^{-4}	0.06248	0.2407	0.4614	0	0.45	0.25	0.75	0.9932	0	0.8
RIT:BBH:0719	−8.90	2.96	-2.89×10^{-4}	0.06312	0.2407	0.4614	0	0.45	0.25	0.75	0.9932	0	0.8
RIT:BBH:0720	−8.90	2.96	-2.88×10^{-4}	0.0631	0.2407	0.4614	0	0.45	0.25	0.75	0.9932	0	0.8
RIT:BBH:0721	−8.91	2.96	-2.93×10^{-4}	0.06323	0.2407	0.4613	0	0.45	0.25	0.75	0.9933	0	0.8
RIT:BBH:0722	−8.91	2.98	-3.08×10^{-4}	0.06408	0.2407	0.4614	0	0.45	0.25	0.75	0.9934	0	0.8
RIT:BBH:0723	−8.94	2.99	-3.14×10^{-4}	0.06425	0.2407	0.4613	0	0.45	0.25	0.75	0.9935	0	0.8
RIT:BBH:0724	−8.95	3.01	-3.35×10^{-4}	0.06516	0.2407	0.4614	0	0.45	0.25	0.75	0.9935	0	0.8
RIT:BBH:0725	−8.97	3.02	-3.39×10^{-4}	0.06527	0.2407	0.4614	0	0.45	0.25	0.75	0.9936	0	0.8
RIT:BBH:0726	−8.98	3.04	-3.58×10^{-4}	0.06598	0.2406	0.4614	0	0.45	0.25	0.75	0.9937	0	0.8
RIT:BBH:0727	−8.99	3.04	-3.60×10^{-4}	0.06602	0.2407	0.4614	0	0.45	0.25	0.75	0.9937	0	0.8
RIT:BBH:0728	−9.85	1.97	-1.58×10^{-4}	0.04671	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.9949	0	0.8
RIT:BBH:0729	−9.86	1.97	-1.59×10^{-4}	0.04674	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.995	0	0.8
RIT:BBH:0730	−9.88	1.97	-1.61×10^{-4}	0.04682	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.995	0	0.8
RIT:BBH:0731	−9.88	1.97	-1.60×10^{-4}	0.04682	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.995	0	0.8
RIT:BBH:0732	−9.86	1.97	-1.59×10^{-4}	0.04674	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.995	0	0.8
RIT:BBH:0733	−8.89	2.94	-2.78×10^{-4}	0.06245	0.2407	0.4614	0	0.45	0.25	0.75	0.9932	0	0.8
RIT:BBH:0734	−8.91	2.96	-2.92×10^{-4}	0.0632	0.2407	0.4613	0	0.45	0.25	0.75	0.9933	0	0.8
RIT:BBH:0735	−9.88	1.97	-1.62×10^{-4}	0.04685	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.995	0	0.8
RIT:BBH:0736	−10.83	2.17	-1.59×10^{-4}	0.04682	0.156	0.4366	0.006944	0.5903	0.1667	0.8333	0.9956	0.25	0.85
RIT:BBH:0746	−8.89	2.96	-2.88×10^{-4}	0.06309	0.2407	0.4614	0	0.45	0.25	0.75	0.9932	0	0.8
RIT:BBH:0747	−5.68	4.82	-7.12×10^{-4}	0.08668	0.4595	0.5288	0.2005	0	0.4595	0.5405	0	0.95	0
RIT:BBH:0749	−8.91	2.96	-2.93×10^{-4}	0.06324	0.2407	0.4613	0	0.45	0.25	0.75	0.9933	0	0.8
RIT:BBH:0750	−7.92	3.98	-4.17×10^{-4}	0.07518	0.2005	0.6566	0.08889	0	0.3333	0.6667	0.9921	0.8	0
RIT:BBH:0751	−7.92	3.98	-4.17×10^{-4}	0.07518	0.2005	0.6566	0.08889	0	0.3333	0.6667	0.9921	0.8	0
RIT:BBH:0752	−7.92	3.98	-4.18×10^{-4}	0.07519	0.2005	0.6566	0.08889	0	0.3333	0.6667	0.9922	0.8	0
RIT:BBH:0753	−10.83	2.17	-1.34×10^{-4}	0.04524	0.09959	0.8065	0.02222	0.1736	0.1667	0.8333	0.9955	0.8	0.25
RIT:BBH:0754	−7.92	3.98	-4.18×10^{-4}	0.07518	0.2005	0.6566	0.08889	0	0.3333	0.6667	0.9922	0.8	0
RIT:BBH:0755	−7.92	3.98	-4.17×10^{-4}	0.07518	0.2005	0.6566	0.08889	0	0.3333	0.6667	0.9921	0.8	0
RIT:BBH:0756	−7.92	3.98	-4.18×10^{-4}	0.07518	0.2005	0.6566	0.08889	0	0.3333	0.6667	0.9922	0.8	0

(Table continued)

TABLE I. *(Continued)*

Run	x_1/m	x_2/m	P_r/m	P_t/m	m_1^p/m	m_2^p/m	$\lvert S_1/m^2\rvert$	$\lvert S_2/m^2\rvert$	m_1^H/m	m_2^H/m	$M_{\rm ADM}/m$	$\lvert a_1/m_1^H\rvert$	$\lvert a_2/m_2^H\rvert$
RIT:BBH:0758	−9.85	1.95	-1.51×10^{-4}	0.04616	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.9949	0	0.8
RIT:BBH:0759	−9.85	1.95	-1.52×10^{-4}	0.04617	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.9949	0	0.8
RIT:BBH:0760	−9.85	1.96	-1.52×10^{-4}	0.0462	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.9949	0	0.8
RIT:BBH:0761	−9.86	1.96	-1.53×10^{-4}	0.04621	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.9949	0	0.8
RIT:BBH:0762	−9.85	1.96	-1.52×10^{-4}	0.0462	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.9949	0	0.8
RIT:BBH:0763	−9.85	1.95	-1.52×10^{-4}	0.04617	0.1597	0.5147	0	0.5556	0.1667	0.8333	0.9949	0	0.8
RIT:BBH:0764	−11.25	0.75	-4.09×10^{-5}	0.02119	0.05943	0.4932	0	0.7471	0.0625	0.9375	0.9981	0	0.85
RIT:BBH:0766	−5.68	4.82	-7.52×10^{-4}	0.09229	0.4477	0.5405	0	0.2776	0.4595	0.5405	0	0	0.95
RIT:BBH:0767	−6.67	3.33	-6.10×10^{-4}	0.08316	0.3333	0.6667	0.1056	0.4222	0.3333	0.6667	0	0.95	0.95
RIT:BBH:0768	−7.21	4.32	-5.10×10^{-4}	0.08076	0.2259	0.6139	0.1125	0	0.375	0.625	0.9915	0.8	0
RIT:BBH:0769	−6.00	4.50	-7.00×10^{-4}	0.08624	0.4286	0.5599	0.1745	0	0.4286	0.5714	0	0.95	0
RIT:BBH:0770	−8.90	2.96	-2.89×10^{-4}	0.06312	0.2407	0.4614	0	0.45	0.25	0.75	0.9932	0	0.8
RIT:BBH:0771	−8.91	2.96	-2.92×10^{-4}	0.0632	0.2407	0.4613	0	0.45	0.25	0.75	0.9933	0	0.8
RIT:BBH:0772	−9.96	2.02	-1.92×10^{-4}	0.0486	0.1596	0.5147	0	0.5556	0.1667	0.8333	0.9953	0	0.8
RIT:BBH:0773	−10.83	2.17	-1.40×10^{-4}	0.04565	0.1561	0.785	0.006944	0.2431	0.1667	0.8333	0.9955	0.25	0.35
RIT:BBH:0774	−7.21	4.32	-5.10×10^{-4}	0.08077	0.2259	0.6139	0.1125	0	0.375	0.625	0.9915	0.8	0
RIT:BBH:0776	−6.30	4.20	-6.79×10^{-4}	0.0852	0.4	0.5887	0.152	0	0.4	0.6	0	0.95	0
RIT:BBH:0777	−6.00	4.50	-7.26×10^{-4}	0.09083	0.4169	0.5714	0	0.3102	0.4286	0.5714	0	0	0.95
RIT:BBH:0778	−10.83	2.17	-1.42×10^{-4}	0.0458	0.09957	0.8065	0.02222	0.1736	0.1667	0.8333	0.9956	0.8	0.25
RIT:BBH:0779	−8.92	2.98	-3.09×10^{-4}	0.06412	0.2407	0.4614	0	0.45	0.25	0.75	0.9934	0	0.8
RIT:BBH:0780	−8.93	2.99	-3.13×10^{-4}	0.06421	0.2407	0.4613	0	0.45	0.25	0.75	0.9934	0	0.8
RIT:BBH:0781	−9.60	2.40	-2.58×10^{-4}	0.05616	0.1432	0.7386	0.028	0.256	0.2	0.8	0.9946	0.7	0.4
RIT:BBH:0782	−7.00	3.50	-5.97×10^{-4}	0.08041	0.3333	0.6562	0.1056	0	0.3333	0.6667	0	0.95	0
RIT:BBH:0784	−9.00	3.00	-3.10×10^{-4}	0.06401	0.1497	0.7227	0.05	0.1406	0.25	0.75	0.9935	0.8	0.25
RIT:BBH:0785	−9.00	3.00	-2.80×10^{-4}	0.06257	0.1497	0.7227	0.05	0.1406	0.25	0.75	0.9934	0.8	0.25
RIT:BBH:0788	−6.30	4.20	-6.93×10^{-4}	0.08887	0.3885	0.6	0	0.342	0.4	0.6	0	0	0.95
RIT:BBH:0789	−8.93	2.99	-3.13×10^{-4}	0.06421	0.2407	0.4613	0	0.45	0.25	0.75	0.9934	0	0.8
RIT:BBH:0790	−8.94	2.99	-3.15×10^{-4}	0.06426	0.2407	0.4613	0	0.45	0.25	0.75	0.9935	0	0.8
RIT:BBH:0792	−7.76	0.2424	-3.32×10^{-5}	0.01346	0.02804	0.9678	0	0	0.0303	0.9697	0.9986	0	0
RIT:BBH:0793	−9.75	3.25	-2.58×10^{-4}	0.06188	0.1501	0.7232	0.05	0.1406	0.25	0.75	0.9941	0.8	0.25
RIT:BBH:0794	−8.91	2.98	-3.08×10^{-4}	0.06407	0.2407	0.4614	0	0.45	0.25	0.75	0.9933	0	0.8
RIT:BBH:0795	−8.92	2.98	-3.10×10^{-4}	0.06412	0.2407	0.4614	0	0.45	0.25	0.75	0.9934	0	0.8
RIT:BBH:0796	−6.67	3.33	-6.87×10^{-4}	0.08467	0.322	0.6667	0	0.4222	0.3333	0.6667	0	0	0.95
RIT:BBH:0797	−9.98	2.03	-2.04×10^{-4}	0.04919	0.1596	0.5147	0	0.5556	0.1667	0.8333	0.9953	0	0.8
RIT:BBH:0798	−9.98	2.03	-2.04×10^{-4}	0.0492	0.1596	0.5147	0	0.5556	0.1667	0.8333	0.9953	0	0.8
RIT:BBH:0799	−9.99	2.03	-2.05×10^{-4}	0.04922	0.1596	0.5147	0	0.5556	0.1667	0.8333	0.9954	0	0.8
RIT:BBH:0800	−9.99	2.03	-2.05×10^{-4}	0.04923	0.1596	0.5147	0	0.5556	0.1667	0.8333	0.9954	0	0.8
RIT:BBH:0801	−9.99	2.03	-2.05×10^{-4}	0.04922	0.1596	0.5147	0	0.5556	0.1667	0.8333	0.9954	0	0.8
RIT:BBH:0802	−9.98	2.03	-2.04×10^{-4}	0.0492	0.1596	0.5147	0	0.5556	0.1667	0.8333	0.9953	0	0.8
RIT:BBH:0805	−9.75	3.25	-2.33×10^{-4}	0.06057	0.1501	0.7233	0.05	0.1406	0.25	0.75	0.9939	0.8	0.25

[14,83,102,108–113], the computation of the peak frequency of the (2,2) mode $\Omega_{22}^{\rm peak}$, peak waveform amplitude $A_{22}^{\rm peak}$ [15,84], and peak luminosity [34,37,62,99]. Recently also surrogate methods have been reported in Refs. [101,114]. Those formulas in turn provide further tools to extract information from the observation of gravitational waves (see for instance our Fig. 9). The tables in Appendix A can be used to further model and test remnant and merger waveform parameters in terms of those of the binary and as a test of gravity.

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APPENDIX: TABLES OF INITIAL DATA AND RESULTS OF THE NEW SIMULATIONS

In this Appendix we provide tables with the relevant BBH configuration details. In Table I, we provide the initial data parameters used to start the full numerical evolutions. In Tables II and III, we provide the binary mass and spin parameters after they settle into a more physical value after radiating and absorbing the spurious gravitation wave content from the initial mathematical choice of conformal flatness. These relaxed values are calculated at a fiducial $t = 200m$. A visualization of the 300 binaries' seven parameter precessing space is displayed in Fig. 10.

In Table IV we provide the initial orbital frequency and eccentricity, as well as the number of orbits to merger and the final eccentricity. The eccentricity is expected to be reduced from its initial value by gravitational radiation, at a rate proportional to $d^{19/12}$ according to [115], with d, the separation of the binary (see, for instance, Fig. 6 of Ref. [116] or Fig. 9 in Ref. [10]).

Finally, In Table V, we provide the values of the energy radiated during the simulation and the final black-hole spin as measured through the (most accurate) isolated horizon formalism [68].

TABLE II. The masses and spins of the nonprecessing BHBs in Table I after the BHs had time to equilibrate ($t/m = 200$).

Run	q^r	m_1^r/m	m_2^r/m	χ_{1z}^r	χ_{2z}^r
RIT:BBH:0357	0.6004	0.3750	0.6245	0.5000	−0.8513
RIT:BBH:0358	0.6001	0.3750	0.6249	0.5000	−0.6502
RIT:BBH:0365	0.3335	0.2500	0.7496	−0.0000	0.8009
RIT:BBH:0366	1.0005	0.5000	0.4998	0.0000	−0.8008
RIT:BBH:0370	0.6672	0.4000	0.5995	−0.5001	−0.8505
RIT:BBH:0371	0.6672	0.4000	0.5995	0.5000	0.8506
RIT:BBH:0373	0.0667	0.0625	0.9375	0.0000	0.0000
RIT:BBH:0374	0.6000	0.3750	0.6250	−0.0000	0.5000
RIT:BBH:0380	0.6001	0.3750	0.6249	−0.5000	0.6502
RIT:BBH:0384	0.8497	0.4593	0.5405	0.8008	−0.5001
RIT:BBH:0385	1.0005	0.5000	0.4998	0.0000	0.8008
RIT:BBH:0386	0.6672	0.4000	0.5995	−0.5000	0.8506
RIT:BBH:0387	0.6664	0.3998	0.6000	−0.8008	0.2500
RIT:BBH:0388	0.6672	0.4000	0.5995	0.5000	−0.8505
RIT:BBH:0390	0.8497	0.4593	0.5405	−0.8008	−0.5001
RIT:BBH:0391	0.6664	0.3998	0.6000	−0.8008	−0.2500
RIT:BBH:0392	0.5998	0.3749	0.6250	−0.8007	0.0000
RIT:BBH:0395	0.7500	0.4286	0.5714	−0.2500	−0.2500
RIT:BBH:0396	0.6004	0.3750	0.6245	−0.5000	0.8512
RIT:BBH:0397	0.6000	0.3750	0.6250	−0.5000	−0.2500
RIT:BBH:0398	0.6004	0.3750	0.6245	0.0000	0.8513
RIT:BBH:0399	0.7500	0.4286	0.5714	0.2500	0.2500
RIT:BBH:0400	0.5998	0.3749	0.6250	0.8006	0.0000

(Table continued)

TABLE II. *(Continued)*

Run	q^r	m_1^r/m	m_2^r/m	χ_{1z}^r	χ_{2z}^r
RIT:BBH:0401	0.6672	0.4000	0.5995	0.2500	0.8506
RIT:BBH:0402	0.6001	0.3750	0.6249	0.5000	0.6502
RIT:BBH:0403	0.8496	0.4593	0.5405	−0.8008	0.0000
RIT:BBH:0404	0.6667	0.4000	0.6000	0.2500	0.3500
RIT:BBH:0405	0.6672	0.4000	0.5995	−0.2500	−0.8505
RIT:BBH:0406	0.6672	0.4000	0.5995	0.2500	−0.8505
RIT:BBH:0407	0.6664	0.3998	0.6000	0.8008	−0.2500
RIT:BBH:0408	0.8496	0.4593	0.5405	−0.8008	0.5001
RIT:BBH:0409	0.6667	0.4000	0.6000	−0.2500	−0.3500
RIT:BBH:0411	0.6664	0.3998	0.6000	0.8008	0.2500
RIT:BBH:0412	0.6672	0.4000	0.5995	−0.2500	0.8507
RIT:BBH:0413	0.6004	0.3750	0.6245	0.5000	0.8513
RIT:BBH:0414	0.6667	0.4000	0.6000	0.2500	−0.3500
RIT:BBH:0415	0.6667	0.4000	0.6000	−0.2500	0.3500
RIT:BBH:0416	0.1429	0.1250	0.8750	−0.0000	0.0000
RIT:BBH:0417	0.4142	0.2929	0.7071	−0.2501	−0.2501
RIT:BBH:0418	0.8496	0.4593	0.5405	0.8008	0.0000
RIT:BBH:0420	0.8496	0.4593	0.5405	0.8008	0.5001
RIT:BBH:0421	0.6000	0.3750	0.6250	−0.5000	0.2500
RIT:BBH:0422	0.6000	0.3750	0.6250	0.5000	−0.2500
RIT:BBH:0423	0.4142	0.2929	0.7071	0.2501	−0.3501
RIT:BBH:0430	0.6000	0.3750	0.6250	0.5000	0.2500
RIT:BBH:0431	0.4142	0.2929	0.7071	0.2501	0.2501
RIT:BBH:0432	0.8506	0.4595	0.5402	0.2500	−0.8512
RIT:BBH:0434	0.4142	0.2929	0.7071	−0.2501	0.3501
RIT:BBH:0435	0.4145	0.2929	0.7066	0.2501	0.8513
RIT:BBH:0436	0.4141	0.2928	0.7071	−0.8009	−0.2500
RIT:BBH:0437	0.8506	0.4595	0.5402	−0.2500	−0.8512
RIT:BBH:0438	0.4145	0.2929	0.7066	−0.2501	0.8515
RIT:BBH:0442	0.0667	0.0625	0.9367	−0.0000	−0.8514
RIT:BBH:0446	0.4998	0.3332	0.6666	−0.8007	0.5000
RIT:BBH:0447	0.5000	0.3333	0.6667	−0.2500	−0.2500
RIT:BBH:0449	0.4141	0.2928	0.7071	0.8009	0.2501
RIT:BBH:0451	0.4998	0.3332	0.6666	0.8007	−0.5001
RIT:BBH:0452	0.5000	0.3333	0.6667	−0.2500	0.2500
RIT:BBH:0454	0.5000	0.3333	0.6667	0.2500	−0.2500
RIT:BBH:0455	0.8185	0.4500	0.5498	−0.0000	−0.8011
RIT:BBH:0456	0.8506	0.4595	0.5402	0.2500	0.8512
RIT:BBH:0457	0.5000	0.3333	0.6667	0.2500	0.2500
RIT:BBH:0458	0.9250	0.4805	0.5195	0.0000	0.0000
RIT:BBH:0459	0.8185	0.4500	0.5498	0.0000	0.8011
RIT:BBH:0460	0.8506	0.4595	0.5402	−0.2500	0.8512
RIT:BBH:0461	0.4145	0.2929	0.7066	0.2501	−0.8514
RIT:BBH:0462	0.5004	0.3333	0.6662	−0.2500	0.8514
RIT:BBH:0463	0.6001	0.3749	0.6247	−0.8006	−0.8008
RIT:BBH:0464	0.5998	0.3749	0.6250	−0.8007	−0.5000
RIT:BBH:0465	0.5004	0.3333	0.6662	−0.2500	−0.8514
RIT:BBH:0466	0.5004	0.3333	0.6662	0.2500	−0.8514
RIT:BBH:0467	0.0667	0.0625	0.9367	−0.0000	0.8514
RIT:BBH:0468	1.0000	0.4998	0.4998	−0.9505	−0.9505
RIT:BBH:0469	0.4145	0.2929	0.7066	−0.2501	−0.8514
RIT:BBH:0470	0.6004	0.3750	0.6246	−0.2500	−0.8514
RIT:BBH:0471	0.5998	0.3749	0.6250	0.8006	−0.5001
RIT:BBH:0472	1.0000	0.4998	0.4998	0.8008	0.8008
RIT:BBH:0473	0.5525	0.3559	0.6441	0.0478	0.5651

(Table continued)

TABLE II. *(Continued)*

Run	q^r	m_1^r/m	m_2^r/m	χ_{1z}^r	χ_{2z}^r
RIT:BBH:0474	0.6004	0.3750	0.6245	0.2500	−0.8514
RIT:BBH:0475	0.5998	0.3749	0.6250	−0.8007	0.5000
RIT:BBH:0476	0.6000	0.3750	0.6250	−0.2500	−0.3500
RIT:BBH:0477	0.5004	0.3333	0.6662	0.2500	0.8514
RIT:BBH:0478	0.6001	0.3749	0.6247	0.8006	−0.8008
RIT:BBH:0480	0.6004	0.3750	0.6245	0.2500	0.8514
RIT:BBH:0481	0.5998	0.3749	0.6250	0.8006	0.5000
RIT:BBH:0482	0.6001	0.3749	0.6247	0.8007	0.8008
RIT:BBH:0483	0.6000	0.3750	0.6250	0.2500	−0.3500
RIT:BBH:0484	0.1429	0.1250	0.8749	−0.0000	−0.6030
RIT:BBH:0485	0.6000	0.3750	0.6250	−0.2500	0.3500
RIT:BBH:0486	0.6004	0.3750	0.6245	−0.2500	0.8514
RIT:BBH:0487	0.6000	0.3750	0.6250	0.2500	0.3500
RIT:BBH:0488	0.6001	0.3749	0.6247	−0.8007	0.8008
RIT:BBH:0489	0.5998	0.3749	0.6250	0.8006	0.2500
RIT:BBH:0492	0.5525	0.3559	0.6441	0.0478	0.5651
RIT:BBH:0494	0.3333	0.2500	0.7500	−0.2500	0.3500
RIT:BBH:0495	0.0667	0.0625	0.9375	0.0000	−0.2604
RIT:BBH:0497	0.5998	0.3749	0.6250	−0.8007	0.2500
RIT:BBH:0499	1.0000	0.4998	0.4998	−0.9502	0.9502
RIT:BBH:0501	0.5998	0.3749	0.6250	−0.8007	−0.2500
RIT:BBH:0502	0.5998	0.3749	0.6250	0.8006	−0.2500
RIT:BBH:0509	0.7501	0.4284	0.5711	−0.8208	−0.8209
RIT:BBH:0513	0.7501	0.4284	0.5711	0.8208	0.8209
RIT:BBH:0514	0.4140	0.2927	0.7071	−0.5007	0.8500
RIT:BBH:0515	0.2500	0.2000	0.8000	−0.4003	−0.2500
RIT:BBH:0516	0.2501	0.2000	0.7996	−0.8005	−0.8009
RIT:BBH:0517	0.2500	0.2000	0.8000	−0.4003	0.2500
RIT:BBH:0518	0.2501	0.2000	0.7996	0.8004	−0.8009
RIT:BBH:0526	0.2500	0.2000	0.8000	−0.0000	−0.4000
RIT:BBH:0528	0.8504	0.4594	0.5403	−0.9499	−0.9507
RIT:BBH:0529	0.9256	0.4805	0.5191	0.0000	−0.8512
RIT:BBH:0530	0.7505	0.4286	0.5710	−0.2500	0.8512
RIT:BBH:0531	0.9256	0.4805	0.5191	0.0000	0.8512
RIT:BBH:0532	0.2500	0.2000	0.8000	−0.0000	0.4000
RIT:BBH:0533	0.2499	0.2000	0.8000	0.8005	0.0000
RIT:BBH:0534	0.9250	0.4805	0.5195	0.2500	−0.3500
RIT:BBH:0535	0.2502	0.2000	0.7996	0.4003	0.8009
RIT:BBH:0536	0.9246	0.4803	0.5195	−0.8008	0.0000
RIT:BBH:0537	0.7505	0.4286	0.5710	0.2500	0.8512
RIT:BBH:0538	0.2502	0.2000	0.7996	−0.4002	−0.8009
RIT:BBH:0539	0.9250	0.4805	0.5195	0.2500	0.3500
RIT:BBH:0545	0.6674	0.4002	0.5995	−0.9491	−0.9512
RIT:BBH:0546	0.2500	0.2000	0.8000	0.4003	0.2500
RIT:BBH:0548	0.9250	0.4803	0.5193	−0.8007	−0.8007
RIT:BBH:0549	0.2502	0.2000	0.7996	−0.4003	0.8009
RIT:BBH:0550	0.2499	0.2000	0.8000	−0.8005	0.0000
RIT:BBH:0552	0.9250	0.4805	0.5195	−0.2500	−0.3500
RIT:BBH:0555	0.9250	0.4805	0.5195	−0.2500	0.3500
RIT:BBH:0556	0.5011	0.3337	0.6659	−0.9479	−0.9517
RIT:BBH:0557	0.9250	0.4803	0.5192	−0.8008	0.8007
RIT:BBH:0558	0.9250	0.4803	0.5192	0.8007	0.8008
RIT:BBH:0559	0.9246	0.4803	0.5195	0.8007	0.0000
RIT:BBH:0561	0.5011	0.3337	0.6659	0.9477	−0.9516
RIT:BBH:0562	0.2500	0.2000	0.8000	0.4003	−0.2500

(Table continued)

TABLE II. *(Continued)*

Run	q^r	m_1^r/m	m_2^r/m	χ_{1z}^r	χ_{2z}^r
RIT:BBH:0563	0.9250	0.4803	0.5192	0.8007	−0.8008
RIT:BBH:0564	0.8500	0.4595	0.5405	−0.5000	−0.8500
RIT:BBH:0565	0.7505	0.4286	0.5710	−0.2500	−0.8512
RIT:BBH:0566	0.7506	0.4286	0.5711	0.9494	−0.9510
RIT:BBH:0567	0.3336	0.2500	0.7494	0.2500	0.8514
RIT:BBH:0568	0.7505	0.4286	0.5710	0.2500	−0.8512
RIT:BBH:0569	0.4249	0.2982	0.7017	−0.0100	0.6001
RIT:BBH:0570	0.2502	0.2000	0.7996	0.4002	−0.8009
RIT:BBH:0571	0.8504	0.4594	0.5403	0.9498	−0.9506
RIT:BBH:0572	0.3333	0.2500	0.7500	−0.2500	−0.3500
RIT:BBH:0573	1.0002	0.5000	0.4999	0.0000	0.9501
RIT:BBH:0574	0.2502	0.2000	0.7994	−0.0000	−0.8514
RIT:BBH:0575	0.3333	0.2500	0.7500	0.2500	−0.3500
RIT:BBH:0576	0.3333	0.2500	0.7500	0.2500	0.3500
RIT:BBH:0577	0.8504	0.4595	0.5403	−0.9498	0.9506
RIT:BBH:0578	0.2501	0.1999	0.7996	−0.8005	0.8009
RIT:BBH:0579	0.3336	0.2500	0.7494	−0.2500	0.8514
RIT:BBH:0580	0.2501	0.1999	0.7996	0.8006	0.8009
RIT:BBH:0581	0.7506	0.4287	0.5711	−0.9494	0.9509
RIT:BBH:0583	0.7495	0.4283	0.5714	0.8510	−0.2500
RIT:BBH:0584	0.7495	0.4283	0.5714	−0.8511	−0.2500
RIT:BBH:0585	0.3336	0.2500	0.7494	−0.2500	−0.8514
RIT:BBH:0604	0.7495	0.4283	0.5714	0.8510	0.2500
RIT:BBH:0605	0.3336	0.2500	0.7494	0.2500	−0.8514
RIT:BBH:0612	0.7495	0.4283	0.5714	−0.8511	0.2500
RIT:BBH:0613	0.2502	0.2000	0.7994	0.0000	0.8514
RIT:BBH:0614	0.2002	0.1667	0.8327	−0.2500	−0.8514
RIT:BBH:0615	0.8497	0.4595	0.5407	−0.9498	0.0000
RIT:BBH:0616	0.6675	0.4002	0.5995	−0.9490	0.9511
RIT:BBH:0617	0.6264	0.3851	0.6148	−0.3200	0.8200
RIT:BBH:0630	0.9751	0.4937	0.5063	0.3400	−0.2200
RIT:BBH:0637	0.2001	0.1667	0.8329	−0.0000	−0.8010
RIT:BBH:0642	0.8504	0.4595	0.5403	0.9497	0.9505
RIT:BBH:0643	0.8497	0.4591	0.5403	0.0000	−0.9508
RIT:BBH:0644	0.7500	0.4287	0.5716	−0.9494	0.0000
RIT:BBH:0655	0.6668	0.4002	0.6002	−0.9490	0.0000
RIT:BBH:0657	0.5507	0.3551	0.6449	−0.5500	0.8100
RIT:BBH:0658	0.7498	0.4282	0.5711	0.0000	−0.9511
RIT:BBH:0659	1.0017	0.4999	0.4990	−0.9504	0.0000
RIT:BBH:0660	0.2000	0.1667	0.8333	−0.2501	−0.3500
RIT:BBH:0678	0.2500	0.2000	0.8000	0.7001	−0.4000
RIT:BBH:0679	0.5011	0.3337	0.6659	−0.9477	0.9516
RIT:BBH:0681	0.6665	0.3996	0.5996	0.0000	−0.9512
RIT:BBH:0687	0.6675	0.4002	0.5996	0.9489	0.9510
RIT:BBH:0688	0.4992	0.3324	0.6660	0.0000	−0.9518
RIT:BBH:0690	0.2002	0.1667	0.8327	0.2501	0.8514
RIT:BBH:0691	0.2001	0.1667	0.8329	0.0000	0.8010
RIT:BBH:0705	0.2500	0.2000	0.8000	0.7002	0.4000
RIT:BBH:0706	0.5004	0.3337	0.6668	−0.9478	0.0000
RIT:BBH:0714	0.2500	0.2000	0.8000	−0.7002	0.4000
RIT:BBH:0736	0.2002	0.1667	0.8327	0.2500	−0.8514
RIT:BBH:0747	0.8500	0.4595	0.5406	0.9498	0.0000
RIT:BBH:0753	0.2000	0.1666	0.8333	0.8006	−0.2500
RIT:BBH:0764	0.0667	0.0625	0.9367	0.0000	−0.8514
RIT:BBH:0766	0.8504	0.4595	0.5403	0.0000	0.9506

(Table continued)

TABLE II. *(Continued)*

Run	q^r	m_1^r/m	m_2^r/m	χ_{1z}^r	χ_{2z}^r
RIT:BBH:0767	0.5011	0.3337	0.6659	0.9477	0.9516
RIT:BBH:0769	0.7502	0.4287	0.5715	0.9494	0.0000
RIT:BBH:0773	0.2000	0.1667	0.8333	0.2501	−0.3500
RIT:BBH:0776	0.6670	0.4002	0.6000	0.9490	0.0000
RIT:BBH:0777	0.7504	0.4286	0.5711	0.0000	0.9510
RIT:BBH:0778	0.2000	0.1666	0.8333	−0.8005	−0.2500
RIT:BBH:0781	0.2500	0.2000	0.8000	−0.7002	−0.4000
RIT:BBH:0782	0.5006	0.3337	0.6667	0.9478	0.0000
RIT:BBH:0784	0.3332	0.2499	0.7500	0.8007	−0.2500
RIT:BBH:0785	0.3332	0.2499	0.7500	0.8007	0.2500
RIT:BBH:0788	0.6671	0.4000	0.5996	0.0000	0.9511
RIT:BBH:0792	0.0313	0.0303	0.9697	−0.0000	0.0000
RIT:BBH:0793	0.3332	0.2499	0.7500	−0.8007	−0.2500
RIT:BBH:0796	0.5005	0.3333	0.6660	0.0000	0.9516
RIT:BBH:0805	0.3332	0.2499	0.7500	−0.8007	0.2500

TABLE III. The mass and spin of the precessing BHBs in Table I after the BHs had time to equilibrate ($t/m = 200$).

Run	q^r	m_1^r/m	m_2^r/m	χ_{1x}^r	χ_{1y}^r	χ_{1z}^r	χ_{2x}^r	χ_{2y}^r	χ_{2z}^r
RIT:BBH:0275	0.1430	0.1250	0.8743	⋯	⋯	⋯	−0.6003	−0.0334	−0.6028
RIT:BBH:0282	0.0667	0.0625	0.9367	⋯	⋯	⋯	−0.8120	−0.0333	−0.2538
RIT:BBH:0310	0.7140	0.4165	0.5833	0.3710	0.1619	0.6908	⋯	⋯	⋯
RIT:BBH:0313	0.7140	0.4165	0.5833	0.0723	0.3985	0.6906	⋯	⋯	⋯
RIT:BBH:0315	0.7140	0.4165	0.5833	0.2591	0.3202	0.6866	⋯	⋯	⋯
RIT:BBH:0320	0.7140	0.4165	0.5833	−0.1246	0.3558	0.7063	⋯	⋯	⋯
RIT:BBH:0323	1.0000	0.5002	0.5002	−0.6913	−0.2925	0.6166	0.6912	0.2925	0.6166
RIT:BBH:0325	0.7140	0.4165	0.5833	−0.3871	0.0396	0.6997	⋯	⋯	⋯
RIT:BBH:0327	0.7140	0.4165	0.5833	−0.3021	0.2350	0.7032	⋯	⋯	⋯
RIT:BBH:0328	0.7140	0.4165	0.5833	0.6349	0.2836	0.3970	⋯	⋯	⋯
RIT:BBH:0329	0.7140	0.4165	0.5833	0.4108	0.5638	0.3930	⋯	⋯	⋯
RIT:BBH:0330	0.7141	0.4166	0.5833	−0.2270	0.6441	0.4176	⋯	⋯	⋯
RIT:BBH:0331	1.0000	0.5005	0.5005	−0.6971	−0.2924	0.6403	0.6971	0.2924	0.6403
RIT:BBH:0332	0.7141	0.4165	0.5833	0.1041	0.6878	0.3962	⋯	⋯	⋯
RIT:BBH:0333	0.7140	0.4165	0.5833	0.5082	0.2637	−0.5597	⋯	⋯	⋯
RIT:BBH:0334	0.7140	0.4165	0.5833	0.3110	0.4884	−0.5530	⋯	⋯	⋯
RIT:BBH:0335	0.7140	0.4165	0.5833	0.0642	0.5730	−0.5554	⋯	⋯	⋯
RIT:BBH:0340	0.3335	0.2500	0.7497	⋯	⋯	⋯	−0.7504	0.0175	−0.0005
RIT:BBH:0341	0.7140	0.4165	0.5833	−0.6809	0.0696	0.4154	⋯	⋯	⋯
RIT:BBH:0342	0.7141	0.4165	0.5833	−0.2116	0.5206	−0.5702	⋯	⋯	⋯
RIT:BBH:0343	0.7140	0.4165	0.5833	0.7146	0.3612	0.0080	⋯	⋯	⋯
RIT:BBH:0346	0.7140	0.4165	0.5833	0.4638	0.6526	0.0046	⋯	⋯	⋯
RIT:BBH:0347	0.7141	0.4165	0.5833	−0.5390	0.4215	0.4155	⋯	⋯	⋯
RIT:BBH:0349	0.7141	0.4166	0.5833	0.1072	0.7932	0.0059	⋯	⋯	⋯
RIT:BBH:0351	1.0005	0.5000	0.4998	⋯	⋯	⋯	0.3838	0.1479	−0.6870
RIT:BBH:0353	1.0004	0.5000	0.4998	⋯	⋯	⋯	0.2811	0.3045	−0.6852
RIT:BBH:0354	1.0004	0.5000	0.4998	⋯	⋯	⋯	−0.0916	0.3955	−0.6902
RIT:BBH:0355	0.7141	0.4165	0.5833	−0.4602	0.3324	−0.5646	⋯	⋯	⋯
RIT:BBH:0356	1.0004	0.5000	0.4998	⋯	⋯	⋯	0.0934	0.4001	−0.6873
RIT:BBH:0359	1.0004	0.5000	0.4998	⋯	⋯	⋯	−0.2932	0.2703	−0.6944
RIT:BBH:0360	0.7140	0.4165	0.5833	−0.5681	0.0286	−0.5635	⋯	⋯	⋯
RIT:BBH:0361	1.0004	0.5000	0.4998	⋯	⋯	⋯	−0.3957	0.0934	−0.6899

(Table continued)

TABLE III. *(Continued)*

Run	q^r	m_1^r/m	m_2^r/m	χ_{1x}^r	χ_{1y}^r	χ_{1z}^r	χ_{2x}^r	χ_{2y}^r	χ_{2z}^r
RIT:BBH:0362	1.0004	0.5000	0.4998	···	···	···	0.4488	0.5417	−0.3826
RIT:BBH:0363	1.0000	0.5003	0.5003	−0.0862	−0.7524	0.6068	0.0862	0.7524	0.6068
RIT:BBH:0364	1.0005	0.5000	0.4998	···	···	···	0.6574	0.2428	−0.3874
RIT:BBH:0367	1.0004	0.5000	0.4998	···	···	···	−0.5104	0.4653	−0.4050
RIT:BBH:0368	1.0004	0.5000	0.4998	···	···	···	−0.6813	0.1483	−0.3937
RIT:BBH:0369	1.0004	0.5000	0.4998	···	···	···	−0.1811	0.6673	−0.4037
RIT:BBH:0372	1.0004	0.5000	0.4998	···	···	···	0.1484	0.6853	−0.3865
RIT:BBH:0375	0.7141	0.4166	0.5833	−0.2745	0.7515	0.0217	···	···	···
RIT:BBH:0376	1.0004	0.5000	0.4998	···	···	···	0.5365	0.5944	0.0055
RIT:BBH:0377	1.0005	0.5000	0.4998	···	···	···	0.7519	0.2753	0.0117
RIT:BBH:0378	0.7141	0.4166	0.5833	−0.6339	0.4886	0.0164	···	···	···
RIT:BBH:0379	0.7140	0.4165	0.5833	−0.7969	0.0751	0.0150	···	···	···
RIT:BBH:0381	1.0004	0.5000	0.4998	···	···	···	0.1975	0.7759	0.0031
RIT:BBH:0382	1.0003	0.5000	0.4998	···	···	···	−0.2162	0.7708	0.0042
RIT:BBH:0383	1.0004	0.5000	0.4998	···	···	···	−0.5726	0.5596	0.0061
RIT:BBH:0389	1.0004	0.5000	0.4998	···	···	···	−0.7827	0.1687	0.0055
RIT:BBH:0393	1.0000	0.5003	0.5003	−0.4480	−0.6046	0.6133	0.4480	0.6046	0.6133
RIT:BBH:0394	1.0000	0.5003	0.5003	0.7459	−0.1012	0.6138	−0.7459	0.1012	0.6138
RIT:BBH:0410	1.0000	0.5004	0.5004	0.2954	−0.6999	0.6039	−0.2954	0.6999	0.6039
RIT:BBH:0419	1.0000	0.5004	0.5004	0.6003	−0.4630	0.6074	−0.6004	0.4630	0.6074
RIT:BBH:0424	1.0004	0.5000	0.4998	···	···	···	−0.4893	0.4903	0.4015
RIT:BBH:0425	1.0004	0.5000	0.4998	···	···	···	−0.6755	0.1582	0.3997
RIT:BBH:0426	1.0005	0.5000	0.4998	···	···	···	0.6499	0.2309	0.4069
RIT:BBH:0427	1.0004	0.5000	0.4998	···	···	···	0.4752	0.5115	0.3921
RIT:BBH:0428	1.0004	0.5000	0.4998	···	···	···	0.1773	0.6738	0.3945
RIT:BBH:0433	1.0004	0.5000	0.4998	···	···	···	−0.1511	0.6762	0.4011
RIT:BBH:0439	1.0004	0.5000	0.4998	···	···	···	−0.2771	0.2960	0.6905
RIT:BBH:0440	1.0004	0.5000	0.4998	···	···	···	−0.3924	0.1020	0.6905
RIT:BBH:0441	1.0005	0.5000	0.4998	···	···	···	0.3716	0.1314	0.6970
RIT:BBH:0443	1.0004	0.5000	0.4998	···	···	···	0.1899	−0.3567	0.6913
RIT:BBH:0444	1.0005	0.5000	0.4998	···	···	···	−0.3480	−0.2128	0.6891
RIT:BBH:0445	1.0004	0.5000	0.4998	···	···	···	−0.0756	0.3986	0.6903
RIT:BBH:0448	1.0004	0.5000	0.4998	···	···	···	0.1180	0.3867	0.6911
RIT:BBH:0450	0.3335	0.2500	0.7497	···	···	···	−0.7415	−0.1166	0.0035
RIT:BBH:0453	1.0004	0.5000	0.4998	···	···	···	0.2804	0.2987	0.6880
RIT:BBH:0479	0.7520	0.4292	0.5707	0.6818	0.1238	0.0048	−0.2341	−0.1147	0.6883
RIT:BBH:0490	0.8186	0.4500	0.5497	···	···	···	0.3721	0.1207	0.6985
RIT:BBH:0491	0.8186	0.4500	0.5497	···	···	···	0.2809	0.2936	0.6899
RIT:BBH:0493	0.8186	0.4500	0.5497	···	···	···	0.1191	0.3881	0.6901
RIT:BBH:0496	0.8186	0.4500	0.5497	···	···	···	−0.0720	0.3940	0.6932
RIT:BBH:0498	0.8186	0.4500	0.5497	···	···	···	−0.2719	0.2902	0.6948
RIT:BBH:0500	0.8186	0.4500	0.5497	···	···	···	−0.3887	0.1182	0.6899
RIT:BBH:0503	1.0000	0.5004	0.5004	−0.5216	0.5514	0.6054	0.5216	−0.5514	0.6054
RIT:BBH:0504	1.0000	0.5003	0.5003	0.5222	0.5407	0.6145	−0.5222	−0.5407	0.6145
RIT:BBH:0505	0.8186	0.4500	0.5497	···	···	···	0.6622	0.2016	0.4024
RIT:BBH:0506	0.8185	0.4500	0.5498	···	···	···	−0.4815	0.4900	0.4116
RIT:BBH:0507	0.3335	0.2500	0.7497	···	···	···	−0.7046	−0.2587	0.0076
RIT:BBH:0508	0.8186	0.4500	0.5497	···	···	···	0.4687	0.5113	0.4005
RIT:BBH:0510	0.8185	0.4500	0.5498	···	···	···	0.1800	0.6724	0.3956
RIT:BBH:0511	0.8185	0.4500	0.5498	···	···	···	−0.1470	0.6721	0.4093
RIT:BBH:0512	0.8185	0.4500	0.5497	···	···	···	−0.6694	0.1705	0.4052
RIT:BBH:0519	0.8186	0.4500	0.5497	···	···	···	0.7570	0.2607	0.0147
RIT:BBH:0520	0.8185	0.4500	0.5497	···	···	···	0.4728	0.5186	−0.3862
RIT:BBH:0521	0.8185	0.4500	0.5498	···	···	···	0.1774	0.6761	−0.3905
RIT:BBH:0522	0.8185	0.4500	0.5498	···	···	···	−0.1838	0.6708	−0.3963

(Table continued)

TABLE III. *(Continued)*

Run	q^r	m_1^r/m	m_2^r/m	χ_{1x}^r	χ_{1y}^r	χ_{1z}^r	χ_{2x}^r	χ_{2y}^r	χ_{2z}^r
RIT:BBH:0523	0.8185	0.4500	0.5498	···	···	···	−0.4942	0.4885	−0.3981
RIT:BBH:0524	0.8185	0.4500	0.5497	···	···	···	−0.6787	0.1510	−0.3975
RIT:BBH:0525	0.8186	0.4500	0.5497	···	···	···	0.6597	0.2344	−0.3885
RIT:BBH:0527	0.8186	0.4500	0.5497	···	···	···	0.5479	0.5839	0.0052
RIT:BBH:0540	0.8186	0.4500	0.5497	···	···	···	0.2824	0.3037	−0.6848
RIT:BBH:0541	0.8186	0.4500	0.5497	···	···	···	0.0918	0.4036	−0.6853
RIT:BBH:0542	0.8186	0.4500	0.5497	···	···	···	−0.0957	0.3853	−0.6952
RIT:BBH:0543	0.8186	0.4500	0.5497	···	···	···	−0.2778	0.2941	−0.6909
RIT:BBH:0544	0.8186	0.4500	0.5497	···	···	···	−0.3924	0.0947	−0.6914
RIT:BBH:0547	0.8186	0.4500	0.5497	···	···	···	0.3918	0.1274	−0.6865
RIT:BBH:0551	0.8185	0.4500	0.5498	···	···	···	−0.7793	0.1832	0.0071
RIT:BBH:0553	0.8185	0.4500	0.5498	···	···	···	−0.1853	0.7788	0.0096
RIT:BBH:0554	0.8185	0.4500	0.5498	···	···	···	0.1979	0.7756	0.0035
RIT:BBH:0560	0.8185	0.4500	0.5498	···	···	···	−0.5615	0.5705	0.0065
RIT:BBH:0582	0.9180	0.4786	0.5214	−0.2843	−0.2275	−0.2115	−0.4642	0.0092	0.4505
RIT:BBH:0586	0.5003	0.3333	0.6663	···	···	···	0.4035	0.0644	0.6888
RIT:BBH:0587	0.5003	0.3333	0.6663	···	···	···	0.3190	0.2550	0.6890
RIT:BBH:0588	0.5002	0.3333	0.6663	···	···	···	0.1463	0.3790	0.6902
RIT:BBH:0589	0.5002	0.3333	0.6663	···	···	···	−0.0626	0.3976	0.6924
RIT:BBH:0590	0.5002	0.3333	0.6663	···	···	···	−0.2462	0.3067	0.6977
RIT:BBH:0591	0.5002	0.3333	0.6663	···	···	···	−0.3747	0.1443	0.6930
RIT:BBH:0592	0.5003	0.3333	0.6663	···	···	···	0.6792	0.1406	0.4005
RIT:BBH:0593	0.5002	0.3333	0.6663	···	···	···	0.5113	0.4681	0.4012
RIT:BBH:0594	0.5002	0.3333	0.6663	···	···	···	0.2351	0.6549	0.3966
RIT:BBH:0595	0.5002	0.3333	0.6664	···	···	···	−0.0914	0.6839	0.4066
RIT:BBH:0596	0.5002	0.3333	0.6663	···	···	···	−0.4253	0.5494	0.3984
RIT:BBH:0597	0.5002	0.3333	0.6663	···	···	···	−0.6496	0.2485	0.3971
RIT:BBH:0598	0.5002	0.3333	0.6663	···	···	···	0.3984	0.0949	−0.6883
RIT:BBH:0599	0.5002	0.3333	0.6663	···	···	···	0.3007	0.2822	−0.6866
RIT:BBH:0600	0.5002	0.3333	0.6663	···	···	···	0.1209	0.3936	−0.6870
RIT:BBH:0601	0.5002	0.3333	0.6663	···	···	···	−0.0622	0.3934	−0.6949
RIT:BBH:0602	0.5002	0.3333	0.6663	···	···	···	−0.2518	0.3110	−0.6938
RIT:BBH:0603	0.5002	0.3333	0.6663	···	···	···	−0.3769	0.1456	−0.6916
RIT:BBH:0606	0.5003	0.3333	0.6663	···	···	···	0.7788	0.1865	0.0123
RIT:BBH:0607	0.5002	0.3333	0.6663	···	···	···	0.5819	0.5503	0.0093
RIT:BBH:0608	0.5002	0.3333	0.6663	···	···	···	0.2578	0.7582	0.0050
RIT:BBH:0609	0.5002	0.3333	0.6664	···	···	···	−0.1231	0.7913	0.0086
RIT:BBH:0610	0.5002	0.3333	0.6664	···	···	···	−0.5037	0.6226	0.0036
RIT:BBH:0611	0.5002	0.3333	0.6663	···	···	···	−0.7577	0.2594	0.0043
RIT:BBH:0618	0.5003	0.3333	0.6663	···	···	···	0.6822	0.1544	−0.3902
RIT:BBH:0619	0.5002	0.3333	0.6663	···	···	···	0.5134	0.4759	−0.3892
RIT:BBH:0620	0.5002	0.3333	0.6663	···	···	···	0.2084	0.6694	−0.3873
RIT:BBH:0621	0.5002	0.3333	0.6664	···	···	···	−0.1209	0.6830	−0.4004
RIT:BBH:0622	0.5002	0.3333	0.6663	···	···	···	−0.4486	0.5298	−0.3994
RIT:BBH:0623	0.5002	0.3333	0.6663	···	···	···	−0.6625	0.2053	−0.4005
RIT:BBH:0624	0.6670	0.4000	0.5997	···	···	···	−0.3627	−0.1818	0.6905
RIT:BBH:0625	0.6670	0.4000	0.5997	···	···	···	0.1818	−0.3474	0.6983
RIT:BBH:0626	0.6670	0.4000	0.5997	···	···	···	−0.6040	−0.3437	0.3979
RIT:BBH:0627	0.6670	0.4000	0.5997	···	···	···	0.3164	−0.6087	0.4131
RIT:BBH:0628	0.6670	0.4000	0.5997	···	···	···	−0.6940	−0.3998	0.0033
RIT:BBH:0629	0.6669	0.4000	0.5998	···	···	···	0.3667	−0.7117	0.0110
RIT:BBH:0631	0.5003	0.3333	0.6663	···	···	···	−0.6164	−0.3244	−0.3954
RIT:BBH:0632	0.5002	0.3333	0.6664	···	···	···	0.2973	−0.6308	−0.3939
RIT:BBH:0633	0.5002	0.3333	0.6663	···	···	···	−0.3552	−0.1891	−0.6925
RIT:BBH:0634	0.5002	0.3333	0.6663	···	···	···	0.1889	−0.3544	−0.6930

(Table continued)

TABLE III. *(Continued)*

Run	q^r	m_1^r/m	m_2^r/m	χ_{1x}^r	χ_{1y}^r	χ_{1z}^r	χ_{2x}^r	χ_{2y}^r	χ_{2z}^r
RIT:BBH:0635	0.5003	0.3333	0.6663	···	···	···	−0.7186	−0.3537	0.0006
RIT:BBH:0636	0.5002	0.3333	0.6664	···	···	···	0.3535	−0.7186	0.0097
RIT:BBH:0638	0.5003	0.3333	0.6663	···	···	···	−0.6142	−0.3178	0.4041
RIT:BBH:0639	0.5002	0.3333	0.6663	···	···	···	0.2856	−0.6215	0.4167
RIT:BBH:0640	0.5003	0.3333	0.6663	···	···	···	−0.3688	−0.1633	0.6920
RIT:BBH:0641	0.5002	0.3333	0.6663	···	···	···	0.1594	−0.3656	0.6946
RIT:BBH:0645	0.8186	0.4500	0.5497	···	···	···	−0.3446	−0.2160	−0.6897
RIT:BBH:0646	0.8186	0.4500	0.5497	···	···	···	0.2083	−0.3382	−0.6952
RIT:BBH:0647	0.8186	0.4500	0.5497	···	···	···	−0.5875	−0.3780	−0.3916
RIT:BBH:0648	0.8185	0.4500	0.5498	···	···	···	0.3526	−0.6022	−0.3924
RIT:BBH:0649	0.8186	0.4500	0.5497	···	···	···	−0.6812	−0.4208	0.0034
RIT:BBH:0650	0.8185	0.4500	0.5498	···	···	···	0.3942	−0.6965	0.0133
RIT:BBH:0651	0.8186	0.4500	0.5497	···	···	···	−0.5866	−0.3687	0.4016
RIT:BBH:0652	0.8185	0.4500	0.5498	···	···	···	0.3211	−0.6120	0.4041
RIT:BBH:0653	0.8186	0.4500	0.5497	···	···	···	−0.3433	−0.2101	0.6921
RIT:BBH:0654	0.8186	0.4500	0.5497	···	···	···	0.1851	−0.3505	0.6956
RIT:BBH:0656	0.3335	0.2500	0.7496	···	···	···	0.3953	0.0596	0.6940
RIT:BBH:0661	1.0004	0.5000	0.4998	···	···	···	−0.6553	−0.4602	0.0026
RIT:BBH:0662	1.0003	0.5000	0.4998	···	···	···	0.4083	−0.6885	0.0145
RIT:BBH:0663	1.0004	0.5000	0.4998	···	···	···	−0.5709	−0.4043	−0.3897
RIT:BBH:0664	1.0004	0.5000	0.4998	···	···	···	0.3761	−0.5851	−0.3965
RIT:BBH:0665	1.0005	0.5000	0.4998	···	···	···	−0.3294	−0.2387	−0.6898
RIT:BBH:0666	1.0004	0.5000	0.4998	···	···	···	0.2124	−0.3459	−0.6902
RIT:BBH:0667	0.7140	0.4165	0.5833	−0.4382	−0.3826	−0.5502	···	···	···
RIT:BBH:0668	0.7141	0.4165	0.5833	0.3380	−0.4574	−0.5634	···	···	···
RIT:BBH:0669	1.0005	0.5000	0.4998	···	···	···	−0.5749	−0.3885	0.3998
RIT:BBH:0670	1.0004	0.5000	0.4998	···	···	···	0.3448	−0.5947	0.4104
RIT:BBH:0671	0.7140	0.4165	0.5833	−0.5959	−0.5345	0.0147	···	···	···
RIT:BBH:0672	0.7141	0.4166	0.5833	0.4598	−0.6552	0.0034	···	···	···
RIT:BBH:0673	0.7140	0.4165	0.5833	−0.3107	−0.2579	0.6914	···	···	···
RIT:BBH:0674	0.7140	0.4165	0.5833	0.2236	−0.3134	0.7019	···	···	···
RIT:BBH:0675	0.7140	0.4165	0.5833	−0.5333	−0.4448	0.3986	···	···	···
RIT:BBH:0676	0.7141	0.4166	0.5833	0.3959	−0.5629	0.4089	···	···	···
RIT:BBH:0677	0.3335	0.2500	0.7496	···	···	···	0.3132	0.2507	0.6932
RIT:BBH:0682	0.2001	0.1667	0.8329	···	···	···	0.6937	0.0625	−0.3955
RIT:BBH:0683	0.2001	0.1667	0.8329	···	···	···	0.5697	0.4006	−0.3956
RIT:BBH:0684	0.2001	0.1667	0.8329	···	···	···	0.2926	0.6319	−0.3957
RIT:BBH:0685	0.2001	0.1667	0.8329	···	···	···	−0.4002	0.5674	−0.3993
RIT:BBH:0686	0.2001	0.1667	0.8329	···	···	···	−0.6299	0.2911	−0.4000
RIT:BBH:0689	0.5998	0.3749	0.6250	0.3726	0.1713	0.6876	···	···	···
RIT:BBH:0692	0.3335	0.2500	0.7496	···	···	···	0.4041	0.0625	−0.6887
RIT:BBH:0693	0.3335	0.2500	0.7496	···	···	···	0.3198	0.2546	−0.6887
RIT:BBH:0694	0.3335	0.2500	0.7496	···	···	···	0.1483	0.3809	−0.6888
RIT:BBH:0695	0.3335	0.2500	0.7496	···	···	···	−0.0623	0.4019	−0.6900
RIT:BBH:0696	0.3335	0.2500	0.7496	···	···	···	−0.2539	0.3141	−0.6916
RIT:BBH:0697	0.3335	0.2500	0.7496	···	···	···	−0.3718	0.1426	−0.6949
RIT:BBH:0698	0.3335	0.2500	0.7496	···	···	···	0.6866	0.1249	−0.3929
RIT:BBH:0699	0.3335	0.2500	0.7496	···	···	···	0.5335	0.4521	−0.3905
RIT:BBH:0700	0.3335	0.2500	0.7496	···	···	···	0.2646	0.6450	−0.3941
RIT:BBH:0701	0.3335	0.2500	0.7496	···	···	···	−0.0941	0.6897	−0.3961
RIT:BBH:0702	0.3335	0.2500	0.7496	···	···	···	−0.4248	0.5482	−0.4005
RIT:BBH:0703	0.3335	0.2500	0.7496	···	···	···	−0.6427	0.2632	−0.3988
RIT:BBH:0704	0.3335	0.2500	0.7496	···	···	···	0.1729	0.3624	0.6929
RIT:BBH:0707	0.2001	0.1667	0.8329	···	···	···	0.7985	0.0628	−0.0012
RIT:BBH:0708	0.2001	0.1667	0.8329	···	···	···	0.6421	0.4788	0.0061

(Table continued)

TABLE III. *(Continued)*

Run	q^r	m_1^r/m	m_2^r/m	χ_{1x}^r	χ_{1y}^r	χ_{1z}^r	χ_{2x}^r	χ_{2y}^r	χ_{2z}^r
RIT:BBH:0709	0.2001	0.1667	0.8329	···	···	···	0.3449	0.7229	0.0025
RIT:BBH:0710	0.2001	0.1667	0.8329	···	···	···	−0.0626	0.7985	0.0037
RIT:BBH:0711	0.2001	0.1667	0.8329	···	···	···	−0.4533	0.6603	0.0043
RIT:BBH:0712	0.2001	0.1667	0.8329	···	···	···	−0.7229	0.3448	···
RIT:BBH:0713	0.5998	0.3749	0.6250	0.2533	0.3268	0.6856	···	···	···
RIT:BBH:0715	0.3335	0.2500	0.7496	···	···	···	−0.0311	0.3959	0.6955
RIT:BBH:0716	0.3335	0.2500	0.7496	···	···	···	−0.2269	0.3302	0.6935
RIT:BBH:0717	0.3335	0.2500	0.7496	···	···	···	−0.3785	−0.1340	0.6930
RIT:BBH:0718	0.3335	0.2500	0.7496	···	···	···	0.1346	−0.3818	0.6910
RIT:BBH:0719	0.3335	0.2500	0.7496	···	···	···	0.5501	0.4258	0.3969
RIT:BBH:0720	0.3335	0.2500	0.7496	···	···	···	−0.6406	−0.2680	0.3991
RIT:BBH:0721	0.3335	0.2500	0.7496	···	···	···	0.2390	−0.6520	0.3989
RIT:BBH:0722	0.3335	0.2500	0.7496	···	···	···	−0.7321	−0.3247	0.0037
RIT:BBH:0723	0.3335	0.2500	0.7496	···	···	···	0.2960	−0.7441	0.0080
RIT:BBH:0724	0.3335	0.2500	0.7496	···	···	···	−0.6283	−0.2971	−0.3980
RIT:BBH:0725	0.3335	0.2500	0.7496	···	···	···	0.2692	−0.6427	−0.3948
RIT:BBH:0726	0.3335	0.2500	0.7496	···	···	···	−0.3682	−0.1633	−0.6922
RIT:BBH:0727	0.3335	0.2500	0.7496	···	···	···	0.1617	−0.3680	−0.6927
RIT:BBH:0728	0.2001	0.1667	0.8329	···	···	···	0.6916	0.0616	0.3993
RIT:BBH:0729	0.2001	0.1667	0.8329	···	···	···	0.5676	0.3999	0.3994
RIT:BBH:0730	0.2001	0.1667	0.8329	···	···	···	0.2920	0.6301	0.3990
RIT:BBH:0731	0.2001	0.1667	0.8329	···	···	···	−0.3740	0.5849	0.3995
RIT:BBH:0732	0.2001	0.1667	0.8329	···	···	···	−0.6167	0.3198	0.3987
RIT:BBH:0733	0.3335	0.2500	0.7496	···	···	···	−0.3641	0.1740	0.6918
RIT:BBH:0734	0.3335	0.2500	0.7496	···	···	···	0.2634	0.6433	0.3978
RIT:BBH:0735	0.2001	0.1667	0.8329	···	···	···	−0.0314	0.6925	0.4012
RIT:BBH:0746	0.3335	0.2500	0.7496	···	···	···	0.6892	0.0928	0.3972
RIT:BBH:0749	0.3335	0.2500	0.7496	···	···	···	−0.0616	0.6878	0.4056
RIT:BBH:0750	0.4998	0.3332	0.6667	0.3543	0.1924	0.6919	···	···	···
RIT:BBH:0751	0.4998	0.3332	0.6667	0.2432	0.3352	0.6854	···	···	···
RIT:BBH:0752	0.4999	0.3332	0.6667	−0.1443	0.3662	0.6973	···	···	···
RIT:BBH:0754	0.4999	0.3332	0.6667	−0.3196	0.2256	0.6987	···	···	···
RIT:BBH:0755	0.4998	0.3332	0.6667	−0.3911	0.0159	0.6986	···	···	···
RIT:BBH:0756	0.4999	0.3332	0.6667	0.0624	0.3945	0.6940	···	···	···
RIT:BBH:0758	0.2001	0.1667	0.8329	···	···	···	0.4039	0.0311	0.6910
RIT:BBH:0759	0.2001	0.1667	0.8329	···	···	···	0.3347	0.2291	0.6907
RIT:BBH:0760	0.2001	0.1667	0.8329	···	···	···	0.1744	0.3647	0.6915
RIT:BBH:0761	0.2001	0.1667	0.8329	···	···	···	−0.0313	0.4028	0.6916
RIT:BBH:0762	0.2001	0.1667	0.8329	···	···	···	−0.2002	0.3468	0.6937
RIT:BBH:0763	0.2001	0.1667	0.8329	···	···	···	−0.3468	0.2002	0.6937
RIT:BBH:0768	0.5998	0.3749	0.6250	0.0615	0.4006	0.6904	···	···	···
RIT:BBH:0770	0.3335	0.2500	0.7496	···	···	···	−0.6386	0.2631	0.4056
RIT:BBH:0771	0.3335	0.2500	0.7496	···	···	···	−0.4001	0.5674	0.3992
RIT:BBH:0772	0.2001	0.1667	0.8329	···	···	···	−0.0626	0.6934	−0.3960
RIT:BBH:0774	0.5998	0.3749	0.6250	−0.1386	0.3614	0.7007	···	···	···
RIT:BBH:0779	0.3335	0.2500	0.7496	···	···	···	−0.7358	0.3162	···
RIT:BBH:0780	0.3335	0.2500	0.7496	···	···	···	−0.4781	0.6425	0.0042
RIT:BBH:0789	0.3335	0.2500	0.7496	···	···	···	0.2875	0.7475	0.0056
RIT:BBH:0790	0.3335	0.2500	0.7496	···	···	···	−0.0938	0.7953	0.0049
RIT:BBH:0794	0.3335	0.2500	0.7496	···	···	···	0.7912	0.1245	0.0049
RIT:BBH:0795	0.3335	0.2500	0.7496	···	···	···	0.6228	0.5035	0.0050
RIT:BBH:0797	0.2001	0.1667	0.8329	···	···	···	0.4044	0.0311	−0.6907
RIT:BBH:0798	0.2001	0.1667	0.8329	···	···	···	0.3337	0.2287	−0.6913
RIT:BBH:0799	0.2001	0.1667	0.8329	···	···	···	0.1738	0.3638	−0.6921
RIT:BBH:0800	0.2001	0.1667	0.8329	···	···	···	−0.0314	0.3991	−0.6937
RIT:BBH:0801	0.2001	0.1667	0.8329	···	···	···	−0.2254	0.3280	−0.6951
RIT:BBH:0802	0.2001	0.1667	0.8329	···	···	···	−0.3618	0.1726	−0.6934

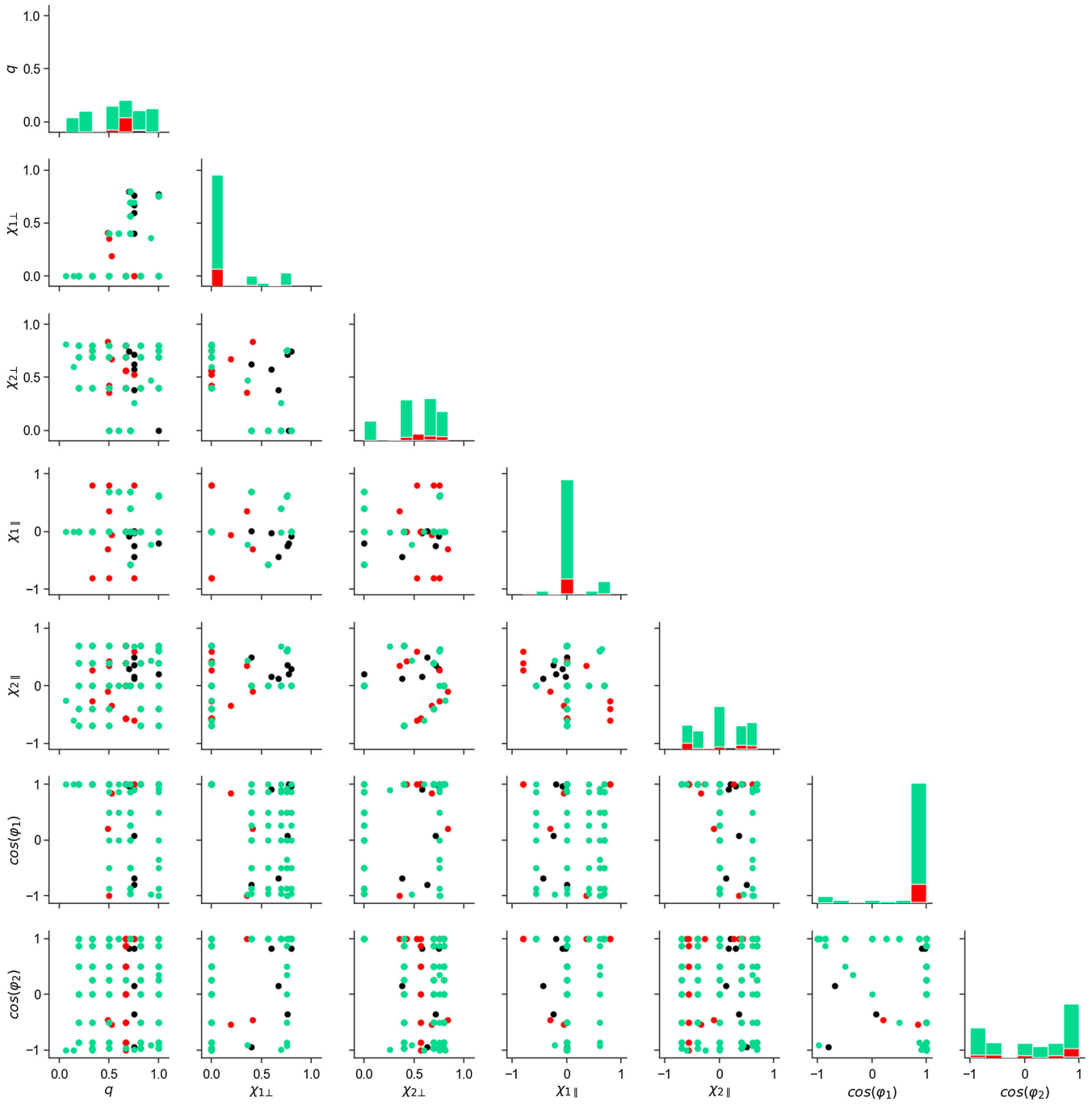

FIG. 10. Panels showing different combinations of the seven binary parameters of the precessing parameter space $(q, |\chi_1|, \theta_1, \varphi_1, |\chi_2|, \theta_2, \varphi_2)$ for the 300 precessing simulations (black first release, red second release, blue third release) in this catalog.

TABLE IV. Table of the initial orbital frequency $m\omega_i$, number of orbits to merger N, and the initial and final eccentricities, e_i and e_f, for the spinning cases.

Run	$m\omega_i$	N	e_i	e_f
RIT:BBH:0275	0.0192	18.0	0.0038	0.0037
RIT:BBH:0282	0.0280	14.6	0.0066	0.0076
RIT:BBH:0310	0.0236	10.4	0.0029	0.0016
RIT:BBH:0313	0.0236	10.5	0.0040	0.0014
RIT:BBH:0315	0.0236	10.5	0.0069	0.0016
RIT:BBH:0320	0.0236	10.5	0.0070	0.0014
RIT:BBH:0323	0.0340	7.0	0.0075	0.0027
RIT:BBH:0325	0.0236	10.6	0.0033	0.0015
RIT:BBH:0327	0.0236	10.5	0.0070	0.0015
RIT:BBH:0328	0.0236	9.9	0.0034	0.0026
RIT:BBH:0329	0.0237	9.9	0.0068	0.0025
RIT:BBH:0330	0.0236	10.0	0.0040	0.0018
RIT:BBH:0331	0.0339	7.1	0.0075	0.0018
RIT:BBH:0332	0.0237	9.9	0.0070	0.0019
RIT:BBH:0333	0.0239	8.2	0.0063	0.0018
RIT:BBH:0334	0.0239	8.5	0.0064	0.0018
RIT:BBH:0335	0.0239	8.4	0.0066	0.0021
RIT:BBH:0340	0.0218	12.8	0.0059	0.0030
RIT:BBH:0341	0.0236	10.1	0.0068	0.0019
RIT:BBH:0342	0.0239	8.4	0.0067	0.0030
RIT:BBH:0343	0.0237	9.2	0.0065	0.0019
RIT:BBH:0346	0.0238	9.2	0.0066	0.0023
RIT:BBH:0347	0.0236	10.0	0.0069	0.0014
RIT:BBH:0349	0.0238	9.2	0.0068	0.0024
RIT:BBH:0351	0.0211	9.5	0.0066	0.0014
RIT:BBH:0353	0.0211	9.7	0.0066	0.0014
RIT:BBH:0354	0.0211	9.7	0.0067	0.0016
RIT:BBH:0355	0.0239	8.4	0.0065	0.0023
RIT:BBH:0356	0.0211	9.7	0.0066	0.0015
RIT:BBH:0357	0.0214	9.4	0.0061	0.0014
RIT:BBH:0358	0.0213	10.1	0.0064	0.0012
RIT:BBH:0359	0.0211	9.7	0.0066	0.0021
RIT:BBH:0360	0.0239	8.4	0.0064	0.0020
RIT:BBH:0361	0.0211	9.7	0.0066	0.0015
RIT:BBH:0362	0.0211	10.5	0.0066	0.0010
RIT:BBH:0363	0.0336	7.0	0.0103	0.0038
RIT:BBH:0364	0.0211	10.2	0.0066	0.0009
RIT:BBH:0365	0.0217	17.5	0.0034	0.0008
RIT:BBH:0366	0.0202	10.4	0.0063	0.0012
RIT:BBH:0367	0.0210	10.4	0.0079	0.0014
RIT:BBH:0368	0.0210	10.4	0.0066	0.0012
RIT:BBH:0369	0.0211	10.4	0.0068	0.0016
RIT:BBH:0370	0.0232	7.0	0.0066	0.0021
RIT:BBH:0371	0.0219	14.4	0.0064	0.0013
RIT:BBH:0372	0.0211	10.4	0.0067	0.0013
RIT:BBH:0373	0.0281	19.0	0.0007	0.0006
RIT:BBH:0374	0.0208	13.5	0.0062	0.0012
RIT:BBH:0375	0.0237	9.4	0.0070	0.0018
RIT:BBH:0376	0.0210	11.2	0.0067	0.0019
RIT:BBH:0377	0.0210	11.2	0.0067	0.0008
RIT:BBH:0378	0.0237	9.3	0.0068	0.0014
RIT:BBH:0379	0.0237	9.3	0.0065	0.0015
RIT:BBH:0380	0.0209	13.2	0.0063	0.0011
RIT:BBH:0381	0.0210	11.2	0.0068	0.0018
RIT:BBH:0382	0.0210	11.4	0.0068	0.0016
RIT:BBH:0383	0.0209	11.4	0.0068	0.0010
RIT:BBH:0384	0.0198	12.9	0.0068	0.0012
RIT:BBH:0385	0.0197	14.8	0.0073	0.0010
RIT:BBH:0386	0.0221	12.4	0.0063	0.0011
RIT:BBH:0387	0.0226	9.5	0.0062	0.0014
RIT:BBH:0388	0.0227	8.6	0.0066	0.0018
RIT:BBH:0389	0.0209	11.3	0.0067	0.0019
RIT:BBH:0390	0.0204	9.1	0.0065	0.0016
RIT:BBH:0391	0.0230	8.2	0.0065	0.0018
RIT:BBH:0392	0.0213	10.1	0.0062	0.0015
RIT:BBH:0393	0.0335	7.0	0.0104	0.0041
RIT:BBH:0394	0.0345	7.0	0.0047	0.0041
RIT:BBH:0395	0.0227	9.1	0.0070	0.0016
RIT:BBH:0396	0.0208	14.1	0.0061	0.0010
RIT:BBH:0397	0.0213	9.8	0.0066	0.0018
RIT:BBH:0398	0.0207	15.1	0.0062	0.0011
RIT:BBH:0399	0.0223	11.4	0.0064	0.0013
RIT:BBH:0400	0.0209	13.1	0.0069	0.0012
RIT:BBH:0401	0.0219	13.9	0.0064	0.0014
RIT:BBH:0402	0.0207	15.2	0.0061	0.0010
RIT:BBH:0403	0.0202	10.5	0.0063	0.0013
RIT:BBH:0404	0.0222	12.2	0.0063	0.0011
RIT:BBH:0405	0.0231	7.4	0.0066	0.0019
RIT:BBH:0406	0.0228	8.1	0.0066	0.0015
RIT:BBH:0407	0.0223	11.1	0.0070	0.0011
RIT:BBH:0408	0.0200	12.0	0.0061	0.0011
RIT:BBH:0409	0.0227	8.9	0.0069	0.0018
RIT:BBH:0410	0.0341	7.0	0.0074	0.0033
RIT:BBH:0411	0.0221	12.7	0.0068	0.0014
RIT:BBH:0412	0.0221	12.7	0.0063	0.0014
RIT:BBH:0413	0.0206	16.1	0.0040	0.0009
RIT:BBH:0414	0.0225	9.8	0.0068	0.0011
RIT:BBH:0415	0.0223	11.2	0.0066	0.0013
RIT:BBH:0416	0.0248	14.4	0.0020	0.0006
RIT:BBH:0417	0.0199	12.6	0.0037	0.0009
RIT:BBH:0418	0.0197	14.5	0.0041	0.0011
RIT:BBH:0419	0.0345	7.0	0.0097	0.0033
RIT:BBH:0420	0.0195	16.1	0.0043	0.0009
RIT:BBH:0421	0.0211	11.6	0.0064	0.0010
RIT:BBH:0422	0.0210	11.6	0.0066	0.0009
RIT:BBH:0423	0.0199	12.8	0.0037	0.0008
RIT:BBH:0424	0.0209	12.2	0.0065	0.0010
RIT:BBH:0425	0.0209	12.3	0.0068	0.0011
RIT:BBH:0426	0.0209	12.2	0.0068	0.0014
RIT:BBH:0427	0.0209	12.2	0.0068	0.0012
RIT:BBH:0428	0.0209	12.2	0.0068	0.0012
RIT:BBH:0430	0.0208	13.5	0.0064	0.0008
RIT:BBH:0431	0.0196	16.0	0.0054	0.0006
RIT:BBH:0432	0.0202	10.6	0.0064	0.0013
RIT:BBH:0433	0.0209	12.2	0.0068	0.0012
RIT:BBH:0434	0.0196	15.7	0.0053	0.0006
RIT:BBH:0435	0.0194	19.5	0.0060	0.0007
RIT:BBH:0436	0.0200	11.9	0.0050	0.0008
RIT:BBH:0437	0.0204	9.5	0.0063	0.0014
RIT:BBH:0438	0.0194	18.7	0.0050	0.0009
RIT:BBH:0439	0.0209	12.9	0.0068	0.0013
RIT:BBH:0440	0.0209	12.9	0.0068	0.0014

(Table continued)

(Table continued)

TABLE IV. *(Continued)*

Run	$m\omega_i$	N	e_i	e_f
RIT:BBH:0441	0.0209	12.9	0.0068	0.0014
RIT:BBH:0442	0.0309	6.6	0.0039	0.0026
RIT:BBH:0443	0.0209	13.1	0.0065	0.0013
RIT:BBH:0444	0.0209	13.1	0.0068	0.0014
RIT:BBH:0445	0.0209	13.0	0.0068	0.0012
RIT:BBH:0446	0.0198	14.4	0.0055	0.0008
RIT:BBH:0447	0.0200	11.9	0.0066	0.0011
RIT:BBH:0448	0.0209	13.0	0.0067	0.0012
RIT:BBH:0449	0.0195	17.4	0.0048	0.0010
RIT:BBH:0450	0.0228	11.9	0.0057	0.0029
RIT:BBH:0451	0.0199	12.7	0.0067	0.0012
RIT:BBH:0452	0.0197	14.4	0.0058	0.0006
RIT:BBH:0453	0.0209	13.0	0.0065	0.0013
RIT:BBH:0454	0.0199	12.7	0.0065	0.0010
RIT:BBH:0455	0.0216	8.9	0.0064	0.0018
RIT:BBH:0456	0.0196	15.7	0.0068	0.0010
RIT:BBH:0457	0.0197	15.0	0.0058	0.0008
RIT:BBH:0458	0.0211	11.3	0.0068	0.0012
RIT:BBH:0459	0.0209	13.6	0.0061	0.0011
RIT:BBH:0460	0.0197	14.4	0.0070	0.0010
RIT:BBH:0461	0.0202	10.4	0.0057	0.0015
RIT:BBH:0462	0.0195	17.4	0.0040	0.0009
RIT:BBH:0463	0.0219	7.4	0.0059	0.0018
RIT:BBH:0464	0.0217	8.4	0.0062	0.0015
RIT:BBH:0465	0.0203	9.4	0.0062	0.0018
RIT:BBH:0466	0.0202	10.2	0.0062	0.0012
RIT:BBH:0467	0.0271	39.9	0.0018	0.0005
RIT:BBH:0468	0.0251	4.1	0.0188	0.0033
RIT:BBH:0469	0.0203	9.8	0.0057	0.0014
RIT:BBH:0470	0.0217	8.2	0.0062	0.0019
RIT:BBH:0471	0.0211	11.2	0.0068	0.0015
RIT:BBH:0472	0.0219	14.3	0.0069	0.0013
RIT:BBH:0473	0.0315	7.5	0.0066	0.0029
RIT:BBH:0474	0.0215	9.0	0.0062	0.0014
RIT:BBH:0475	0.0211	11.9	0.0060	0.0011
RIT:BBH:0476	0.0213	9.9	0.0066	0.0014
RIT:BBH:0477	0.0194	18.4	0.0040	0.0008
RIT:BBH:0478	0.0213	10.1	0.0065	0.0011
RIT:BBH:0479	0.0433	4.6	0.0073	0.0029
RIT:BBH:0480	0.0206	15.6	0.0062	0.0010
RIT:BBH:0481	0.0207	15.2	0.0065	0.0011
RIT:BBH:0482	0.0206	16.5	0.0065	0.0010
RIT:BBH:0483	0.0212	10.8	0.0066	0.0012
RIT:BBH:0484	0.0193	17.3	0.0034	0.0006
RIT:BBH:0485	0.0210	12.5	0.0064	0.0009
RIT:BBH:0486	0.0207	14.5	0.0062	0.0010
RIT:BBH:0487	0.0208	13.5	0.0063	0.0011
RIT:BBH:0488	0.0209	13.2	0.0059	0.0010
RIT:BBH:0489	0.0208	14.4	0.0067	0.0011
RIT:BBH:0490	0.0222	12.0	0.0065	0.0010
RIT:BBH:0491	0.0222	12.0	0.0066	0.0010
RIT:BBH:0492	0.0181	18.0	0.0060	0.0007
RIT:BBH:0493	0.0222	12.1	0.0065	0.0010
RIT:BBH:0494	0.0196	17.3	0.0060	0.0005
RIT:BBH:0495	0.0286	14.8	0.0018	0.0011
RIT:BBH:0496	0.0221	12.1	0.0065	0.0009
RIT:BBH:0497	0.0212	11.0	0.0061	0.0009
RIT:BBH:0498	0.0221	12.0	0.0065	0.0009
RIT:BBH:0499	0.0276	7.2	0.0157	0.0016
RIT:BBH:0500	0.0222	12.0	0.0065	0.0010
RIT:BBH:0501	0.0215	9.5	0.0061	0.0017
RIT:BBH:0502	0.0210	12.1	0.0069	0.0013
RIT:BBH:0503	0.0345	7.0	0.0095	0.0015
RIT:BBH:0504	0.0336	7.0	0.0099	0.0039
RIT:BBH:0505	0.0223	11.2	0.0062	0.0010
RIT:BBH:0506	0.0222	11.3	0.0065	0.0010
RIT:BBH:0507	0.0219	12.8	0.0057	0.0022
RIT:BBH:0508	0.0222	11.3	0.0065	0.0009
RIT:BBH:0509	0.0206	8.4	0.0060	0.0016
RIT:BBH:0510	0.0223	11.2	0.0065	0.0010
RIT:BBH:0511	0.0223	11.3	0.0066	0.0014
RIT:BBH:0512	0.0222	11.3	0.0066	0.0011
RIT:BBH:0513	0.0219	14.6	0.0069	0.0013
RIT:BBH:0514	0.0194	18.5	0.0023	0.0010
RIT:BBH:0515	0.0223	11.6	0.0051	0.0009
RIT:BBH:0516	0.0232	7.9	0.0065	0.0018
RIT:BBH:0517	0.0219	15.2	0.0049	0.0008
RIT:BBH:0518	0.0227	9.5	0.0047	0.0015
RIT:BBH:0519	0.0223	10.1	0.0064	0.0013
RIT:BBH:0520	0.0223	9.3	0.0066	0.0018
RIT:BBH:0521	0.0224	9.3	0.0067	0.0016
RIT:BBH:0522	0.0224	9.3	0.0065	0.0024
RIT:BBH:0523	0.0223	9.3	0.0065	0.0023
RIT:BBH:0524	0.0223	9.3	0.0067	0.0015
RIT:BBH:0525	0.0224	9.1	0.0062	0.0016
RIT:BBH:0526	0.0224	11.4	0.0050	0.0015
RIT:BBH:0527	0.0223	10.1	0.0063	0.0015
RIT:BBH:0528	0.0272	4.7	0.0188	0.0056
RIT:BBH:0529	0.0215	8.9	0.0064	0.0018
RIT:BBH:0530	0.0221	12.2	0.0066	0.0010
RIT:BBH:0531	0.0208	13.6	0.0068	0.0012
RIT:BBH:0532	0.0218	17.0	0.0047	0.0004
RIT:BBH:0533	0.0220	14.8	0.0057	0.0012
RIT:BBH:0534	0.0212	10.9	0.0068	0.0014
RIT:BBH:0535	0.0215	20.9	0.0031	0.0007
RIT:BBH:0536	0.0215	9.2	0.0066	0.0015
RIT:BBH:0537	0.0220	13.4	0.0065	0.0011
RIT:BBH:0538	0.0229	8.2	0.0044	0.0011
RIT:BBH:0539	0.0209	12.8	0.0066	0.0009
RIT:BBH:0540	0.0225	8.5	0.0065	0.0017
RIT:BBH:0541	0.0225	8.5	0.0066	0.0021
RIT:BBH:0542	0.0225	8.5	0.0067	0.0019
RIT:BBH:0543	0.0225	8.5	0.0066	0.0020
RIT:BBH:0544	0.0225	8.5	0.0065	0.0020
RIT:BBH:0545	0.0272	4.3	0.0178	0.0033
RIT:BBH:0546	0.0219	16.2	0.0050	0.0005
RIT:BBH:0547	0.0225	8.3	0.0067	0.0018
RIT:BBH:0548	0.0220	7.4	0.0063	0.0020
RIT:BBH:0549	0.0216	19.9	0.0044	0.0007
RIT:BBH:0550	0.0223	12.9	0.0045	0.0013
RIT:BBH:0551	0.0223	10.2	0.0064	0.0016
RIT:BBH:0552	0.0213	9.7	0.0070	0.0011
RIT:BBH:0553	0.0222	10.3	0.0067	0.0015
RIT:BBH:0554	0.0224	10.4	0.0066	0.0019

(Table continued)

TABLE IV. *(Continued)*

Run	$m\omega_i$	N	e_i	e_f
RIT:BBH:0555	0.0211	11.7	0.0068	0.0012
RIT:BBH:0556	0.0299	3.9	0.0164	0.0049
RIT:BBH:0557	0.0211	11.5	0.0065	0.0009
RIT:BBH:0558	0.0206	15.6	0.0068	0.0011
RIT:BBH:0559	0.0208	13.3	0.0068	0.0013
RIT:BBH:0560	0.0223	10.3	0.0064	0.0014
RIT:BBH:0561	0.0308	5.1	0.0070	0.0041
RIT:BBH:0562	0.0222	12.8	0.0051	0.0009
RIT:BBH:0563	0.0212	11.0	0.0066	0.0011
RIT:BBH:0564	0.0203	9.0	0.0076	0.0021
RIT:BBH:0565	0.0231	7.2	0.0065	0.0026
RIT:BBH:0566	0.0279	6.7	0.0075	0.0020
RIT:BBH:0567	0.0193	21.8	0.0036	0.0007
RIT:BBH:0568	0.0229	8.1	0.0065	0.0016
RIT:BBH:0569	0.0250	11.6	0.0058	0.0012
RIT:BBH:0570	0.0228	9.0	0.0045	0.0012
RIT:BBH:0571	0.0277	7.0	0.0075	0.0026
RIT:BBH:0572	0.0199	12.9	0.0056	0.0008
RIT:BBH:0573	0.0291	8.3	0.0077	0.0018
RIT:BBH:0574	0.0229	8.5	0.0044	0.0014
RIT:BBH:0575	0.0198	13.6	0.0032	0.0008
RIT:BBH:0576	0.0195	18.1	0.0032	0.0007
RIT:BBH:0577	0.0274	7.7	0.0072	0.0017
RIT:BBH:0578	0.0217	19.3	0.0023	0.0005
RIT:BBH:0579	0.0193	21.0	0.0036	0.0007
RIT:BBH:0580	0.0215	21.5	0.0027	0.0008
RIT:BBH:0581	0.0273	8.1	0.0070	0.0021
RIT:BBH:0582	0.0313	6.7	0.0072	0.0031
RIT:BBH:0583	0.0223	11.1	0.0071	0.0011
RIT:BBH:0584	0.0230	7.7	0.0063	0.0018
RIT:BBH:0585	0.0203	10.2	0.0051	0.0010
RIT:BBH:0586	0.0223	13.6	0.0061	0.0011
RIT:BBH:0587	0.0223	13.6	0.0060	0.0011
RIT:BBH:0588	0.0223	13.6	0.0058	0.0011
RIT:BBH:0589	0.0223	13.6	0.0058	0.0012
RIT:BBH:0590	0.0223	13.6	0.0059	0.0012
RIT:BBH:0591	0.0223	13.6	0.0060	0.0011
RIT:BBH:0592	0.0224	12.3	0.0063	0.0013
RIT:BBH:0593	0.0224	12.4	0.0059	0.0010
RIT:BBH:0594	0.0224	12.5	0.0056	0.0008
RIT:BBH:0595	0.0223	12.5	0.0057	0.0011
RIT:BBH:0596	0.0223	12.5	0.0059	0.0012
RIT:BBH:0597	0.0223	12.4	0.0062	0.0013
RIT:BBH:0598	0.0228	8.2	0.0062	0.0024
RIT:BBH:0599	0.0228	8.4	0.0057	0.0016
RIT:BBH:0600	0.0228	8.4	0.0058	0.0011
RIT:BBH:0601	0.0227	8.4	0.0058	0.0013
RIT:BBH:0602	0.0227	8.4	0.0058	0.0014
RIT:BBH:0603	0.0227	8.4	0.0061	0.0020
RIT:BBH:0604	0.0221	12.8	0.0069	0.0008
RIT:BBH:0605	0.0202	10.8	0.0052	0.0008
RIT:BBH:0606	0.0225	10.7	0.0063	0.0016
RIT:BBH:0607	0.0226	10.8	0.0060	0.0018
RIT:BBH:0608	0.0225	11.2	0.0059	0.0019
RIT:BBH:0609	0.0224	11.1	0.0060	0.0018
RIT:BBH:0610	0.0223	11.0	0.0062	0.0012
RIT:BBH:0611	0.0224	10.9	0.0064	0.0014
RIT:BBH:0612	0.0227	9.1	0.0062	0.0013
RIT:BBH:0613	0.0215	20.9	0.0033	0.0007
RIT:BBH:0614	0.0202	11.9	0.0039	0.0008
RIT:BBH:0615	0.0284	5.6	0.0089	0.0038
RIT:BBH:0616	0.0272	8.6	0.0068	0.0015
RIT:BBH:0617	0.0333	7.0	0.0078	0.0029
RIT:BBH:0618	0.0227	9.2	0.0061	0.0012
RIT:BBH:0619	0.0227	9.4	0.0060	0.0014
RIT:BBH:0620	0.0226	9.5	0.0060	0.0019
RIT:BBH:0621	0.0225	9.5	0.0062	0.0011
RIT:BBH:0622	0.0225	9.5	0.0063	0.0019
RIT:BBH:0623	0.0226	9.4	0.0063	0.0012
RIT:BBH:0624	0.0246	10.8	0.0065	0.0015
RIT:BBH:0625	0.0246	10.8	0.0065	0.0013
RIT:BBH:0626	0.0240	10.4	0.0065	0.0018
RIT:BBH:0627	0.0239	10.5	0.0065	0.0016
RIT:BBH:0628	0.0232	9.9	0.0064	0.0011
RIT:BBH:0629	0.0230	9.8	0.0061	0.0017
RIT:BBH:0630	0.0283	6.9	0.0083	0.0026
RIT:BBH:0631	0.0227	9.4	0.0061	0.0011
RIT:BBH:0632	0.0225	9.4	0.0062	0.0021
RIT:BBH:0633	0.0228	8.2	0.0061	0.0016
RIT:BBH:0634	0.0227	8.3	0.0062	0.0014
RIT:BBH:0635	0.0226	10.9	0.0062	0.0015
RIT:BBH:0636	0.0223	10.9	0.0061	0.0013
RIT:BBH:0637	0.0227	9.7	0.0038	0.0015
RIT:BBH:0638	0.0224	12.5	0.0062	0.0012
RIT:BBH:0639	0.0223	12.6	0.0060	0.0014
RIT:BBH:0640	0.0223	13.7	0.0061	0.0011
RIT:BBH:0641	0.0223	13.7	0.0059	0.0012
RIT:BBH:0642	0.0285	10.6	0.0073	0.0017
RIT:BBH:0643	0.0261	5.9	0.0091	0.0022
RIT:BBH:0644	0.0283	5.7	0.0088	0.0033
RIT:BBH:0645	0.0225	8.5	0.0067	0.0017
RIT:BBH:0646	0.0225	8.4	0.0068	0.0020
RIT:BBH:0647	0.0224	9.3	0.0063	0.0013
RIT:BBH:0648	0.0224	9.1	0.0064	0.0017
RIT:BBH:0649	0.0224	10.2	0.0063	0.0019
RIT:BBH:0650	0.0223	10.2	0.0066	0.0017
RIT:BBH:0651	0.0223	11.4	0.0065	0.0011
RIT:BBH:0652	0.0222	11.4	0.0067	0.0013
RIT:BBH:0653	0.0222	12.2	0.0066	0.0011
RIT:BBH:0654	0.0221	12.2	0.0065	0.0009
RIT:BBH:0655	0.0283	5.7	0.0086	0.0029
RIT:BBH:0656	0.0222	16.4	0.0053	0.0008
RIT:BBH:0657	0.0325	7.3	0.0074	0.0021
RIT:BBH:0658	0.0261	6.1	0.0091	0.0022
RIT:BBH:0659	0.0259	6.2	0.0094	0.0046
RIT:BBH:0660	0.0198	16.0	0.0044	0.0006
RIT:BBH:0661	0.0210	11.3	0.0067	0.0010
RIT:BBH:0662	0.0209	11.3	0.0067	0.0012
RIT:BBH:0663	0.0211	10.4	0.0066	0.0009
RIT:BBH:0664	0.0210	10.3	0.0067	0.0018
RIT:BBH:0665	0.0211	9.7	0.0066	0.0014
RIT:BBH:0666	0.0211	9.6	0.0066	0.0013
RIT:BBH:0667	0.0239	8.4	0.0065	0.0013
RIT:BBH:0668	0.0239	8.2	0.0066	0.0017

(Table continued)

TABLE IV. *(Continued)*

Run	$m\omega_i$	N	e_i	e_f
RIT:BBH:0669	0.0209	12.3	0.0068	0.0012
RIT:BBH:0670	0.0209	12.4	0.0065	0.0011
RIT:BBH:0671	0.0238	9.3	0.0066	0.0013
RIT:BBH:0672	0.0237	9.2	0.0069	0.0016
RIT:BBH:0673	0.0236	10.6	0.0069	0.0016
RIT:BBH:0674	0.0236	10.6	0.0070	0.0014
RIT:BBH:0675	0.0237	10.0	0.0067	0.0008
RIT:BBH:0676	0.0236	10.1	0.0070	0.0016
RIT:BBH:0677	0.0222	16.1	0.0051	0.0009
RIT:BBH:0678	0.0223	11.9	0.0051	0.0012
RIT:BBH:0679	0.0289	8.8	0.0064	0.0015
RIT:BBH:0681	0.0261	5.7	0.0091	0.0021
RIT:BBH:0682	0.0224	12.2	0.0045	0.0050
RIT:BBH:0683	0.0224	12.4	0.0041	0.0051
RIT:BBH:0684	0.0223	12.6	0.0037	0.0042
RIT:BBH:0685	0.0222	12.6	0.0046	0.0044
RIT:BBH:0686	0.0223	12.4	0.0048	0.0046
RIT:BBH:0687	0.0284	10.8	0.0072	0.0016
RIT:BBH:0688	0.0257	5.9	0.0098	0.0050
RIT:BBH:0689	0.0236	10.5	0.0068	0.0015
RIT:BBH:0690	0.0191	29.3	0.0031	0.0005
RIT:BBH:0691	0.0220	22.7	0.0030	0.0008
RIT:BBH:0692	0.0227	8.7	0.0054	0.0019
RIT:BBH:0693	0.0227	8.9	0.0054	0.0011
RIT:BBH:0694	0.0227	8.9	0.0053	0.0010
RIT:BBH:0695	0.0226	8.9	0.0054	0.0015
RIT:BBH:0696	0.0226	8.9	0.0055	0.0019
RIT:BBH:0697	0.0227	8.9	0.0055	0.0020
RIT:BBH:0698	0.0226	10.1	0.0055	0.0024
RIT:BBH:0699	0.0226	10.3	0.0053	0.0017
RIT:BBH:0700	0.0225	10.4	0.0050	0.0023
RIT:BBH:0701	0.0224	10.5	0.0052	0.0023
RIT:BBH:0702	0.0224	10.4	0.0055	0.0025
RIT:BBH:0703	0.0225	10.3	0.0058	0.0028
RIT:BBH:0704	0.0222	16.2	0.0048	0.0009
RIT:BBH:0705	0.0217	18.0	0.0052	0.0006
RIT:BBH:0706	0.0281	6.4	0.0079	0.0020
RIT:BBH:0707	0.0222	15.3	0.0053	0.0039
RIT:BBH:0708	0.0223	15.7	0.0042	0.0042
RIT:BBH:0709	0.0222	15.8	0.0030	0.0043
RIT:BBH:0710	0.0220	16.0	0.0033	0.0046
RIT:BBH:0711	0.0220	15.9	0.0044	0.0044
RIT:BBH:0712	0.0221	15.6	0.0052	0.0040
RIT:BBH:0713	0.0236	10.5	0.0068	0.0014
RIT:BBH:0714	0.0219	16.3	0.0046	0.0007
RIT:BBH:0715	0.0222	16.2	0.0049	0.0011
RIT:BBH:0716	0.0221	16.2	0.0051	0.0010
RIT:BBH:0717	0.0222	16.3	0.0052	0.0009
RIT:BBH:0718	0.0221	16.3	0.0050	0.0010
RIT:BBH:0719	0.0223	14.4	0.0052	0.0017
RIT:BBH:0720	0.0223	14.5	0.0055	0.0018
RIT:BBH:0721	0.0221	14.8	0.0049	0.0018
RIT:BBH:0722	0.0225	12.3	0.0056	0.0025
RIT:BBH:0723	0.0222	12.5	0.0052	0.0029
RIT:BBH:0724	0.0226	10.1	0.0055	0.0030
RIT:BBH:0725	0.0224	10.3	0.0054	0.0030
RIT:BBH:0726	0.0227	8.7	0.0054	0.0024
RIT:BBH:0727	0.0226	8.8	0.0053	0.0022
RIT:BBH:0728	0.0221	18.8	0.0052	0.0034
RIT:BBH:0729	0.0221	18.9	0.0042	0.0028
RIT:BBH:0730	0.0221	19.2	0.0030	0.0036
RIT:BBH:0731	0.0219	19.1	0.0044	0.0033
RIT:BBH:0732	0.0220	18.9	0.0052	0.0032
RIT:BBH:0733	0.0222	16.2	0.0052	0.0010
RIT:BBH:0734	0.0223	14.6	0.0046	0.0016
RIT:BBH:0735	0.0220	19.3	0.0033	0.0035
RIT:BBH:0736	0.0201	12.4	0.0039	0.0013
RIT:BBH:0746	0.0223	14.6	0.0057	0.0017
RIT:BBH:0747	0.0271	9.2	0.0076	0.0017
RIT:BBH:0749	0.0222	14.7	0.0047	0.0018
RIT:BBH:0750	0.0224	11.7	0.0067	0.0015
RIT:BBH:0751	0.0225	11.7	0.0068	0.0015
RIT:BBH:0752	0.0225	11.7	0.0066	0.0017
RIT:BBH:0753	0.0196	18.1	0.0052	0.0010
RIT:BBH:0754	0.0225	11.7	0.0066	0.0017
RIT:BBH:0755	0.0224	11.9	0.0067	0.0015
RIT:BBH:0756	0.0225	11.7	0.0068	0.0016
RIT:BBH:0758	0.0220	21.8	0.0044	0.0013
RIT:BBH:0759	0.0220	21.6	0.0040	0.0016
RIT:BBH:0760	0.0220	21.7	0.0036	0.0010
RIT:BBH:0761	0.0220	21.8	0.0032	0.0016
RIT:BBH:0762	0.0219	21.7	0.0039	0.0012
RIT:BBH:0763	0.0220	21.6	0.0043	0.0013
RIT:BBH:0764	0.0227	16.1	0.0024	0.0015
RIT:BBH:0766	0.0269	9.4	0.0072	0.0011
RIT:BBH:0767	0.0283	11.8	0.0066	0.0014
RIT:BBH:0768	0.0236	10.5	0.0069	0.0012
RIT:BBH:0769	0.0271	8.8	0.0074	0.0015
RIT:BBH:0770	0.0222	14.5	0.0058	0.0017
RIT:BBH:0771	0.0221	14.6	0.0053	0.0018
RIT:BBH:0772	0.0222	12.7	0.0039	0.0063
RIT:BBH:0773	0.0197	16.5	0.0045	0.0005
RIT:BBH:0774	0.0236	10.5	0.0069	0.0011
RIT:BBH:0776	0.0272	8.8	0.0073	0.0021
RIT:BBH:0777	0.0268	9.9	0.0070	0.0010
RIT:BBH:0778	0.0199	16.1	0.0039	0.0011
RIT:BBH:0779	0.0223	12.3	0.0060	0.0023
RIT:BBH:0780	0.0222	12.5	0.0056	0.0033
RIT:BBH:0781	0.0226	10.3	0.0045	0.0006
RIT:BBH:0782	0.0272	8.8	0.0073	0.0018
RIT:BBH:0784	0.0223	11.9	0.0062	0.0013
RIT:BBH:0785	0.0219	14.9	0.0060	0.0010
RIT:BBH:0788	0.0267	10.3	0.0068	0.0014
RIT:BBH:0789	0.0224	12.5	0.0036	0.0029
RIT:BBH:0790	0.0222	12.6	0.0037	0.0027
RIT:BBH:0792	0.0386	13.0	0.0017	0.0009
RIT:BBH:0793	0.0201	12.6	0.0049	0.0013
RIT:BBH:0794	0.0224	12.1	0.0059	0.0024
RIT:BBH:0795	0.0225	12.5	0.0053	0.0025
RIT:BBH:0796	0.0285	10.4	0.0064	0.0014
RIT:BBH:0797	0.0226	10.1	0.0041	0.0021
RIT:BBH:0798	0.0226	10.3	0.0040	0.0021
RIT:BBH:0799	0.0225	10.3	0.0039	0.0020
RIT:BBH:0800	0.0225	10.4	0.0039	0.0021

(Table continued)

TABLE IV. *(Continued)*

Run	$m\omega_i$	N	e_i	e_f
RIT:BBH:0801	0.0225	10.4	0.0040	0.0018
RIT:BBH:0802	0.0225	10.3	0.0041	0.0020
RIT:BBH:0805	0.0198	15.7	0.0054	0.0008

TABLE V. The energy radiated, $\delta\mathcal{M}^{\rm IH} = M_{\rm adm} - M^{\rm IH}_{\rm rem}$, and final spin, $\chi^{\rm IH}_{\rm rem}$, as measured using the IH formalism The error bars are due to variations in the measured mass and spin with time. For aligned systems with final spin antialigned to the initial orbital angular momentum the minus sign is preserved.

Run	$\delta\mathcal{M}^{\rm IH}$	$\chi^{\rm IH}_{\rm rem}$
RIT:BBH:0275	0.009755 ± 0.000021	0.466308 ± 0.000064
RIT:BBH:0282	0.005172 ± 0.000045	0.716323 ± 0.000227
RIT:BBH:0310	0.053655 ± 0.000000	0.738437 ± 0.000001
RIT:BBH:0313	0.053591 ± 0.000000	0.738922 ± 0.000000
RIT:BBH:0315	0.053710 ± 0.000000	0.738432 ± 0.000000
RIT:BBH:0320	0.053412 ± 0.000000	0.739440 ± 0.000001
RIT:BBH:0323	0.075869 ± 0.000002	0.852506 ± 0.000002
RIT:BBH:0325	0.053473 ± 0.000000	0.738955 ± 0.000000
RIT:BBH:0327	0.053347 ± 0.000000	0.739469 ± 0.000001
RIT:BBH:0328	0.050319 ± 0.000000	0.716657 ± 0.000001
RIT:BBH:0329	0.050818 ± 0.000000	0.715311 ± 0.000003
RIT:BBH:0330	0.050938 ± 0.000000	0.715846 ± 0.000001
RIT:BBH:0331	0.074855 ± 0.000087	0.861545 ± 0.000090
RIT:BBH:0332	0.051104 ± 0.000000	0.714947 ± 0.000002
RIT:BBH:0333	0.041546 ± 0.000000	0.619534 ± 0.000043
RIT:BBH:0334	0.041386 ± 0.000000	0.620094 ± 0.000047
RIT:BBH:0335	0.041449 ± 0.000001	0.619904 ± 0.000046
RIT:BBH:0340	0.032341 ± 0.000003	0.674305 ± 0.000036
RIT:BBH:0341	0.050067 ± 0.000000	0.717811 ± 0.000004
RIT:BBH:0342	0.041668 ± 0.000000	0.619130 ± 0.000043
RIT:BBH:0343	0.046832 ± 0.000000	0.679796 ± 0.000000
RIT:BBH:0346	0.047275 ± 0.000000	0.678798 ± 0.000001
RIT:BBH:0347	0.050399 ± 0.000000	0.717356 ± 0.000001
RIT:BBH:0349	0.047258 ± 0.000000	0.679542 ± 0.000001
RIT:BBH:0351	0.040819 ± 0.000001	0.584446 ± 0.000053
RIT:BBH:0353	0.040811 ± 0.000002	0.584424 ± 0.000053
RIT:BBH:0354	0.041065 ± 0.000001	0.583552 ± 0.000052
RIT:BBH:0355	0.041839 ± 0.000000	0.618519 ± 0.000045
RIT:BBH:0356	0.040928 ± 0.000002	0.584007 ± 0.000053
RIT:BBH:0357	0.034114 ± 0.000001	0.455868 ± 0.000011
RIT:BBH:0358	0.036350 ± 0.000000	0.512342 ± 0.000013
RIT:BBH:0359	0.041089 ± 0.000002	0.583508 ± 0.000053
RIT:BBH:0360	0.041781 ± 0.000001	0.618725 ± 0.000042
RIT:BBH:0361	0.040960 ± 0.000002	0.583985 ± 0.000052
RIT:BBH:0362	0.044146 ± 0.000001	0.644315 ± 0.000023
RIT:BBH:0363	0.080653 ± 0.000020	0.844587 ± 0.000017
RIT:BBH:0364	0.044426 ± 0.000001	0.643407 ± 0.000023
RIT:BBH:0365	0.052618 ± 0.000005	0.876523 ± 0.000124
RIT:BBH:0366	0.039642 ± 0.000003	0.559645 ± 0.000059
RIT:BBH:0367	0.045173 ± 0.000000	0.640764 ± 0.000023
RIT:BBH:0368	0.045020 ± 0.000000	0.641387 ± 0.000023
RIT:BBH:0369	0.044721 ± 0.000000	0.642352 ± 0.000022
RIT:BBH:0370	0.031615 ± 0.000002	0.400535 ± 0.000008
RIT:BBH:0371	0.078912 ± 0.000019	0.895118 ± 0.000209
RIT:BBH:0372	0.044282 ± 0.000001	0.643899 ± 0.000023
RIT:BBH:0373	0.005174 ± 0.000009	0.188442 ± 0.000008
RIT:BBH:0374	0.054164 ± 0.000000	0.782005 ± 0.000005
RIT:BBH:0375	0.046773 ± 0.000000	0.681434 ± 0.000001
RIT:BBH:0376	0.050937 ± 0.000002	0.704897 ± 0.000007
RIT:BBH:0377	0.050309 ± 0.000000	0.706334 ± 0.000001
RIT:BBH:0378	0.046242 ± 0.000000	0.682750 ± 0.000000
RIT:BBH:0379	0.046277 ± 0.000000	0.681889 ± 0.000002
RIT:BBH:0380	0.053249 ± 0.000001	0.783458 ± 0.000011
RIT:BBH:0381	0.051040 ± 0.000002	0.705475 ± 0.000005
RIT:BBH:0382	0.050558 ± 0.000001	0.707614 ± 0.000004
RIT:BBH:0383	0.049554 ± 0.000001	0.710402 ± 0.000004
RIT:BBH:0384	0.049609 ± 0.000001	0.687883 ± 0.000003
RIT:BBH:0385	0.062676 ± 0.000000	0.802730 ± 0.000008
RIT:BBH:0386	0.059790 ± 0.000005	0.817937 ± 0.000068
RIT:BBH:0387	0.042726 ± 0.000002	0.651504 ± 0.000005
RIT:BBH:0388	0.036553 ± 0.000000	0.498418 ± 0.000020
RIT:BBH:0389	0.049397 ± 0.000002	0.709704 ± 0.000006
RIT:BBH:0390	0.035368 ± 0.000001	0.480527 ± 0.000014
RIT:BBH:0391	0.035986 ± 0.000000	0.526490 ± 0.000025
RIT:BBH:0392	0.037855 ± 0.000001	0.587302 ± 0.000024
RIT:BBH:0393	0.078994 ± 0.000003	0.846074 ± 0.000002
RIT:BBH:0394	0.074703 ± 0.000025	0.856458 ± 0.000021
RIT:BBH:0395	0.040747 ± 0.000001	0.593679 ± 0.000031
RIT:BBH:0396	0.060027 ± 0.000000	0.832976 ± 0.000005
RIT:BBH:0397	0.036097 ± 0.000002	0.542549 ± 0.000019
RIT:BBH:0398	0.067527 ± 0.000005	0.867067 ± 0.000072
RIT:BBH:0399	0.054165 ± 0.000001	0.753026 ± 0.000025
RIT:BBH:0400	0.049324 ± 0.000000	0.710801 ± 0.000002
RIT:BBH:0401	0.073001 ± 0.000046	0.877129 ± 0.001996
RIT:BBH:0402	0.066410 ± 0.000002	0.852634 ± 0.000003
RIT:BBH:0403	0.040185 ± 0.000003	0.579541 ± 0.000036
RIT:BBH:0404	0.054719 ± 0.000002	0.768266 ± 0.000003
RIT:BBH:0405	0.032710 ± 0.000000	0.425646 ± 0.000004
RIT:BBH:0406	0.035171 ± 0.000000	0.474611 ± 0.000014
RIT:BBH:0407	0.047369 ± 0.000001	0.674076 ± 0.000013
RIT:BBH:0408	0.046691 ± 0.000003	0.674423 ± 0.000003
RIT:BBH:0409	0.037911 ± 0.000002	0.554349 ± 0.000039
RIT:BBH:0410	0.078966 ± 0.000013	0.849620 ± 0.000011
RIT:BBH:0411	0.059329 ± 0.000036	0.789935 ± 0.000094
RIT:BBH:0412	0.063605 ± 0.000016	0.838353 ± 0.000179
RIT:BBH:0413	0.077347 ± 0.000025	0.898630 ± 0.000168
RIT:BBH:0414	0.041171 ± 0.000001	0.601077 ± 0.000052
RIT:BBH:0415	0.049252 ± 0.000001	0.725417 ± 0.000008
RIT:BBH:0416	0.012257 ± 0.000003	0.336496 ± 0.000003
RIT:BBH:0417	0.029699 ± 0.000000	0.481455 ± 0.000020
RIT:BBH:0418	0.059272 ± 0.000008	0.777776 ± 0.000057
RIT:BBH:0419	0.076170 ± 0.000021	0.855008 ± 0.000018
RIT:BBH:0420	0.074180 ± 0.000002	0.861615 ± 0.000034
RIT:BBH:0421	0.043810 ± 0.000001	0.679501 ± 0.000005
RIT:BBH:0422	0.041993 ± 0.000001	0.622391 ± 0.000034
RIT:BBH:0423	0.029890 ± 0.000001	0.466418 ± 0.000020

(Table continued)

TABLE V. *(Continued)*

Run	$\delta\mathcal{M}^{\mathrm{IH}}$	$\chi^{\mathrm{IH}}_{\mathrm{rem}}$
RIT:BBH:0424	0.056607 ± 0.000000	0.758792 ± 0.000002
RIT:BBH:0425	0.056948 ± 0.000003	0.758096 ± 0.000014
RIT:BBH:0426	0.056222 ± 0.000003	0.760313 ± 0.000016
RIT:BBH:0427	0.055508 ± 0.000002	0.762270 ± 0.000015
RIT:BBH:0428	0.055318 ± 0.000002	0.762735 ± 0.000013
RIT:BBH:0430	0.052506 ± 0.000001	0.754092 ± 0.000003
RIT:BBH:0431	0.040231 ± 0.000002	0.691050 ± 0.000084
RIT:BBH:0432	0.039565 ± 0.000003	0.552085 ± 0.000008
RIT:BBH:0433	0.055715 ± 0.000002	0.761422 ± 0.000012
RIT:BBH:0434	0.040174 ± 0.000001	0.706298 ± 0.000067
RIT:BBH:0435	0.064829 ± 0.000009	0.898043 ± 0.000123
RIT:BBH:0436	0.028311 ± 0.000001	0.454846 ± 0.000027
RIT:BBH:0437	0.035928 ± 0.000003	0.485296 ± 0.000003
RIT:BBH:0438	0.059245 ± 0.000021	0.880373 ± 0.000465
RIT:BBH:0439	0.060842 ± 0.000001	0.792165 ± 0.000012
RIT:BBH:0440	0.061152 ± 0.000002	0.791374 ± 0.000026
RIT:BBH:0441	0.061152 ± 0.000001	0.791527 ± 0.000010
RIT:BBH:0442	0.003473 ± 0.000008	-0.523922 ± 0.000028
RIT:BBH:0443	0.060677 ± 0.000001	0.792655 ± 0.000020
RIT:BBH:0444	0.061032 ± 0.000001	0.791912 ± 0.000010
RIT:BBH:0445	0.060572 ± 0.000002	0.793015 ± 0.000028
RIT:BBH:0446	0.044611 ± 0.000000	0.733549 ± 0.000002
RIT:BBH:0447	0.033814 ± 0.000003	0.527149 ± 0.000013
RIT:BBH:0448	0.060607 ± 0.000002	0.793064 ± 0.000027
RIT:BBH:0449	0.043345 ± 0.000010	0.713231 ± 0.000094
RIT:BBH:0450	0.031622 ± 0.000001	0.677033 ± 0.000110
RIT:BBH:0451	0.034893 ± 0.000002	0.509449 ± 0.000009
RIT:BBH:0452	0.042244 ± 0.000001	0.687860 ± 0.000004
RIT:BBH:0453	0.060877 ± 0.000001	0.792365 ± 0.000018
RIT:BBH:0454	0.035939 ± 0.000003	0.557891 ± 0.000017
RIT:BBH:0455	0.037582 ± 0.000003	0.519807 ± 0.000148
RIT:BBH:0456	0.072479 ± 0.000002	0.859171 ± 0.000004
RIT:BBH:0457	0.045475 ± 0.000002	0.716303 ± 0.000008
RIT:BBH:0458	0.048232 ± 0.000001	0.685624 ± 0.000007
RIT:BBH:0459	0.065273 ± 0.000091	0.828282 ± 0.001935
RIT:BBH:0460	0.061470 ± 0.000003	0.803196 ± 0.000036
RIT:BBH:0461	0.024872 ± 0.000012	0.271057 ± 0.000043
RIT:BBH:0462	0.062203 ± 0.000004	0.867224 ± 0.000021
RIT:BBH:0463	0.029381 ± 0.000000	0.358998 ± 0.000004
RIT:BBH:0464	0.032014 ± 0.000001	0.446120 ± 0.000007
RIT:BBH:0465	0.027536 ± 0.000004	0.325633 ± 0.000002
RIT:BBH:0466	0.028988 ± 0.000003	0.358585 ± 0.000003
RIT:BBH:0467	0.013279 ± 0.000036	0.884539 ± 0.001557
RIT:BBH:0468	0.032076 ± 0.000095	0.375080 ± 0.000060
RIT:BBH:0469	0.023867 ± 0.000007	0.246034 ± 0.000034
RIT:BBH:0470	0.030928 ± 0.000000	0.392487 ± 0.000006
RIT:BBH:0471	0.040104 ± 0.000001	0.577264 ± 0.000025
RIT:BBH:0472	0.088933 ± 0.000035	0.907779 ± 0.000479
RIT:BBH:0473	0.055285 ± 0.000001	0.801709 ± 0.000002
RIT:BBH:0474	0.032966 ± 0.000000	0.435000 ± 0.000008
RIT:BBH:0475	0.046680 ± 0.000001	0.722327 ± 0.000005
RIT:BBH:0476	0.036107 ± 0.000001	0.535204 ± 0.000018
RIT:BBH:0477	0.069252 ± 0.000009	0.891624 ± 0.000119
RIT:BBH:0478	0.036170 ± 0.000001	0.494185 ± 0.000014
RIT:BBH:0479	0.063486 ± 0.000000	0.812954 ± 0.000004
RIT:BBH:0480	0.072102 ± 0.000024	0.883323 ± 0.000622
RIT:BBH:0481	0.064803 ± 0.000000	0.836127 ± 0.000014
RIT:BBH:0482	0.081129 ± 0.000008	0.905105 ± 0.000074
RIT:BBH:0483	0.038850 ± 0.000002	0.575602 ± 0.000032
RIT:BBH:0484	0.009012 ± 0.000008	-0.079113 ± 0.000002
RIT:BBH:0485	0.047848 ± 0.000000	0.725122 ± 0.000003
RIT:BBH:0486	0.063557 ± 0.000002	0.850405 ± 0.000034
RIT:BBH:0487	0.052576 ± 0.000001	0.761863 ± 0.000005
RIT:BBH:0488	0.054648 ± 0.000000	0.799134 ± 0.000005
RIT:BBH:0489	0.055917 ± 0.000000	0.774725 ± 0.000005
RIT:BBH:0490	0.062685 ± 0.000042	0.816066 ± 0.001009
RIT:BBH:0491	0.063097 ± 0.000065	0.815053 ± 0.003471
RIT:BBH:0492	0.055262 ± 0.000001	0.801684 ± 0.000017
RIT:BBH:0493	0.063392 ± 0.000062	0.814616 ± 0.003462
RIT:BBH:0494	0.034594 ± 0.000002	0.684784 ± 0.000022
RIT:BBH:0495	0.004439 ± 0.000003	-0.028322 ± 0.000000
RIT:BBH:0496	0.063363 ± 0.000066	0.815005 ± 0.003477
RIT:BBH:0497	0.041765 ± 0.000001	0.655728 ± 0.000014
RIT:BBH:0498	0.062909 ± 0.000065	0.816097 ± 0.002830
RIT:BBH:0499	0.049576 ± 0.000097	0.683193 ± 0.000092
RIT:BBH:0500	0.062559 ± 0.000071	0.816606 ± 0.003480
RIT:BBH:0501	0.034663 ± 0.000001	0.517374 ± 0.000017
RIT:BBH:0502	0.044202 ± 0.000000	0.644875 ± 0.000034
RIT:BBH:0503	0.076966 ± 0.000024	0.853642 ± 0.000019
RIT:BBH:0504	0.078223 ± 0.000004	0.847466 ± 0.000004
RIT:BBH:0505	0.057866 ± 0.000008	0.775191 ± 0.000005
RIT:BBH:0506	0.056313 ± 0.000004	0.780899 ± 0.000125
RIT:BBH:0507	0.032713 ± 0.000004	0.674826 ± 0.000068
RIT:BBH:0508	0.058142 ± 0.000004	0.775107 ± 0.000015
RIT:BBH:0509	0.031853 ± 0.000001	0.397515 ± 0.000003
RIT:BBH:0510	0.057524 ± 0.000004	0.777808 ± 0.000072
RIT:BBH:0511	0.057188 ± 0.000009	0.778977 ± 0.000072
RIT:BBH:0512	0.056989 ± 0.000010	0.777675 ± 0.000048
RIT:BBH:0513	0.088344 ± 0.000001	0.911908 ± 0.000005
RIT:BBH:0514	0.056645 ± 0.000002	0.870299 ± 0.000071
RIT:BBH:0515	0.018923 ± 0.000004	0.330332 ± 0.000006
RIT:BBH:0516	0.014841 ± 0.000004	0.021118 ± 0.000001
RIT:BBH:0517	0.025120 ± 0.000000	0.594763 ± 0.000012
RIT:BBH:0518	0.016036 ± 0.000001	0.056985 ± 0.000004
RIT:BBH:0519	0.049058 ± 0.000001	0.715216 ± 0.000049
RIT:BBH:0520	0.043322 ± 0.000006	0.631578 ± 0.000023
RIT:BBH:0521	0.042829 ± 0.000008	0.633525 ± 0.000017
RIT:BBH:0522	0.043088 ± 0.000009	0.632352 ± 0.000017
RIT:BBH:0523	0.043510 ± 0.000002	0.630486 ± 0.000002
RIT:BBH:0524	0.043963 ± 0.000003	0.628571 ± 0.000004
RIT:BBH:0525	0.043623 ± 0.000003	0.630192 ± 0.000012
RIT:BBH:0526	0.018056 ± 0.000005	0.257903 ± 0.000005
RIT:BBH:0527	0.049770 ± 0.000004	0.713020 ± 0.000085
RIT:BBH:0528	0.031321 ± 0.000015	0.367704 ± 0.000008
RIT:BBH:0529	0.038569 ± 0.000000	0.537254 ± 0.000005
RIT:BBH:0530	0.062903 ± 0.000001	0.822578 ± 0.000020
RIT:BBH:0531	0.065293 ± 0.000001	0.820652 ± 0.000031
RIT:BBH:0532	0.028842 ± 0.000002	0.679180 ± 0.000011
RIT:BBH:0533	0.023254 ± 0.000004	0.486890 ± 0.000009
RIT:BBH:0534	0.046443 ± 0.000001	0.661080 ± 0.000028

(Table continued)

TABLE V. *(Continued)*

Run	$\delta\mathcal{M}^{\rm IH}$	$\chi^{\rm IH}_{\rm rem}$
RIT:BBH:0535	0.045424 ± 0.000020	0.881730 ± 0.000535
RIT:BBH:0536	0.040030 ± 0.000000	0.570538 ± 0.000010
RIT:BBH:0537	0.073123 ± 0.000001	0.869130 ± 0.000067
RIT:BBH:0538	0.015113 ± 0.000006	0.030392 ± 0.000003
RIT:BBH:0539	0.058162 ± 0.000008	0.776326 ± 0.000205
RIT:BBH:0540	0.038959 ± 0.000000	0.553916 ± 0.000130
RIT:BBH:0541	0.039054 ± 0.000005	0.553444 ± 0.000117
RIT:BBH:0542	0.039207 ± 0.000007	0.552913 ± 0.000115
RIT:BBH:0543	0.039249 ± 0.000001	0.552901 ± 0.000087
RIT:BBH:0544	0.039099 ± 0.000003	0.553352 ± 0.000092
RIT:BBH:0545	0.029184 ± 0.000004	0.328540 ± 0.000002
RIT:BBH:0546	0.026575 ± 0.000002	0.609586 ± 0.000006
RIT:BBH:0547	0.038936 ± 0.000005	0.553962 ± 0.000116
RIT:BBH:0548	0.033386 ± 0.000001	0.424909 ± 0.000006
RIT:BBH:0549	0.041753 ± 0.000003	0.870683 ± 0.000112
RIT:BBH:0550	0.021023 ± 0.000003	0.455629 ± 0.000005
RIT:BBH:0551	0.048796 ± 0.000010	0.716622 ± 0.000117
RIT:BBH:0552	0.041243 ± 0.000001	0.589701 ± 0.000006
RIT:BBH:0553	0.050908 ± 0.000003	0.710862 ± 0.000074
RIT:BBH:0554	0.050774 ± 0.000006	0.710644 ± 0.000098
RIT:BBH:0555	0.050336 ± 0.000000	0.709231 ± 0.000035
RIT:BBH:0556	0.025137 ± 0.000020	0.243923 ± 0.000008
RIT:BBH:0557	0.050413 ± 0.000001	0.706486 ± 0.000033
RIT:BBH:0558	0.088722 ± 0.000006	0.907706 ± 0.000174
RIT:BBH:0559	0.061163 ± 0.000004	0.791257 ± 0.000061
RIT:BBH:0560	0.049946 ± 0.000005	0.714447 ± 0.000092
RIT:BBH:0561	0.030453 ± 0.000029	0.370165 ± 0.000015
RIT:BBH:0562	0.019810 ± 0.000001	0.346877 ± 0.000012
RIT:BBH:0563	0.047229 ± 0.000000	0.659955 ± 0.000031
RIT:BBH:0564	0.034430 ± 0.000006	0.451211 ± 0.000006
RIT:BBH:0565	0.034461 ± 0.000002	0.457852 ± 0.000000
RIT:BBH:0566	0.041404 ± 0.000025	0.568919 ± 0.000022
RIT:BBH:0567	0.058103 ± 0.000002	0.901714 ± 0.000042
RIT:BBH:0568	0.037456 ± 0.000001	0.514935 ± 0.000000
RIT:BBH:0569	0.049869 ± 0.000003	0.805301 ± 0.000083
RIT:BBH:0570	0.015713 ± 0.000008	0.048338 ± 0.000006
RIT:BBH:0571	0.047169 ± 0.000899	0.618874 ± 0.000621
RIT:BBH:0572	0.023841 ± 0.000001	0.375989 ± 0.000003
RIT:BBH:0573	0.066632 ± 0.000067	0.822612 ± 0.000062
RIT:BBH:0574	0.015145 ± 0.000009	0.011647 ± 0.000001
RIT:BBH:0575	0.024752 ± 0.000001	0.392744 ± 0.000004
RIT:BBH:0576	0.036354 ± 0.000002	0.699326 ± 0.000025
RIT:BBH:0577	0.052912 ± 0.000033	0.736463 ± 0.000033
RIT:BBH:0578	0.040221 ± 0.000002	0.864225 ± 0.000025
RIT:BBH:0579	0.054030 ± 0.000002	0.889763 ± 0.000031
RIT:BBH:0580	0.047403 ± 0.000002	0.887412 ± 0.000074
RIT:BBH:0581	0.055045 ± 0.000046	0.772307 ± 0.000044
RIT:BBH:0582	0.053989 ± 0.000001	0.750068 ± 0.000011
RIT:BBH:0583	0.051310 ± 0.000000	0.709188 ± 0.000002
RIT:BBH:0584	0.036723 ± 0.000000	0.525781 ± 0.000002
RIT:BBH:0585	0.019772 ± 0.000001	0.145959 ± 0.000004
RIT:BBH:0586	0.058956 ± 0.000005	0.851208 ± 0.000011
RIT:BBH:0587	0.059250 ± 0.000004	0.850466 ± 0.000005
RIT:BBH:0588	0.059665 ± 0.000004	0.849713 ± 0.000003
RIT:BBH:0589	0.060087 ± 0.000002	0.849032 ± 0.000008
RIT:BBH:0590	0.060053 ± 0.000005	0.849361 ± 0.000002
RIT:BBH:0591	0.059276 ± 0.000004	0.850922 ± 0.000009
RIT:BBH:0592	0.050393 ± 0.000003	0.802069 ± 0.000029
RIT:BBH:0593	0.050386 ± 0.000006	0.802019 ± 0.000030
RIT:BBH:0594	0.050452 ± 0.000004	0.802374 ± 0.000036
RIT:BBH:0595	0.050800 ± 0.000003	0.801461 ± 0.000033
RIT:BBH:0596	0.052500 ± 0.000003	0.796794 ± 0.000028
RIT:BBH:0597	0.052147 ± 0.000003	0.798292 ± 0.000024
RIT:BBH:0598	0.030383 ± 0.000004	0.429837 ± 0.000012
RIT:BBH:0599	0.030273 ± 0.000004	0.430775 ± 0.000010
RIT:BBH:0600	0.030166 ± 0.000004	0.431726 ± 0.000009
RIT:BBH:0601	0.030088 ± 0.000005	0.432215 ± 0.000007
RIT:BBH:0602	0.030162 ± 0.000005	0.431393 ± 0.000010
RIT:BBH:0603	0.030356 ± 0.000004	0.429939 ± 0.000011
RIT:BBH:0604	0.063604 ± 0.000000	0.810142 ± 0.000006
RIT:BBH:0605	0.020420 ± 0.000001	0.163889 ± 0.000006
RIT:BBH:0606	0.043619 ± 0.000004	0.701703 ± 0.000010
RIT:BBH:0607	0.043603 ± 0.000004	0.702443 ± 0.000011
RIT:BBH:0608	0.043695 ± 0.000002	0.702706 ± 0.000005
RIT:BBH:0609	0.043654 ± 0.000004	0.703475 ± 0.000008
RIT:BBH:0610	0.041992 ± 0.000004	0.709008 ± 0.000008
RIT:BBH:0611	0.042191 ± 0.000002	0.706267 ± 0.000007
RIT:BBH:0612	0.042838 ± 0.000000	0.636955 ± 0.000001
RIT:BBH:0613	0.046877 ± 0.000026	0.900332 ± 0.000343
RIT:BBH:0614	0.011870 ± 0.000001	-0.101988 ± 0.000009
RIT:BBH:0615	0.039057 ± 0.000006	0.559604 ± 0.000005
RIT:BBH:0616	0.056926 ± 0.000011	0.801817 ± 0.000009
RIT:BBH:0617	0.061322 ± 0.000002	0.833450 ± 0.000015
RIT:BBH:0618	0.034470 ± 0.000004	0.575668 ± 0.000052
RIT:BBH:0619	0.034336 ± 0.000005	0.576260 ± 0.000052
RIT:BBH:0620	0.034358 ± 0.000005	0.576799 ± 0.000051
RIT:BBH:0621	0.034476 ± 0.000007	0.576258 ± 0.000052
RIT:BBH:0622	0.035284 ± 0.000006	0.572108 ± 0.000053
RIT:BBH:0623	0.035340 ± 0.000004	0.572076 ± 0.000049
RIT:BBH:0624	0.063423 ± 0.000001	0.833070 ± 0.000043
RIT:BBH:0625	0.062617 ± 0.000001	0.834858 ± 0.000060
RIT:BBH:0626	0.055065 ± 0.000000	0.792026 ± 0.000014
RIT:BBH:0627	0.057292 ± 0.000000	0.787216 ± 0.000005
RIT:BBH:0628	0.048232 ± 0.000001	0.712225 ± 0.000009
RIT:BBH:0629	0.046712 ± 0.000001	0.717638 ± 0.000009
RIT:BBH:0630	0.049920 ± 0.000008	0.701714 ± 0.000043
RIT:BBH:0631	0.034347 ± 0.000004	0.576093 ± 0.000051
RIT:BBH:0632	0.034799 ± 0.000007	0.574488 ± 0.000055
RIT:BBH:0633	0.030332 ± 0.000005	0.430265 ± 0.000011
RIT:BBH:0634	0.030097 ± 0.000004	0.432003 ± 0.000010
RIT:BBH:0635	0.043605 ± 0.000005	0.702119 ± 0.000006
RIT:BBH:0636	0.043122 ± 0.000005	0.705537 ± 0.000005
RIT:BBH:0637	0.012175 ± 0.000022	-0.067152 ± 0.000017
RIT:BBH:0638	0.050338 ± 0.000004	0.802032 ± 0.000034
RIT:BBH:0639	0.051488 ± 0.000002	0.799448 ± 0.000010
RIT:BBH:0640	0.059071 ± 0.000006	0.850863 ± 0.000003
RIT:BBH:0641	0.060179 ± 0.000005	0.848974 ± 0.000003
RIT:BBH:0642	0.105978 ± 0.000041	0.941309 ± 0.000027
RIT:BBH:0643	0.036775 ± 0.000006	0.499016 ± 0.000004
RIT:BBH:0644	0.038882 ± 0.000007	0.570816 ± 0.000006

(Table continued)

TABLE V. *(Continued)*

Run	$\delta\mathcal{M}^{\mathrm{IH}}$	$\chi^{\mathrm{IH}}_{\mathrm{rem}}$
RIT:BBH:0645	0.038928 ± 0.000001	0.554029 ± 0.000123
RIT:BBH:0646	0.039256 ± 0.000001	0.552832 ± 0.000076
RIT:BBH:0647	0.043479 ± 0.000004	0.630925 ± 0.000033
RIT:BBH:0648	0.043361 ± 0.000002	0.631335 ± 0.000007
RIT:BBH:0649	0.049551 ± 0.000004	0.713573 ± 0.000089
RIT:BBH:0650	0.050672 ± 0.000000	0.712221 ± 0.000020
RIT:BBH:0651	0.057943 ± 0.000007	0.775224 ± 0.000005
RIT:BBH:0652	0.056772 ± 0.000006	0.780066 ± 0.000083
RIT:BBH:0653	0.062880 ± 0.000032	0.815572 ± 0.000732
RIT:BBH:0654	0.063172 ± 0.000047	0.815569 ± 0.001616
RIT:BBH:0655	0.038167 ± 0.000005	0.575508 ± 0.000005
RIT:BBH:0656	0.048789 ± 0.000002	0.860471 ± 0.000058
RIT:BBH:0657	0.057559 ± 0.000003	0.830054 ± 0.000000
RIT:BBH:0658	0.034812 ± 0.000039	0.463470 ± 0.000029
RIT:BBH:0659	0.038433 ± 0.000012	0.534745 ± 0.000010
RIT:BBH:0660	0.014497 ± 0.000001	0.203808 ± 0.000010
RIT:BBH:0661	0.050698 ± 0.000002	0.705290 ± 0.000006
RIT:BBH:0662	0.050063 ± 0.000000	0.709147 ± 0.000001
RIT:BBH:0663	0.044226 ± 0.000001	0.644051 ± 0.000023
RIT:BBH:0664	0.044984 ± 0.000000	0.641411 ± 0.000022
RIT:BBH:0665	0.040795 ± 0.000001	0.584500 ± 0.000053
RIT:BBH:0666	0.041098 ± 0.000001	0.583455 ± 0.000053
RIT:BBH:0667	0.041441 ± 0.000000	0.619890 ± 0.000047
RIT:BBH:0668	0.041774 ± 0.000000	0.618750 ± 0.000045
RIT:BBH:0669	0.055805 ± 0.000003	0.761466 ± 0.000016
RIT:BBH:0670	0.056141 ± 0.000002	0.760121 ± 0.000012
RIT:BBH:0671	0.047100 ± 0.000000	0.679071 ± 0.000000
RIT:BBH:0672	0.046477 ± 0.000000	0.682283 ± 0.000002
RIT:BBH:0673	0.053705 ± 0.000000	0.738358 ± 0.000000
RIT:BBH:0674	0.053356 ± 0.000001	0.739535 ± 0.000000
RIT:BBH:0675	0.050570 ± 0.000000	0.715912 ± 0.000003
RIT:BBH:0676	0.050688 ± 0.000000	0.716618 ± 0.000001
RIT:BBH:0677	0.049031 ± 0.000001	0.859922 ± 0.000019
RIT:BBH:0678	0.018777 ± 0.000004	0.272422 ± 0.000006
RIT:BBH:0679	0.059155 ± 0.000095	0.858853 ± 0.000082
RIT:BBH:0681	0.033054 ± 0.000018	0.424415 ± 0.000011
RIT:BBH:0682	0.015776 ± 0.000017	0.510385 ± 0.000040
RIT:BBH:0683	0.015756 ± 0.000014	0.510845 ± 0.000037
RIT:BBH:0684	0.015508 ± 0.000014	0.513199 ± 0.000042
RIT:BBH:0685	0.015971 ± 0.000017	0.509879 ± 0.000028
RIT:BBH:0686	0.015703 ± 0.000015	0.512256 ± 0.000033
RIT:BBH:0687	0.101832 ± 0.000141	0.943042 ± 0.000108
RIT:BBH:0688	0.027384 ± 0.000013	0.307036 ± 0.000007
RIT:BBH:0689	0.048574 ± 0.000000	0.704214 ± 0.000001
RIT:BBH:0690	0.040435 ± 0.000001	0.902206 ± 0.000022
RIT:BBH:0691	0.036400 ± 0.000009	0.873384 ± 0.000264
RIT:BBH:0692	0.021645 ± 0.000001	0.318473 ± 0.000018
RIT:BBH:0693	0.021756 ± 0.000000	0.317474 ± 0.000017
RIT:BBH:0694	0.021837 ± 0.000003	0.317090 ± 0.000010
RIT:BBH:0695	0.021890 ± 0.000004	0.317004 ± 0.000013
RIT:BBH:0696	0.021802 ± 0.000003	0.318053 ± 0.000015
RIT:BBH:0697	0.021617 ± 0.000000	0.319314 ± 0.000018
RIT:BBH:0698	0.025636 ± 0.000005	0.526479 ± 0.000008
RIT:BBH:0699	0.025489 ± 0.000006	0.527429 ± 0.000010
RIT:BBH:0700	0.025688 ± 0.000004	0.527110 ± 0.000008

(Table continued)

TABLE V. *(Continued)*

Run	$\delta\mathcal{M}^{\mathrm{IH}}$	$\chi^{\mathrm{IH}}_{\mathrm{rem}}$
RIT:BBH:0701	0.025531 ± 0.000002	0.528160 ± 0.000002
RIT:BBH:0702	0.025475 ± 0.000002	0.527208 ± 0.000002
RIT:BBH:0703	0.026364 ± 0.000002	0.522468 ± 0.000003
RIT:BBH:0704	0.049293 ± 0.000001	0.859538 ± 0.000009
RIT:BBH:0705	0.030465 ± 0.000000	0.691071 ± 0.000000
RIT:BBH:0706	0.034507 ± 0.000007	0.565324 ± 0.000006
RIT:BBH:0707	0.020526 ± 0.000016	0.689788 ± 0.000014
RIT:BBH:0708	0.020884 ± 0.000017	0.688633 ± 0.000033
RIT:BBH:0709	0.021285 ± 0.000004	0.686541 ± 0.000033
RIT:BBH:0710	0.020756 ± 0.000005	0.688724 ± 0.000023
RIT:BBH:0711	0.021363 ± 0.000010	0.687488 ± 0.000043
RIT:BBH:0712	0.021450 ± 0.000018	0.685740 ± 0.000038
RIT:BBH:0713	0.048632 ± 0.000000	0.704139 ± 0.000000
RIT:BBH:0714	0.027409 ± 0.000000	0.666580 ± 0.000023
RIT:BBH:0715	0.049699 ± 0.000001	0.858851 ± 0.000004
RIT:BBH:0716	0.049893 ± 0.000000	0.858653 ± 0.000011
RIT:BBH:0717	0.048895 ± 0.000000	0.860184 ± 0.000023
RIT:BBH:0718	0.049896 ± 0.000001	0.858540 ± 0.000006
RIT:BBH:0719	0.040860 ± 0.000002	0.804192 ± 0.000035
RIT:BBH:0720	0.040768 ± 0.000003	0.804210 ± 0.000064
RIT:BBH:0721	0.040637 ± 0.000003	0.805358 ± 0.000059
RIT:BBH:0722	0.033696 ± 0.000000	0.688607 ± 0.000075
RIT:BBH:0723	0.033534 ± 0.000001	0.690179 ± 0.000065
RIT:BBH:0724	0.025482 ± 0.000005	0.527249 ± 0.000009
RIT:BBH:0725	0.025333 ± 0.000002	0.528779 ± 0.000001
RIT:BBH:0726	0.021703 ± 0.000001	0.317879 ± 0.000017
RIT:BBH:0727	0.021874 ± 0.000004	0.317331 ± 0.000010
RIT:BBH:0728	0.026788 ± 0.000004	0.802091 ± 0.000025
RIT:BBH:0729	0.026774 ± 0.000005	0.802483 ± 0.000037
RIT:BBH:0730	0.028023 ± 0.000000	0.799994 ± 0.000000
RIT:BBH:0731	0.026804 ± 0.000001	0.802839 ± 0.000011
RIT:BBH:0732	0.028079 ± 0.000003	0.799475 ± 0.000012
RIT:BBH:0733	0.049113 ± 0.000002	0.860168 ± 0.000062
RIT:BBH:0734	0.041598 ± 0.000001	0.802929 ± 0.000023
RIT:BBH:0735	0.028204 ± 0.000001	0.799676 ± 0.000018
RIT:BBH:0736	0.012097 ± 0.000001	-0.094247 ± 0.000007
RIT:BBH:0746	0.041084 ± 0.000002	0.803423 ± 0.000033
RIT:BBH:0747	0.062178 ± 0.000010	0.794207 ± 0.000010
RIT:BBH:0749	0.041378 ± 0.000002	0.803747 ± 0.000028
RIT:BBH:0750	0.042934 ± 0.000002	0.663992 ± 0.000001
RIT:BBH:0751	0.042988 ± 0.000003	0.663925 ± 0.000004
RIT:BBH:0752	0.042861 ± 0.000002	0.664398 ± 0.000001
RIT:BBH:0753	0.015964 ± 0.000002	0.278649 ± 0.000007
RIT:BBH:0754	0.042815 ± 0.000002	0.664461 ± 0.000000
RIT:BBH:0755	0.042845 ± 0.000002	0.664284 ± 0.000001
RIT:BBH:0756	0.042951 ± 0.000003	0.664127 ± 0.000006
RIT:BBH:0758	0.034112 ± 0.000000	0.856356 ± 0.000070
RIT:BBH:0759	0.034025 ± 0.000000	0.856690 ± 0.000084
RIT:BBH:0760	0.034027 ± 0.000001	0.856820 ± 0.000080
RIT:BBH:0761	0.033855 ± 0.000000	0.857246 ± 0.000083
RIT:BBH:0762	0.033421 ± 0.000001	0.857900 ± 0.000078
RIT:BBH:0763	0.033891 ± 0.000000	0.856641 ± 0.000056
RIT:BBH:0764	0.003481 ± 0.000004	-0.523892 ± 0.000006
RIT:BBH:0766	0.069846 ± 0.000011	0.847565 ± 0.000009
RIT:BBH:0767	0.093972 ± 0.000226	0.946244 ± 0.000169

(Table continued)

TABLE V. *(Continued)*

Run	$\delta\mathcal{M}^{\mathrm{IH}}$	$\chi^{\mathrm{IH}}_{\mathrm{rem}}$
RIT:BBH:0768	0.048564 ± 0.000001	0.704462 ± 0.000005
RIT:BBH:0769	0.058345 ± 0.000019	0.769883 ± 0.000018
RIT:BBH:0770	0.042631 ± 0.000003	0.799235 ± 0.000038
RIT:BBH:0771	0.040475 ± 0.000002	0.804995 ± 0.000031
RIT:BBH:0772	0.015550 ± 0.000016	0.513368 ± 0.000030
RIT:BBH:0773	0.014818 ± 0.000002	0.210993 ± 0.000014
RIT:BBH:0774	0.048434 ± 0.000002	0.704864 ± 0.000009
RIT:BBH:0776	0.054457 ± 0.000016	0.745095 ± 0.000016
RIT:BBH:0777	0.071429 ± 0.000091	0.864500 ± 0.000081
RIT:BBH:0778	0.014818 ± 0.000003	0.256067 ± 0.000005
RIT:BBH:0779	0.031861 ± 0.000000	0.695155 ± 0.000067
RIT:BBH:0780	0.033610 ± 0.000000	0.690452 ± 0.000068
RIT:BBH:0781	0.017400 ± 0.000004	0.242897 ± 0.000005
RIT:BBH:0782	0.044535 ± 0.000013	0.677505 ± 0.000012
RIT:BBH:0784	0.027083 ± 0.000003	0.455190 ± 0.000001
RIT:BBH:0785	0.035941 ± 0.000000	0.672477 ± 0.000009
RIT:BBH:0788	0.072671 ± 0.000003	0.878489 ± 0.000004
RIT:BBH:0789	0.032801 ± 0.000000	0.692215 ± 0.000064
RIT:BBH:0790	0.032838 ± 0.000001	0.692466 ± 0.000065
RIT:BBH:0792	0.002153 ± 0.000027	0.100644 ± 0.000009
RIT:BBH:0793	0.023913 ± 0.000002	0.402428 ± 0.000001
RIT:BBH:0794	0.033602 ± 0.000001	0.688687 ± 0.000081
RIT:BBH:0795	0.033631 ± 0.000000	0.688947 ± 0.000068
RIT:BBH:0796	0.072225 ± 0.000064	0.906437 ± 0.000049
RIT:BBH:0797	0.013012 ± 0.000024	0.278813 ± 0.000055
RIT:BBH:0798	0.012961 ± 0.000024	0.279350 ± 0.000059
RIT:BBH:0799	0.012956 ± 0.000021	0.279400 ± 0.000055
RIT:BBH:0800	0.012964 ± 0.000023	0.279055 ± 0.000051
RIT:BBH:0801	0.013091 ± 0.000021	0.277442 ± 0.000044
RIT:BBH:0802	0.013150 ± 0.000020	0.277359 ± 0.000047
RIT:BBH:0805	0.030868 ± 0.000002	0.624745 ± 0.000010

[1] F. Pretorius, Phys. Rev. Lett. **95**, 121101 (2005).
[2] M. Campanelli, C. O. Lousto, P. Marronetti, and Y. Zlochower, Phys. Rev. Lett. **96**, 111101 (2006).
[3] J. G. Baker, J. Centrella, D.-I. Choi, M. Koppitz, and J. van Meter, Phys. Rev. Lett. **96**, 111102 (2006).
[4] M. Campanelli, C. O. Lousto, H. Nakano, and Y. Zlochower, Phys. Rev. D **79**, 084010 (2009).
[5] χ denotes the spin angular momentum of a black hole in units of the square of its mass. The maximum possible spin is $\chi = 1$.
[6] G. Lovelace, M. A. Scheel, R. Owen, M. Giesler, R. Katebi, B. Szilágyi, T. Chu, N. Demos, D. A. Hemberger, L. E. Kidder, H. P. Pfeiffer, and N. Afshari, Classical Quantum Gravity **32**, 065007 (2015).
[7] Y. Zlochower, J. Healy, C. O. Lousto, and I. Ruchlin, Phys. Rev. D **96**, 044002 (2017).
[8] C. O. Lousto and J. Healy, arXiv:2006.04818 [Phys. Rev. Lett. (to be published)].
[9] C. O. Lousto and Y. Zlochower, Phys. Rev. D **88**, 024001 (2013).
[10] C. O. Lousto, J. Healy, and H. Nakano, Phys. Rev. D **93**, 044031 (2016).
[11] B. Szilagyi, J. Blackman, A. Buonanno, A. Taracchini, H. P. Pfeiffer, M. A. Scheel, T. Chu, L. E. Kidder, and Y. Pan, Phys. Rev. Lett. **115**, 031102 (2015).
[12] M. Campanelli, C. O. Lousto, and Y. Zlochower, Phys. Rev. D **74**, 041501(R) (2006).
[13] M. Hannam, S. Husa, B. Bruegmann, and A. Gopakumar, Phys. Rev. D **78**, 104007 (2008).
[14] D. A. Hemberger, G. Lovelace, T. J. Loredo, L. E. Kidder, M. A. Scheel, B. Szilágyi, N. W. Taylor, and S. A. Teukolsky, Phys. Rev. D **88**, 064014 (2013).
[15] J. Healy and C. O. Lousto, Phys. Rev. D **97**, 084002 (2018).
[16] M. Campanelli, C. O. Lousto, Y. Zlochower, and D. Merritt, Astrophys. J. **659**, L5 (2007).
[17] M. Campanelli, C. O. Lousto, Y. Zlochower, and D. Merritt, Phys. Rev. Lett. **98**, 231102 (2007).
[18] F. Herrmann, I. Hinder, D. M. Shoemaker, P. Laguna, and R. A. Matzner, Phys. Rev. D **76**, 084032 (2007).
[19] D. Pollney, C. Reisswig, L. Rezzolla, B. Szilágyi, M. Ansorg, B. Deris, P. Diener, E. N. Dorband, M. Koppitz, A. Nagar, and E. Schnetter, Phys. Rev. D **76**, 124002 (2007).
[20] J. G. Baker, J. Centrella, D.-I. Choi, M. Koppitz, J. R. van Meter, and M. C. Miller, Astrophys. J. **653**, L93 (2006).
[21] J. A. González, M. D. Hannam, U. Sperhake, B. Brugmann, and S. Husa, Phys. Rev. Lett. **98**, 231101 (2007).
[22] J. D. Schnittman, A. Buonanno, J. R. van Meter, J. G. Baker, W. D. Boggs, J. Centrella, B. J. Kelly, and S. T. McWilliams, Phys. Rev. D **77**, 044031 (2008).
[23] C. O. Lousto and Y. Zlochower, Phys. Rev. Lett. **107**, 231102 (2011).
[24] C. O. Lousto and J. Healy, Phys. Rev. Lett. **114**, 141101 (2015).
[25] C. O. Lousto and J. Healy, Phys. Rev. D **93**, 124074 (2016).
[26] P. Schmidt, M. Hannam, S. Husa, and P. Ajith, Phys. Rev. D **84**, 024046 (2011).

[27] C. O. Lousto and Y. Zlochower, Phys. Rev. D **89**, 021501 (2014).
[28] L. Pekowsky, R. O'Shaughnessy, J. Healy, and D. Shoemaker, Phys. Rev. D **88**, 024040 (2013).
[29] S. Ossokine, M. Boyle, L. E. Kidder, H. P. Pfeiffer, M. A. Scheel, and B. Szilagyi, Phys. Rev. D **92**, 104028 (2015).
[30] C. O. Lousto and J. Healy, Phys. Rev. D **99**, 064023 (2019).
[31] J. Blackman, S. E. Field, M. A. Scheel, C. R. Galley, D. A. Hemberger, P. Schmidt, and R. Smith, Phys. Rev. D **95**, 104023 (2017).
[32] J. Blackman, S. E. Field, M. A. Scheel, C. R. Galley, C. D. Ott, M. Boyle, L. E. Kidder, H. P. Pfeiffer, and B. Szilgyi, Phys. Rev. D **96**, 024058 (2017).
[33] V. Varma, S. E. Field, M. A. Scheel, J. Blackman, L. E. Kidder, and H. P. Pfeiffer, Phys. Rev. D **99**, 064045 (2019).
[34] B. P. Abbott *et al.* (Virgo, LIGO Scientific Collaborations), Phys. Rev. Lett. **116**, 241102 (2016).
[35] B. Abbott *et al.* (Virgo, LIGO Scientific Collaborations), Phys. Rev. Lett. **116**, 061102 (2016).
[36] B. P. Abbott *et al.* (Virgo, LIGO Scientific Collaborations), Phys. Rev. Lett. **116**, 241103 (2016).
[37] B. P. Abbott *et al.* (Virgo, LIGO Scientific Collaborations), Phys. Rev. X **6**, 041015 (2016).
[38] B. P. Abbott *et al.* (Virgo, LIGO Scientific Collaborations), Classical Quantum Gravity **34**, 104002 (2017).
[39] B. P. Abbott *et al.* (Virgo, LIGO Scientific Collaborations), Phys. Rev. D **94**, 064035 (2016).
[40] B. P. Abbott *et al.* (Virgo, LIGO Scientific Collaborations), Phys. Rev. D **93**, 122004 (2016); **94**, 069903(A) (2016).
[41] G. Lovelace *et al.*, Classical Quantum Gravity **33**, 244002 (2016).
[42] B. Aylott *et al.*, Classical Quantum Gravity **26**, 165008 (2009).
[43] B. Aylott *et al.*, Classical Quantum Gravity **26**, 114008 (2009).
[44] P. Ajith *et al.*, Classical Quantum Gravity **29**, 124001 (2012).
[45] J. Aasi *et al.* (LIGO Scientific Collaboration, Virgo Collaboration, NINJA-2 Collaboration), Classical Quantum Gravity **31**, 115004 (2014).
[46] I. Hinder *et al.*, Classical Quantum Gravity **31**, 025012 (2014).
[47] A. H. Mroue, M. A. Scheel, B. Szilagyi, H. P. Pfeiffer, M. Boyle *et al.*, Phys. Rev. Lett. **111**, 241104 (2013).
[48] J. Blackman, S. E. Field, C. R. Galley, B. Szilágyi, M. A. Scheel, M. Tiglio, and D. A. Hemberger, Phys. Rev. Lett. **115**, 121102 (2015).
[49] T. Chu, H. Fong, P. Kumar, H. P. Pfeiffer, M. Boyle, D. A. Hemberger, L. E. Kidder, M. A. Scheel, and B. Szilagyi, Classical Quantum Gravity **33**, 165001 (2016).
[50] M. Boyle *et al.*, Classical Quantum Gravity **36**, 195006 (2019).
[51] K. Jani, J. Healy, J. A. Clark, L. London, P. Laguna, and D. Shoemaker, Classical Quantum Gravity **33**, 204001 (2016).
[52] J. Healy, C. O. Lousto, Y. Zlochower, and M. Campanelli, Classical Quantum Gravity **34**, 224001 (2017).
[53] J. Healy, C. O. Lousto, J. Lange, R. O'Shaughnessy, Y. Zlochower, and M. Campanelli, Phys. Rev. D **100**, 024021 (2019).
[54] Y. Zlochower, J. G. Baker, M. Campanelli, and C. O. Lousto, Phys. Rev. D **72**, 024021 (2005).
[55] P. Marronetti, W. Tichy, B. Brügmann, J. Gonzalez, and U. Sperhake, Phys. Rev. D **77**, 064010 (2008).
[56] D. Alic, C. Bona-Casas, C. Bona, L. Rezzolla, and C. Palenzuela, Phys. Rev. D **85**, 064040 (2012).
[57] T. Nakamura, K. Oohara, and Y. Kojima, Prog. Theor. Phys. Suppl. **90**, 1 (1987).
[58] M. Shibata and T. Nakamura, Phys. Rev. D **52**, 5428 (1995).
[59] T. W. Baumgarte and S. L. Shapiro, Phys. Rev. D **59**, 024007 (1998).
[60] C. O. Lousto and Y. Zlochower, Phys. Rev. D **77**, 024034 (2008).
[61] Y. Zlochower, M. Ponce, and C. O. Lousto, Phys. Rev. D **86**, 104056 (2012).
[62] J. Healy and C. O. Lousto, Phys. Rev. D **95**, 024037 (2017).
[63] Cactus Computational Toolkit home page: http://cactuscode.org.
[64] E. Schnetter, S. H. Hawley, and I. Hawke, Classical Quantum Gravity **21**, 1465 (2004).
[65] F. Löffler, J. Faber, E. Bentivegna, T. Bode, P. Diener, R. Haas, I. Hinder, B. C. Mundim, C. D. Ott, E. Schnetter, G. Allen, M. Campanelli, and P. Laguna, Classical Quantum Gravity **29**, 115001 (2012).
[66] Einstein Toolkit home page: http://einsteintoolkit.org.
[67] J. Thornburg, Classical Quantum Gravity **21**, 743 (2004).
[68] O. Dreyer, B. Krishnan, D. Shoemaker, and E. Schnetter, Phys. Rev. D **67**, 024018 (2003).
[69] M. Campanelli, C. O. Lousto, Y. Zlochower, B. Krishnan, and D. Merritt, Phys. Rev. D **75**, 064030 (2007).
[70] S. Brandt and B. Brügmann, Phys. Rev. Lett. **78**, 3606 (1997).
[71] M. Ansorg, B. Brügmann, and W. Tichy, Phys. Rev. D **70**, 064011 (2004).
[72] J. Healy, C. O. Lousto, H. Nakano, and Y. Zlochower, Classical Quantum Gravity **34**, 145011 (2017).
[73] A. Buonanno, L. E. Kidder, A. H. Mroue, H. P. Pfeiffer, and A. Taracchini, Phys. Rev. D **83**, 104034 (2011).
[74] A. Ramos-Buades, S. Husa, and G. Pratten, Phys. Rev. D **99**, 023003 (2019).
[75] I. Ruchlin, J. Healy, C. O. Lousto, and Y. Zlochower, Phys. Rev. D **95**, 024033 (2017).
[76] J. Healy, I. Ruchlin, C. O. Lousto, and Y. Zlochower, Phys. Rev. D **94**, 104020 (2016).
[77] J. Healy, C. O. Lousto, I. Ruchlin, and Y. Zlochower, Phys. Rev. D **97**, 104026 (2018).
[78] S. Isoyama and H. Nakano, Classical Quantum Gravity **35**, 024001 (2018).
[79] M. Campanelli and C. O. Lousto, Phys. Rev. D **59**, 124022 (1999).
[80] C. O. Lousto and Y. Zlochower, Phys. Rev. D **76**, 041502(R) (2007).
[81] H. Nakano, J. Healy, C. O. Lousto, and Y. Zlochower, Phys. Rev. D **91**, 104022 (2015).
[82] M. Babiuc, B. Szilagyi, J. Winicour, and Y. Zlochower, Phys. Rev. D **84**, 044057 (2011).
[83] J. Healy, C. O. Lousto, and Y. Zlochower, Phys. Rev. D **90**, 104004 (2014).

[84] J. Healy, C. O. Lousto, and Y. Zlochower, Phys. Rev. D **96**, 024031 (2017).
[85] J. Healy, C. O. Lousto, and N. Rosato, Phys. Rev. D **102**, 024040 (2020).
[86] H.-S. Cho, E. Ochsner, R. O'Shaughnessy, C. Kim, and C.-H. Lee, Phys. Rev. D **87**, 024004 (2013).
[87] J. Healy *et al.*, Phys. Rev. D **97**, 064027 (2018).
[88] C. N. Kozameh, J. I. Nieva, and G. D. Quiroga, Phys. Rev. D **101**, 024028 (2020).
[89] C. N. Kozameh, J. I. Nieva, and G. D. Quiroga, Phys. Rev. D **98**, 064005 (2018).
[90] L. Bernard, L. Blanchet, G. Faye, and T. Marchand, Phys. Rev. D **97**, 044037 (2018).
[91] C. J. Woodford, M. Boyle, and H. P. Pfeiffer, Phys. Rev. D **100**, 124010 (2019).
[92] M. Boyle, Phys. Rev. D **93**, 084031 (2016).
[93] B. J. Kelly and J. G. Baker, Phys. Rev. D **87**, 084004 (2013).
[94] J. M. Bowen and J. W. York, Jr., Phys. Rev. D **21**, 2047 (1980).
[95] DataTables home page: https://datatables.net.
[96] P. Schmidt, I. W. Harry, and H. P. Pfeiffer, arXiv:1703.01076.
[97] J. G. Baker, M. Campanelli, C. Lousto, and R. Takahashi, Phys. Rev. D **65**, 124012 (2002).
[98] C. Reisswig and D. Pollney, Classical Quantum Gravity **28**, 195015 (2011).
[99] D. Keitel *et al.*, Phys. Rev. D **96**, 024006 (2017).
[100] V. Varma, D. Gerosa, L. C. Stein, F. Hébert, and H. Zhang, Phys. Rev. Lett. **122**, 011101 (2019).
[101] V. Varma, S. E. Field, M. A. Scheel, J. Blackman, D. Gerosa, L. C. Stein, L. E. Kidder, and H. P. Pfeiffer, Phys. Rev. Research **1**, 033015 (2019).
[102] Y. Zlochower and C. O. Lousto, Phys. Rev. D **92**, 024022 (2015).
[103] J. Lange *et al.*, Phys. Rev. D **96**, 104041 (2017).
[104] P. Kumar, J. Blackman, S. E. Field, M. Scheel, C. R. Galley, M. Boyle, L. E. Kidder, H. P. Pfeiffer, B. Szilagyi, and S. A. Teukolsky, Phys. Rev. D **99**, 124005 (2019).
[105] J. Sadiq, Y. Zlochower, R. O'Shaughnessy, and J. Lange, Phys. Rev. D **102**, 024012 (2020).
[106] J. Healy, C. O. Lousto, J. Lange, and R. O'Shaughnessy, arXiv:2010.00108.
[107] C. O. Lousto and J. Healy, Phys. Rev. D **100**, 104039 (2019).
[108] E. Barausse, V. Morozova, and L. Rezzolla, Astrophys. J. **758**, 63 (2012).
[109] L. Rezzolla, E. Barausse, E. N. Dorband, D. Pollney, C. Reisswig, J. Seiler, and S. Husa, Phys. Rev. D **78**, 044002 (2008).
[110] F. Hofmann, E. Barausse, and L. Rezzolla, Astrophys. J. **825**, L19 (2016).
[111] X. Jiménez-Forteza, D. Keitel, S. Husa, M. Hannam, S. Khan, and M. Pürrer, Phys. Rev. D **95**, 064024 (2017).
[112] C. O. Lousto, M. Campanelli, Y. Zlochower, and H. Nakano, Classical Quantum Gravity **27**, 114006 (2010).
[113] C. O. Lousto and Y. Zlochower, Phys. Rev. D **89**, 104052 (2014).
[114] D. Gerosa, F. Hébert, and L. C. Stein, Phys. Rev. D **97**, 104049 (2018).
[115] P. Peters, Phys. Rev. **136**, B1224 (1964).
[116] A. H. Mroue, H. P. Pfeiffer, L. E. Kidder, and S. A. Teukolsky, Phys. Rev. D **82**, 124016 (2010).