Erratum: Observational black hole spectroscopy: A time-domain multimode analysis of GW150914
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The measurement of the $\delta\omega$ parameter mentioned in the text was performed with an incorrect configuration that led to an error in the computation of the autocorrelation function. With the correct configuration, such a measurement can instead be performed. For definiteness, we use a Kerr template with a single $(l, m, n) = (2, 2, 0)$ mode. In addition to sampling on all the parameters described in the text, with same priors, we sample on fractional deviations from the general relativity (GR) predictions of the frequency and damping time, following [1,2]

$$\begin{aligned}\omega_{lmn}(M_f, a_f) &\rightarrow (1 + \delta\hat{\omega}_{lmn})\omega_{lmn}(M_f, a_f) \\ \tau_{lmn}(M_f, a_f) &\rightarrow (1 + \delta\hat{\tau}_{lmn})\tau_{lmn}(M_f, a_f),\end{aligned}\tag{1}$$

imposing uniform priors in $[-1, 1]$ on deviation parameters. We observe no change in the inference of extrinsic and orientation/amplitudes parameters, while, not unexpectedly, the posterior for the intrinsic parameters (M_f, a_f) broadens due to the inclusion of the strongly correlated additional parameter.

Figures 1 and 2 show respectively the results obtained when sampling individually on $\delta\omega_{220}$ and on $\delta\tau_{220}$, keeping the other deviation parameter fixed to its GR value of 0. Both figures show the posteriors for different choices of the prior on the start time. Figure 3 instead shows the joint two-dimensional posterior for $\{\delta\omega_{220}$ and $\delta\tau_{220}\}$ obtained when both deviations parameters are allowed to vary simultaneously. All posteriors show agreement with the GR prediction (i.e., identically 0) when the lower bound of the start time prior is equal or greater than 10 M. This is consistent with the fact that a linearized approximation is not valid before 10 M, as previously discussed.

FIG. 1. Posterior distribution over $\delta\omega_{220}$ obtained assuming a uniform prior distribution in $[-1, 1]$.

FIG. 2. Posterior distribution over $\delta\tau_{220}$ obtained assuming a uniform prior distribution in $[-1, 1]$.

FIG. 3. Two-dimensional posterior distribution obtained sampling over $\delta\omega_{220}$ $\delta\tau_{220}$ simultaneously, assuming a uniform prior distribution in $[-1, 1]$ for both parameters.

Our results are in broad agreement with those in [3], but show a different correlation structure in the $\{\delta\omega_{220} - \delta\tau_{220}\}$ plane. This is because of the different choice in the aforementioned study, which tests for violations using the first overtone, instead of the fundamental one.

To quantify the evidence against GR violations, we apply the TIGER framework as presented in Refs. [4,5] to our set of runs; i.e., we compute the Bayes factor among the hypothesis that one or more of the considered deviation parameters differ from 0, against the hypothesis that GR correctly describes the data. We assume an equal prior probability between the GR and the violation-testing modified GR hypotheses. As shown in Table I, when the lower bound of the prior on the start time is equal to or greater than 10 M (where our analysis indicates that a linearized approximation is suitable), the odds ratio

TABLE I. As a function of the lower bound of the prior over the ringdown start time (first column), we show the following: the log Bayes factors vs noise for the GR hypothesis (second column), the hypothesis in which $\delta\omega_{220}$ is allowed to vary (third column), the hypothesis in which $\delta\tau_{220}$ is allowed to vary (fourth column), the hypothesis in which both $\delta\omega_{220}$ and $\delta\tau_{220}$ are allowed to vary simultaneously (fifth column) and, finally, the combined log Bayes factor for the modified GR hypothesis vs GR.

$t_{\text{start}}^{\text{low}}$	GR	$\delta\omega_{220}$	$\delta\tau_{220}$	$\{\delta\omega_{220}, \delta\tau_{220}\}$	$\log(\mathcal{B}_{\text{modGR,GR}})$
$0M$	81.45	79.07	80.32	79.54	-1.67
$5M$	72.82	72.83	74.73	73.49	1.18
$10M$	56.45	55.27	55.52	54.35	-1.29
$15M$	40.41	38.14	38.88	38.29	-1.92
$20M$	28.23	27.10	27.67	25.61	-1.14
$25M$	6.00	3.90	5.31	3.95	-1.38

favors GR, although the signal to noise ratio of the signal is not large enough to draw strong conclusions. This analysis will benefit from the inclusion of multiple sources within a hierarchical framework akin to [6], taking into account theories where deviation coefficients could attain different values for different binary parameters. The application of our analysis framework to multiple sources will be addressed in a forthcoming publication.

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