Erratum: Tidal Deformabilities and Radii of Neutron Stars from the Observation of GW170817 [Phys. Rev. Lett. 121, 091102 (2018)]

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(Received 30 October 2018; published 19 December 2018)

DOI: 10.1103/PhysRevLett.121.259902

In the Letter, we claimed that the GW170817 gravitational-wave data strongly favor models with the common equation of state assumption over those without this assumption. Our statement was based on the values of the Bayes factors that we obtained on comparing the evidences from our parameter estimation analysis of the data using the model with the common equation of state constraint against the model without the constraint. In this Erratum, we retract the statement mentioned above, and correct the Bayes factor values reported in the Letter.

Our parameter estimation analysis was performed using the PyCBC Inference software [1] with the parallel-tempered EMCEE sampler [2–4] that samples the parameter space using an ensemble of Markov chains at different temperatures. The chains at each temperature sample from a posterior modified by the inverse temperature given by

$$p[\vec{\theta}|\vec{d}(t)]_T = p(\vec{\theta})p[\vec{d}(t)|\vec{\theta}]^{1/T}. \tag{1}$$

The chains in the colder temperatures ($T \to 0$) are efficient at finding the peaks of the likelihood $\{\mathcal{L} = p[\vec{d}(t)|\vec{\theta}]\}$, and they sample from the posterior. Therefore, samples from these chains are used in the measurement of parameters of the signal in the data. The chains in the hotter temperatures ($T \to \infty$) are used in exploring more of the parameter space, they sample from the prior, and help the colder chains find the peak of the likelihood.

The evidence in a particular EMCEE run is computed using the thermodynamic integration method which integrates the average logarithm of the likelihood $\langle \ln \mathcal{L} \rangle$ as a function of the inverse temperature β, employing the trapezium rule. Using a sufficiently large number of temperatures placed at the correct locations along the $\langle \ln \mathcal{L} \rangle - \beta$ curve is an important criteria for an accurate measurement of the evidence. It has been pointed out in previous work that it is important to have a high density of β points in locations along the curve where $\langle \ln \mathcal{L} \rangle$ changes substantially with β [5]. While these strategies are not necessary in helping the chains in the coldest temperature contribute to an accurate measurement of the parameters of the

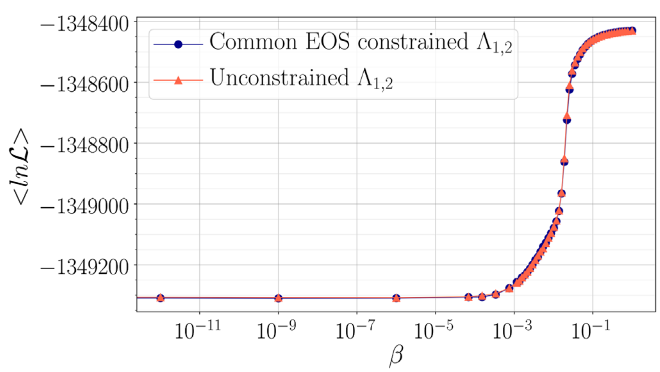

FIG. 1. The average logarithm of the likelihood as a function of inverse temperature from parameter estimation analyses of the GW170817 gravitational-wave data using the common equation of state constrained model (in blue) and unconstrained model (in orange) with the uniform mass prior distribution described in the Letter. The evidence for a model is obtained by integrating its $\ln \mathcal{L}(\beta)$ function. The ratio of the evidences from the models gives the Bayes factor $\mathcal{B}$ indicating which model is favored by the data. It can be seen directly from the plot that the $\ln \mathcal{L}(\beta)$ curves for the two models are very similar to each other, resulting in similar values of evidences, and a $\mathcal{B}$ of order unity. This indicates that the gravitational-wave data do not show a substantial preference between the common equation of state constrained and unconstrained models of the analyses in the Letter based on the values of the evidences for the two models.

signal, these are indeed important for an accurate computation of the evidence supporting the model used to match the data. When comparing between two models, errors in the measurement of the evidence get propagated to the calculation of the Bayes factor, causing a significant drift from its true value.

We had not taken into account some of these facts in our computation of the evidences for the models in the Letter. Pursuing our study in the Letter further, we ran our analyses with an increased number of temperatures, incorporating the strategies mentioned above to correct our measurements of the evidences using the thermodynamic integration method. Comparing between our model assuming the common equation of state constraint and the model without that constraint for the three mass prior cases, we now obtain Bayes factors of the order unity, instead of 369, 125, and 612 as reported in the Letter. Figure 1 shows a comparison of the $\langle \ln \mathcal{L} \rangle - \beta$ curves from our common equation of state constrained and unconstrained analyses for the uniform mass prior case. Based on these results, we state that the gravitational-wave data do not indicate a clear preference between the common equation of state constrained and unconstrained models. We will investigate further details such as the effects of waveform systematics on the values of the Bayes factors, and explore other methods of calculation of the evidence in a future work. Note that the corrections in this Erratum do not affect any of the parameter measurements, and the primary results of the original Letter remain unchanged.

We thank Collin Capano, Reed Essick, Alexander Nitz, Steven Reyes, and Nevin Weinberg for useful discussions.

This work was supported by NSF Grants No. OAC-1541396, No. PHY-1707954, and by the Kathy'73 and Stan'72 Walters Endowed Fund for Science Research at Syracuse University.

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