Distinguishing the nature of comparable-mass neutron star binary systems with multimessenger observations

GW170817 case study

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Probability of remnant mass amount for a NS-BH progenitor of GW170817.

The results of the combined analysis based on the inferred binary parameters from GW measurements using the LVC public data under the assumption of a NS-BH progenitor together with predictions for the remnant mass by Foucart et al 2018, shown in Fig. 4 in the main text, can be further marginalized over the mass ratio. We thus obtain the probability that a NS-BH progenitor for GW170817 produced a given amount of remnant mass as shown in Fig. 1. As systems with $< 0.1\, M_\odot$ of ejecta mass fail to produce the observed EM lightcurve, even under the very conservative assumptions discussed in the main text, our results show that $\lesssim 40\%$ of the parameter space allowed by the GW observations for a NS-BH progenitor of GW170817 is also consistent with the EM constraints. When more refined EM modelling becomes available in the future, Fig. 1 can be used to set tighter constraints on the possibility of a NS-BH progenitor for GW170817.

Tidal effects in the GW phasing for $Q = 1$.

Figure 2 shows a similar phasing comparison as in Fig. 2 in the main text but for equal-mass binaries. The interesting aspect of this comparison is that for the case with a $\Gamma = 2$ polytropic EoS we have accurate NR data for all types of binaries with a total mass of $M = 2.8M_\odot$. For the binary configurations with the DD2 EoS discussed in the main text, $M = 2.88M_\odot$.

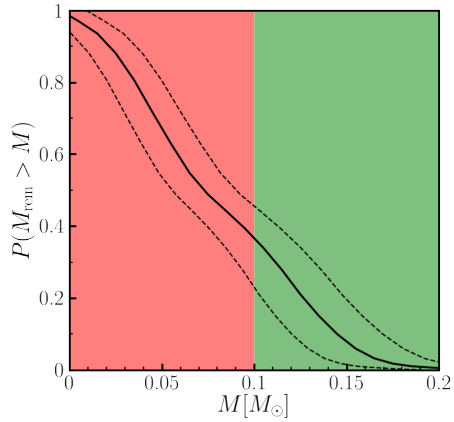

FIG. 1. *Probability that GW170817 produces a remnant mass greater than a given value, if it is a NS-BH merger*. We show results for the model of Foucart et al 2018 (solid line), as well as 1-σ errors in that formula (dashed lines).

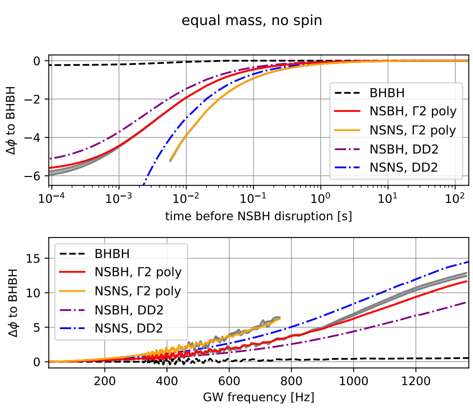

FIG. 2. *GW phase comparisons in an equal-mass case*. All curves with legends are using the SEOBNRv4T model, shaded regions indicate the uncertainty range of NR results due to finite resolution. Note that the grey shading indicating the NR result around the orange NSNS curve is barely visible on the scale of the plot. For the DD2 cases the total mass is $M = 2.88M_\odot$, while the other curves correspond to $M = 2.8M_\odot$.