

# A consistency test of GR using different multipoles of gravitational radiation from binary black holes

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S. Dhanpal, Abhirup Ghosh, P. Ajith, B.S. Sathyaprakash

Testing GR Telecon, December 18, 2017

# Method

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- **Gravitational waveform can be decomposed into the two independent polarisations:**

$$h(t) := h_+(t) - ih_\times(t)$$

- **Alternatively, expand in a basis of spin -2 weighted spherical harmonics:**

$$h(t; \iota, \phi_0, \lambda) = \sum_{l=2}^{\infty} \sum_{m=-l}^l \mathcal{Y}_{lm}^{-2}(\iota, \phi_0) h_{lm}(t, \lambda)$$

$$\lambda = \{M_c, q, t_0, d_L\}$$

- **Split contributions from dominant (2,  $\pm 2$ ) modes, and the subdominant higher-order multipole moments:**

$$h(t; \iota, \phi_0, \lambda) = \mathcal{Y}_{2,\pm 2}^{-2}(\iota, \phi_0) h_{2,\pm 2}(t, \lambda) + \sum_{\text{H.O.M}} \mathcal{Y}_{lm}^{-2}(\iota, \phi_0) h_{lm}(t, \lambda)$$

# Method

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- **The Test: Check for consistency between estimates of  $\lambda$ , independently measured using the dominant and the sub-dominant modes of the gravitational waveform respectively:**

$$h(t; \iota, \phi_0, \lambda, \lambda') = \mathcal{Y}_{2,\pm 2}^{-2}(\iota, \phi_0) h_{2,\pm 2}(t, \lambda) + \sum_{\text{H.O.M}} \mathcal{Y}_{lm}^{-2}(\iota, \phi_0) h_{lm}(t, \lambda')$$

$\lambda$ : PE estimates using dominant (2,  $\pm 2$ ) modes

$\lambda'$ : PE estimates using subdominant higher-order modes

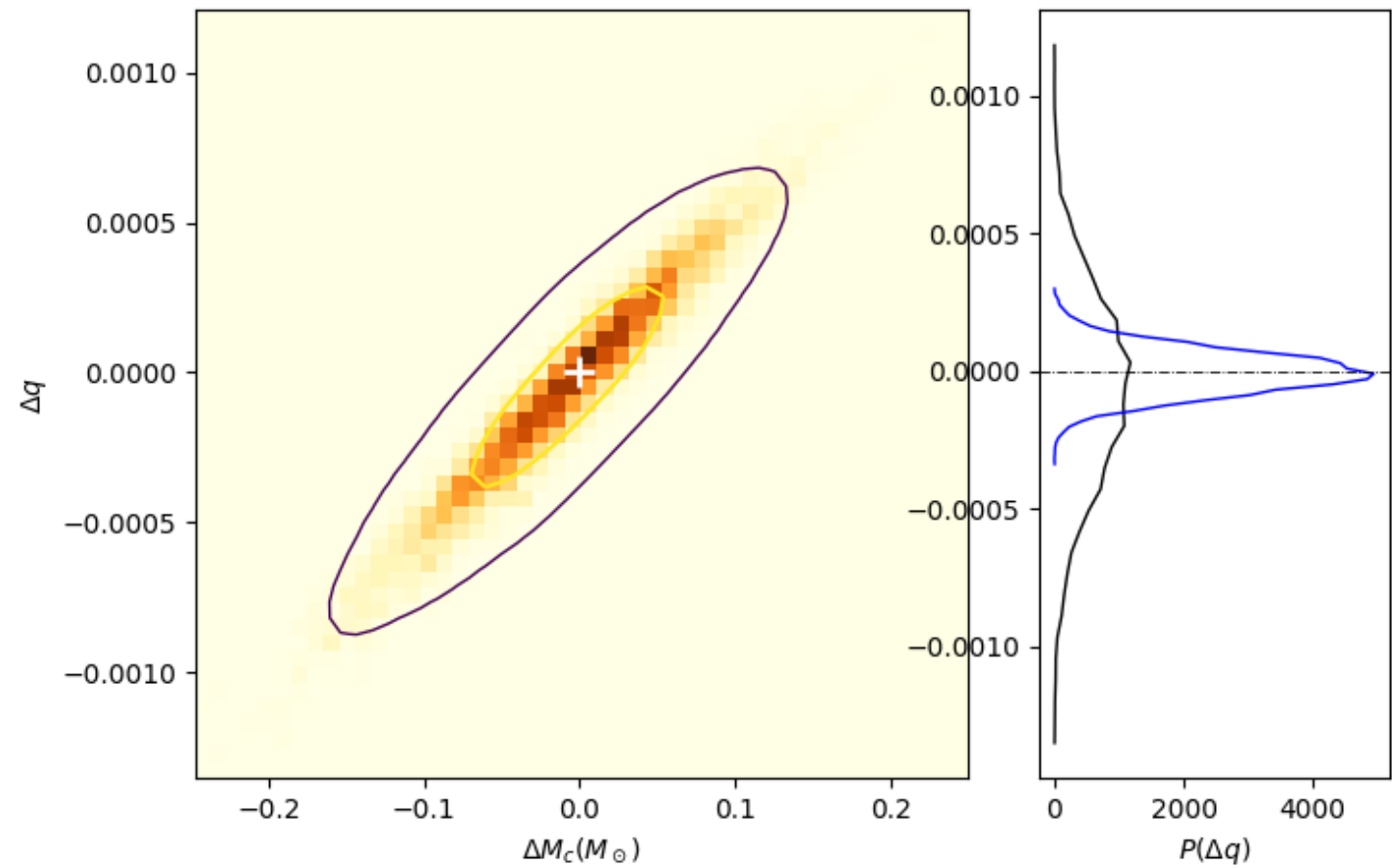
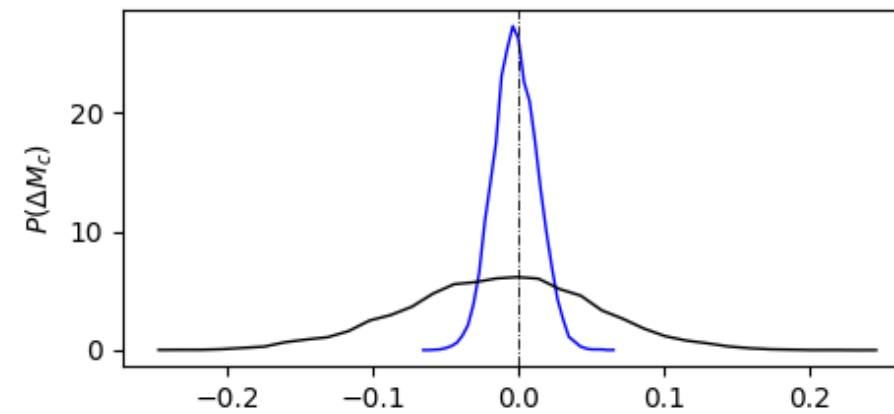
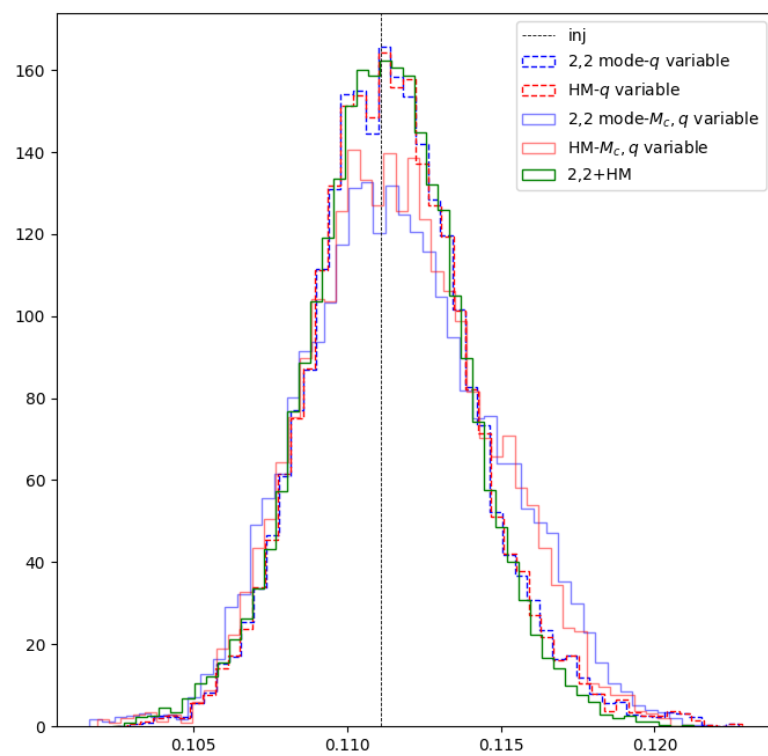
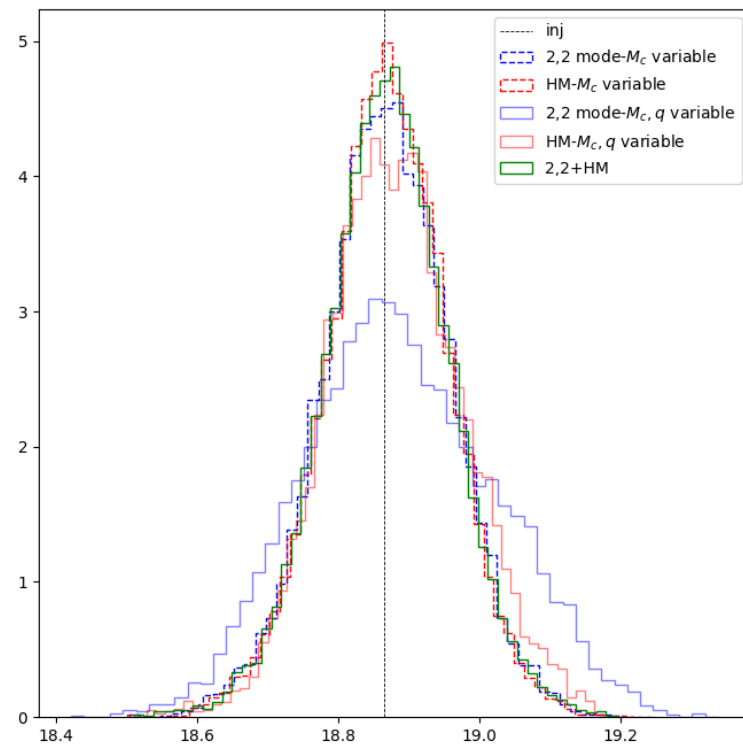
- If GR is correct, these two independent estimates would be consistent with each other.
- Alternatively define:  $\lambda' = \lambda + \Delta\lambda$
- If GR is correct  $p(\Delta\lambda)$  should be consistent with 0.

# Results

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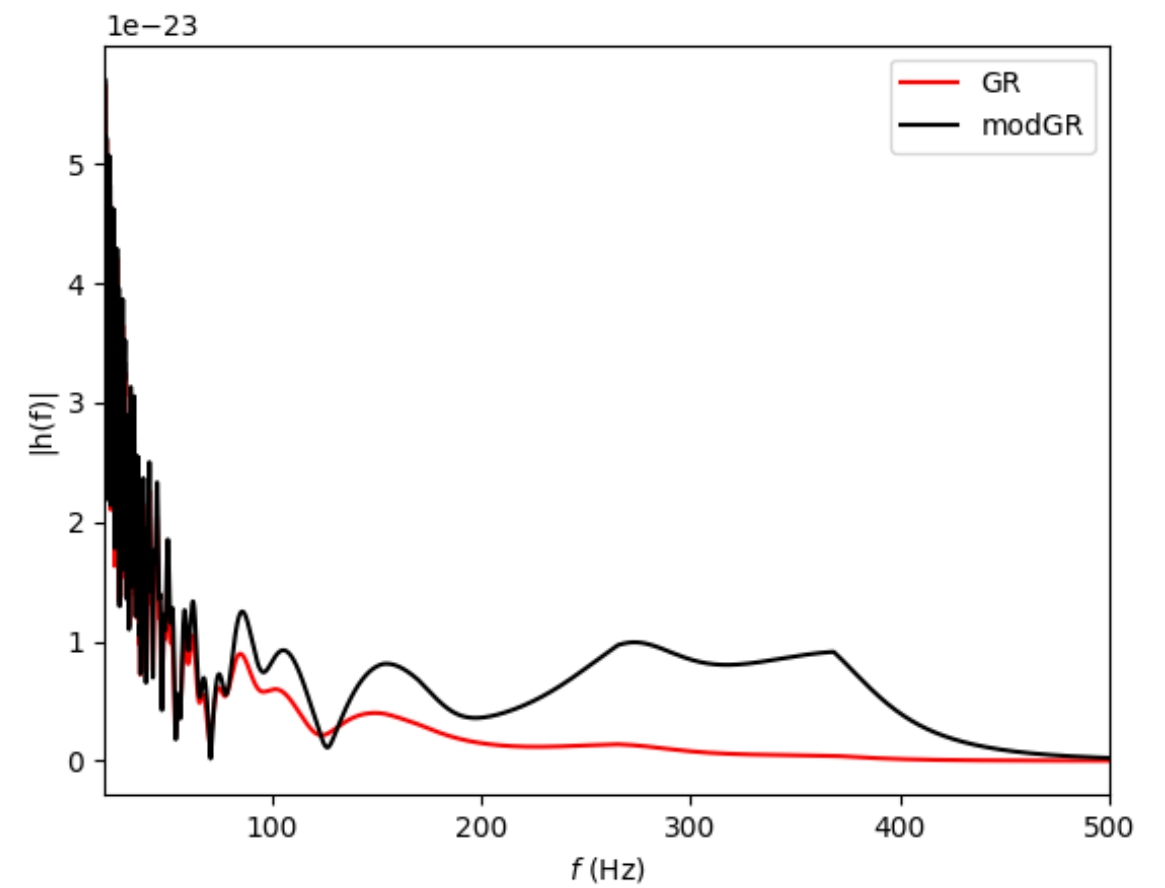
- Analysis:
  - Single IFO PE over  $\lambda = \{M_c, q\}$
  - Fixed SNR = 25 (optimally oriented on the sky)
  - Waveform model: higher-order IMR model described in Mehta et al (arxiv:1708.03501, accepted in PRD)
  - Noise PSD: Advanced LIGO ZDHP noise
  - Sampler: emcee

# Results



# Kludge Waveforms

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# Results

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