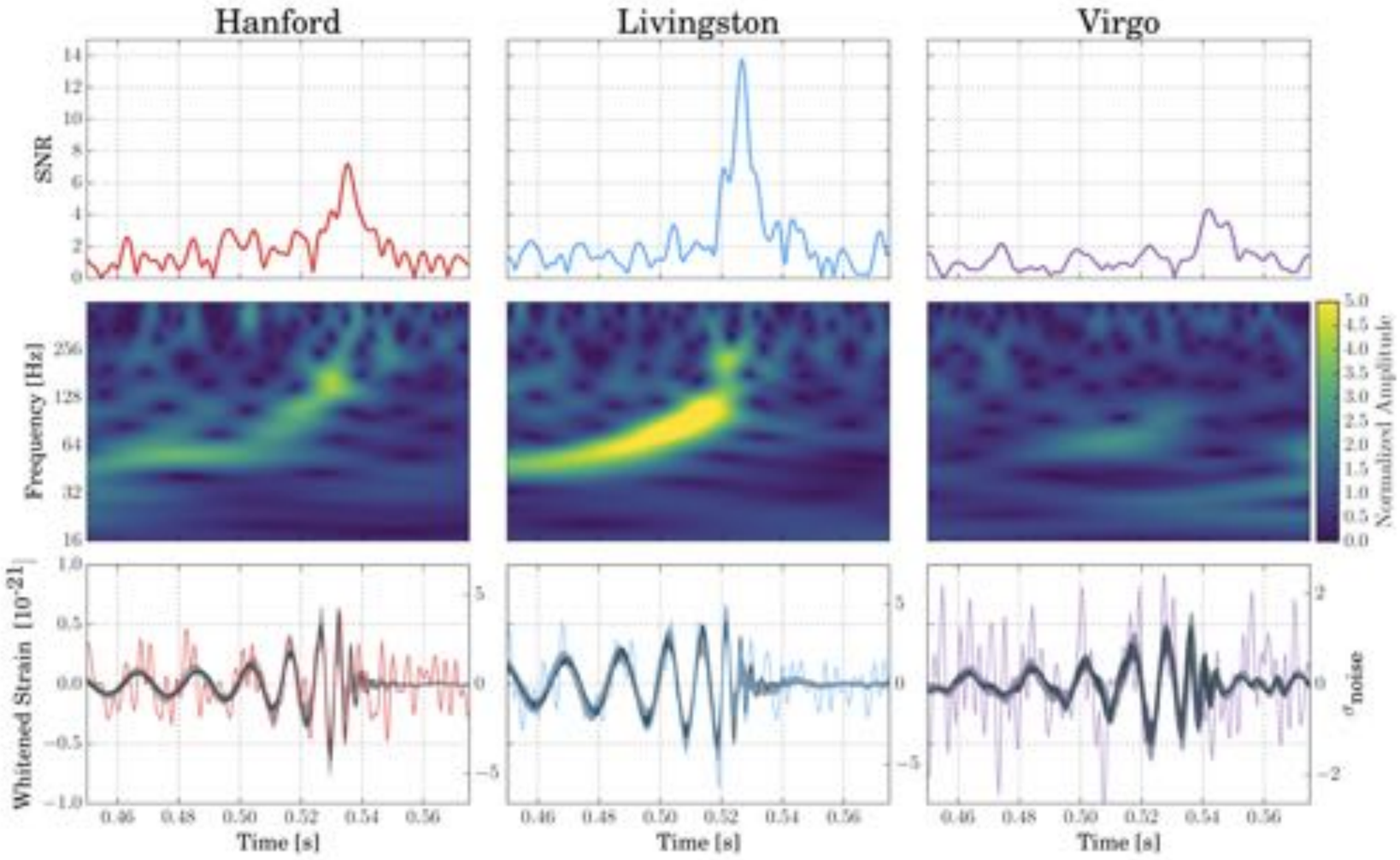
Gravitational wave discovery and characterization of the binary neutron star inspiral GW170817

Tyson B. Littenberg (NASA/MSFC)

for the LIGO Scientific Collaboration and Virgo Collaboration

Advanced LIGO Observing Runs

GW170814 — the 3-detector era begins



LVC, PRL, 119, 141101 (2017)

LIGO/Virgo Compact Binary Analyses

I. Coincident grid search

$$\{m_1, m_2, \mathrm{SNR}\}$$

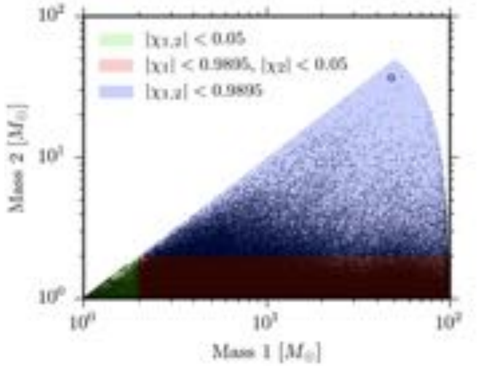
II. Low latency sky maps based on output from search

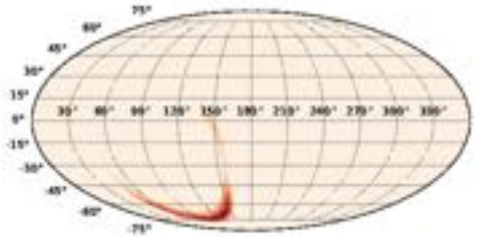
$$p(\alpha, \delta, D_L|d)$$

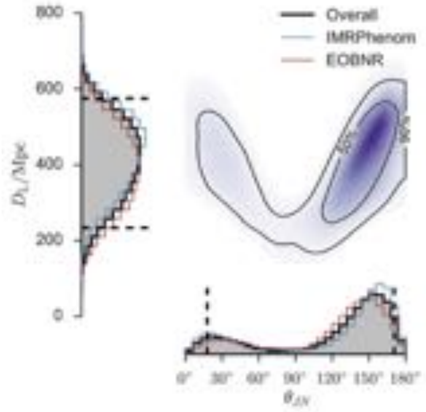
III. Coherent stochastic sampling analysis over *N*-dimensional parameter space

$$p(m_1, m_2, \vec{S}_1, \vec{S}_2, \alpha, \delta, D_L, \vec{L}, \Lambda_1, \Lambda_2|d)$$

e.g. GW150914







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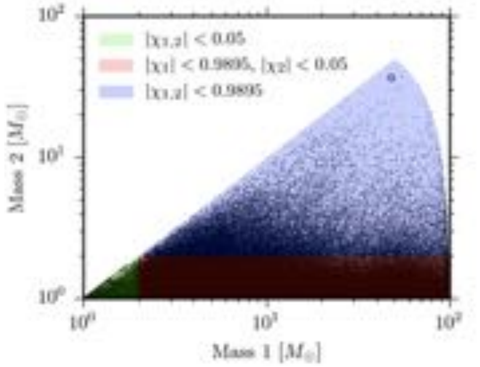
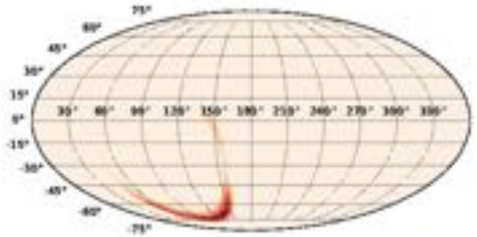
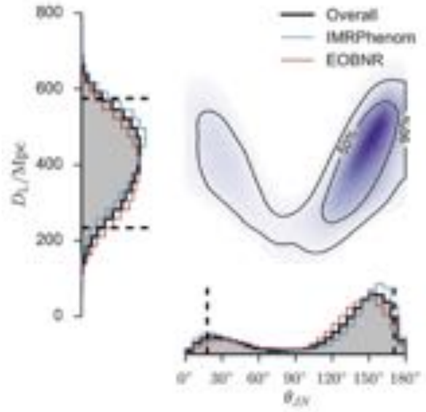
Dependent on waveform model

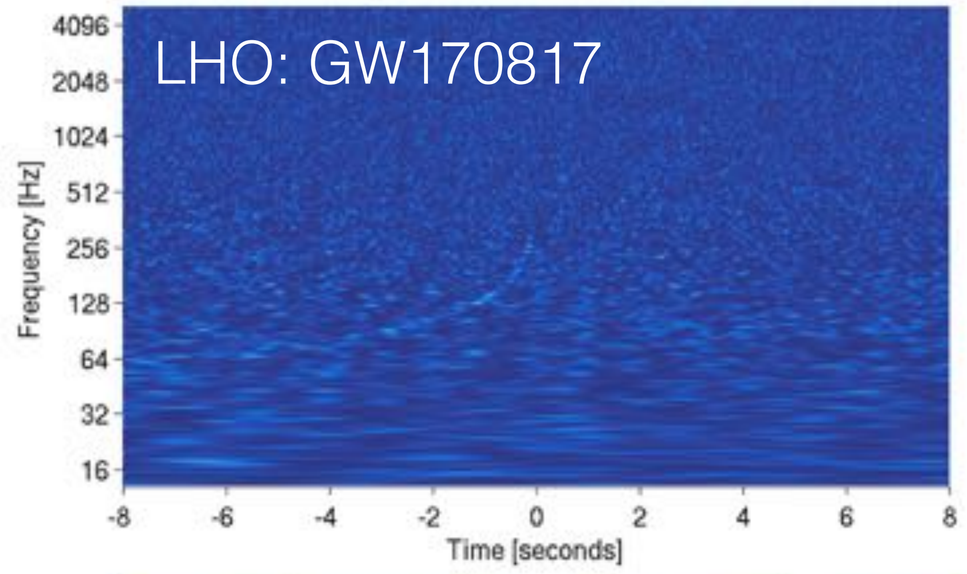
e.g. GW150914







The discovery of GW170817



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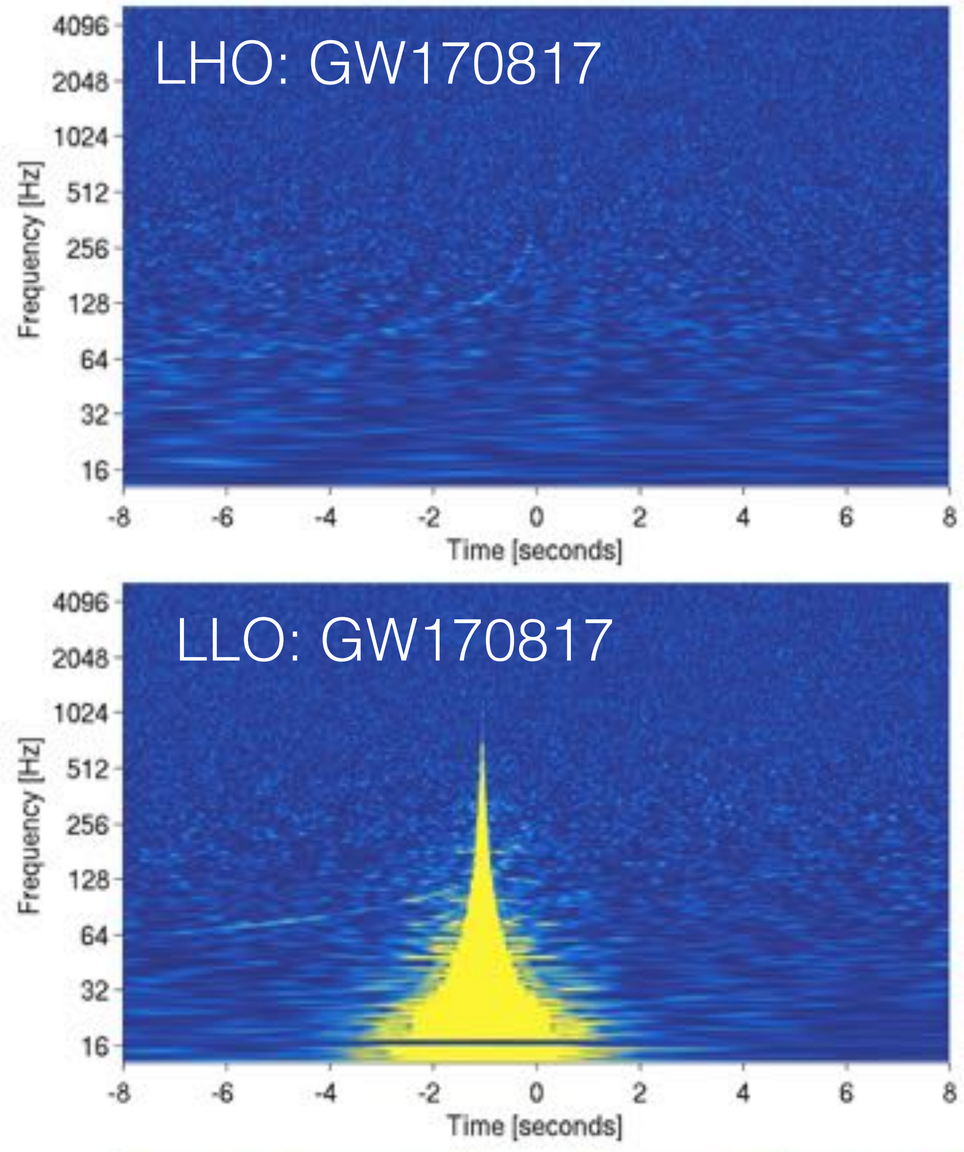

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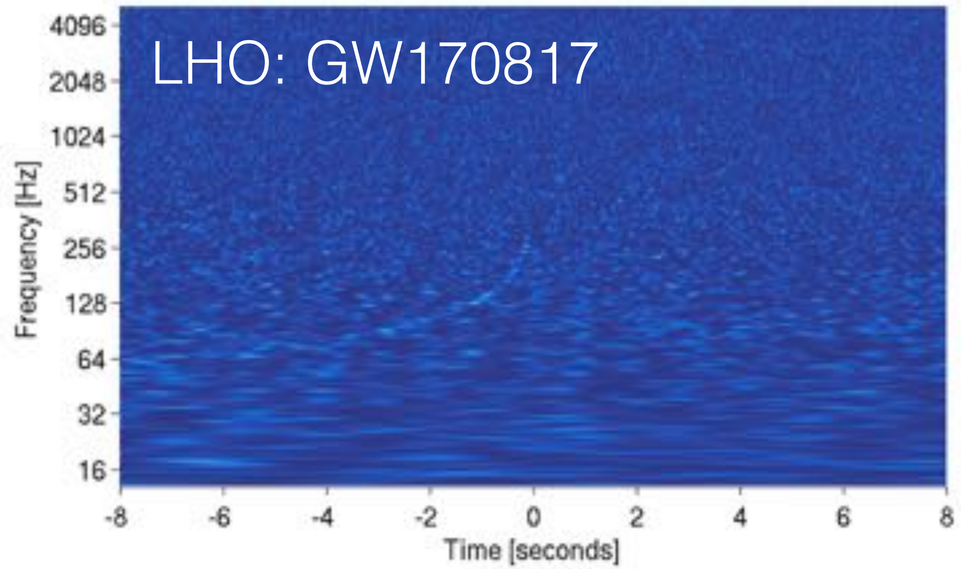
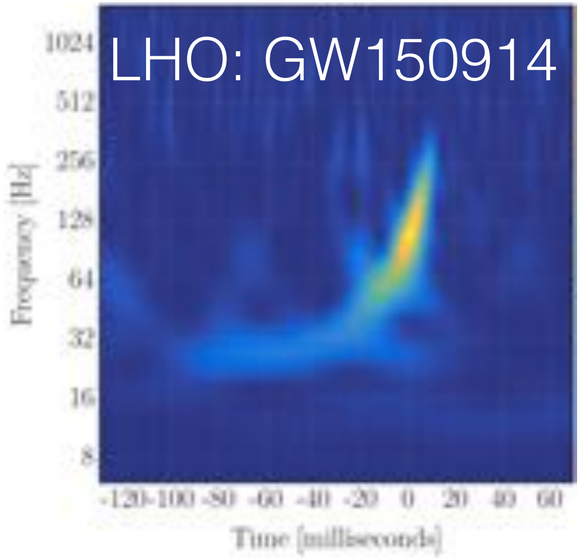
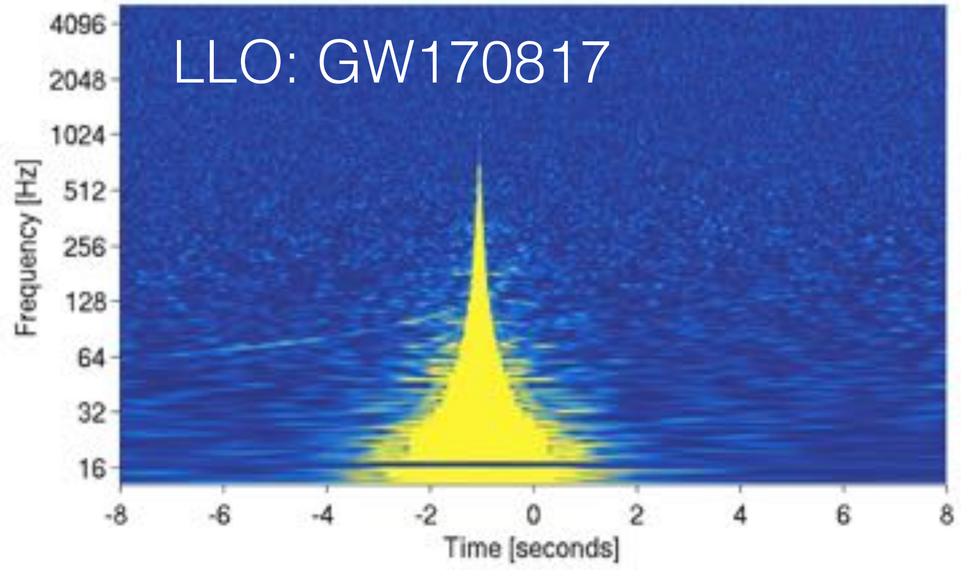
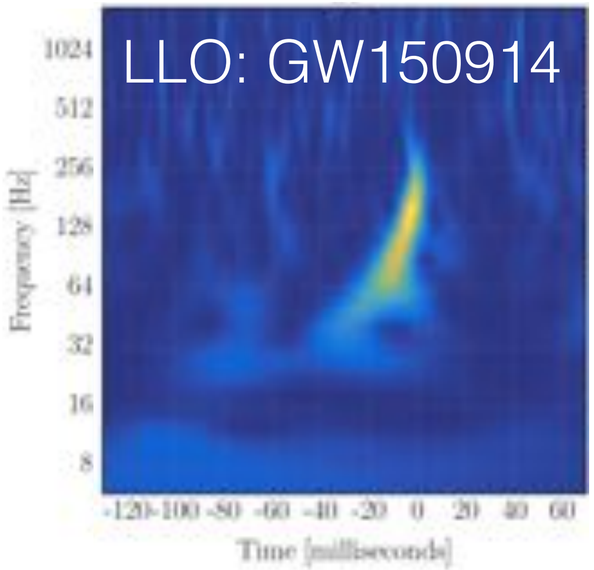
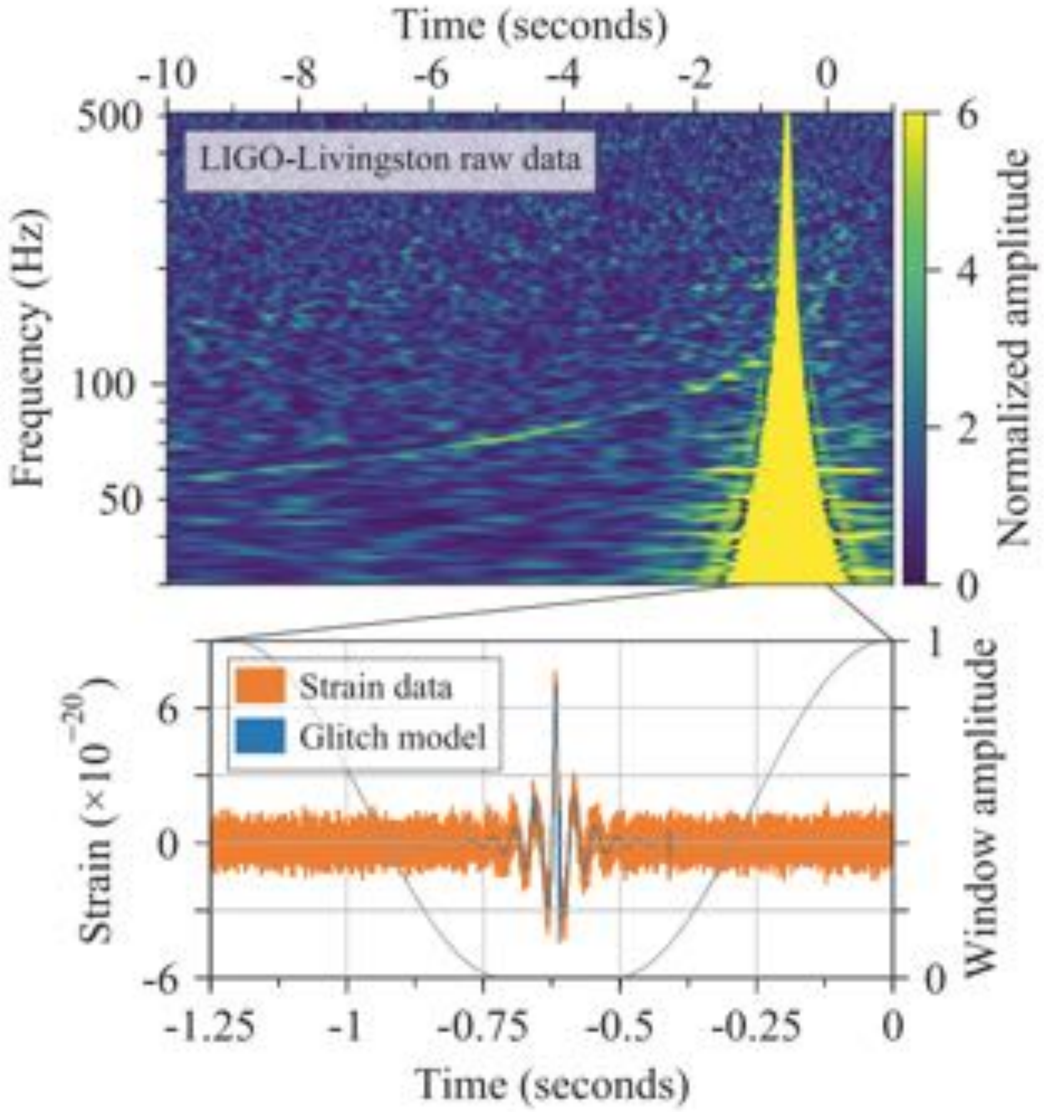








GW170817 Data Cleaning



LVC, PRL. 119, 161101 (2017)

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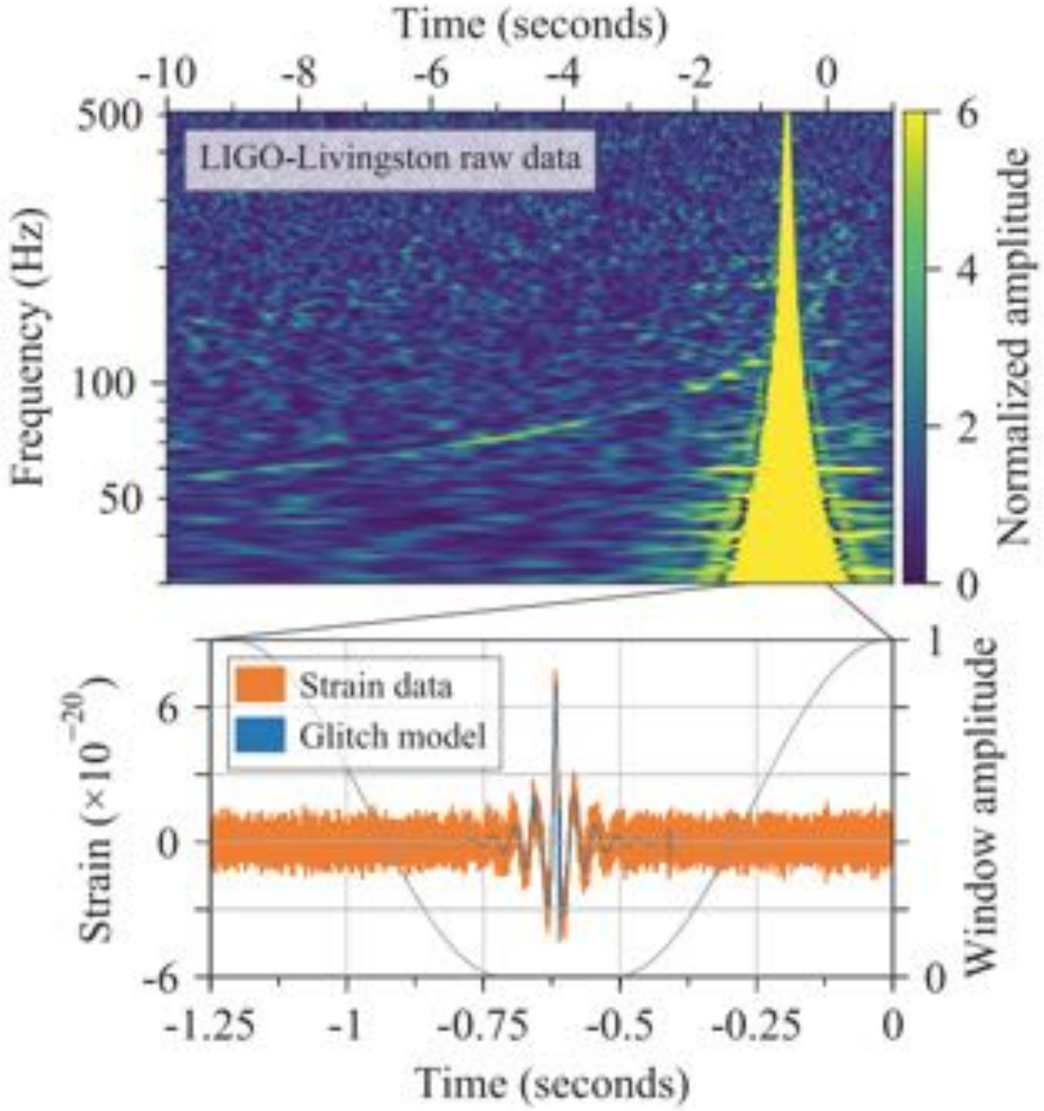
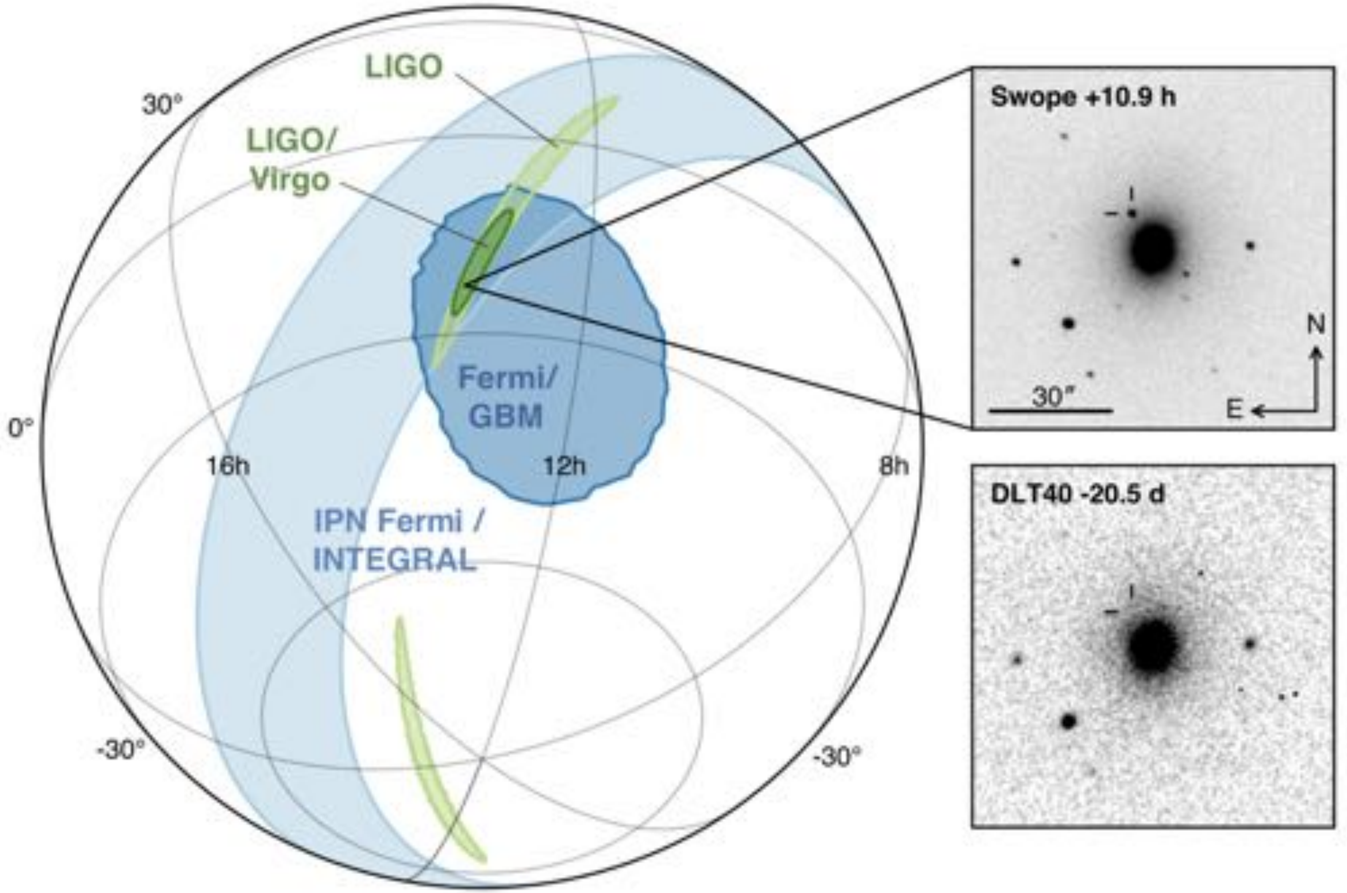


LVC, PRL. 119, 161101 (2017)



LVC+, APJL, 848, 2 (2017)

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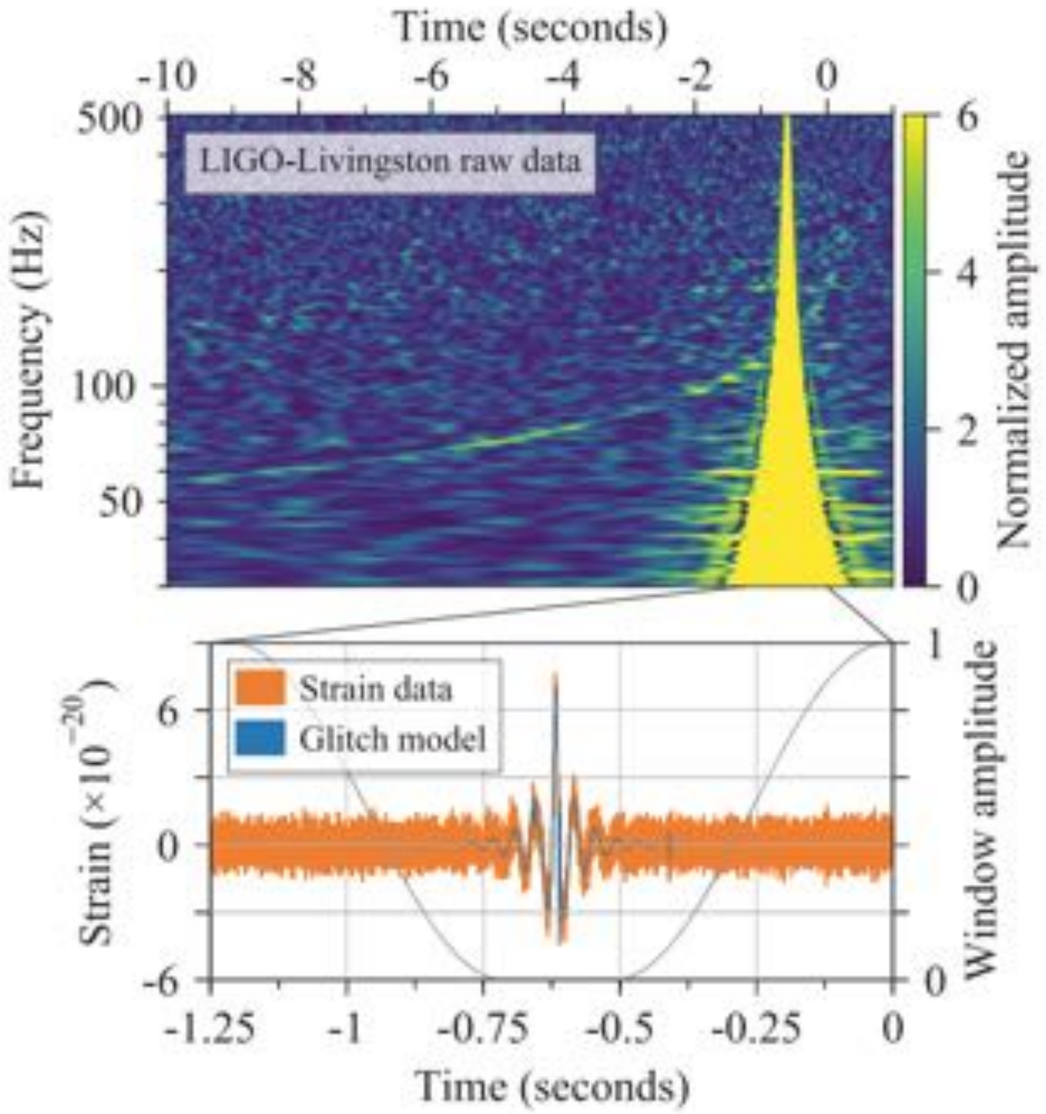
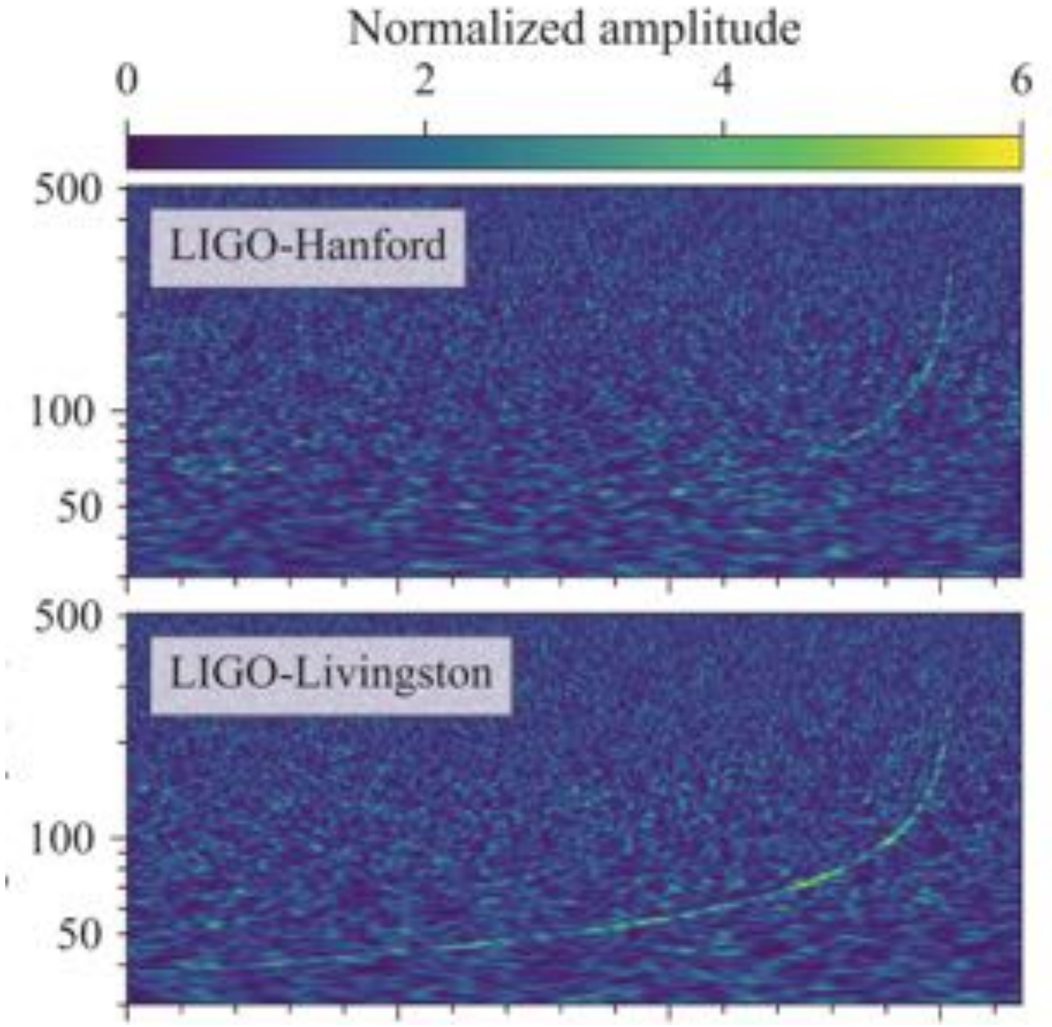
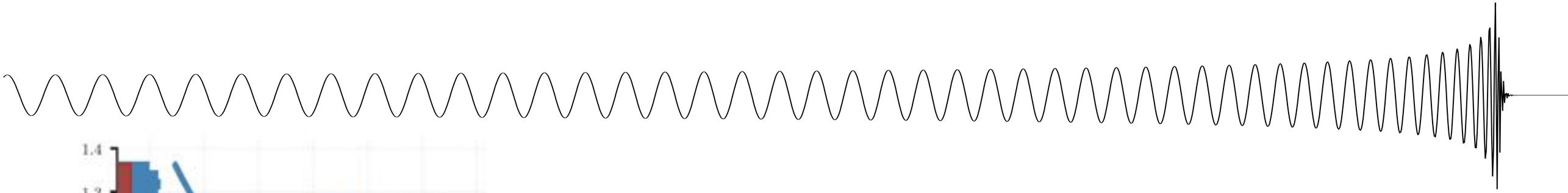
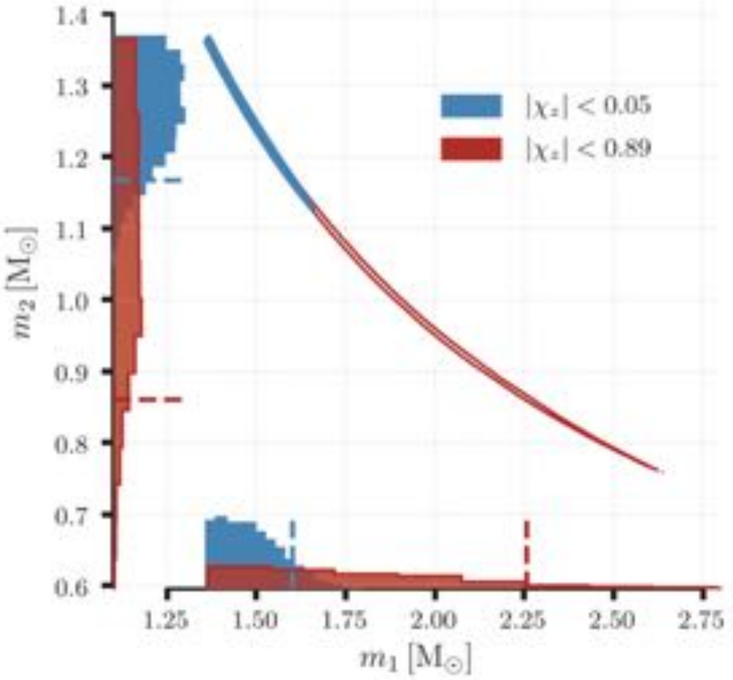




LVC, PRL. 119, 161101 (2017)

What we know from GW170817





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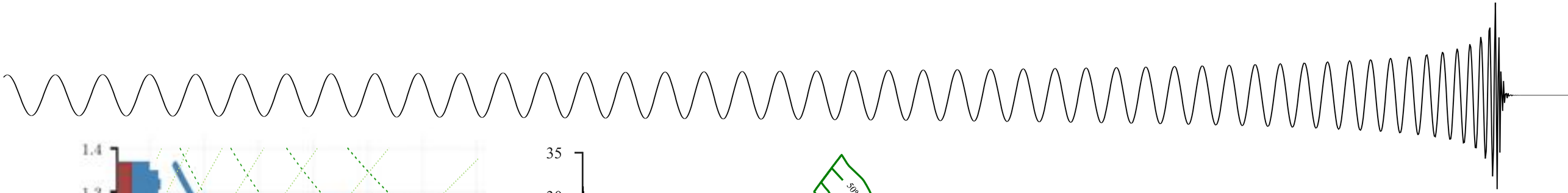
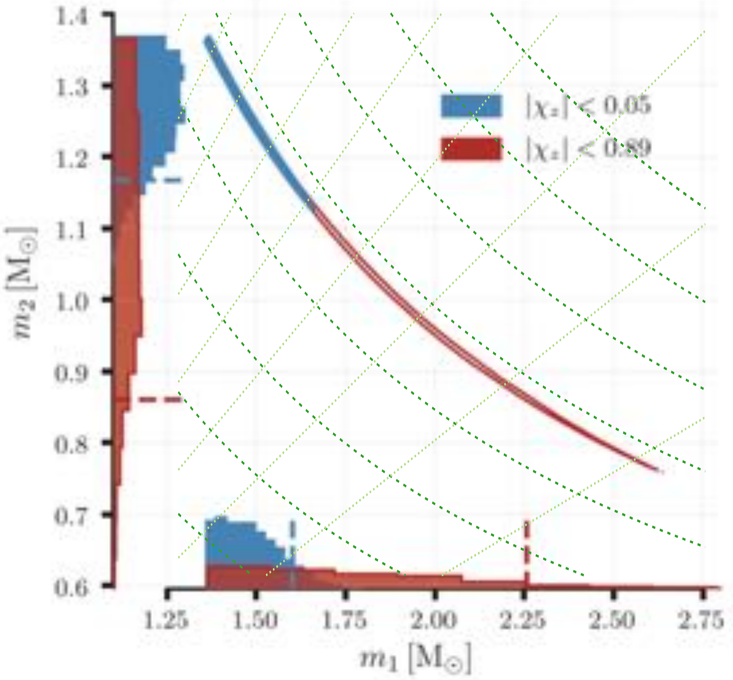
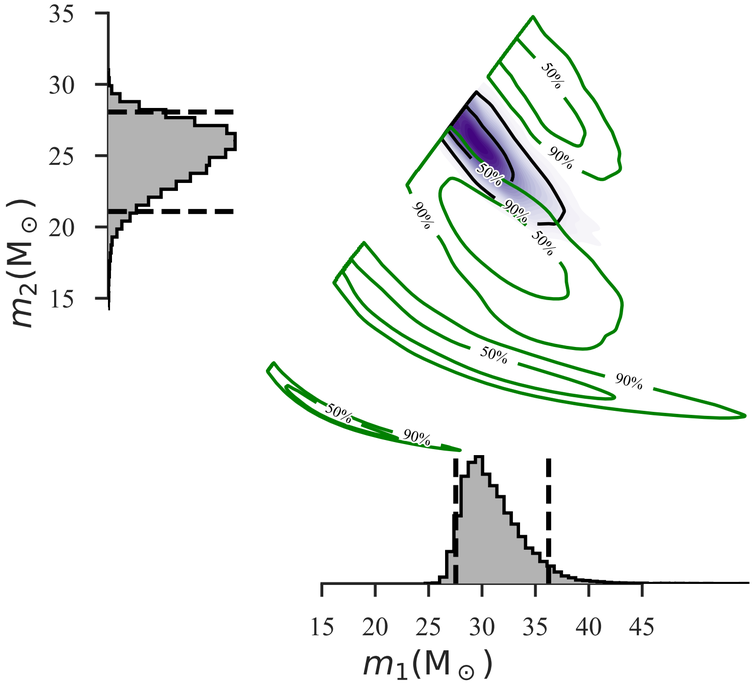




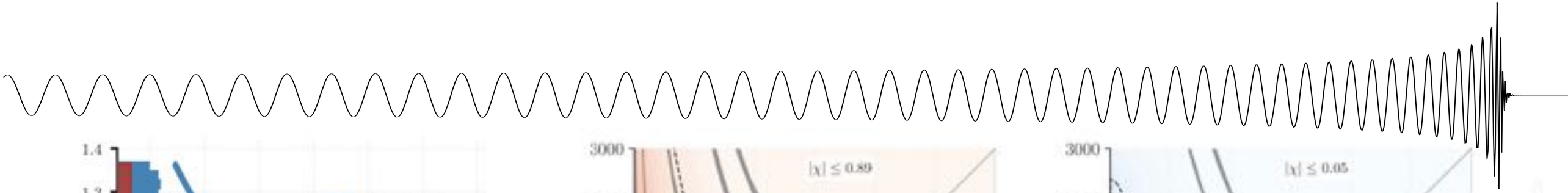
LVC, PRL. 119, 161101 (2017)

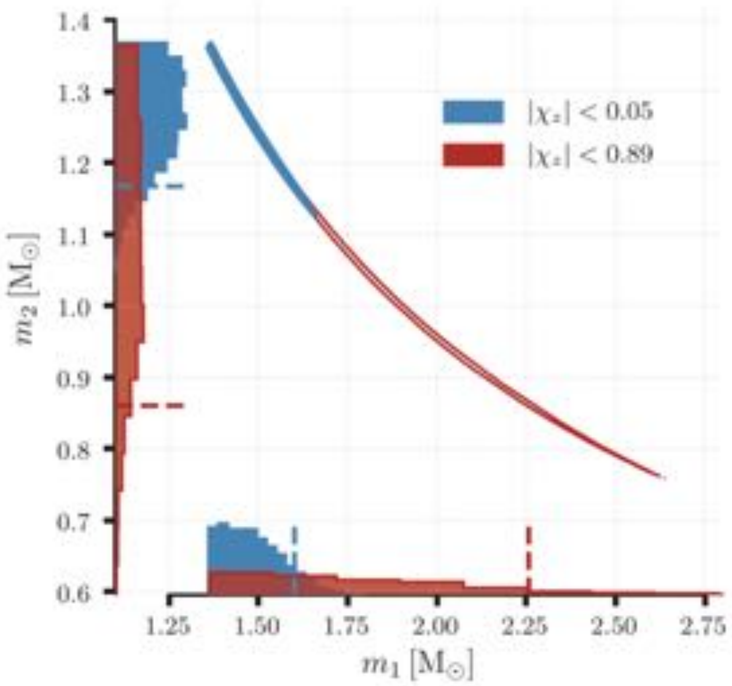


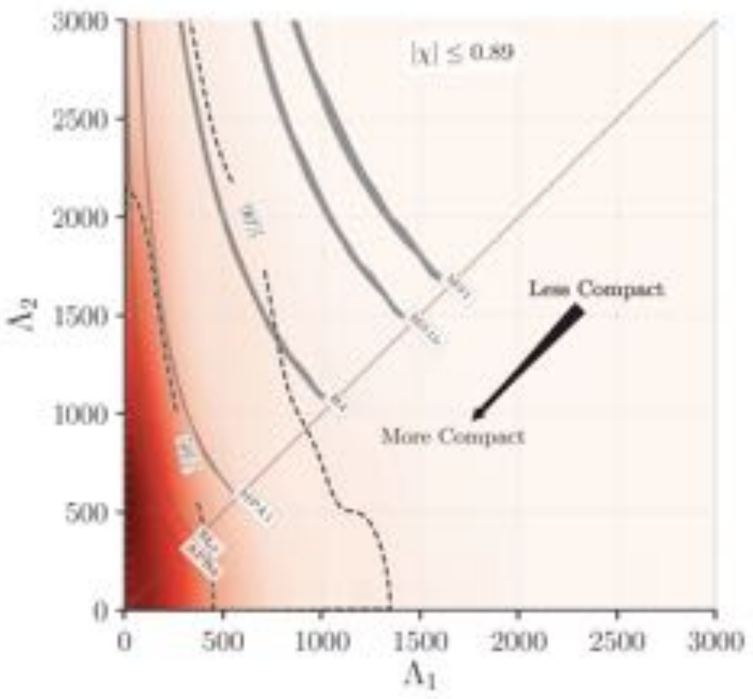
Credit: LVC

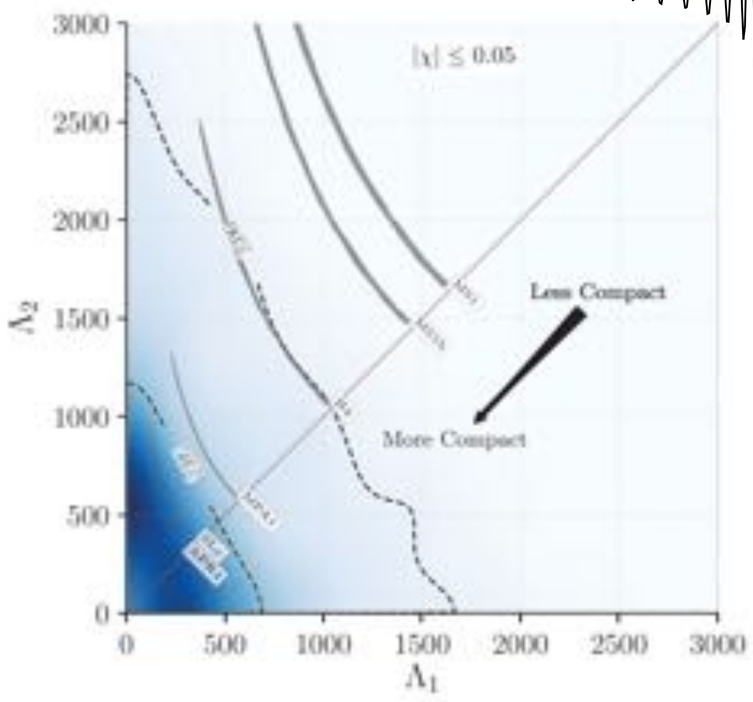
$$\mathcal{M} = \frac{(m_1 m_2)^{3/5}}{(m_1 + m_2)^{1/5}}$$

What we know from GW170817









LVC, PRL. 119, 161101 (2017)

$$\mathcal{M} = \frac{(m_1 m_2)^{3/5}}{(m_1 + m_2)^{1/5}}$$

$$\Lambda = \frac{2}{3} k_2 \left(\frac{R}{m}\right)^5$$

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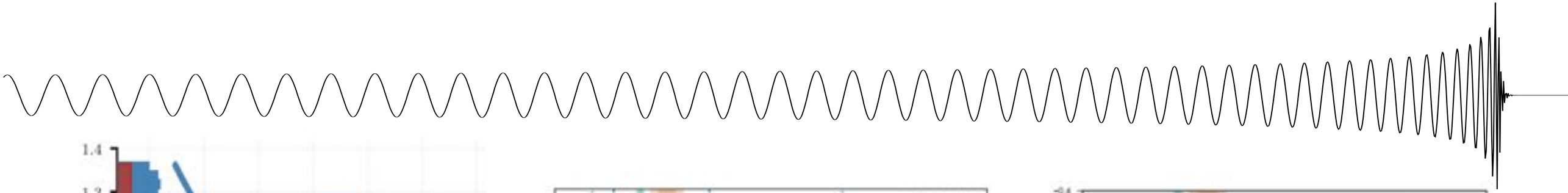

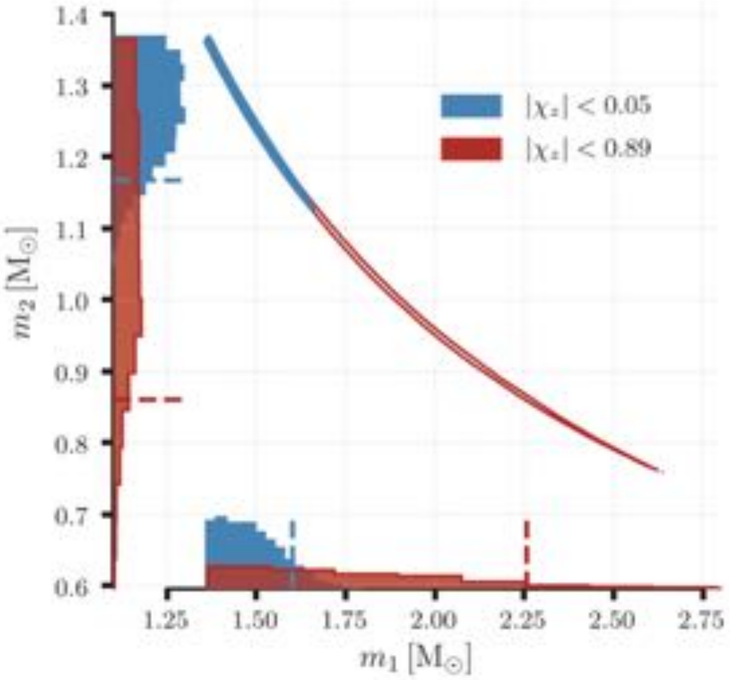

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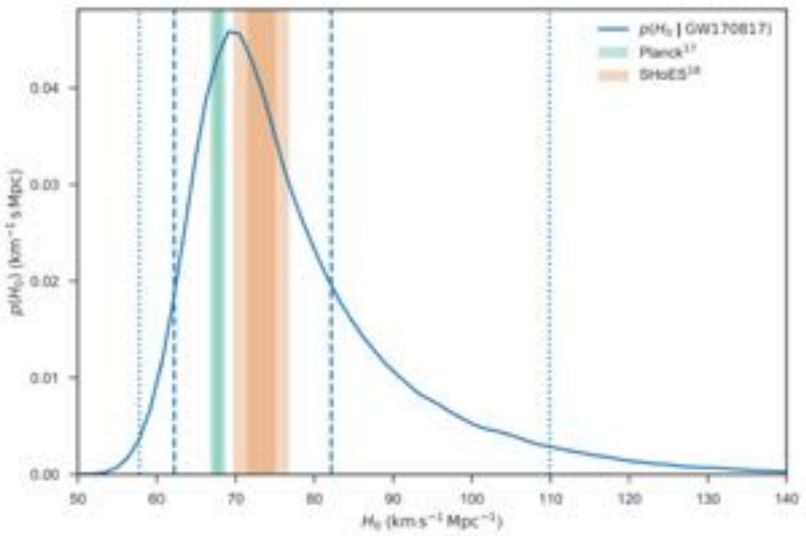
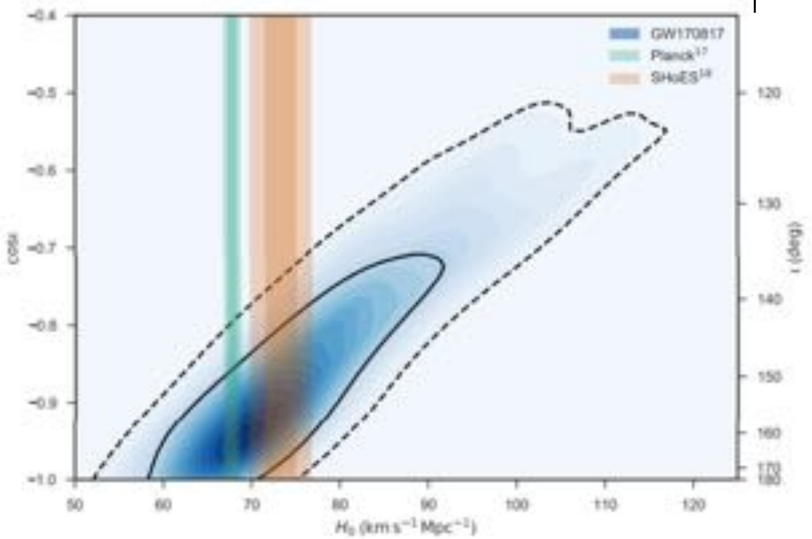


LVC+, Nature 551, 85–88 (2017)



$$\mathcal{M} = \frac{(m_1 m_2)^{3/5}}{(m_1 + m_2)^{1/5}}$$

$$\mathcal{A} = \mathcal{A}(\mathcal{M}, f, D_L, \cos(\iota))$$

$$\text{Hubble's Law} : H_0 = \frac{v}{d}$$

And all that is just the beginning…