Current and future constraints on NS with LIGO/Virgo
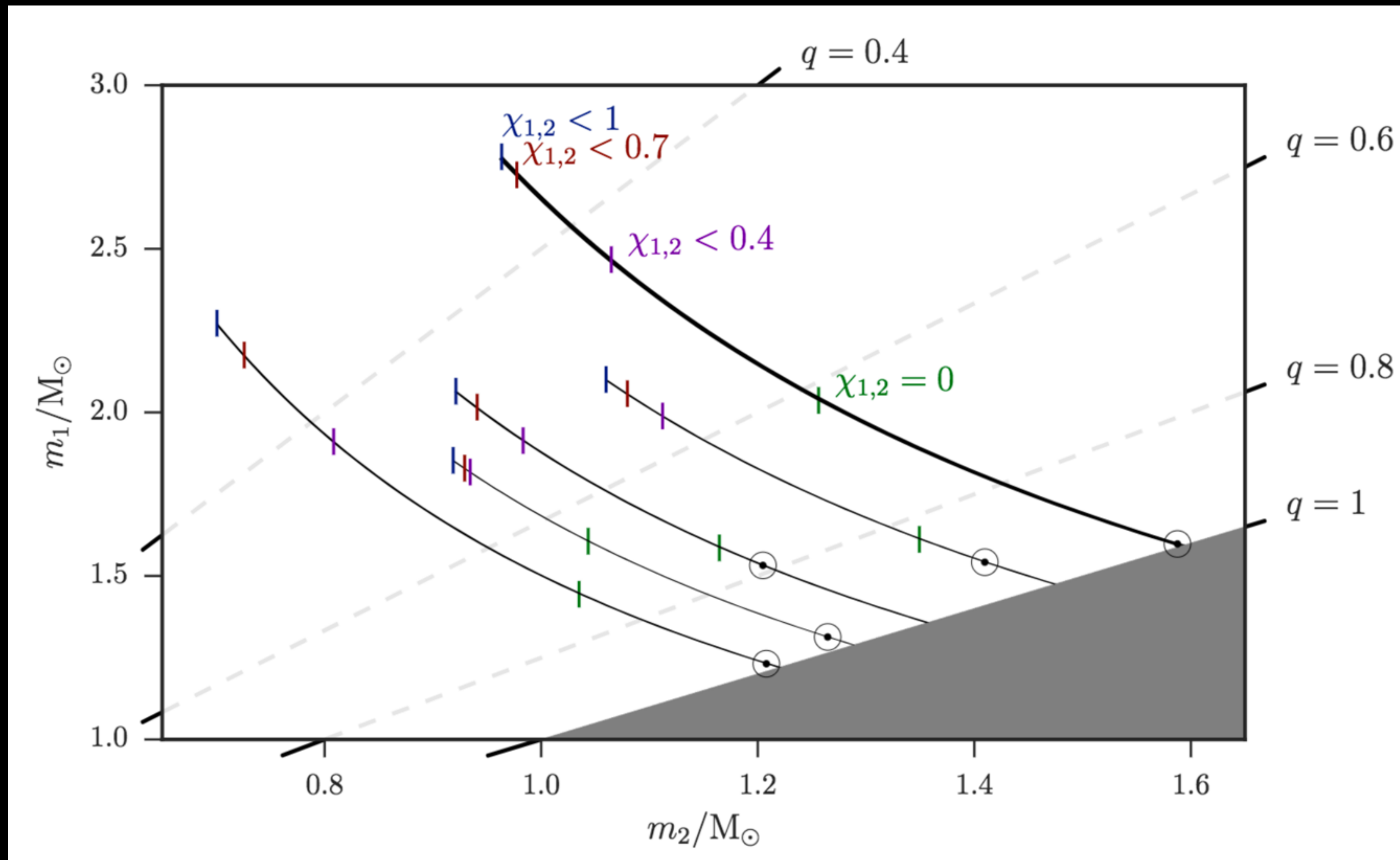

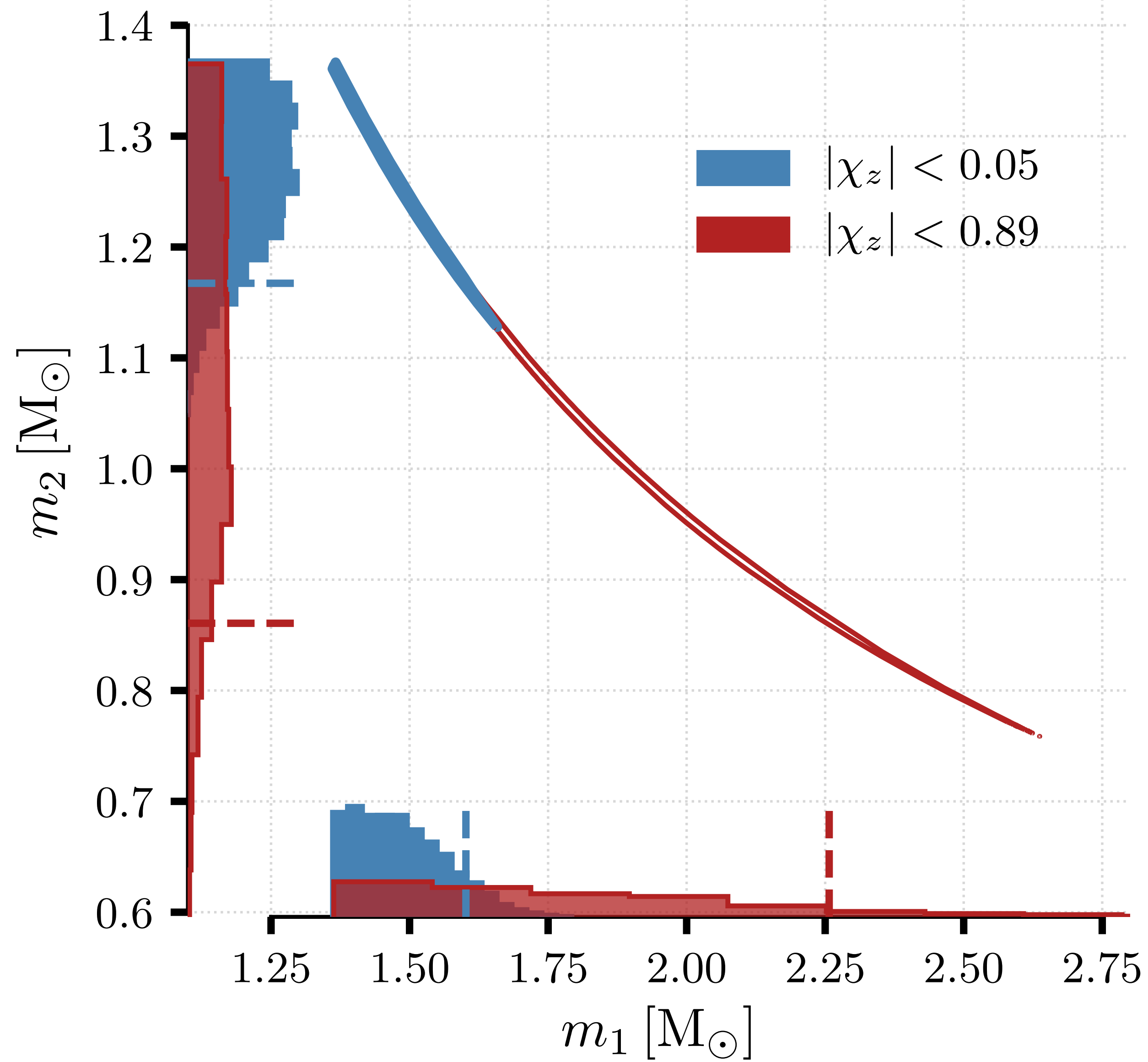Ben Farr

UNIVERSITY OF OREGON

NS Masses

Farr et al. (2016)

GW170817

Signal Model

$$h = F_+ h_+ + F_\times h_\times$$

TaylorF2 (SPA):

$$h_+(t) = \sqrt{\frac{5}{24}} \frac{G^2}{c^5} \frac{\mathcal{M}^{5/6}(Gf/c^3)^{-7/6}}{\pi^{2/3}d} \left(\frac{1+\cos^2\iota}{2}\right) e^{-i\Psi(f)}$$

$$h_\times(t) = -i\sqrt{\frac{5}{24}} \frac{G^2}{c^5} \frac{\mathcal{M}^{5/6}(Gf/c^3)^{-7/6}}{\pi^{2/3}d} \cos\iota \; e^{-i\Psi(f)}$$

$$\Psi(f) = 2\pi f t_c - 2\phi_c - \frac{\pi}{4} + \frac{3}{128\eta x^{5/2}}[1 + \psi_{\mathrm{PP-PN}}(x;\eta) + \psi_{\mathrm{Tidal}}(x;\eta,\Lambda_1,\Lambda_2)]$$
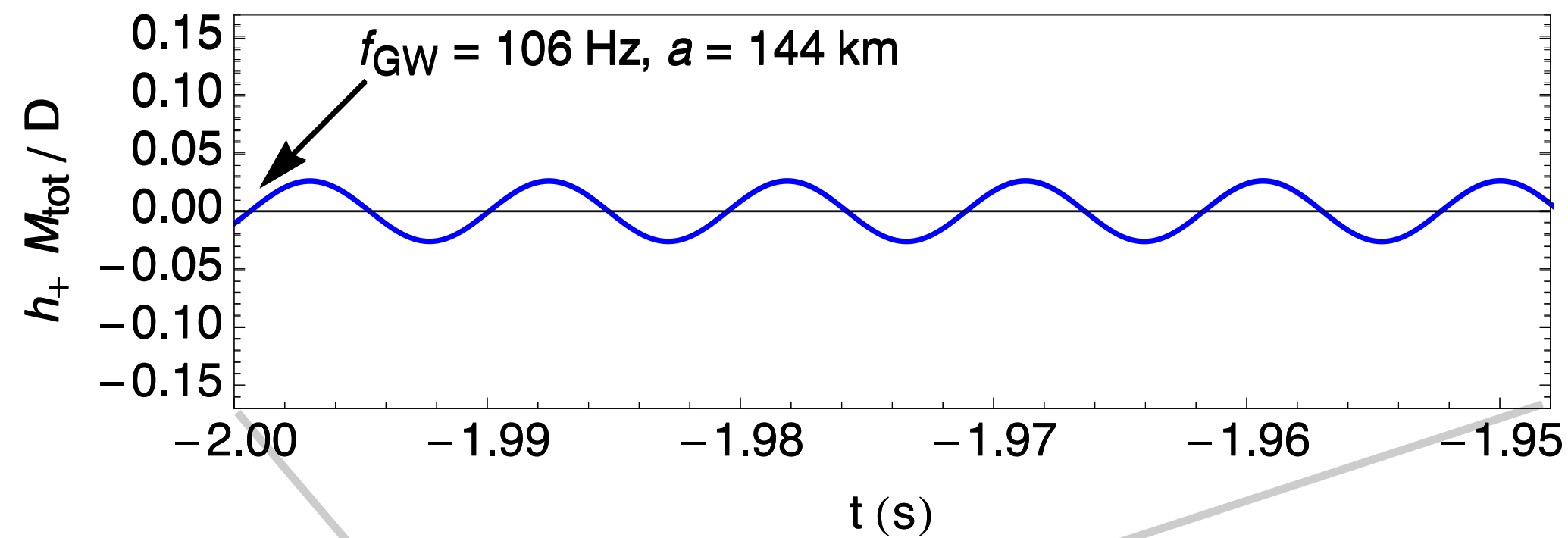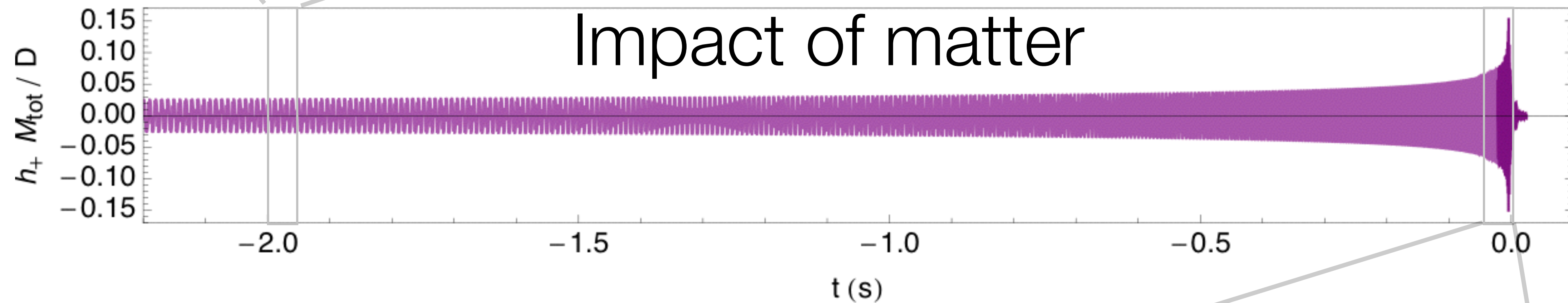
Tidal Parameters

Component deformation:

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

Leading order:

$$\tilde{\Lambda} = \frac{16}{13} \frac{(m_1 + 12m_2)m_1^4 \Lambda_1 + (m_2 + 12m_1)m_2^4 \Lambda_2}{(m_1 + m_2)^5}$$
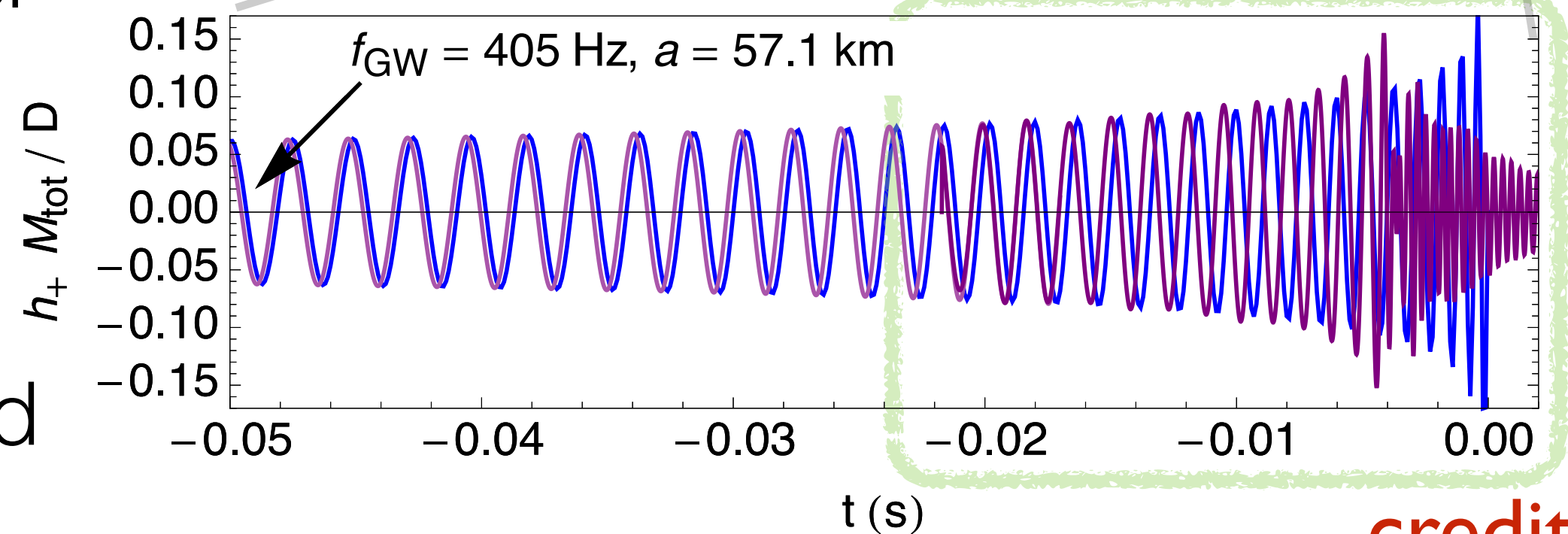
Impact of matter

Hard to modify inspiral: transfer of $\sim10^{46}$ erg at ~100 Hz modifies phase by 10^{-3} radians (Crust shattering, Tsang et al 1110.0467)
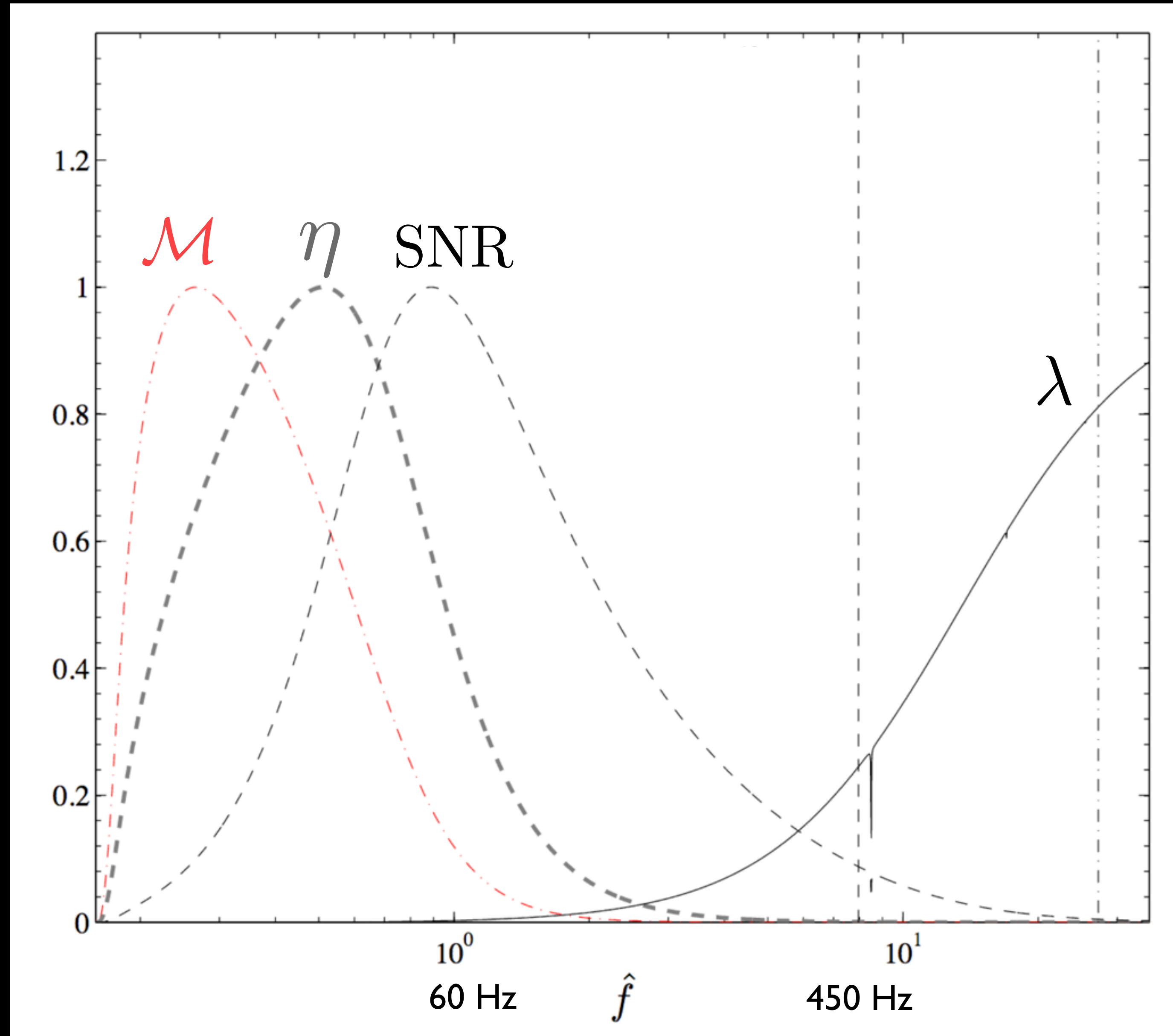
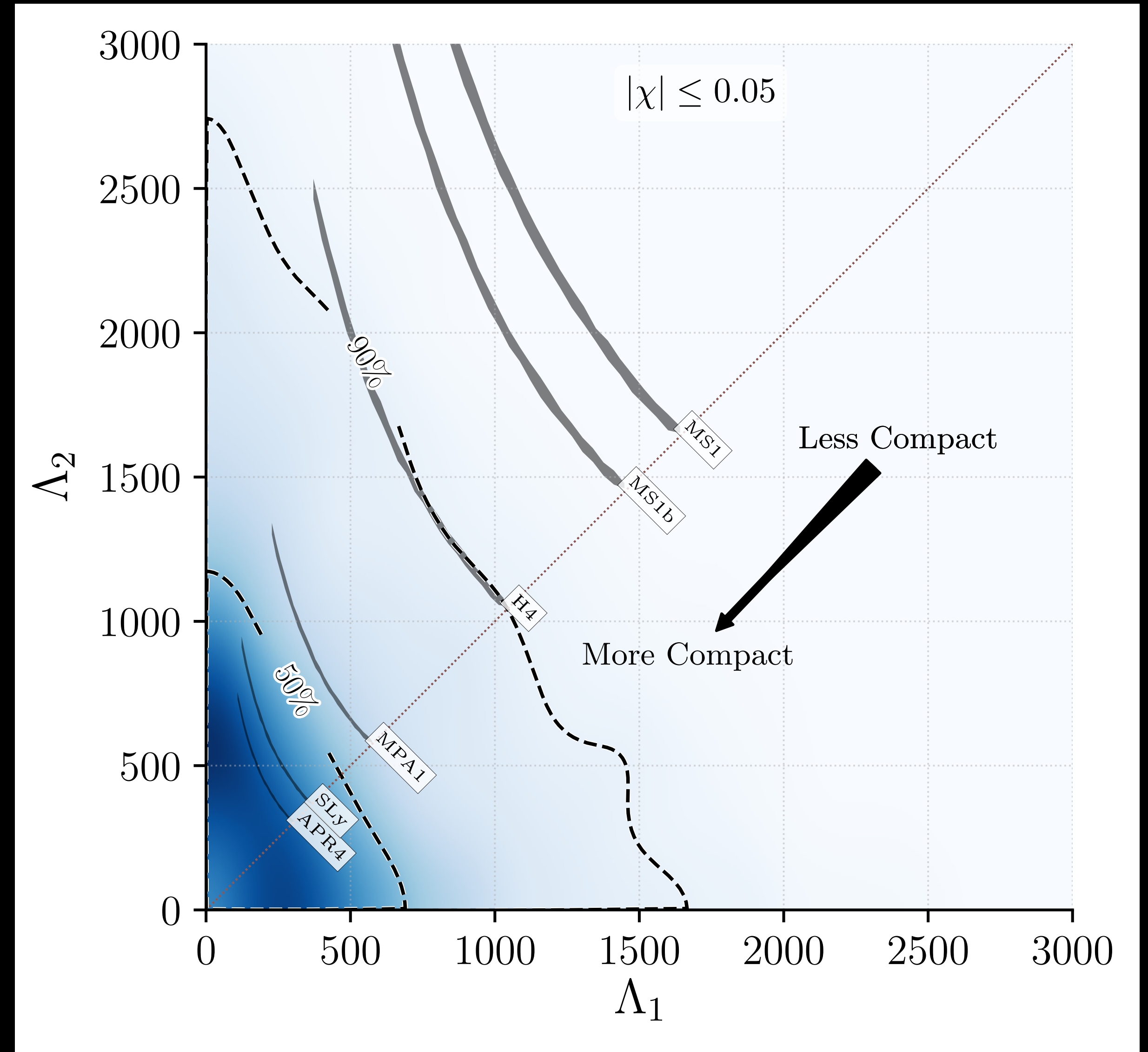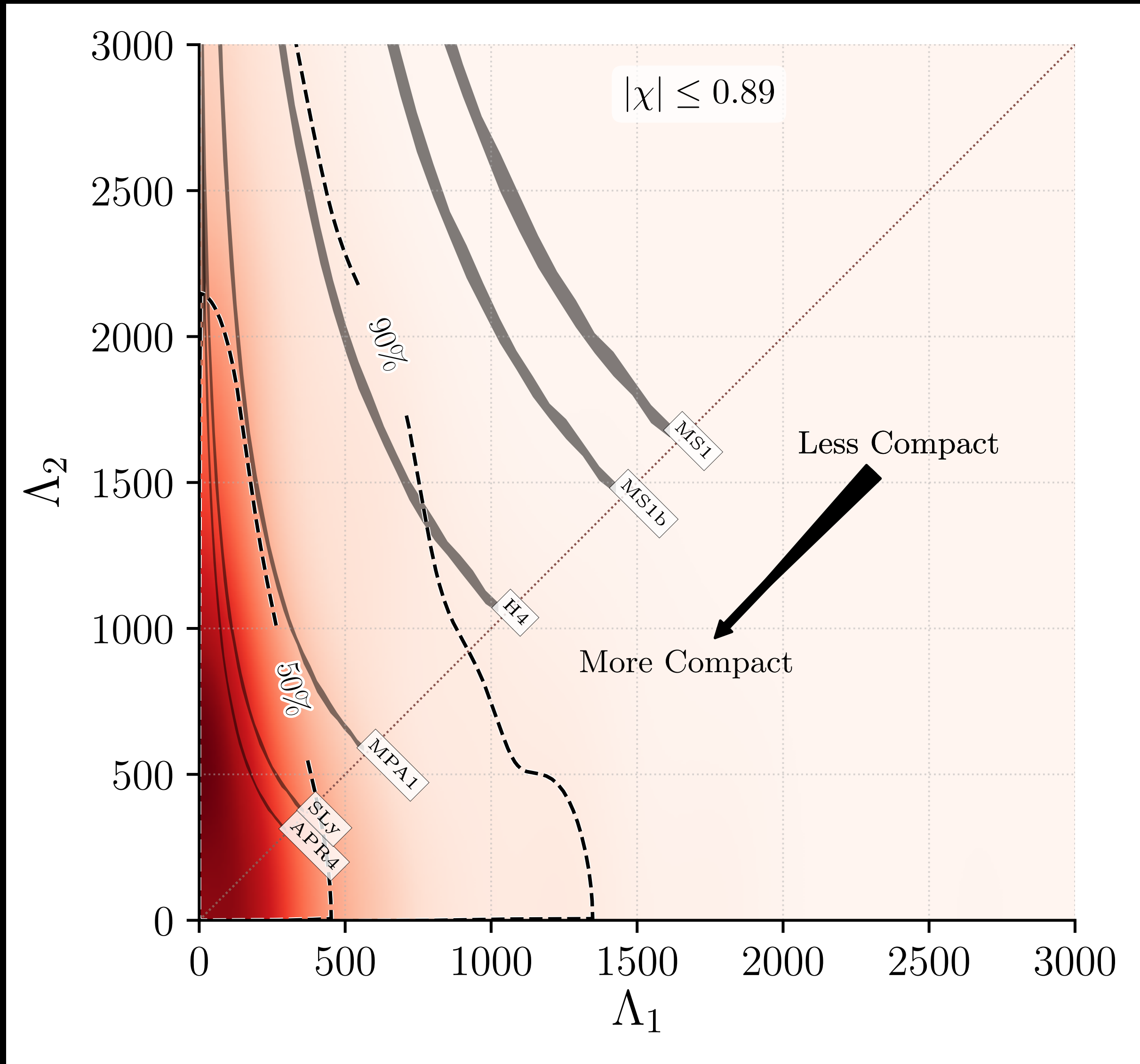Tidal interactions lead to accumulated phase shift at higher frequencies.

For the final coalescence, numerical simulations are required

f_{GW} = 106 Hz, a = 144 km

f_{GW} = 405 Hz, a = 57.1 km

credit: Jocelyn Read

What we learn when

Damour et al. (2012)

Tidal Constraints

What next?