Two strategies to modelling BBH GWs

- Model everything (Blackman, *et. al*…)
  - Not quite:
    - Only high masses (short waveforms)
    - Only up to mass-ratio 1:2
- Add effects on order of difficulty…
  … and measurability (Phenom, EOBNR)
  - What does that mean??

- Mass ratio (2007-8)
- Aligned spin (2009-11)
  - (Phenom: strong degeneracy between spins, χ_{eff})
  - Measuring individual spins will require v. high SNRs*
- Approximate precession (2013-)
  - (Phenom: degeneracy among in-plane components, χ_P)
  - NB: Precession effects are *not* tuned to NR.
- Higher modes (2017-)

Observations

- Measured only mass, mass-ratio, χ_{eff}
- Precession effects were *not* measurable
  - Comparable mass ratios
  - Low (or isotropic) spins

O3 will bring ~20 detections…

… current models are probably good enough

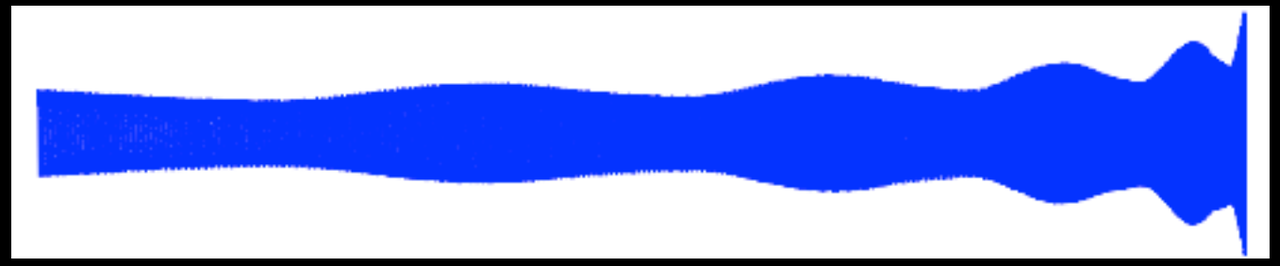
What's the next big thing?

- High aligned spins?
  - unlikely if isotropic spins!
- High mass ratios?
  - Likely less than a few % have q>20
- Measurable precession?
  - ???
- Loud high-mass binary for Kerr tests?
  - we can "already" do that.

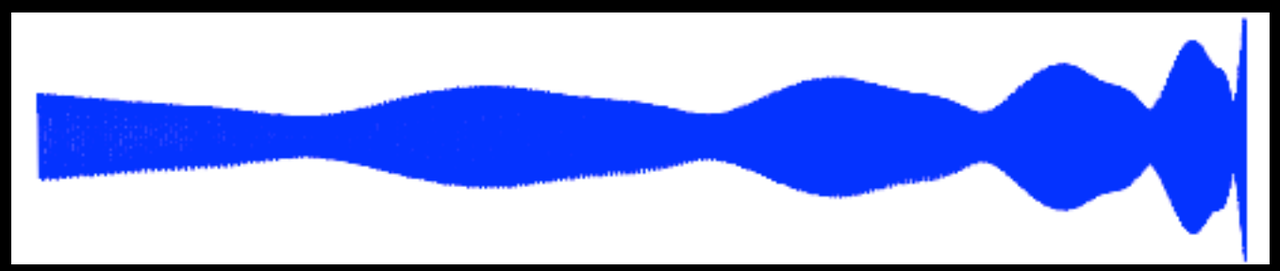
Orientation dependence

q=3, $|\mathbf{S}_2|$ = 0.75 (in plane)

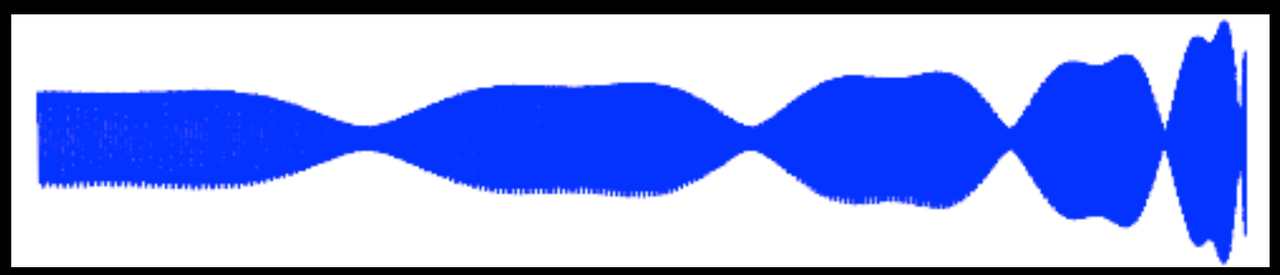
Observer aligned with ***J***



Observer inclined $\pi/6$ to ***J***



Observer inclined $\pi/3$ to ***J***



Observer inclined $\pi/2$ to ***J***