

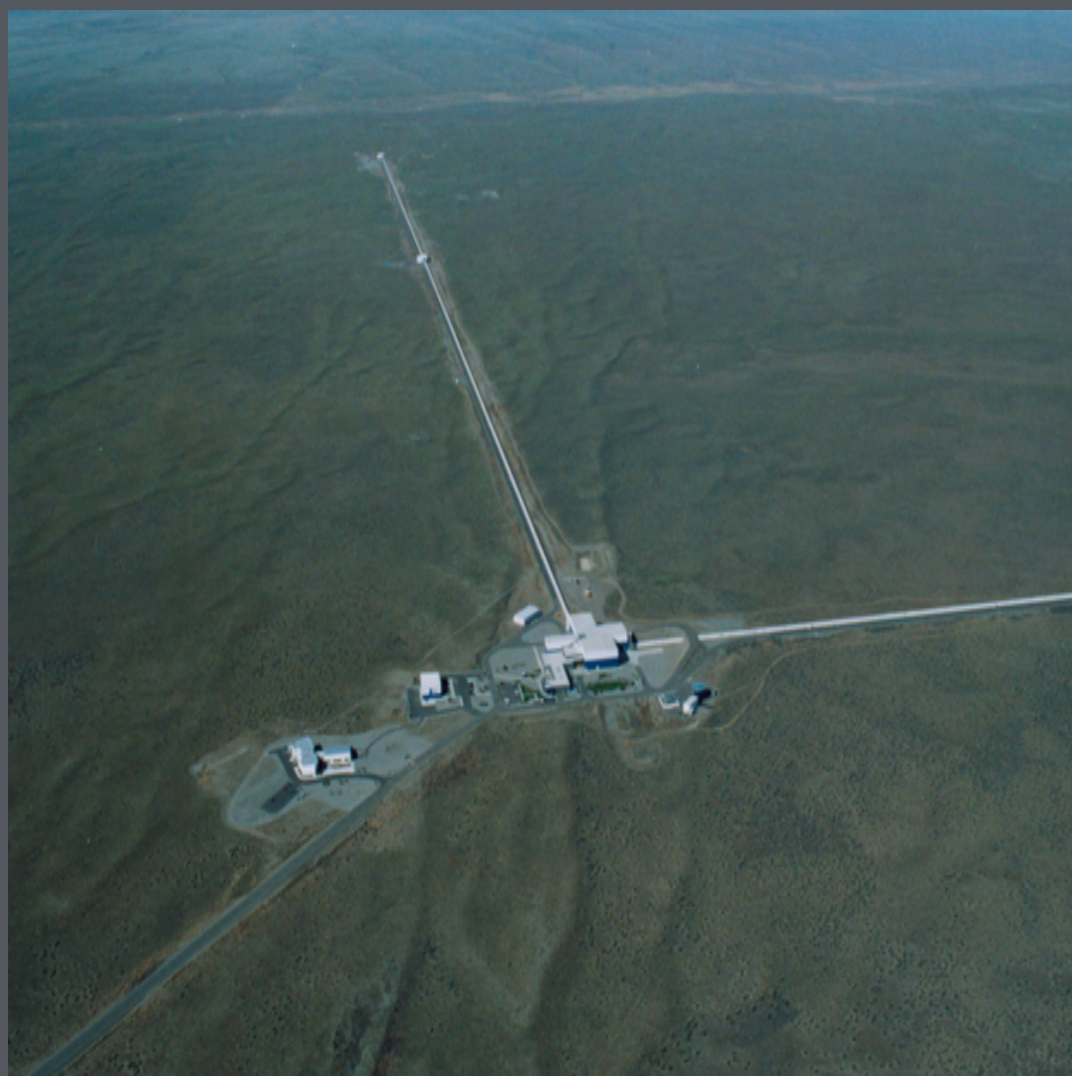
Numerical Relativity Surrogate Model

Jooheon Yoo

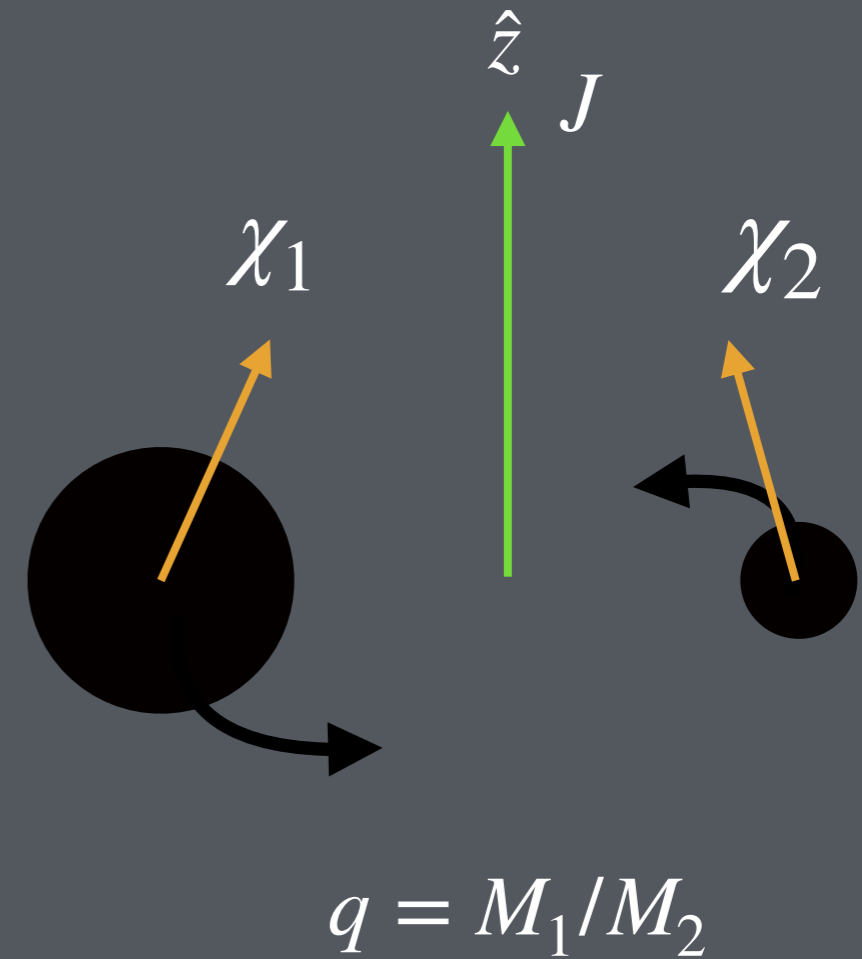
Advisor: Saul Teukolsky and Larry Kidder

Cornell University

Gravitational Wave



Numerical Relativity (NR)



Need: faster alternative !!

Surrogate Waveform Model

EOB/Phenom Models

Physical &
Phenomenological
Approximations

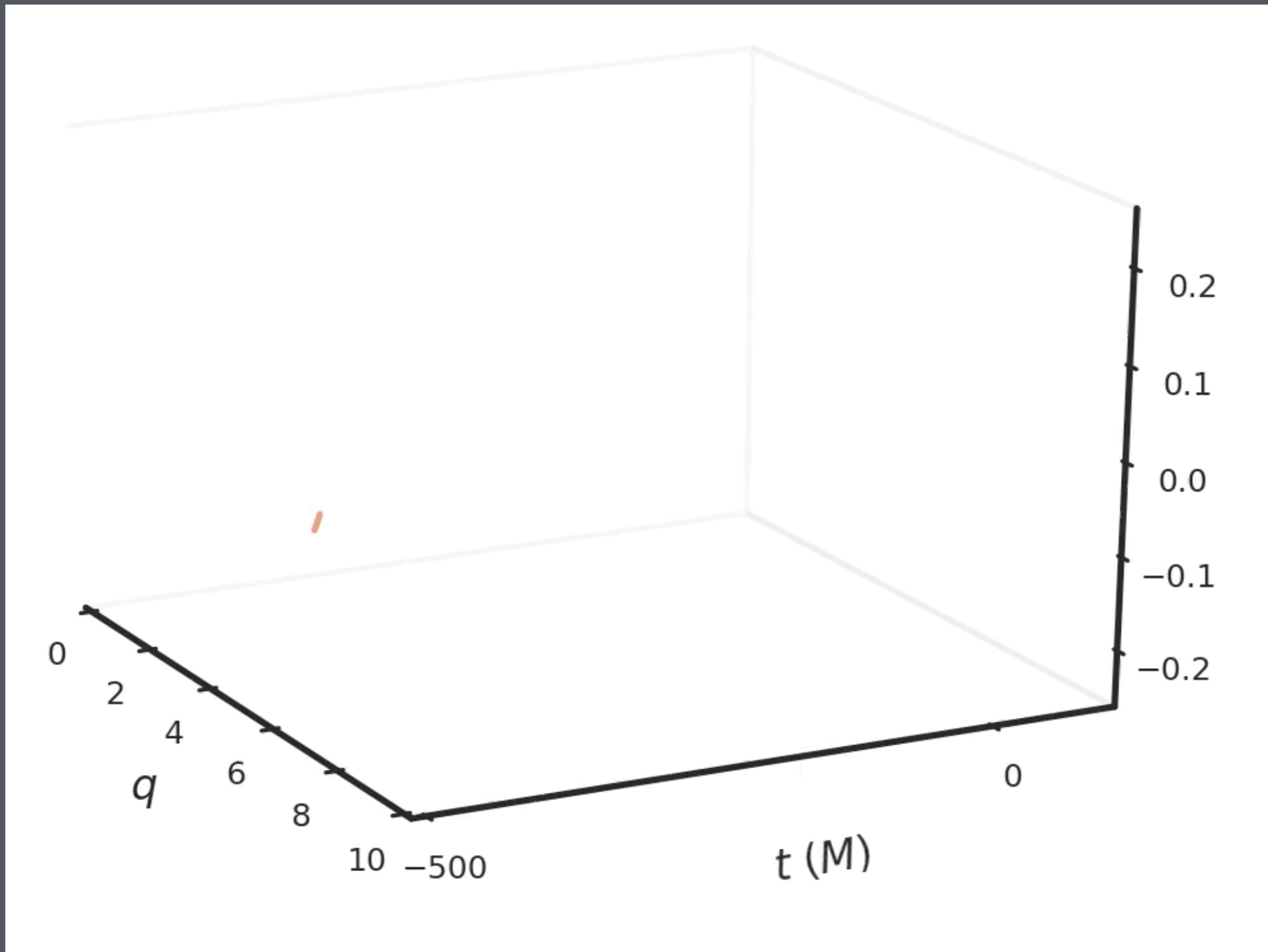
Calibration to NR

Surrogate Models

NR Simulations

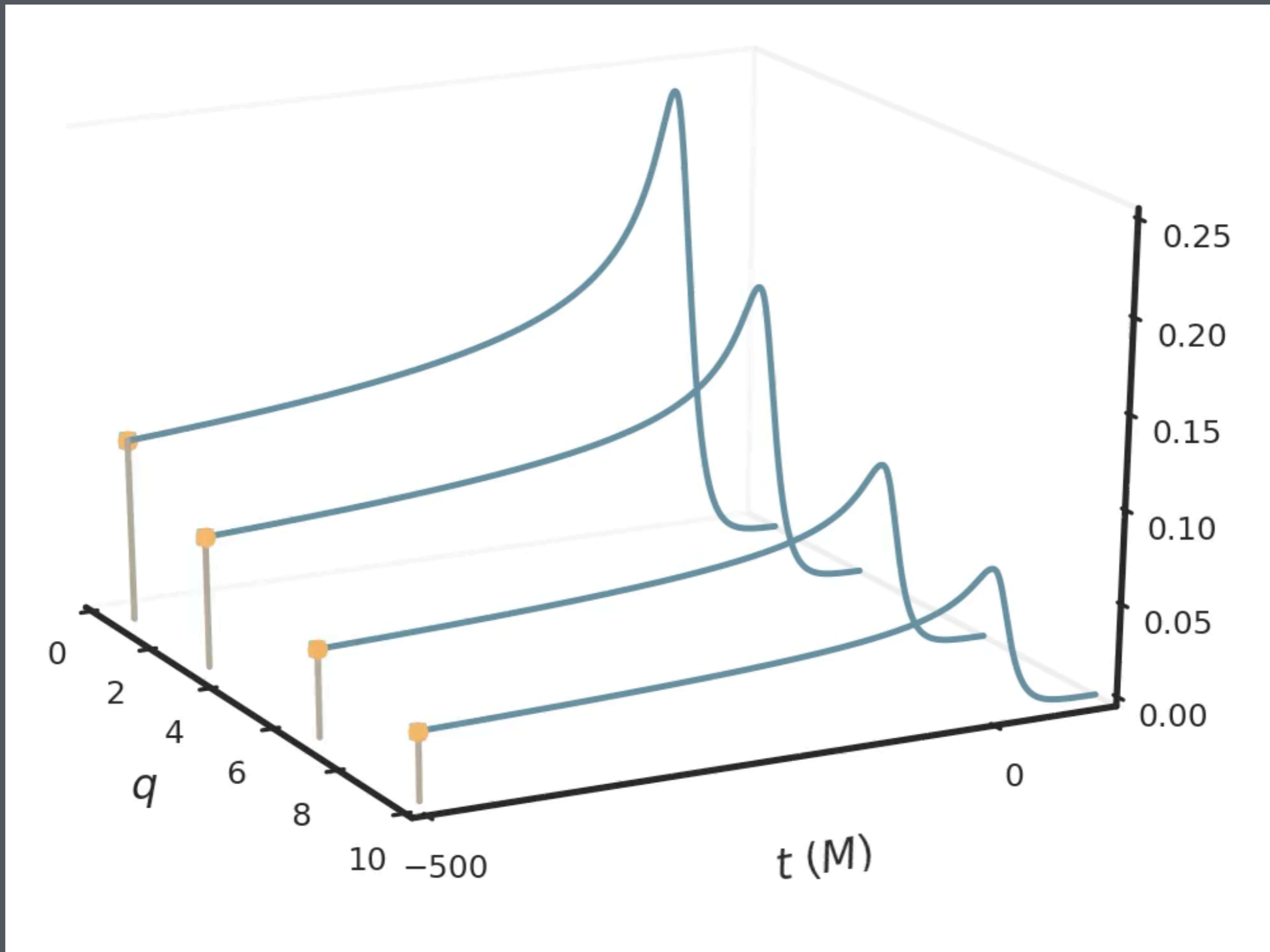
Training

Reduced Basis



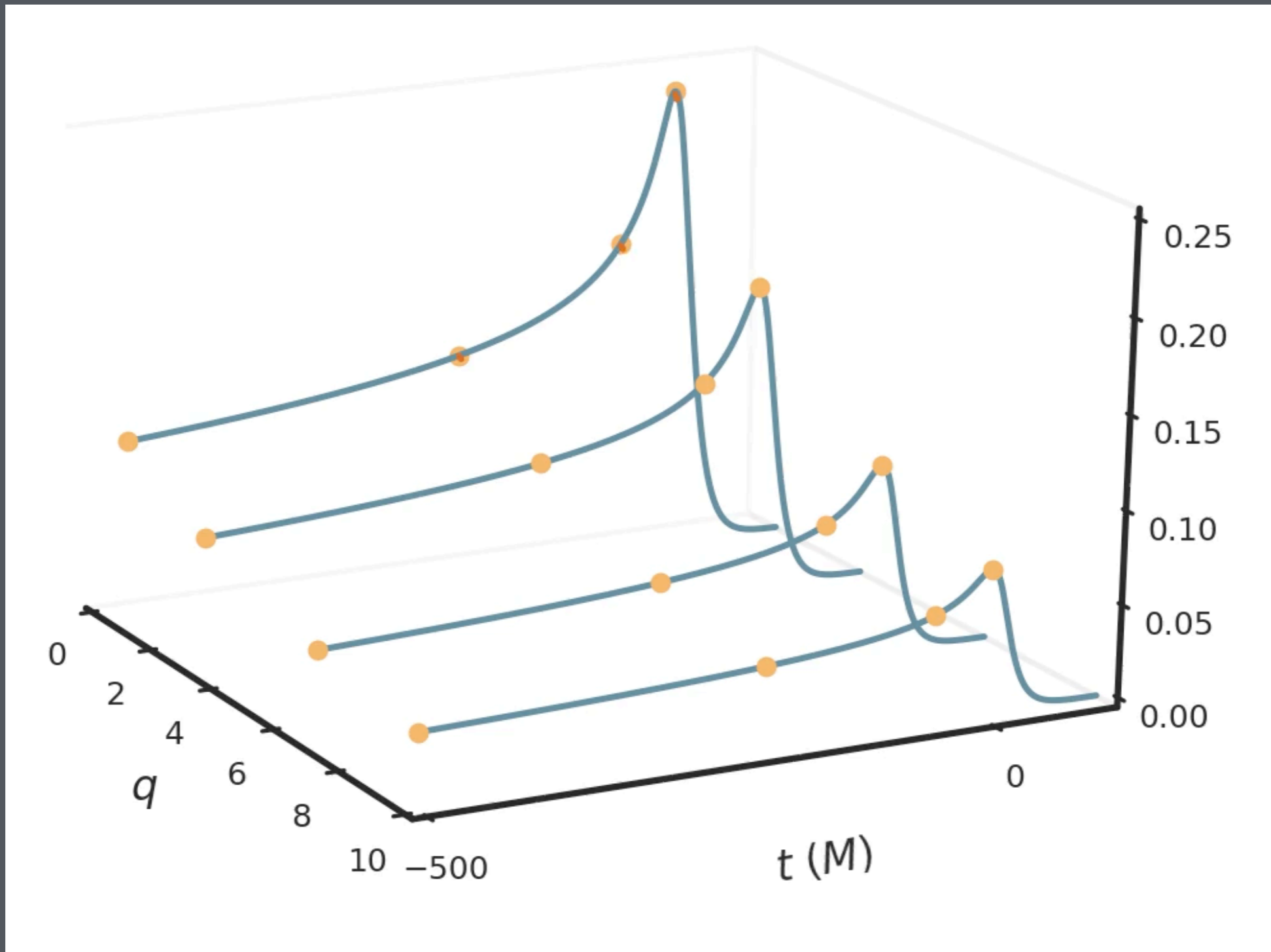
<https://vijayvarma392.github.io/SurrogateMovie/>

Empirical Nodes



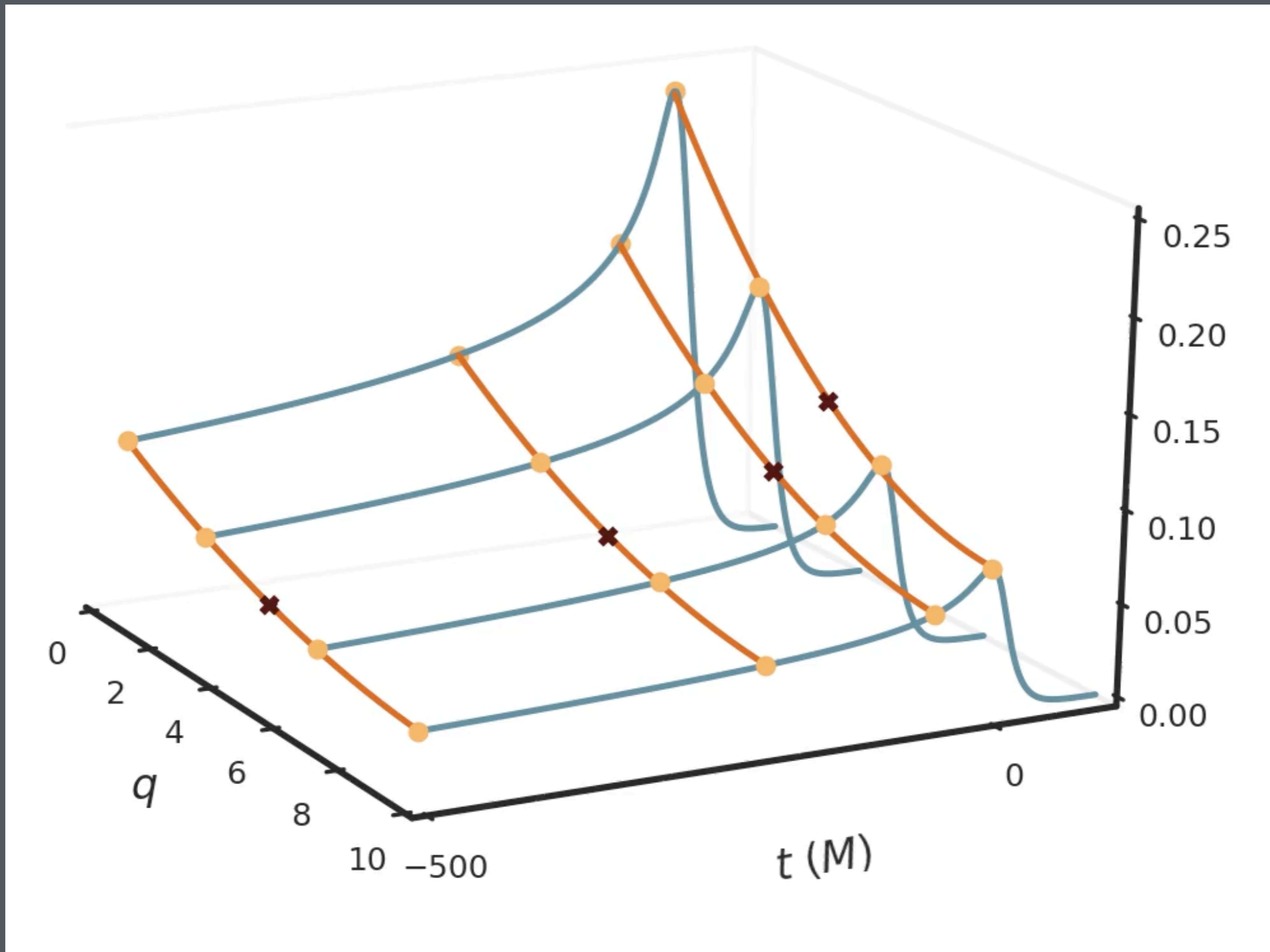
<https://vijayvarma392.github.io/SurrogateMovie/>

Parametric Fit



<https://vijayvarma392.github.io/SurrogateMovie/>

Evaluate



<https://vijayvarma392.github.io/SurrogateMovie/>

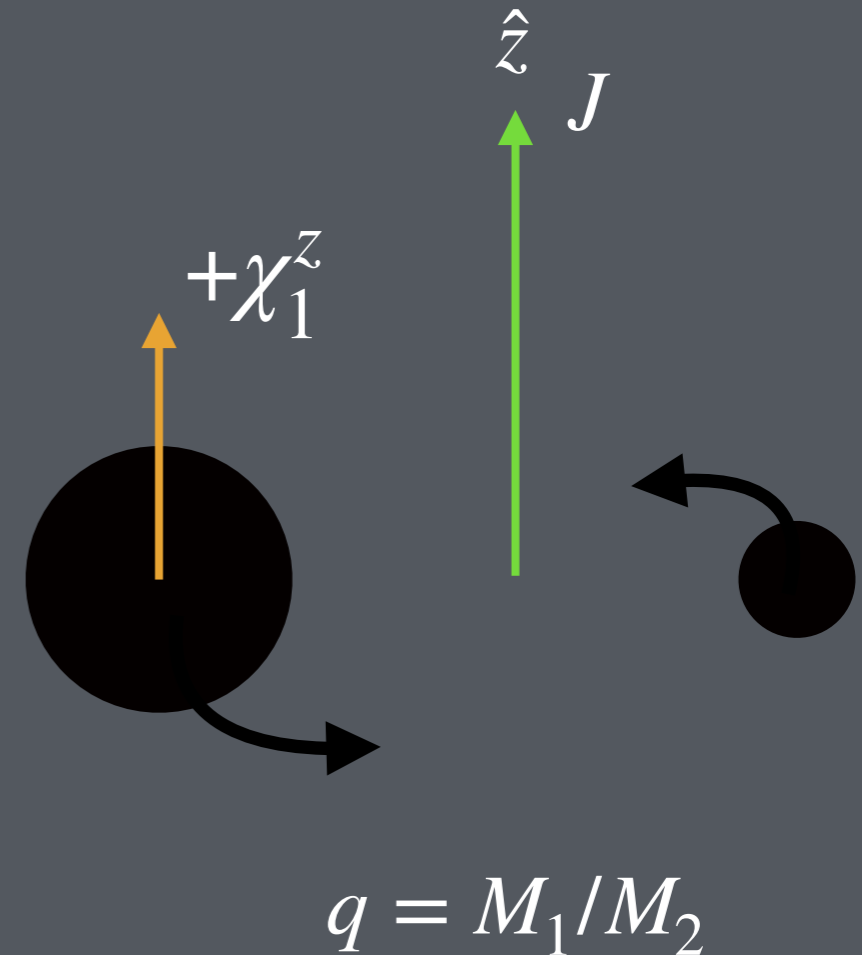
GW190814

- $23 M_{\odot}$ BH with $2.5 M_{\odot}$ companion
- Need: **accurate high mass ratio waveform model**

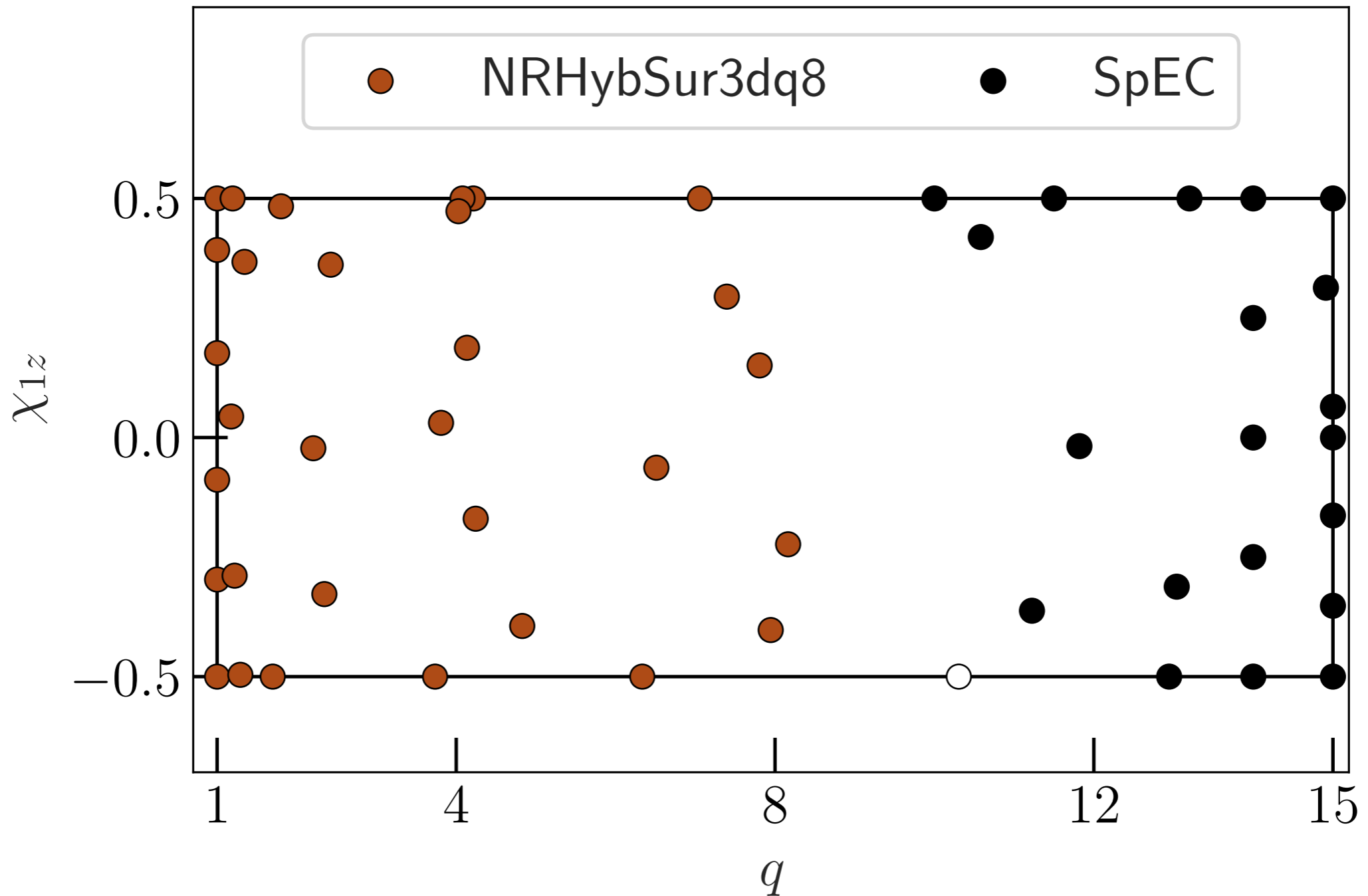


NRHybSur2dq15

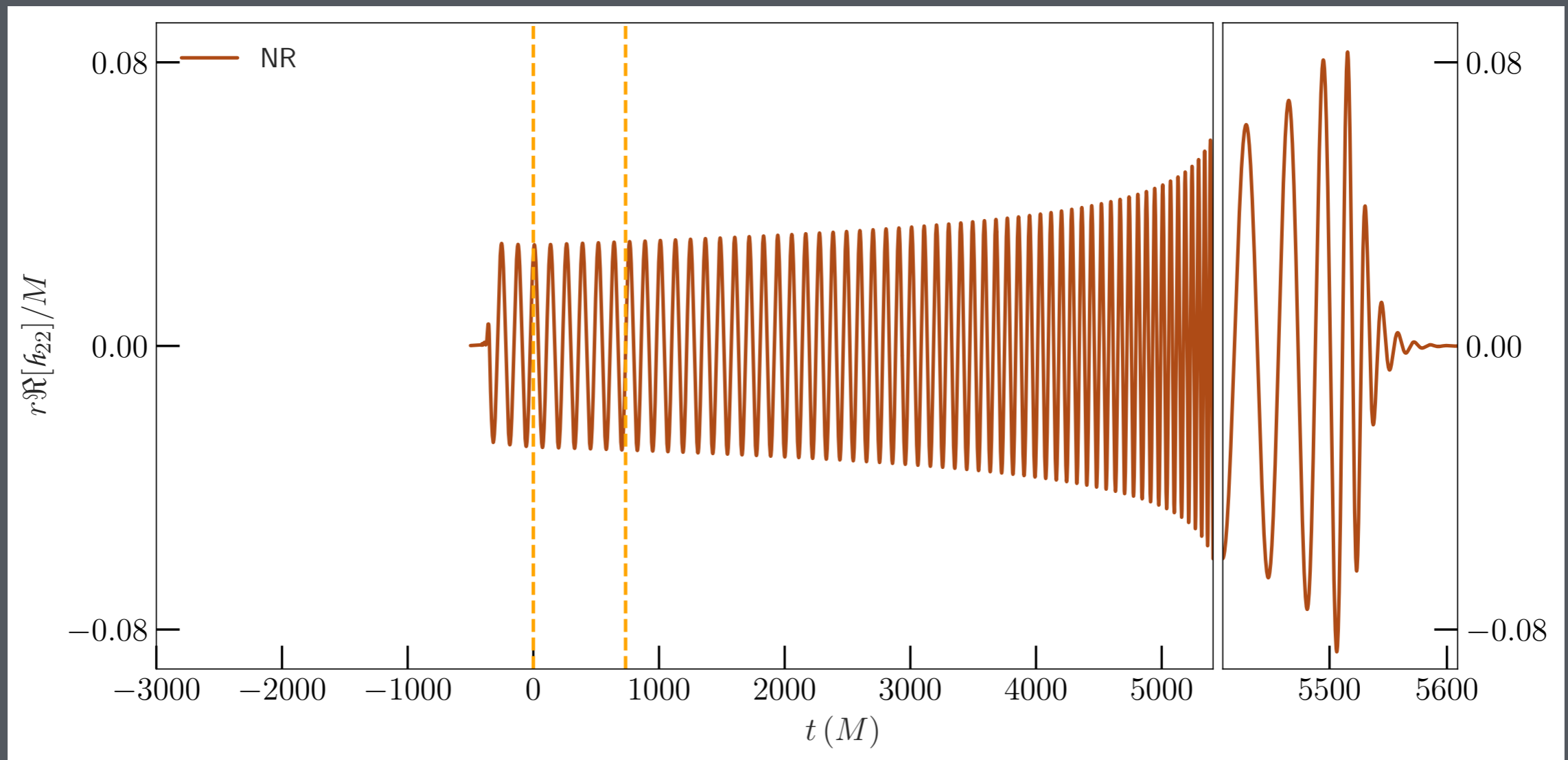
- Aligned spin
- $q \leq 15, -0.5 \leq \chi_1^z \leq 0.5$
- no tidal deformability
- no secondary spin



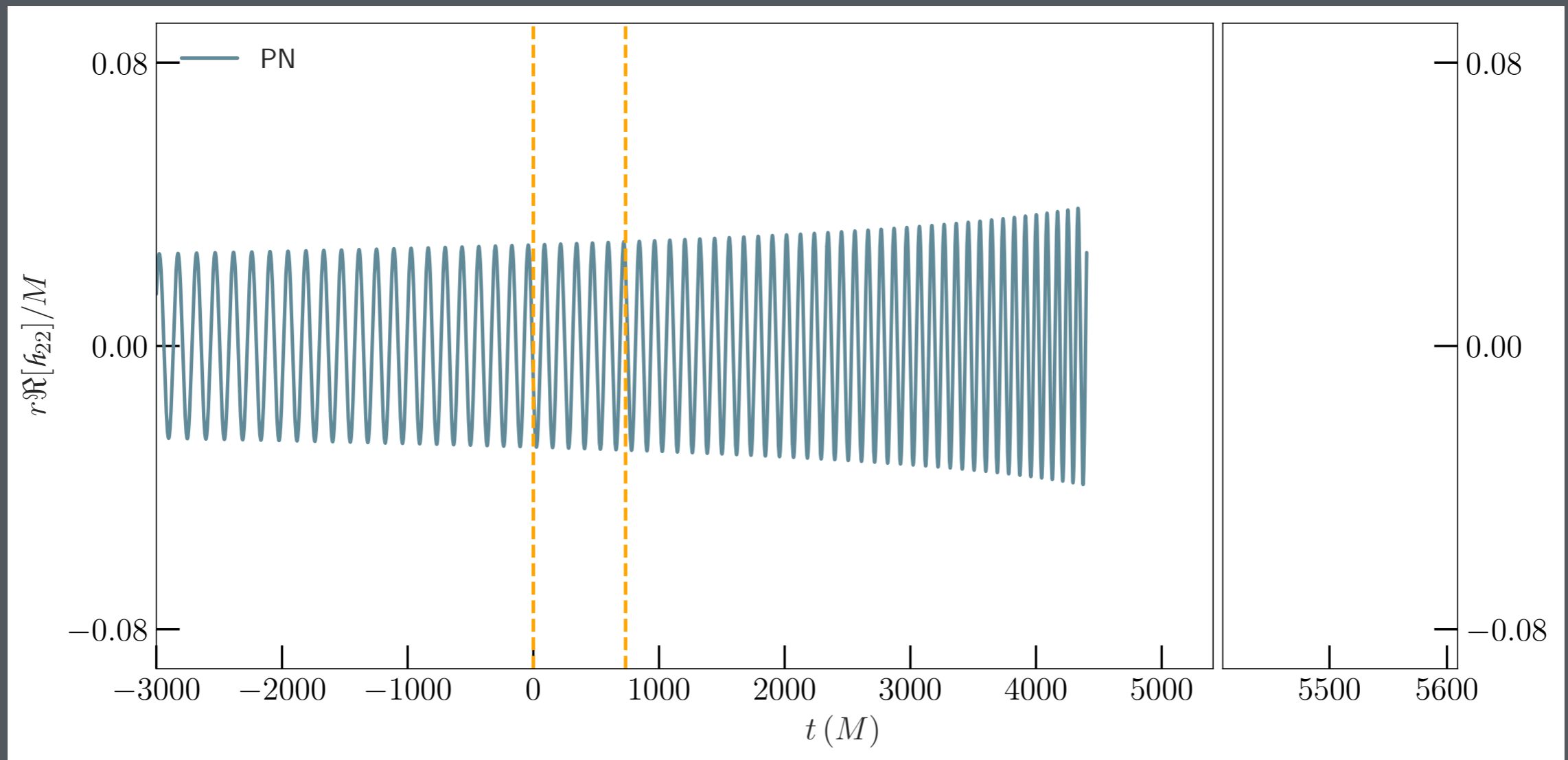
Parameter Distribution



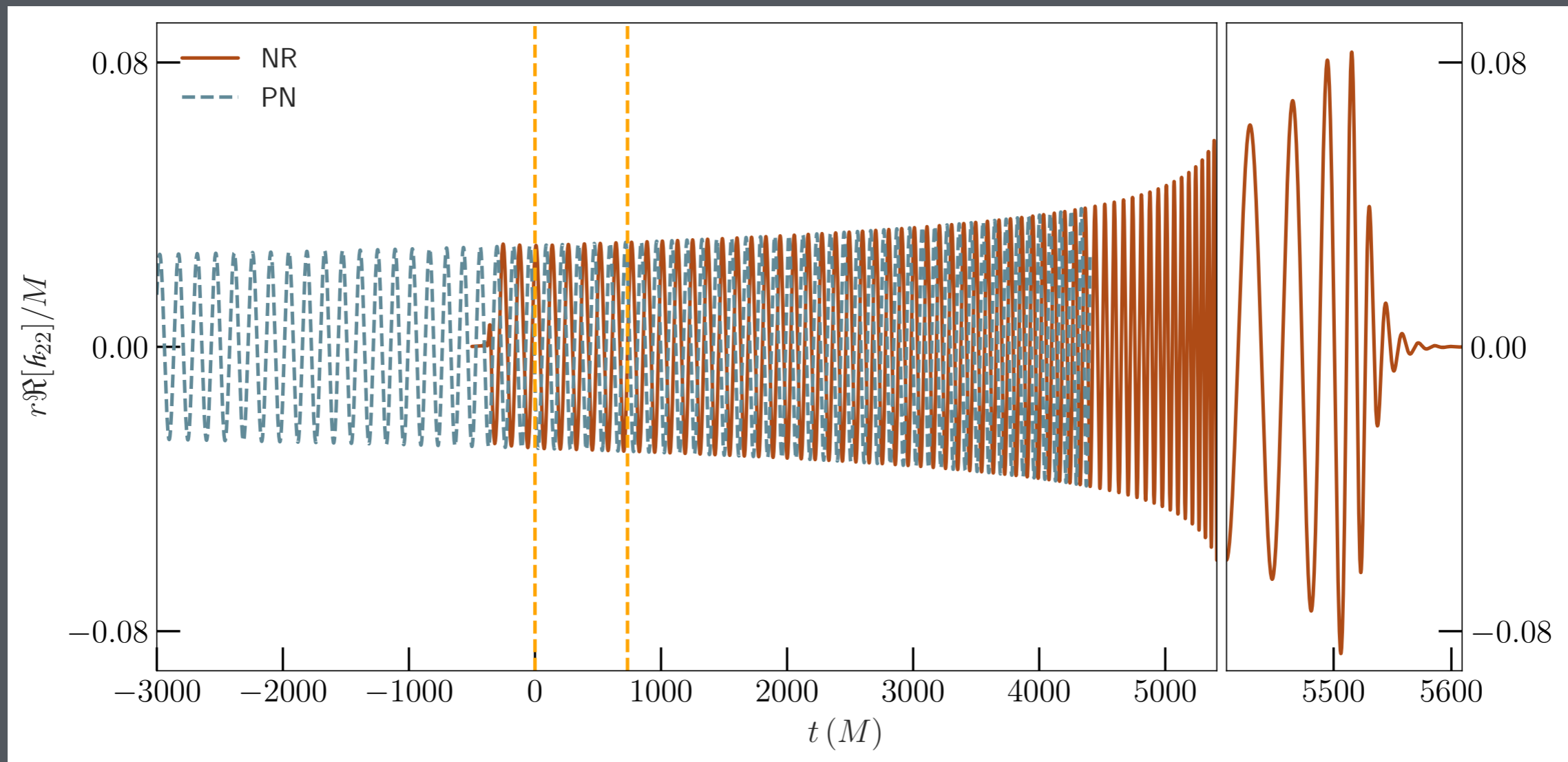
NR Waveform



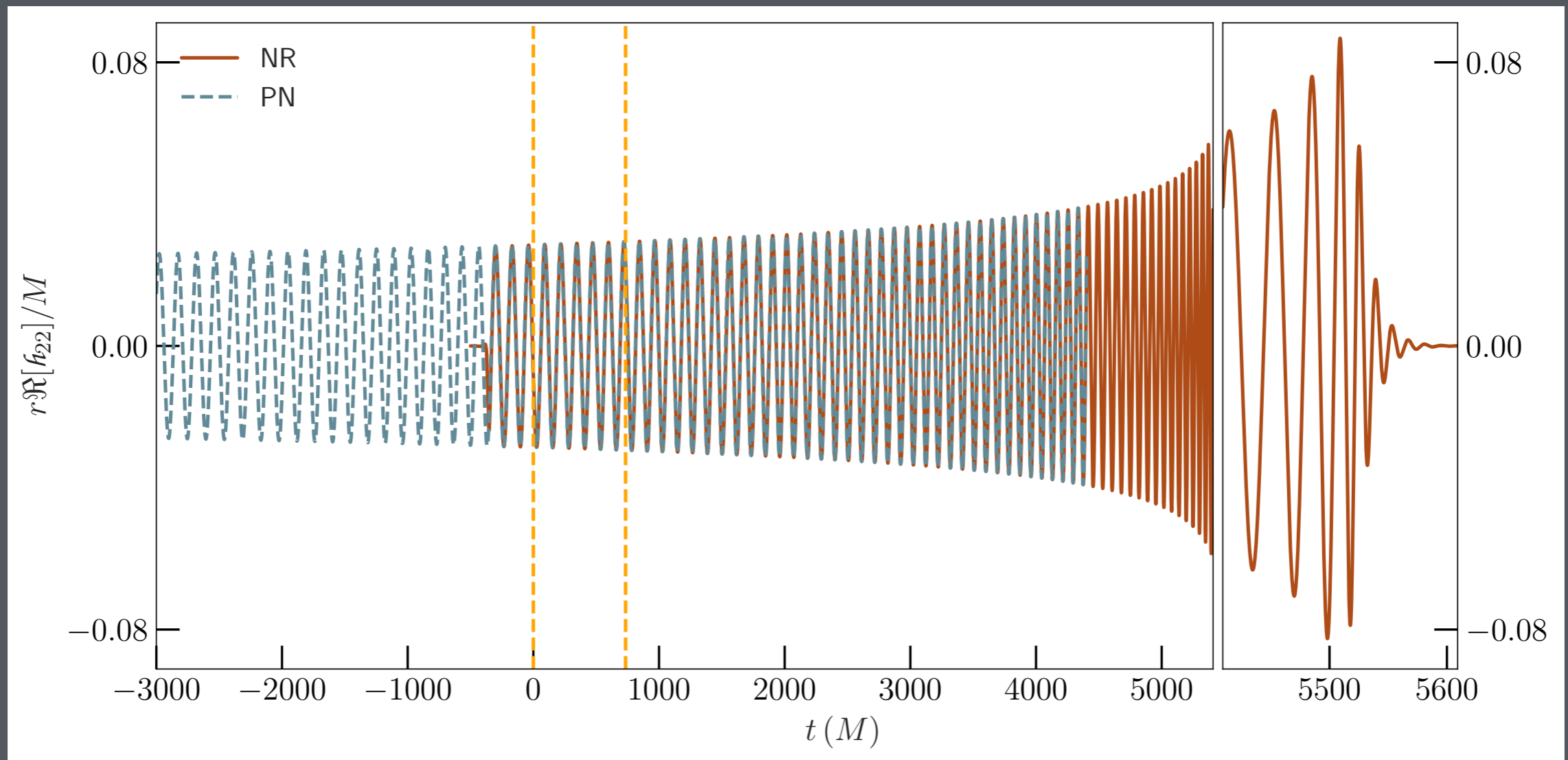
PN Waveform



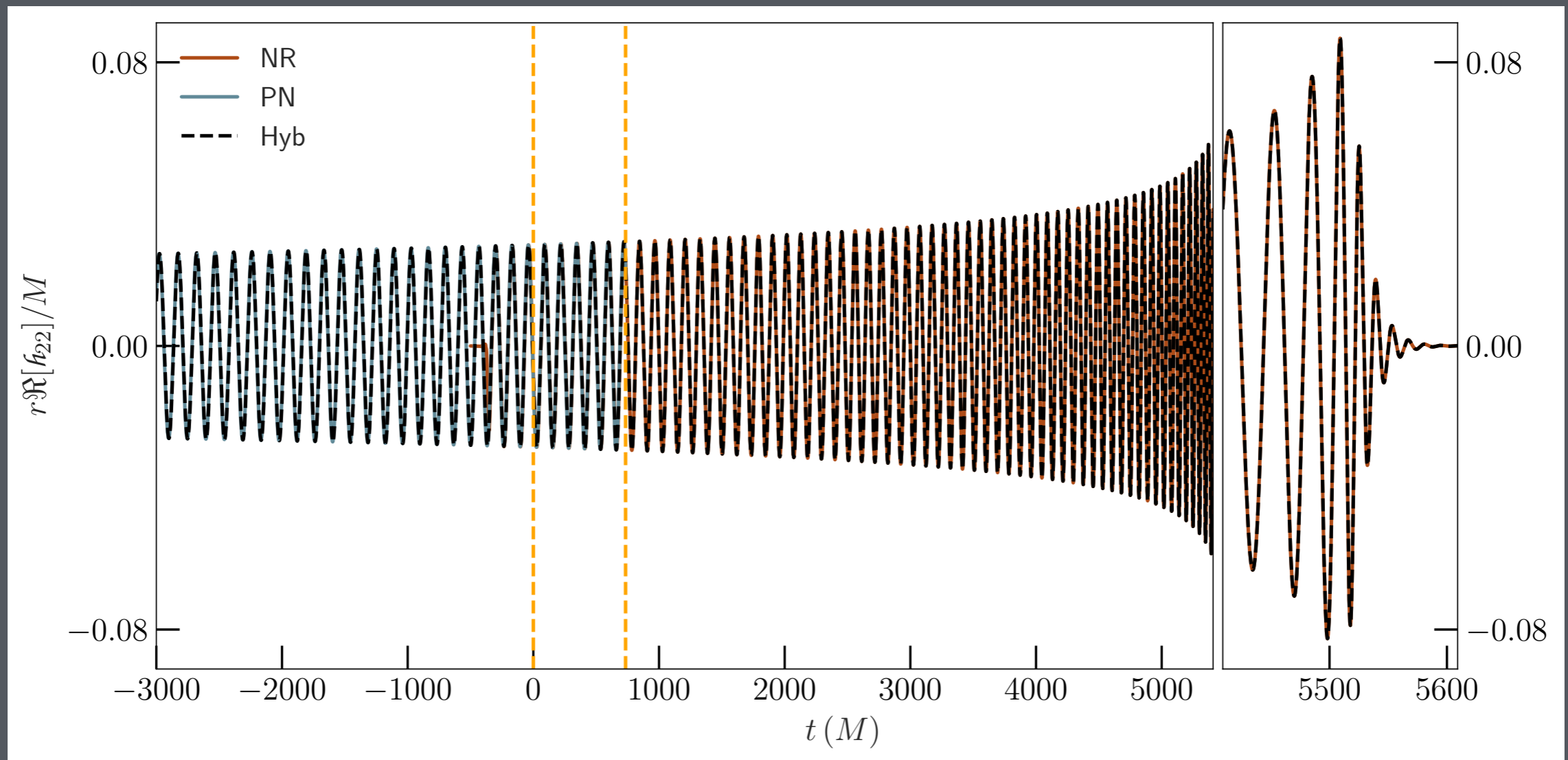
Not Aligned !!!



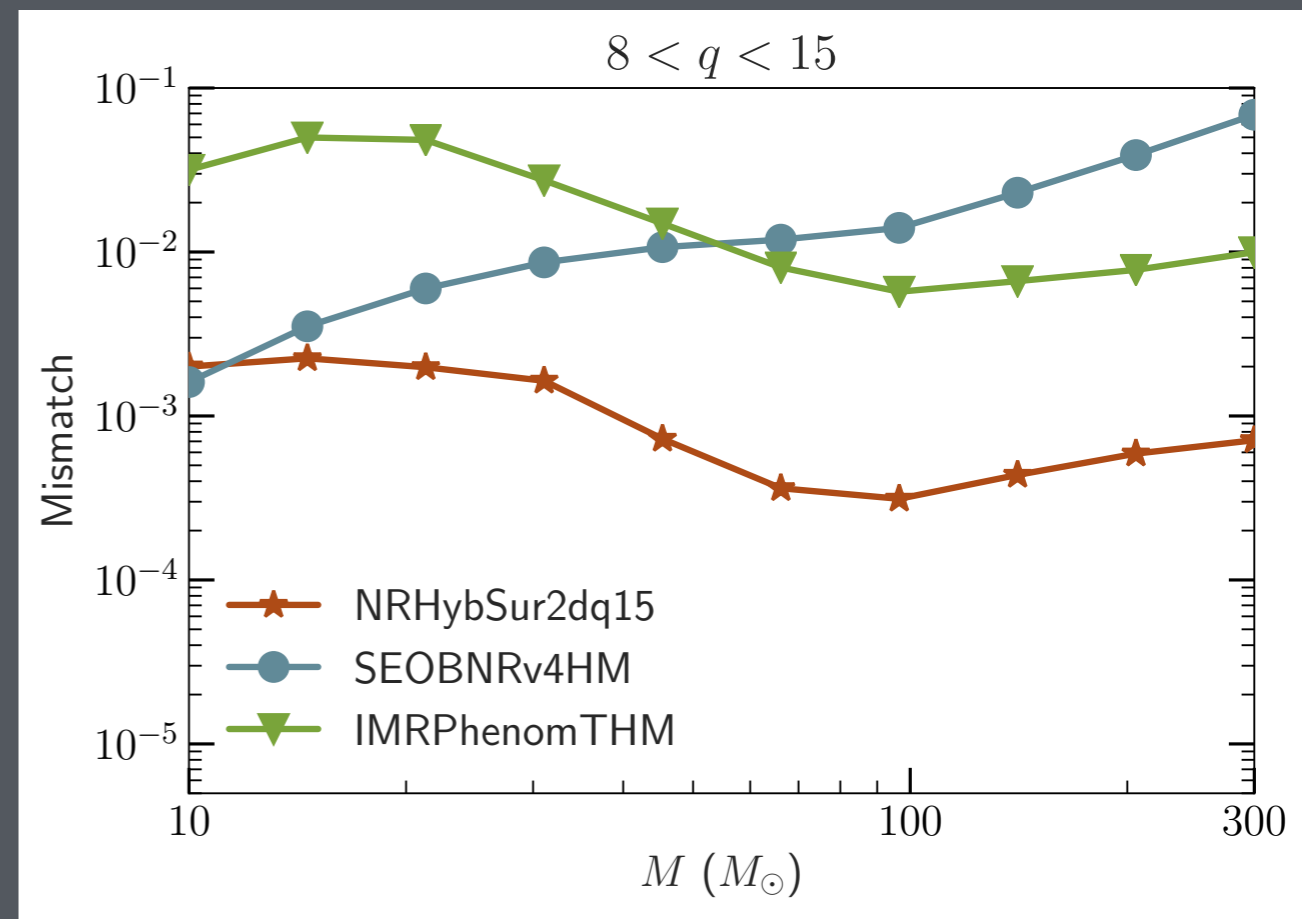
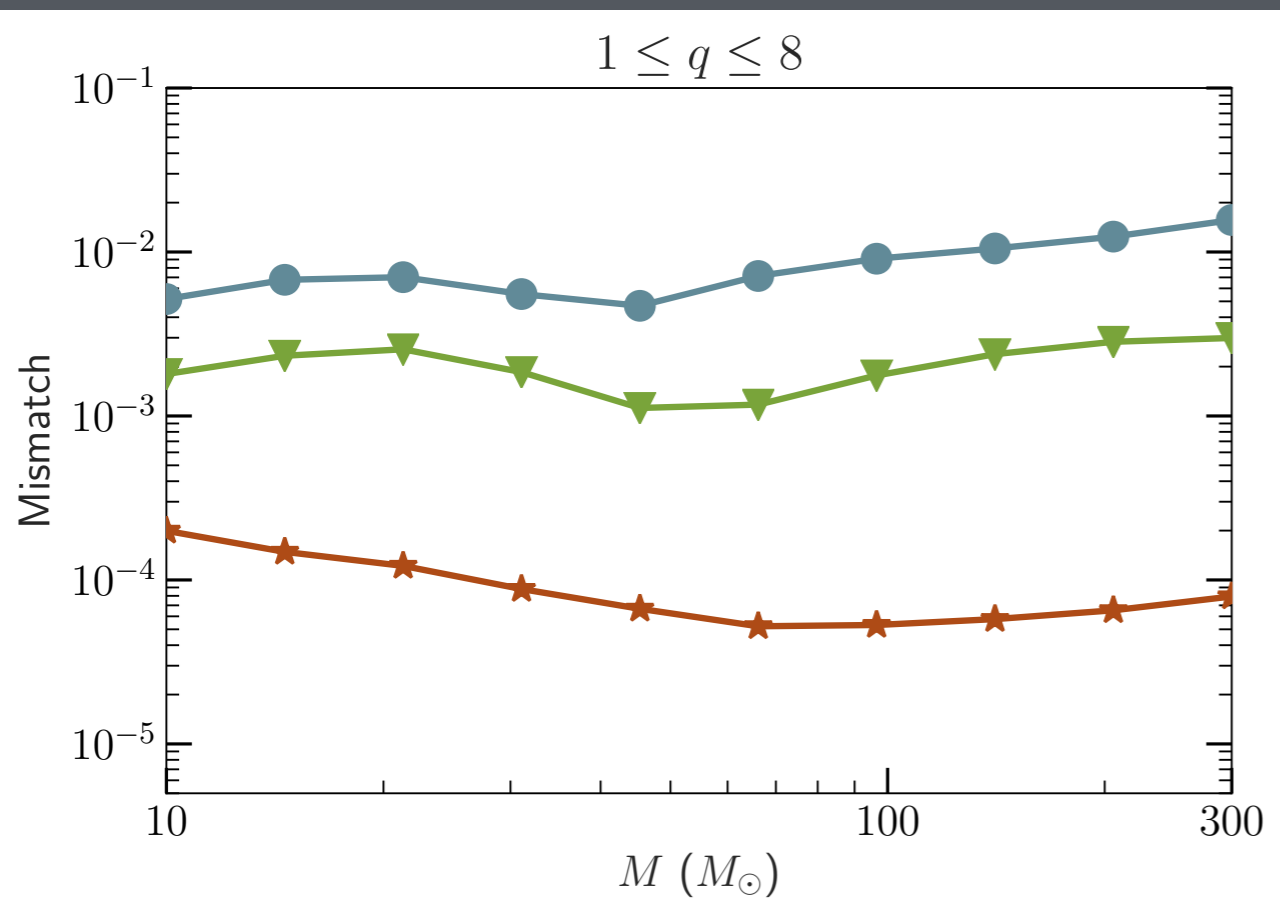
Time/Phase Shift



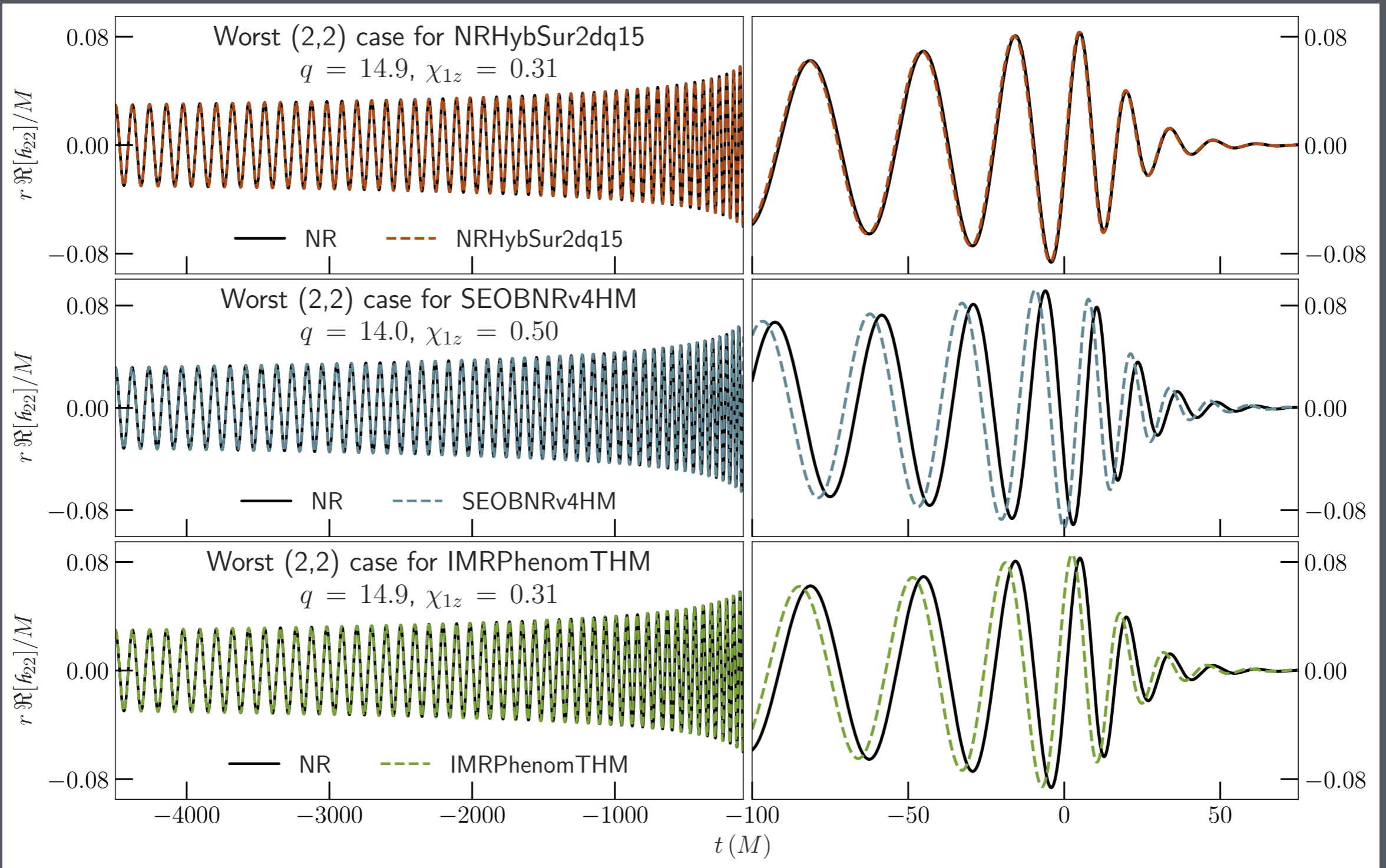
Hybrid Waveform



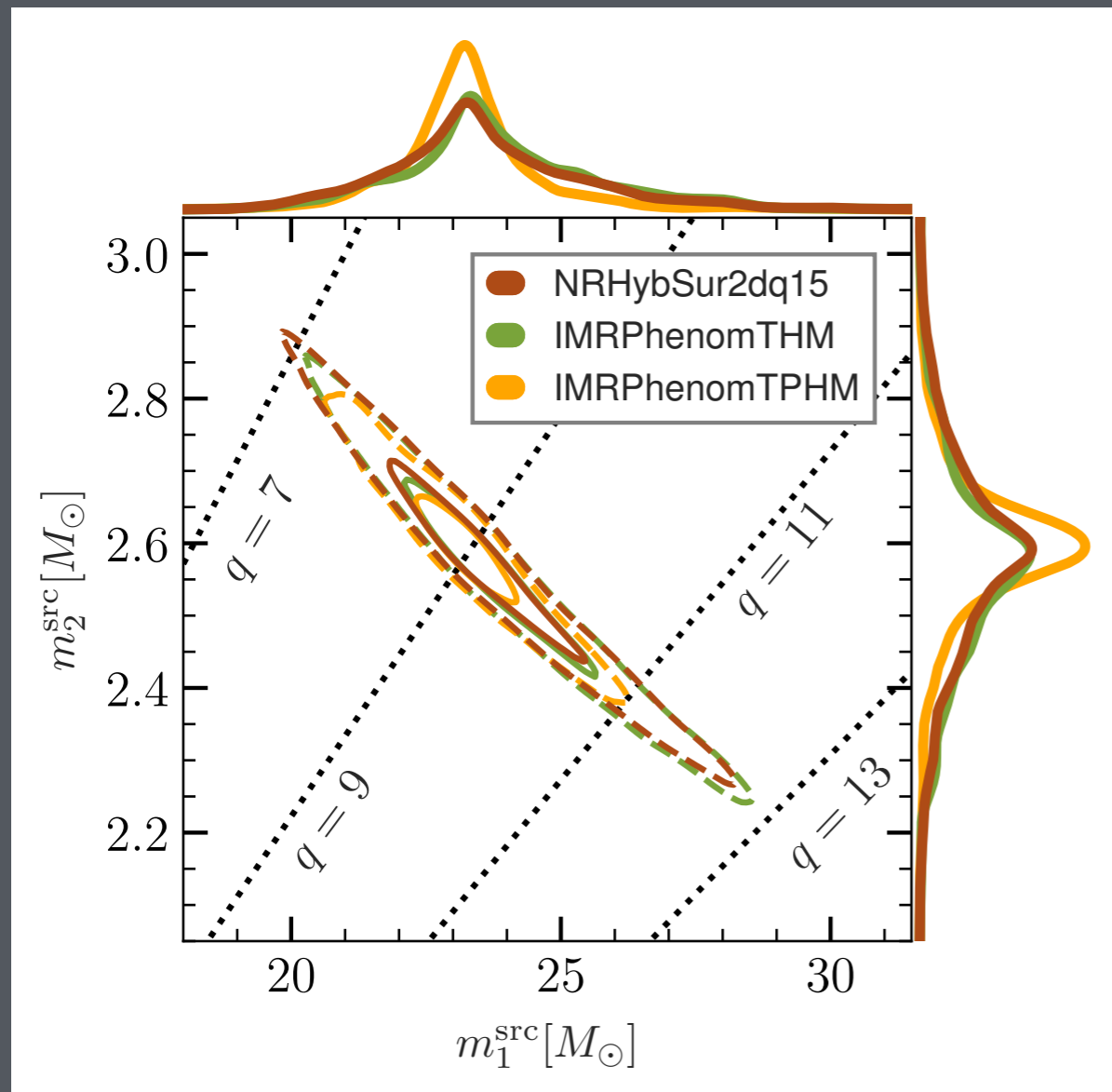
Mismatch



Comparison



Reanalysis of GW190814



- consistent with previous results on detection paper
- precession adds a tighter bound
- need stronger SNR

Summary

- accurate approximate waveform model
- NRHybSur2dq15: 2203.10109
- model is available via [GitHub/gwsurrogate](https://github.com/gwsurrogate)
- re-analysis of GW190814 shows consistent results