Waveform Systematics for Black Hole Binary Mergers Models

Student: Samuel Clyne, University of Rhode Island
Samuel.clyne@uri.edu
Mentor: Dr Michael Puerrer, URI
mpuerrer@uri.edu

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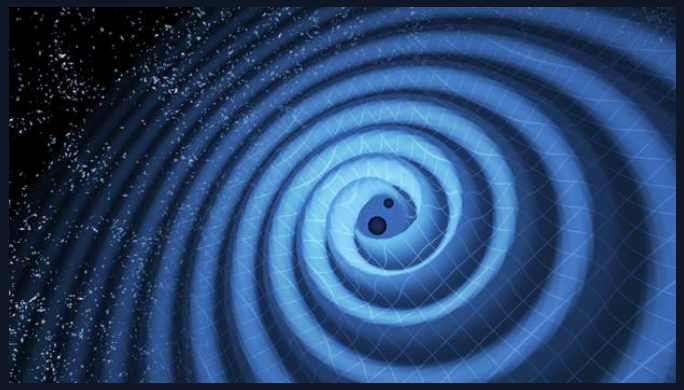
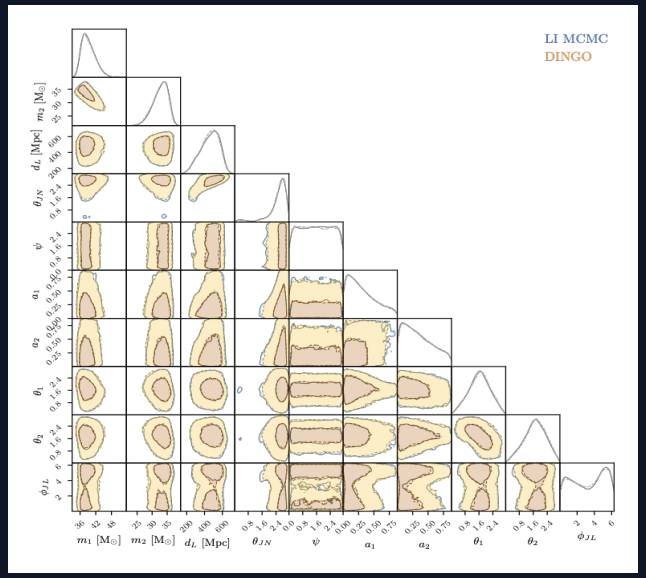
Waveform Systematics for Black Hole Binary Mergers Models

- Black hole mergers can be characterized using gravitational wave data collected at LIGO/Virgo
- Deep Inference for Gravitatational-wave observations (DINGO) leverages neural networks to speed up analysis vs traditional methods
- Training: ~2 weeks (NVIDIA A100)
- Inference: ~ 1 minute [GPU]; ~ hours with importance sampling [CPU]
- Posterior and evidence match with traditional samplers (~ 1 nat)





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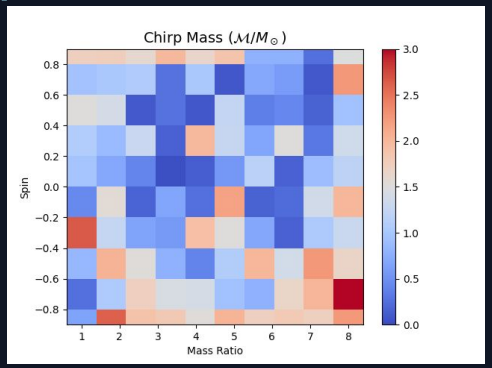
Previous Work

- Imperfections in gravitational waveform models can lead to significant bias in estimating parameters
- Leveraged DINGO networks to analyze many synthetic injections in order to make a visual map of discrepancies between waveforms
- Used simple waveform models (aligned spin, no precession)



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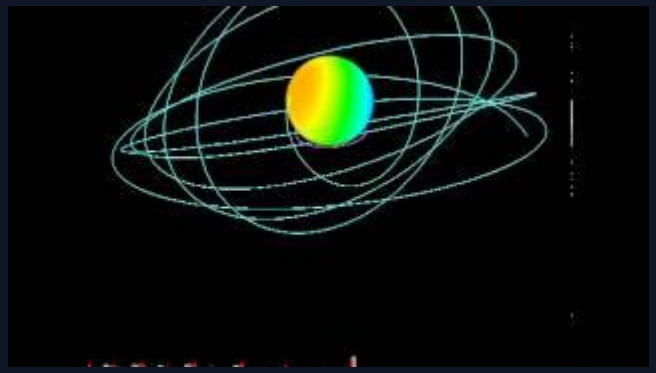
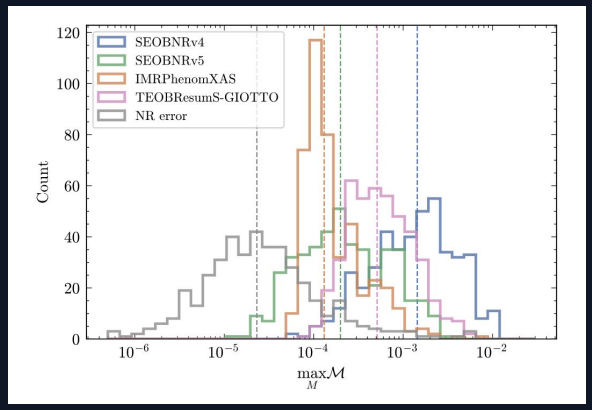
Goals

- Extend previous work creating visual map of model discrepancies to precessing binary systems
- Compute inner product (mismatch) of signals with template waveforms to explore whether metric can predict discrepancies



https://www.youtube.com/watch?v=grA5KfDlsAY&t=1s



Pompili, L., Buonanno, A., Estellés, H., Khalil, M., van de Meent, M., Mihaylov, D. P., ... & Sanchez, J. (2023). Laying the foundation of the effective-one-body waveform models SEOBNRv5: Improved accuracy and efficiency for spinning nonprecessing binary black holes. Physical Review D, 108(12), 124035.

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- Timeframe
  - Start Date: April 1, 2024
  - End date: June 30, 2024

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What I hope to learn

- A deep understanding of the different approximations used in waveform models and their impacts on parameter estimation
- Gain experience training and utilizing complex neural networks efficiently

Waveform Systematics for Black Hole Binary Mergers Models

- Goals for Next Month
  - Begin Inference for new DINGO models
  - Generate python script to compute waveform mismatches across study parameter space

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