

Revealing high-dimensional correlations in realistic gravitational-wave populations using non-parametric PixelPop



- 1 How can we capture the complex, high-dimensional correlations expected in realistic astrophysical populations?
- 2 What is the effect of neglecting correlations between parameters?
- 3 Can we extract astrophysical insights from nonparametric inference? If so, which ones?

Come see our poster to find out!

Sofia Alvarez-Lopez, Jack Heinzl, Matthew Mould, Salvatore Vitale

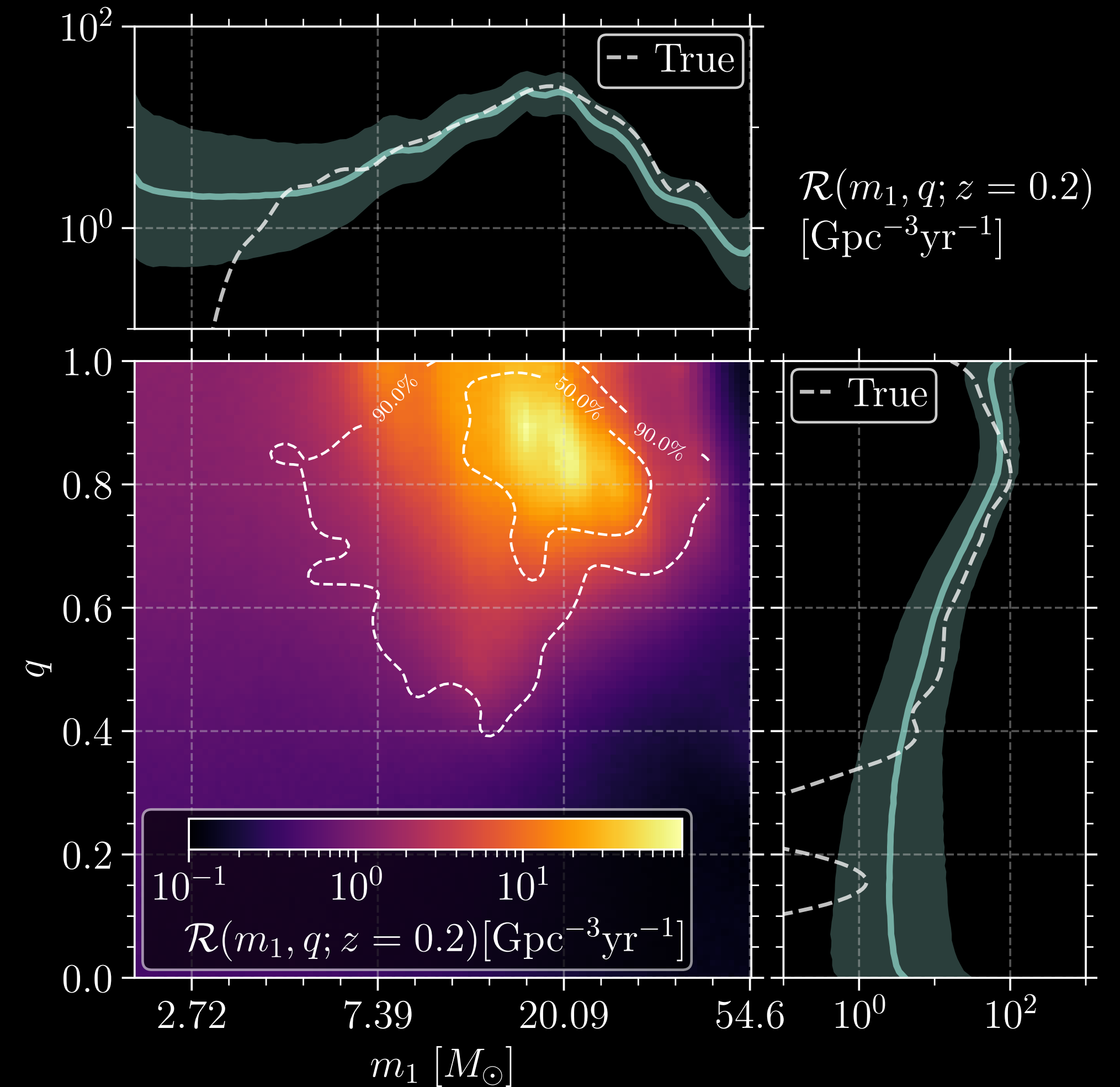


A small teaser...

1 We can! But our models must be very sophisticated to capture the correlations.

2 Biases start to show up. How to overcome them?

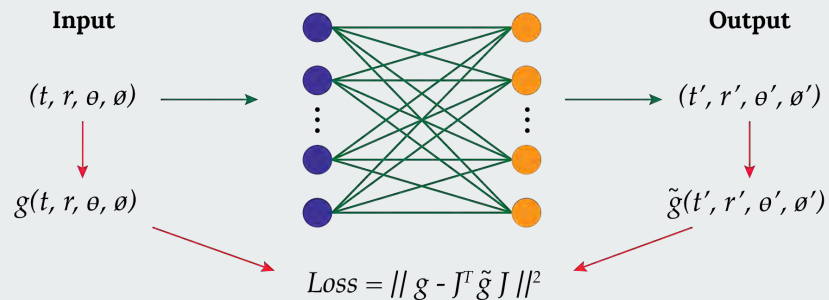
3 We came up with a model-independent method to compare the similarity of astrophysical populations with nonparametric results. Come see our conclusions!



Identifying Spacetimes in General Relativity using Neural Networks

Estuti Shukla, The Pennsylvania State University

- Given two solutions of Einstein's equations, can we tell if they are equivalent?
- We present a deep learning approach aimed at identifying diffeomorphism between equivalent spacetime metrics.
- We find a mapping between a spherically symmetric 1D puncture and analytical form of the Schwarzschild metric.
- This approach can potentially be used to cross-validate puncture results between different numerical relativity codes such as GRATHENA++ and SpECTRE.



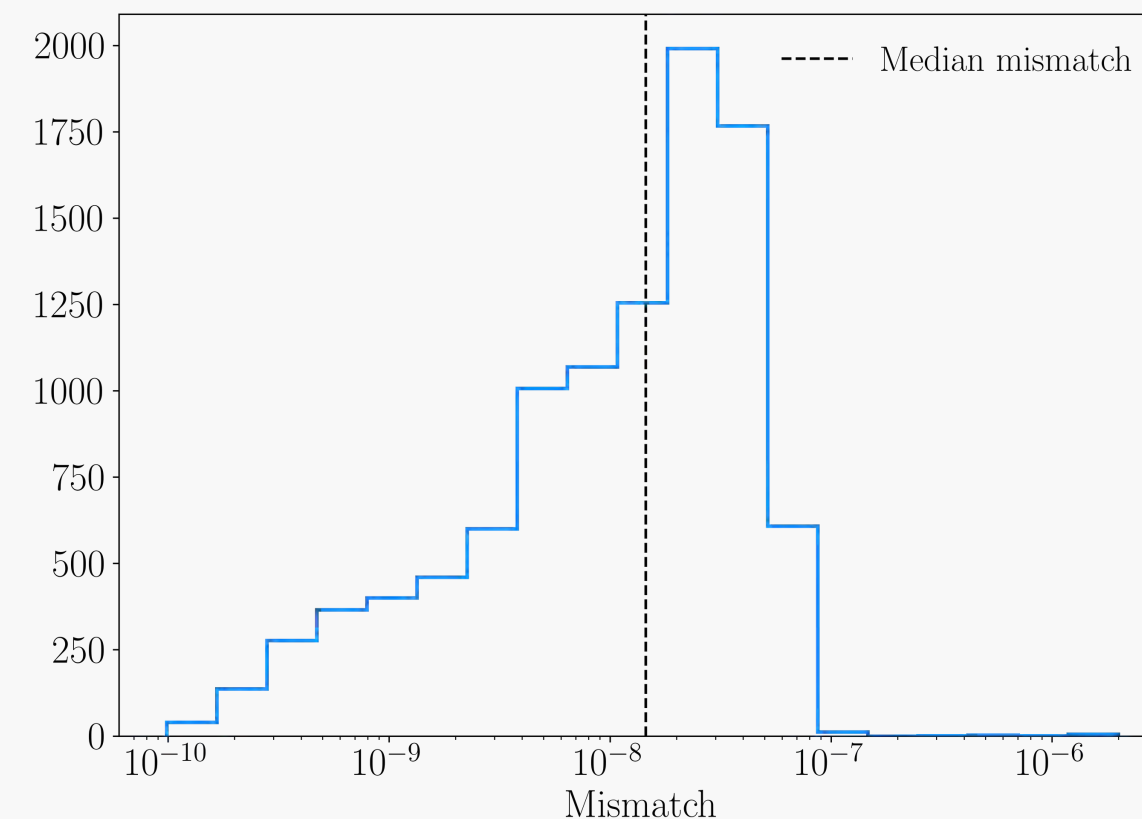
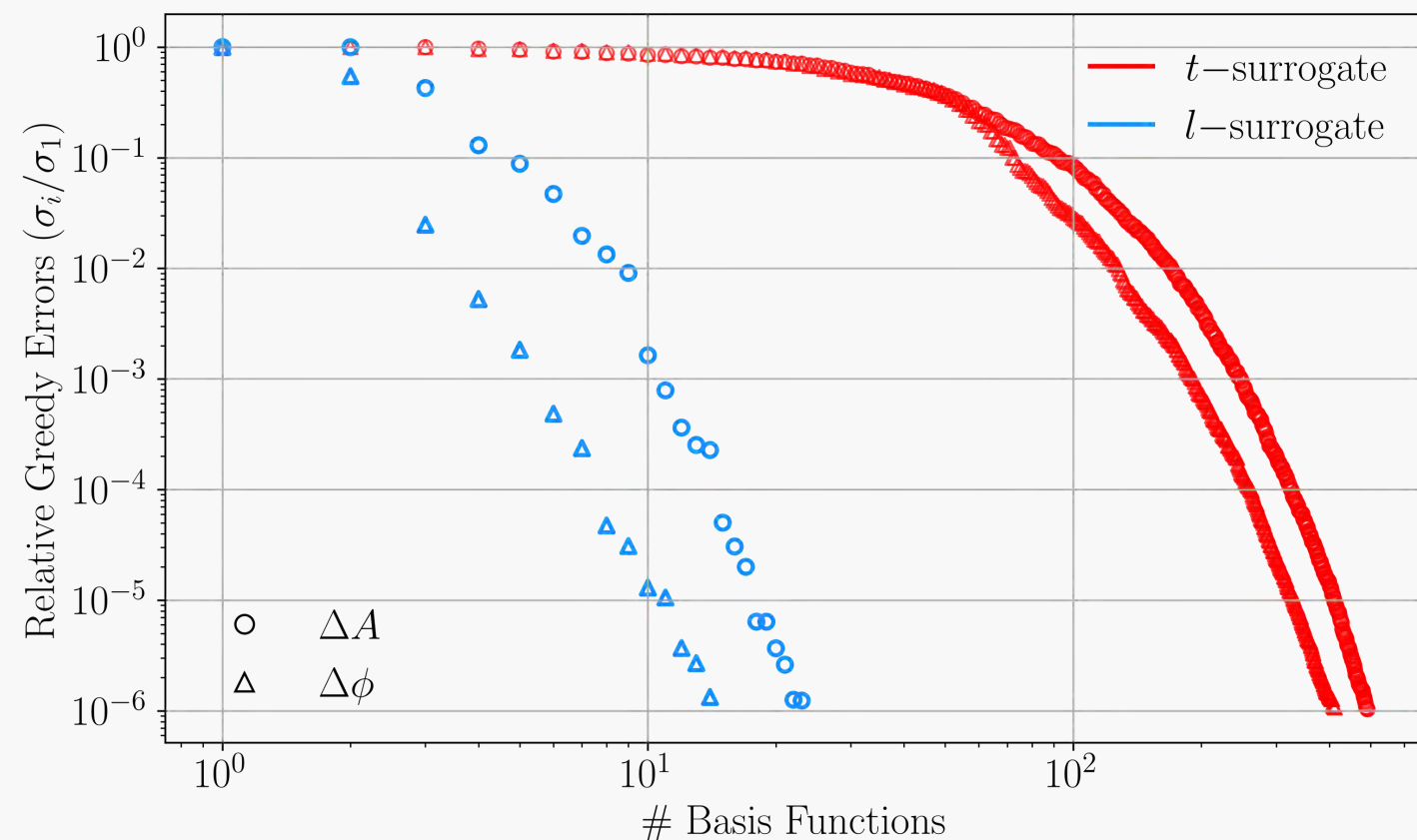
Surrogate Modeling for Long Eccentric BBH waveforms

Akash Maurya,¹ Prayush Kumar,¹ Kaushik Paul,² Chandra Kant Mishra² and the SXS Surrogate Modeling group

¹International Centre for Theoretical Sciences (ICTS), Bengaluru, India

²Indian Institute of Technology Madras, Chennai, India

- We develop a novel parameterization of waveform data-pieces in terms of **mean anomaly** instead of **time**.



Number of basis functions and mismatches for a **~2,000,000M** long eccentric surrogate

- This new parameterization requires **~20x fewer surrogate basis functions**, while remaining **faithful** to the parent waveform model.

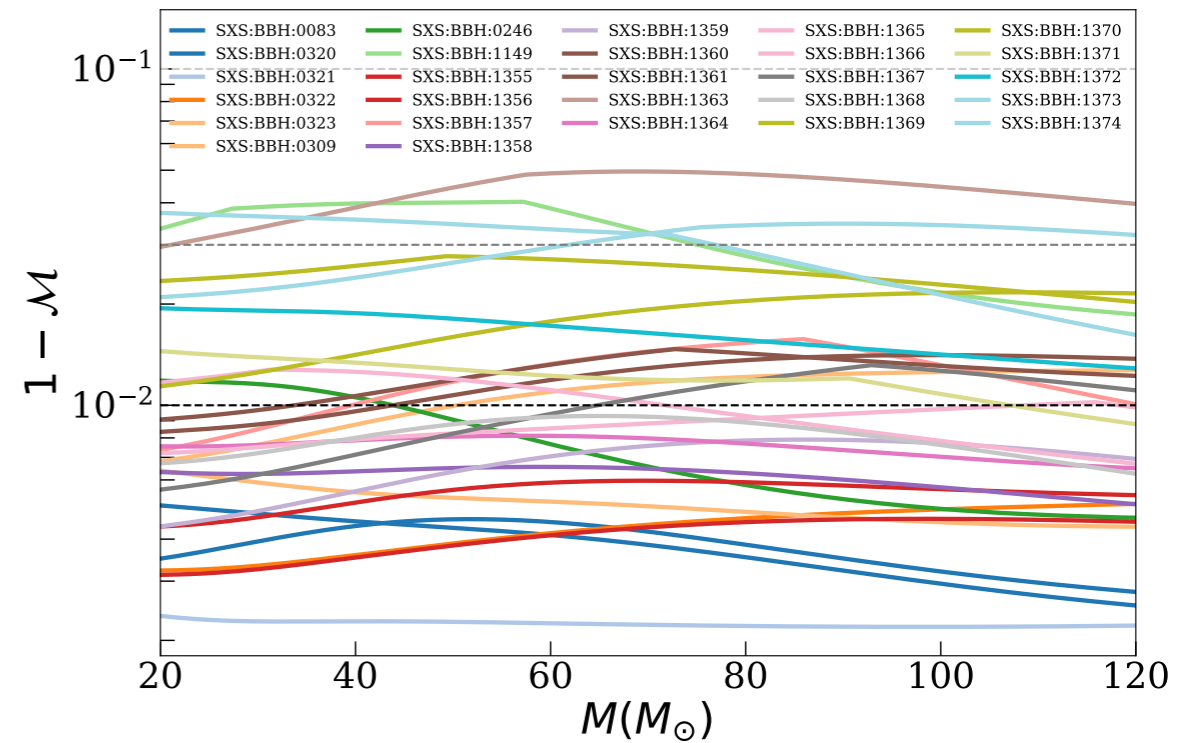
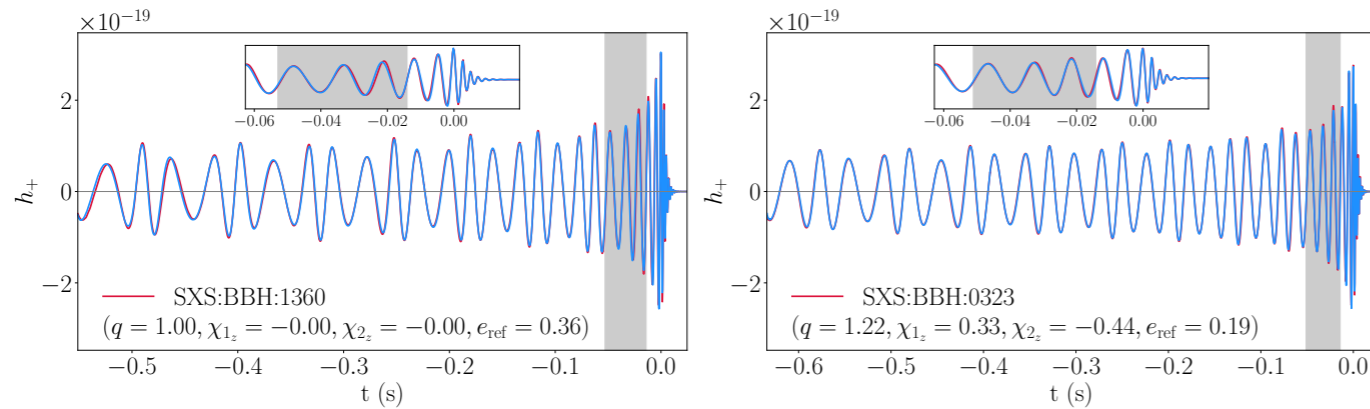


ESIGMAHM

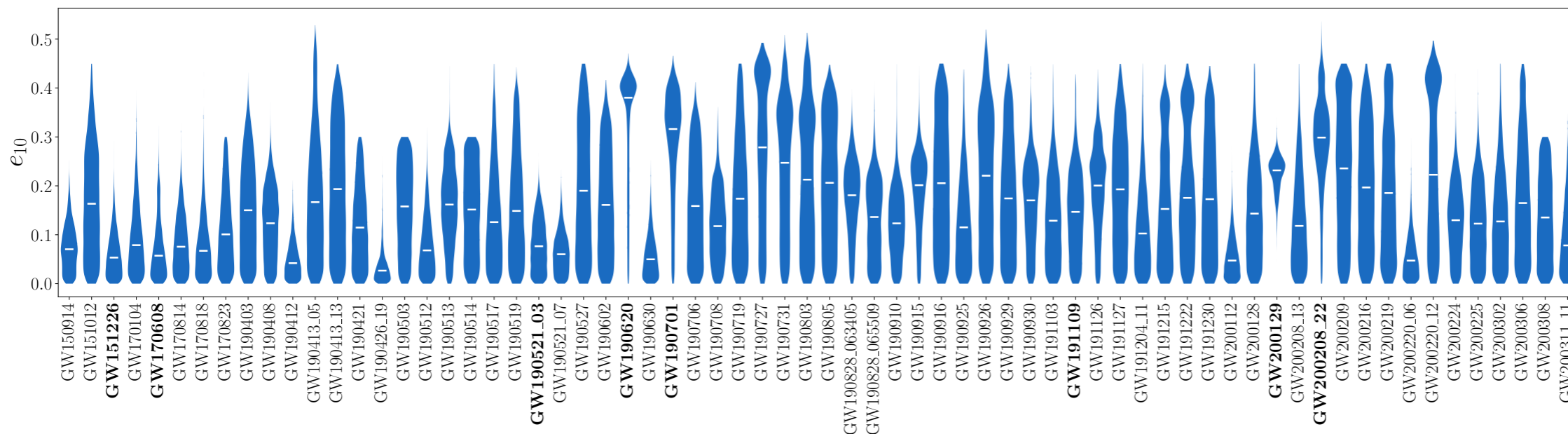
(K. Paul, A. Maurya et al. *Phys. Rev. D* 111, o84074)

InspiralESIGMAHM + NRSur7dq4
(PN+ BHPT/SF)

IMRESIGMAHM
 $(\ell, |m|) = (2,2), (2,1), (3,3), (3,2), (4,4), (4,3)$



Parameter estimation



Details of the model and Parameter estimation results presented on the Poster! →

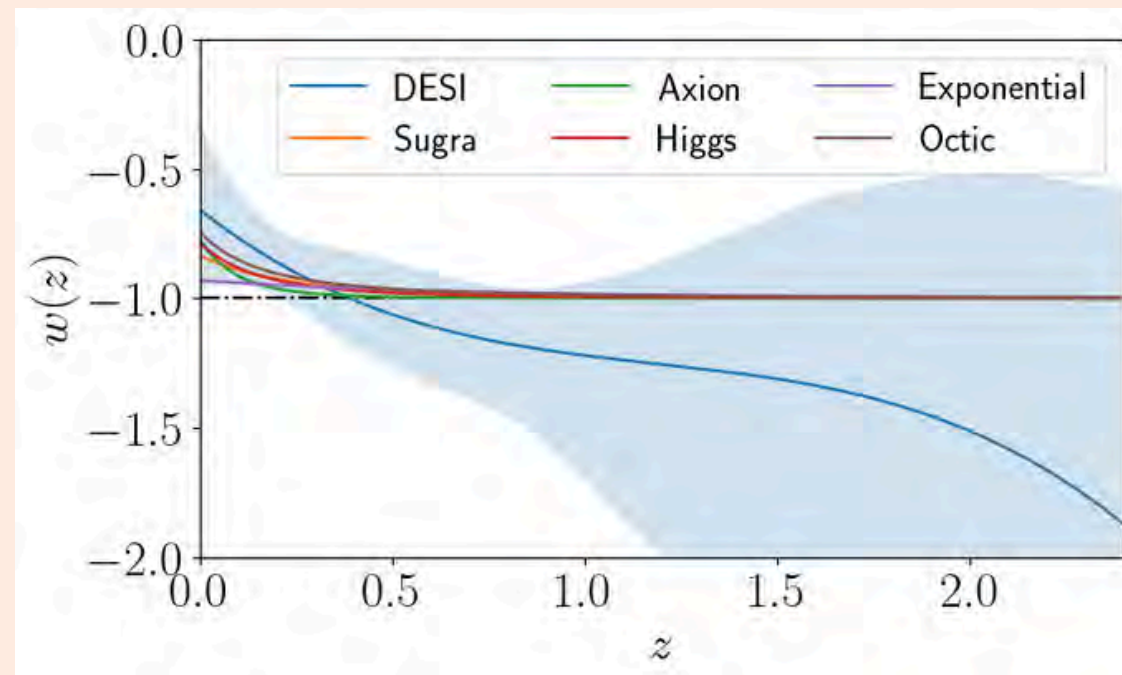


Interpretable Machine Learning for Dynamical Dark Energy Models

by Giulia Borghetto 

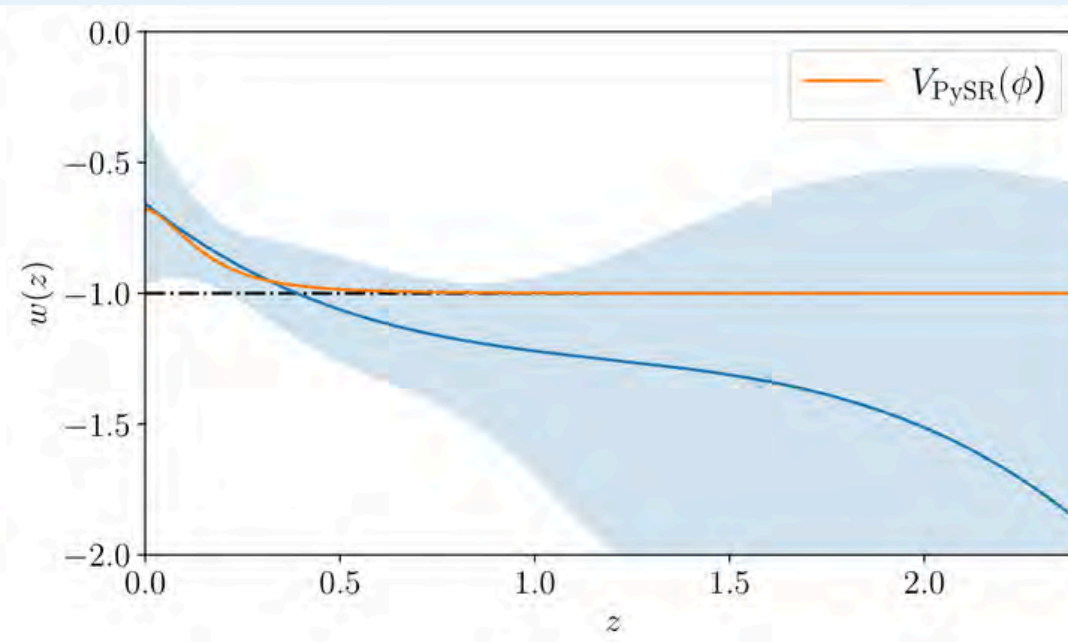
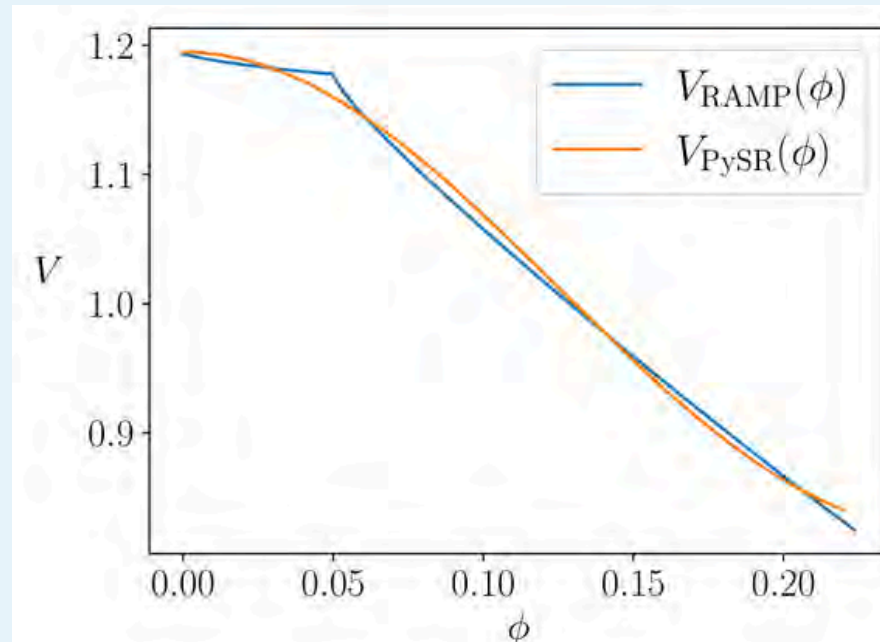


Swansea
University
Prifysgol
Abertawe



Motivation:

- Recent cosmological observations from DESI suggest dynamical dark energy
- Quintessence is a promising model but there is a vast landscape of quintessence potentials
- Can machine learning help identify a valid potential directly from data?



Method:

- Symbolic Regression can learn symbolic models from data
- What is the most meaningful way to use the data and ensure physical interpretability?

On the Generalization Ability of Deep Learning Networks in Gravitational Wave Detection

Paola C. M. Delgado

CEICO – Czech Academy of Sciences

In collaboration with Lucca Fazza



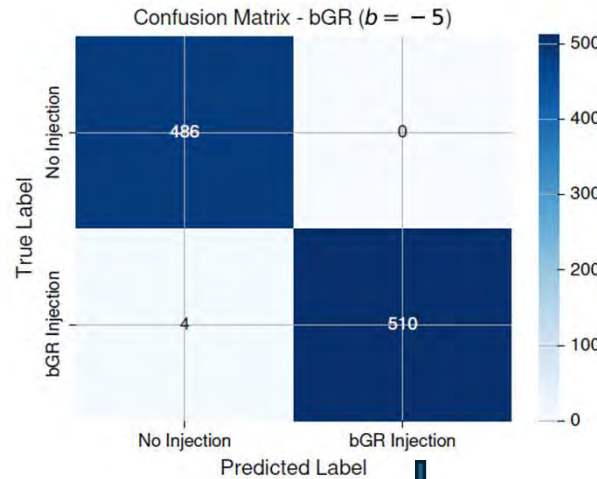
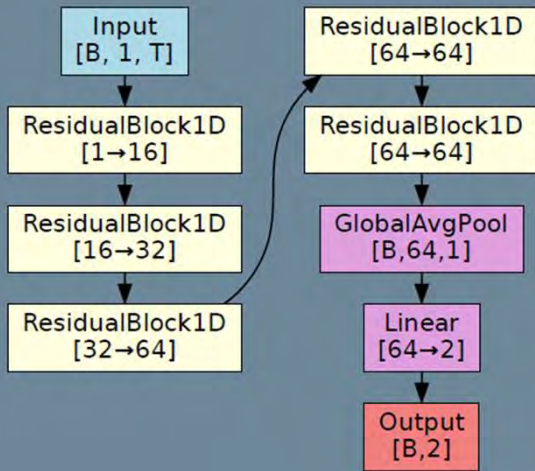
How well can a Neural Network (NN) trained on General Relativity (GR) injections perform on beyond GR (bGR) signals? What can it learn about bGR physics?

Parametrized post-Einsteinian (ppE) waveform:

$$\tilde{h}_p(f) = \tilde{h}_p^{\text{GR}} e^{i\Psi_{\text{GR}}} \left[(1 + \alpha u^a) e^{i\beta u^b} \right]$$

$$u \equiv (G_* M_c \pi f)^{\frac{1}{3}}$$

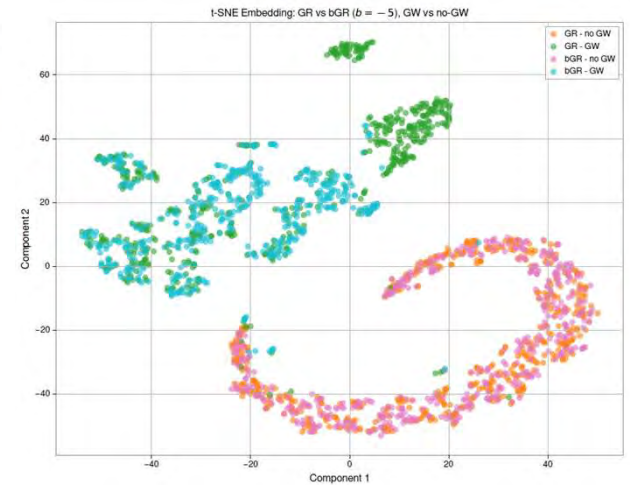
Neural Network architecture:



The GR-trained NN performs well on bGR signals (with amplitude and phase modifications)

The NN clusters noise, GR and bGR somewhat separately

Preliminary results ⚠



Ongoing analysis

- How does the size of the training set affect the results?
- How do different NN models generalize to bGR?
- How do the results change for different values of the ppE parameters a and b ?
- What physics has been learned/generalized by the NN?

