# GRASP24

# Advertisement Session 1

October 23rd

# Low-cost ML Tools for Understanding Gravitational Wave Processes

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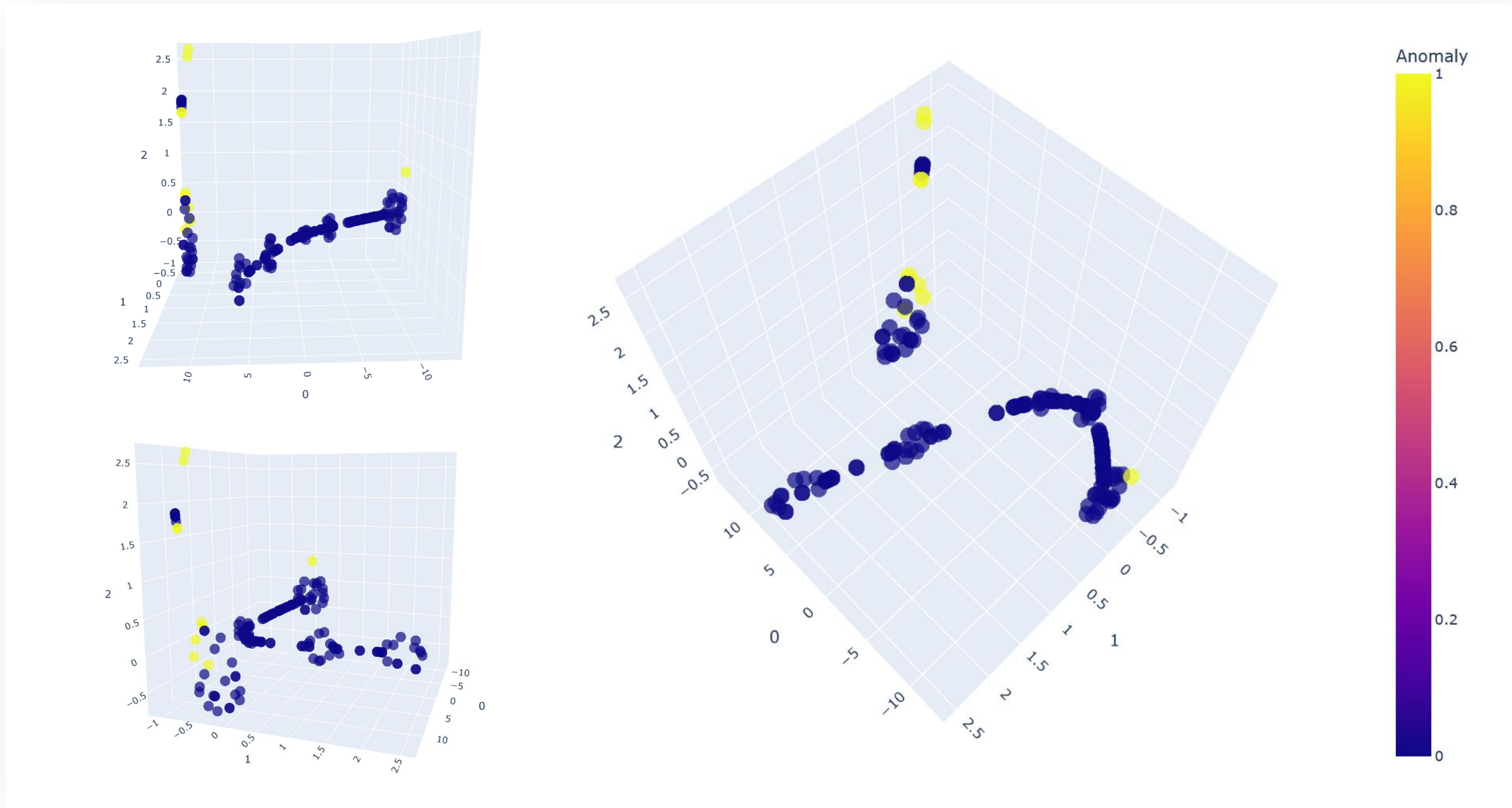
**Background:** In this study, we explore gravitational wave processes by utilizing the GW Transient Catalog and Events dataset. Our primary goal is to democratize data analysis in astrophysics by employing low-cost machine learning tools. By doing so, we aim to make these advanced analytical methods accessible to researchers who may not have access to high-end computational resources. This approach encourages broader participation in astrophysics research and fosters innovation in the field.

**Result 1:** The graph displays clusters from k-means clustering using **Transient** data.


**Result 2:** The 3D graph displays anomalies using **Events** data.

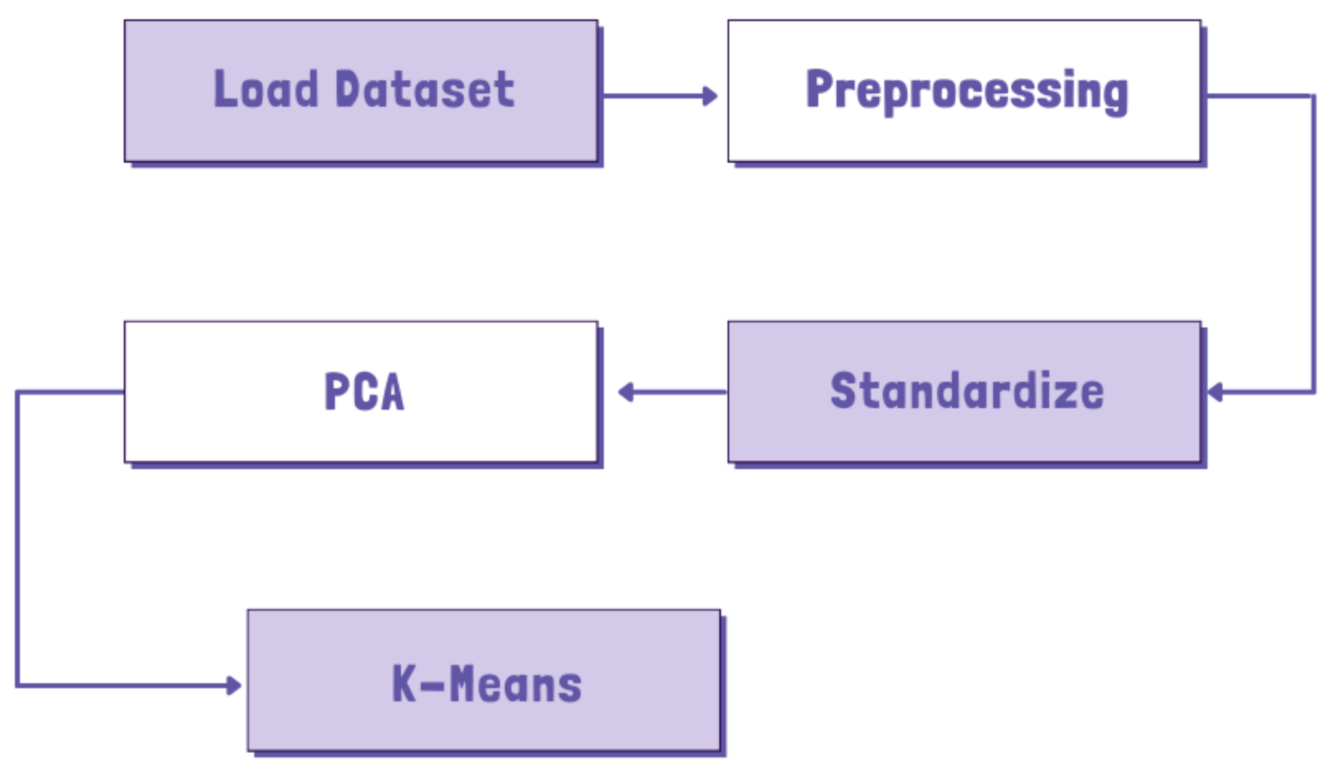



## Methods and Tools

Python

Machine Learning

FLOWCHART




**Limitation:** Missing or incomplete data can skew results and lead to inaccurate interpretations. Additionally, the high dimensionality of the datasets complicates the identification of meaningful patterns or anomalies, as many algorithms struggle to effectively process and visualize such complex data structures.

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# Spectroscopy of magnetized BHs and topological stars

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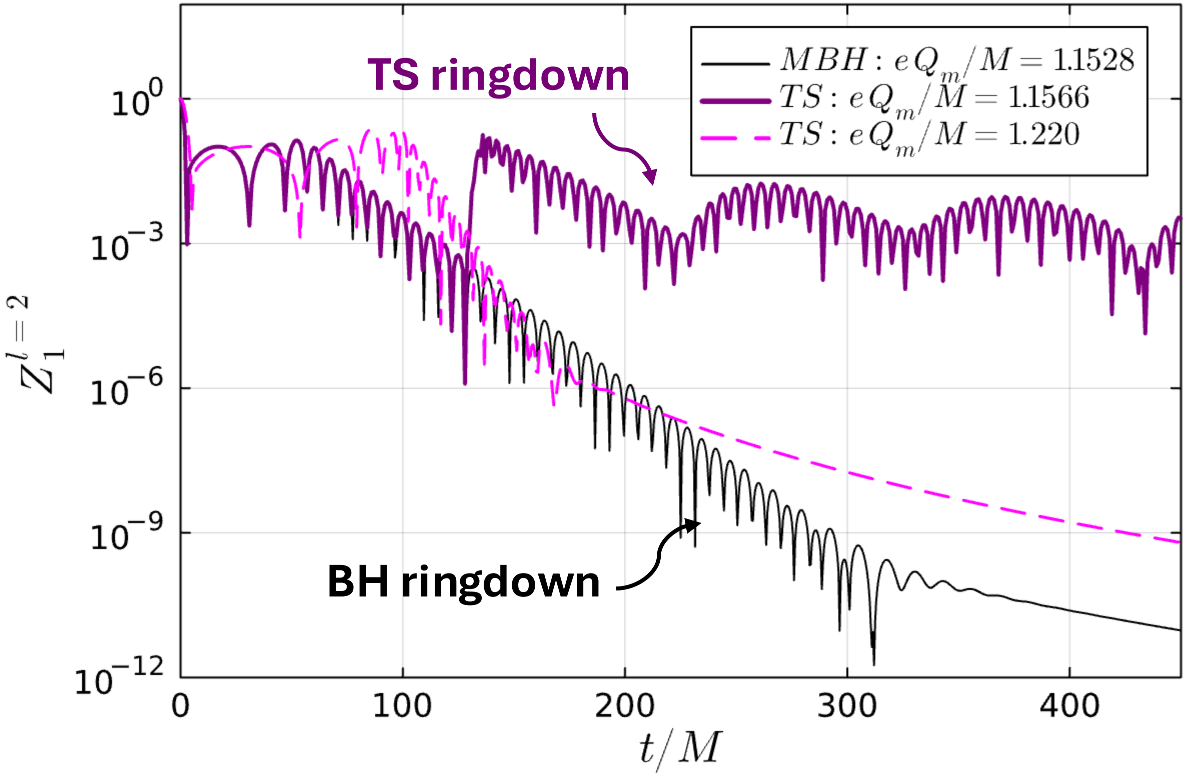
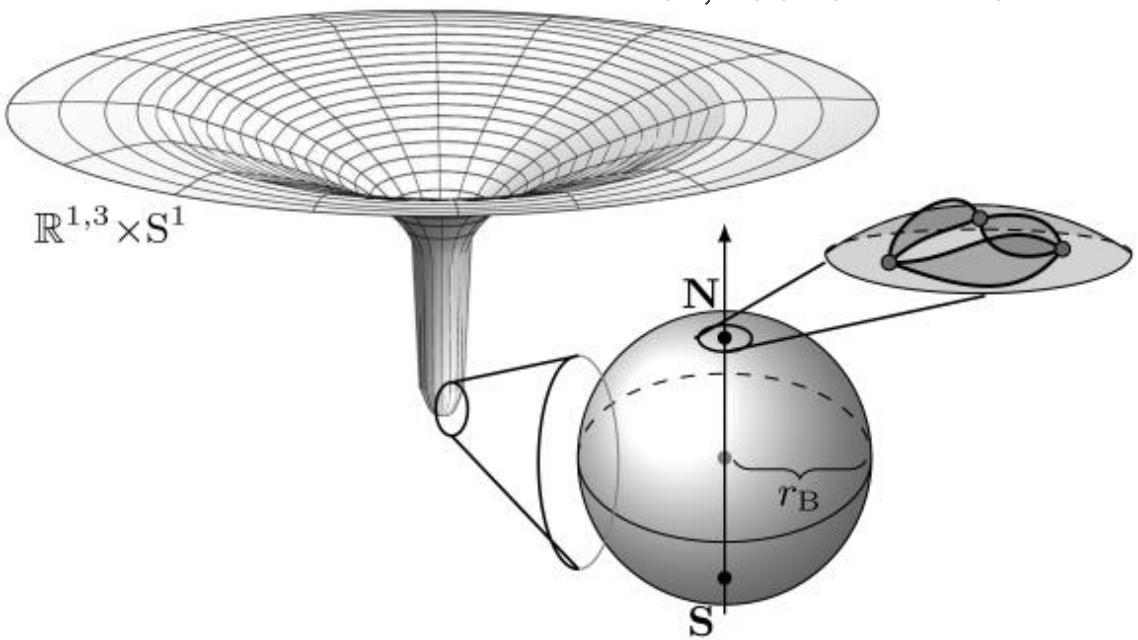



Bah, Heidmann *PRL* 2021




arXiv:2406.19327 (*PRD in press*) with **A. Dima** and **P. Pani**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TEONGRAV

# *Gravitational waves from compact binary systems beyond General Relativity via Effective Field Theory*

Nicola Bartolo, Pierpaolo Mastrolia, Matteo Pegorin, Angelo Ricciardone

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Funded by the European Union NextGenerationEU

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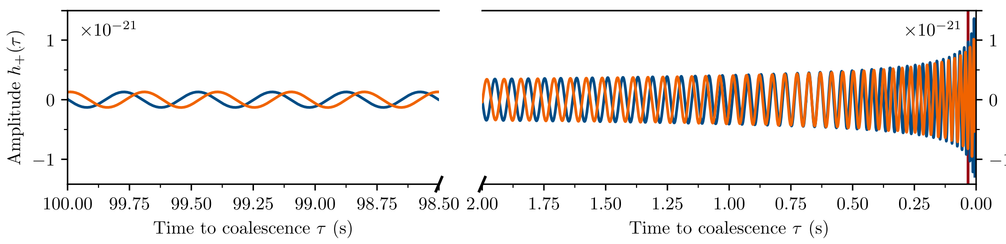
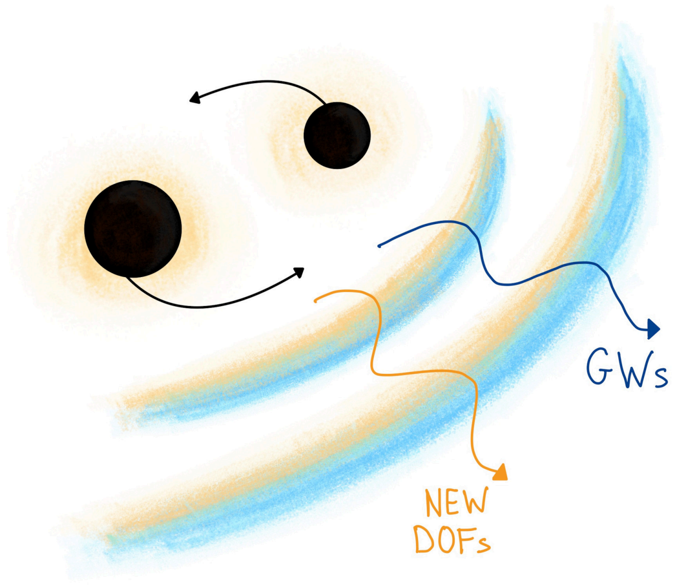
→ Computing *gravitational waveforms*

→ (also) in theories *beyond General Relativity**

→ via *Effective Field Theory*.

*caveats may apply.

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# Non-adiabaticity of gravitons during inflation

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**Cosmological Gravitational Wave Background (CGWB) generated by the quantum fluctuations of the metric**

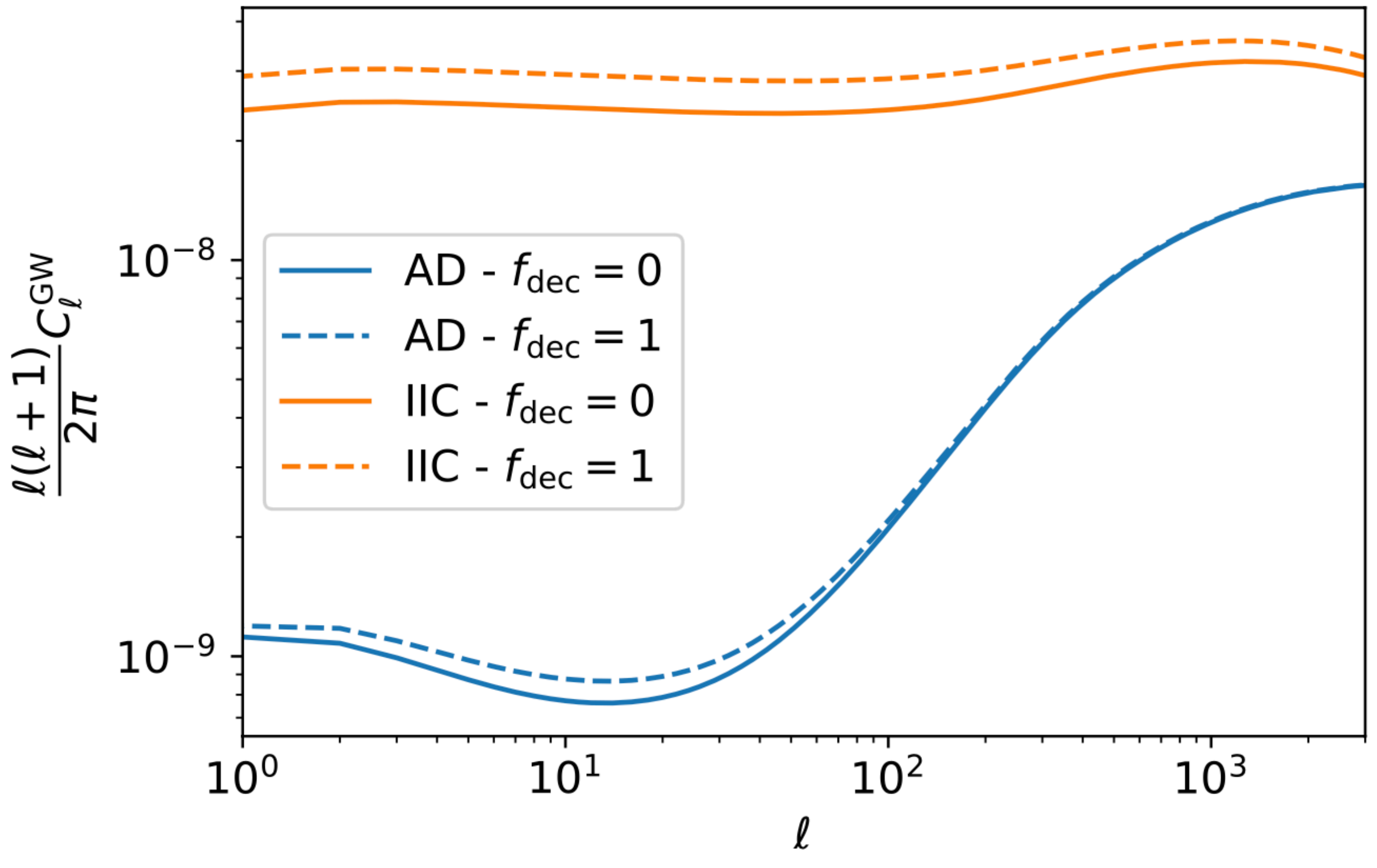
two independent degrees of freedom

(two polarizations of the tensor perturbations)

$$h_{ij}$$

**Any CGWB generated by the quantum fluctuations of the metric during inflation has an intrinsic non-adiabatic perturbation, even in single-field models of inflation.**

$$\delta_{\rm GW} \neq \delta_\gamma$$




*Alina Mierna, PhD Student,*
*Università degli Studi di Padova*

# A novel numerical library for $\nu$-matter interaction rates in Binary Neutron Star Mergers

**Chiesa L.**, Bhattacharyya M., Mazzini F., Guercilena F.M., Perego A. and Radice D.

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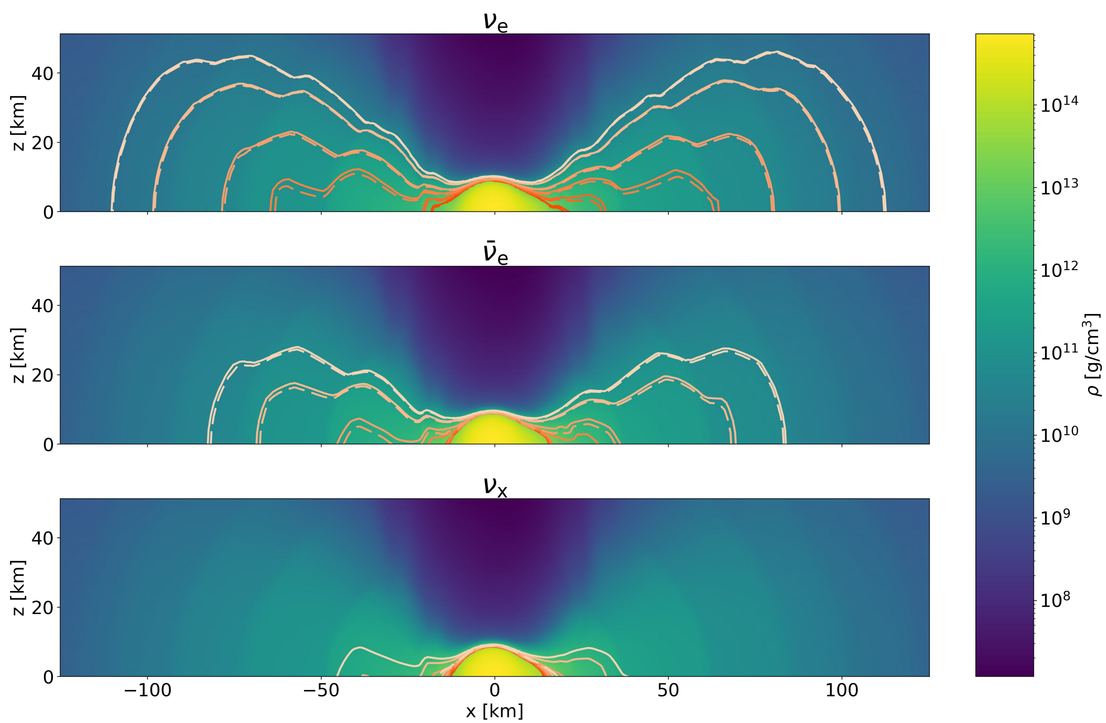
## Neutrinos in Neutron Star Merger simulations

Energy and momentum exchange with matter

Post-merger remnant stability

Disk matter ejection




*n*-to-*p* ratio ⇒ *r*-process nucleosynthesis

Neutrino-powered sGRB jets

$\nu$ luminosities and $\nu$ oscillations

$$\frac{d}{dt} f_\nu = \sum_i \underbrace{j_i(E_\nu)[1-f_\nu] - \lambda_i^{-1}(E_\nu) f_\nu}$$

Boltzmann equation

# of neutrinos emitted/absorbed per unit time by *i*-th reaction

**BNS_NURATES**

A new numerical library for the computation of **detailed $\nu$-matter interaction rates** in BNS merger simulations

# CAN YOU SPOT THE DIFFERENCE?

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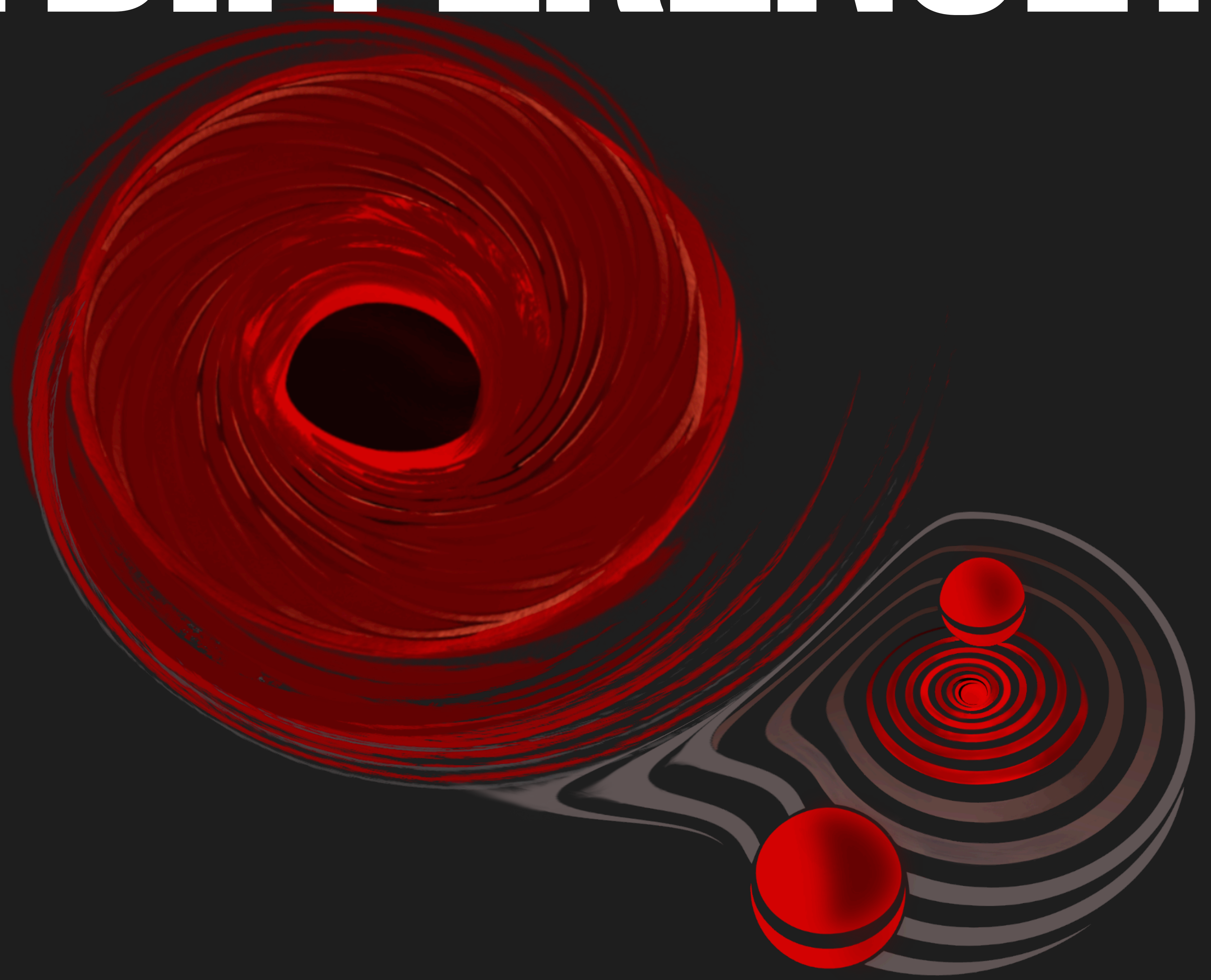

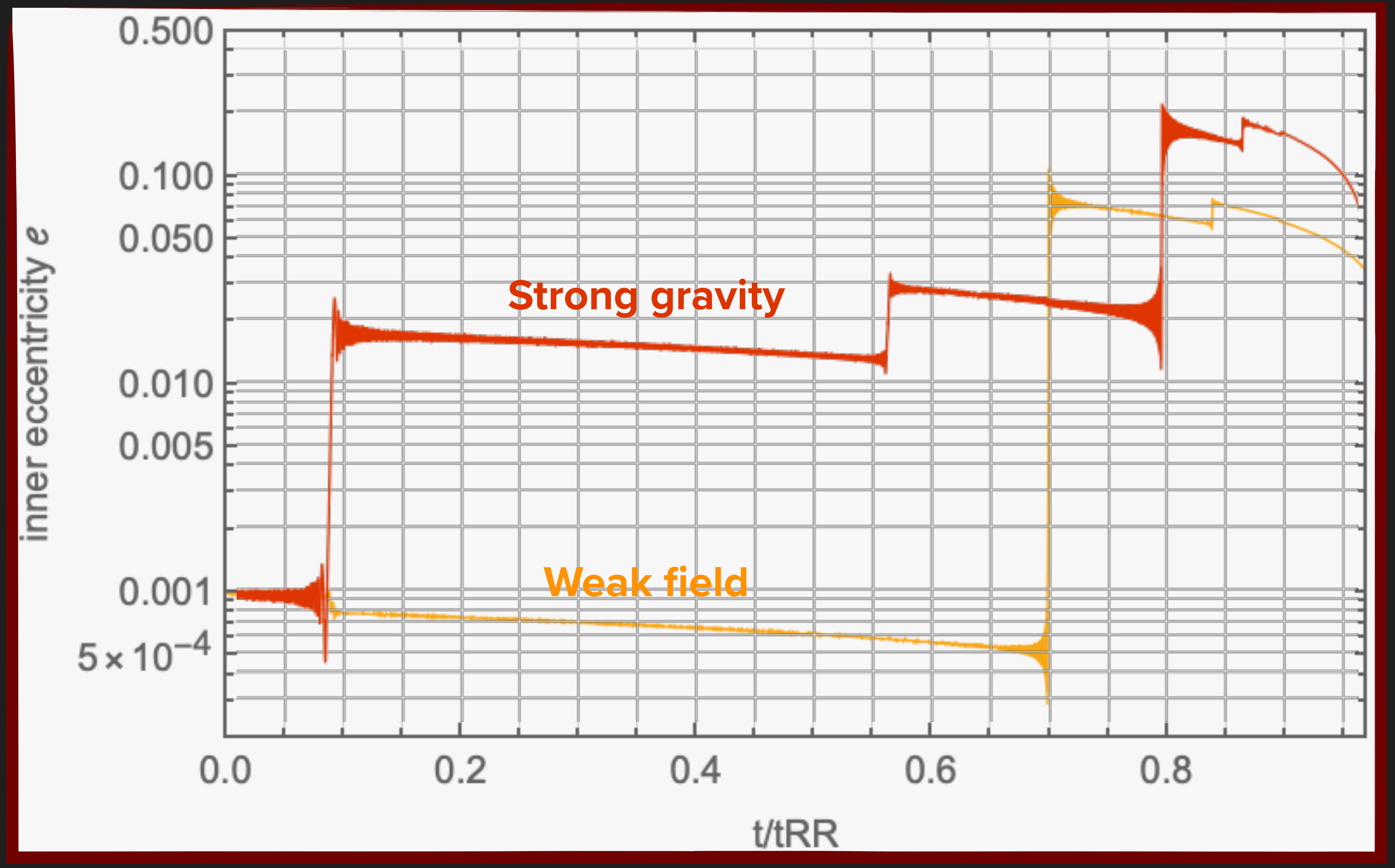


*PRECESSION RESONANCE IN A HIERARCHICAL 3-BODY SYSTEM IN A STRONG GRAVITY REGIME*

# Importance of Noise Filtering for Improving the False Alarm Rate in Gravitational Wave Events

Evdokia C. Koursoumpa

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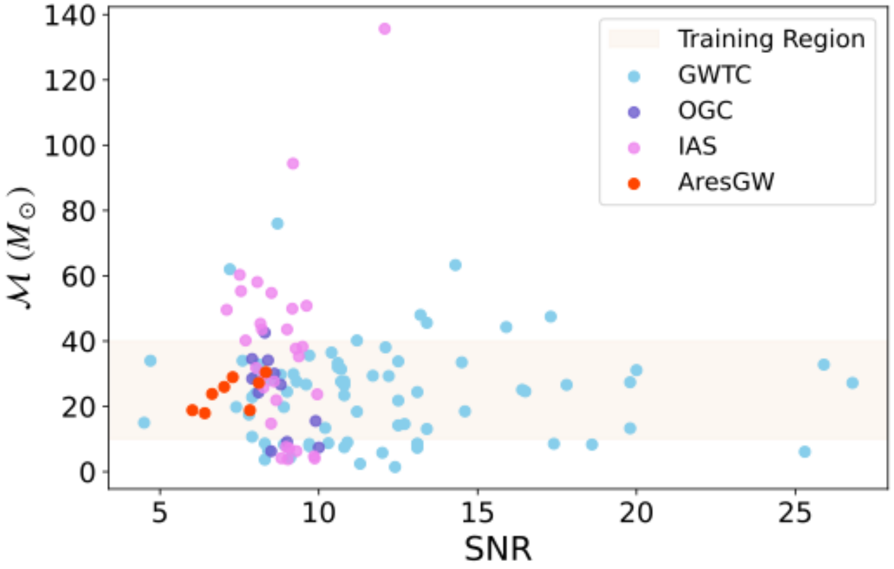
## 8 new BBH low-SNR candidate events, not previously reported, the first to be identified by a machine-learning pipeline, AresGW.




This work is part of a research group's effort to evaluate the sensitivity of the AresGW code to detecting gravitational waves in real-noise data.

## New Gravitational Wave Discoveries Enabled by Machine Learning

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