JAM SADIQ

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SISSA, ⋄ Via Bonomea, 265, 34136 Trieste, Italy

EDUCATION AND EMPLOYMENT

Postdoctoral Researcher *February 2023 - present*
SISSA (International School for Advanced Studies)
Trieste, Italy

Postdoctoral Researcher *October 2020 - September 2022*
University of Santiago de Compostela, Spain
Instituto Galego de Fisica de Altas Enerxias - IGFAE, USC

Assistant Professor in Mathematics *September 2019 - August 2020*
Sukkur IBA University, Sukkur, Sindh, Pakistan
Department of Mathematics and Social Sciences
Courses: General Relativity, Quantum Mechanics, Computational Physics, Introductory Astrophysics

PhD in Astrophysics: Fulbright PhD Fellow *August 2014 - August 2019*
Rochester Institute of Technology, Rochester, NY, 14623
Center for Computational Relativity and Gravitation

Masters of Philosophy (M.Phil) in Mathematics *August 2010 - September 2012*
Quaid-i-Azam University, Islamabad, Pakistan
Department of Mathematics

TECHNICAL STRENGTHS

Software	PyCBC, GWpy, LALSuite, RIFT, GstLAL, Einstein Toolkit, Scikit-learn, PyTorch, TensorFlow, VisIt, Mathematica, Maple, LaTeX, Git, SageMath, GWFAST, SBI
Programing Languages	Python, C/C++, Fortran, R
Operating System	Fedora/CentosOS/Ubuntu Linux, Mac OS, Windows 10

GRANTS AND FELLOWSHIPS

Postdoctoral Fellowship *February 2023 -*
GRAMS Postdoctoral Fellow

Postdoctoral Fellowship *October 2020 - September 2022*
Postdoctoral Research Fellowship at IGFAE under the grant by Xunta de Galicia, at USC, Spain

Fulbright PhD Fellowship *August 2014 - August 2019*
Fulbright PhD Fellowship by US state department for five years which covered the entire cost of my PhD in the US.

Japanese need based Scholarship *January 2009*
Awarded for being a talented and deserving student
Quaid-i-Azam University, Islamabad

PROJECTS

Assessing Analytical Spacetime Models: A Technique for Comparing Evolution with Numerical Relativity in Binary Black Hole Systems

We introduced a novel technique for comparing the evolution of analytical spacetime models with their numerical relativity counterparts. The approach utilizes gauge-independent quantities associated with geodesic deviation. This method serves as a novel way to access the accuracy and limitation of analytical approximate models that have been used to study the dynamics of accretion disks around supermassive black hole binaries.

Constructing Accurate Hybrid Waveforms for Precessing Binary Black Holes in Gravitational-Wave Data Analysis

Construct hybrid waveforms for precessing binary black holes, by combining post-Newtonian waveforms for the early inspiral phase with numerical relativity waveforms for the late inspiral to merger and post-merger phases. Our objective is to create extended hybrid waveforms of high accuracy, enabling precise parameter estimation for signals detected in current and upcoming gravitational wave (GW) observations.

Flexible and fast estimation to infer population properties binary merger population distributions using with adaptive KDE

Utilizing a rapid and flexible adaptive bandwidth Kernel Density Estimator (KDE), we reconstruct the mass distribution of LIGO-Virgo binary mergers based on parameter estimation outputs. Our findings exhibit comparability with established Bayesian hierarchical models, which assume a specific distribution form and are computationally more demanding. Additionally, we introduce a method for detecting and testing the significance of peaks in a distribution.

Binary Vision: Unveiling the Merging Black Hole Binary Mass Distribution through Iterative KDE

Extending our KDE work, we develop a self consistent iterative reweighted KDE based on expectation maximization algorithm and use it to study two-dimensional mass distribution of binary black holes using observed GWs. We studied the correlation between the masses of binary compact objects and the astrophysical implications from these results.

Numerical implicit schemes for solving Einsteins equations in theory beyond GR

I am recently developing an implicit finite difference scheme to solve evolution of scalar field in spherically symmetric spacetime in K-essence theory. The main goal is to show that certain classes for K-essence theories are well posed.

LISA data analysis and LIGO Collaboration

I have recently employed the Kernel Density Estimation (KDE) method to investigate the population properties of intermediate and supermassive binary black holes using mock data observations. This research aligns with the anticipation of future LISA gravitational wave detections. In parallel, I am engaged in a project utilizing the Simulation Based Inference (SBI) technique to develop a sophisticated detection pipeline tailored for LISA observations.

In addition I have also worked in the automation and enhancement of the PyGRB search pipeline as LIGO Scientific Collaboration member. This tool is integral for detecting gravitational waves from observed data and their correlation with Gamma Ray Bursts (GRBs). Further more, I have contributed to data analysis and reviews work within LIGO/Virgo scientific collaboration.

CONFERENCES

(Online) Amaldi15 conference on gravitational waves., July 17-21, 2023

Contributed Talk:Binary vision: The merging black hole binary mass distribution via iterative density estimation

LVK meeting Cardiff September 2022
Poster: Flexible and Fast Estimation of Binary Merger Population Distributions with Adaptive KDE

GWPAW 2021 December 14-17, 2021; Hannover, Germany
Poster: Flexible and Fast Estimation of Binary Merger Population Distributions with Adaptive KDE

(Online) Amaldi14 conference on gravitational waves., July 19-23, 2021
Poster: Flexible and Fast Estimation of Binary Merger Population Distributions with Adaptive KDE

(Online) 11th Iberian Gravitational Waves Meeting, June 9-11, 2021
Talk: Hybrid Waveforms for Precessing Binary Black holes for LIGO Data Analysis

3rd International Conference on Computing, Mathematics and Engineering Technologies (iCoMET), January 29-30, 2020; Sukkur, Sindh, Pakistan
Talk: Waveform template bank for Precessing binary black holes for detection of gravitational waves

APS April Meeting April 13-16, 2019; Denver, Colorado, USA
Talk: Hybrid Wave-forms for Precessing binary black holes for LIGO data analysis

APS April Meeting April 14-17, 2018; Columbus, Ohio, USA
Talk: A new tool to check the accuracy of Analytic Spacetimes for binary black holes

27th Midwest Relativity Meeting, October 12-14, 2017, Ann Arbor, MI, USA
Talk: Comparing Spacetimes using Geometric Scalars

21st International Conference on General Relativity and Gravitation, Columbia University July 10-15, 2016, New York, USA
Talk: Comparing Space-time using Geometric Scalars

WORKSHOPS

Emerging methods in GW population inference, June 24-27, 2024
 Institute for Fundamental Physics of the Universe, Via Beirut, 2, 34151 Trieste TS - Italy

10th Workshop on Collaborative Scientific Software Development and Management of Open Source Scientific Packages, November 6-17, 2023
ICTP, Trieste, Italy

Masterclass in Big data within Science and Industry, September 22nd, 2023
University of Milano-Bicocca (Italy)

European Einstein Toolkit School 2022, 29 August - 2 September, 2022
University College Dublin, Dublin, Ireland

(Online) Summer School in Statistics for Astronomers XVI, June 1–5, 2021
The Pennsylvania State University, USA

(Online) Current challenges in gravitational physics workshop, April 21-28, 2021
SISSA, Italy

(Online) Statistical Methods for the Detection, Classification, and Inference of Relativistic Objects November 16-20, 2020
Brown University in Providence, Rhode Island, USA

Computational Challenges in Gravitational Wave Astronomy, Jan 28 - Feb 1, 2019
University of California, Los Angeles (UCLA), CA, USA

North American Einstein Toolkit School and Workshop NCSA, July 31 - August 4, 2017
University of Illinois at Urbana Champaign, IL, USA

The Astrophysical Black Hole Merger Workshop VI, June 21-22, 2016
Organizing committee member
Center for Computational Relativity and Gravitation, RIT, Rochester, NY, USA

Caltech Gravitational Wave Astrophysics School 2015, July 6-10, 2015
California Institute of Technology, CA, USA

MENTORING AND TEACHING EXPERIENCE

Zainab Mangi (Sukkur IBA University), **supervised masters thesis** titled **Improved hybrid waveforms for generic precessing binary black holes**, 2023

Zainab Mangi, Komal Naz, Kaneez Fatima (Sukkur IBA University), **supervised undergraduate final year research projects** on black hole physics, 2019-2020

Ifra Hassan, Nilo Cher, **co-advised, undergraduate students in summer program** at RIT on visualising two and three body Newtonian dynamics, 2018

Taught courses on **general relativity, quantum mechanics and computational physics** to advanced undergraduate students at Sukkur IBA University, 2019-2020.

Teaching Assistant at Rochester Institute of Technology, USA to help undergrad students in problem solving and homework in the subjects of classical mechanics and computational astrophysics, 2014-2015.

PUBLIC OUTREACH

SISSA for Schools (S4S) volunteer at Trieste, Italy, 2023

Public lecture on Astronomy and Stephen Hawking contributions to cosmology at Sukkur IBA University, Sukkur, Pakistan, 2019

Proposal presentation to Chief Minister on funds **for opening a Planetarium** in Sukkur, Pakistan,2019

Volunteer **World Science Festival** and served as **Science Ambassador for City of Science** event, New York, USA, 2017-2018.

Tutor **for Solar Eclipse** event RIT, Rochester, NY, 2018

Member of Astronomy Section Rochester Academy of Science (ASRAS) and took part in public outreach events 2016-2018

REFERENCES

Yosef Zlochower, Ph.D. advisor
Rochester Institute of Technology
Associate Professor
yrzsma@rit.edu

Enrico Barausse
SISSA, Trieste, Italy
Associate Professor
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Thomas Dent, Postdoc mentor
University of Santiago de Compostela
Research Scientist
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Khalid Saifullah
Quaid-i-Azam University, Islamabad, Pakistan
Associate Professor
saifullah@qau.edu.pk

PUBLICATION DETAILS

A. SELECTED SENIOR-AUTHOR PUBLICATIONS

1. Binary vision: The merging black hole binary mass distribution via iterative density estimation
   Jam Sadiq, Thomas Dent, Mark Gieles, **ApJ 960 65 (2023)**
   DOI: Published in Astrophysical Journal

2. General-relativistic precession in a black-hole binary
   Hannam, M., Hoy, C., Thompson, J.E. et al. , **Nature 610, 652–655 (2022)**
   DOI: https://doi.org/10.1038/s41586-022-05212-z

3. Flexible and Fast Estimation of Binary Merger Population Distributions with Adaptive KDE
   Jam Sadiq, Thomas Dent, Daniel Wysocki, **Phys.Rev.D105 (2022) 12, 123014**, arXiv e-Print
   2112.12659
   DOI: https://journals.aps.org/prd/abstract/10.1103/PhysRevD.105.123014

4. Hybrid waveforms for generic precessing binaries for gravitational-wave data analysis
   Jam Sadiq, Yosef Zlochower, Richard O'Shaughnessy, Jacob Lange, **Phys.Rev.D102 (2020) 2,
   024012**, arXiv e-Print 2001.07109
   DOI: https://doi.org/10.1103/PhysRevD.102.024012

5. Comparing an analytical spacetime metric for a merging binary to a fully nonlinear numerical evolution using curvature scalars
   Jam Sadiq, Yosef Zlochower, Hiroyuki Nakano, **Phys.Rev.D97 (2018), 084007**, arXiv e-Print
   1802.02990 [gr-qc]
   DOI: https://doi.org/10.1103/PhysRevD.97.084007

B. COLLABORATION PUBLICATIONS

These are some of my LIGO and Virgo scientific collaboration publication that I contributed.

1. Search for Gravitational Waves Associated with Gamma-Ray Bursts Detected by Fermi and Swift
   During the LIGO-Virgo Run O3b
   LIGO Scientific and Virgo Collaborations, R. Abbott(LIGO Lab., Caltech) et al., arXiv e-Print
   2111.03608 [astro-ph.HE]

2. Population of merging compact binaries inferred using gravitational waves through GWTC-3
   LIGO Scientific and Virgo Collaborations, R. Abbott(LIGO Lab., Caltech) et al., **Phys.Rev.X 13**
   (2023) 1, 011048
   DOI: https://journals.aps.org/prx/abstract/10.1103/PhysRevX.13.011048

3. GWTC-2: Compact Binary Coalescences Observed by LIGO and Virgo During the First Half of the
   Third Observing Run
   LIGO Scientific and Virgo Collaborations, R. Abbott(LIGO Lab., Caltech) et al. **Phys.Rev.X.11
   (2021) 021053**, arXiv e-Print 2010.14527 [gr-qc]
   DOI: https://doi.org/10.1103/PhysRevX.11.021053

4. All-sky search in early O3 LIGO data for continuous gravitational-wave signals from unknown neutron
   stars in binary systems
   LIGO Scientific and Virgo Collaborations, R. Abbott(LIGO Lab., Caltech) et al., **Phys.Rev.D 103
   (2021) 6, 064017**, arXiv e-Print 2012.12128 [gr-qc]
   DOI: 10.1103/PhysRevD.103.064017

5. Search for intermediate mass black hole binaries in the third observing run of Advanced LIGO and
   Advanced Virgo
   LIGO Scientific and Virgo Collaborations, R. Abbott(LIGO Lab., Caltech) et al., **Astron.Astrophys**.
   659 (2022) A84
   https://doi.org/10.1051/0004-6361/202141452