# Abhishek Karkola

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## Education

- **Cardiff University**: MSc in Gravitational Physics (Grade: MERIT) ⌗      Oct 2022
- **PES Institute of Technology**: Bachelor's of Engineering in Electronics and Communication (Grade: MERIT)      Aug 2020

## Research Experience

### 1) Updating Gravitational Wave Constraints on Modified Gravity [MSc Thesis]

Advisor: Dr Ian Harrison      June 2022- Sep 2022

This project aims to utilize two significant gravitational wave events, GW170817 and GW190521, to constrains on modified theories of gravity. GW190521, detected during O3, is the farthest merger recorded by the Advanced LIGO and Virgo detectors, with a luminosity distance of 4-5 gigaparsecs (Gpc). It involves the merger of two black holes, resulting in the formation of an intermediate mass black hole. The tentative electromagnetic counterpart, ZTF19abanrhr, associated with GW190521 at a redshift of $z = 0.438$, is believed to be generated by the collision of two black holes in an Active Galactic Nucleus (AGN) disc. By assuming a common astrophysical source for GW190521 and ZTF19abanrhr, we can establish constraints on modified theories of gravity. Our analysis focuses on the following three key questions: (1) the impact of including GW190521 as a standard siren on constraining the $\alpha M$ Horndeski parameter, (2) constraining the coefficients associated with the $\alpha M$ and $\alpha B$ Horndeski parameters, and (3) visualizing the contour plots corresponding to the constraints derived from LIGO-Virgo data.

### 2) Parameter Estimation of Gravitational-wave Source

Advisor: Dr Vivian Raymond      Oct 2021 – Jan 2022

Utilise and modify real-world analysis toolkits to perform spectral analysis of gravitational wave time series and to estimate power spectrum densities. Combined the computational, and theoretical skills developed in Data Analysis with the new techniques developed to estimate false alarm rates, calculate detection efficiencies, and evaluate their impact and implications for the physics that can be practicably probed. Applied appropriate sampling algorithms to estimate complex probability density functions and critically evaluate the measurement implications in a range of realistic scenarios. Combine the skills developed in Data Analysis and Gravitational-wave Astrophysics and analysed the real gravitational wave data, making more sophisticated astrophysical interpretations of the signals, and evaluate the consequences of these interpretations within the context of the contemporary scientific literature.

### 3) GARBAGE VOLUME ESTIMATION USING MULTI-VIEW PHOTOS

Advisor: Dr Shikha Tripathi

Built to provide waste management cell with an efficient method for the estimation of sizable garbage dumps. Users are provided with an application which allows them to record a video of the garbage pile, from which multiple composite images are extracted. The images thus extracted are uploaded to the server, after which they undergo image pre-processing. From the pre-processed images, a detailed 3D model is generated. The top view of the model is saved as a 2D image to ensure complete coverage of the model which is then subjected to a segmentation process. Post segmentation remains a model of the garbage pile alone; sans the surrounding environment. It is the newly generated model that undergoes volume estimation.

## Work Experience

### 1) Teaching Assistant at Cardiff University

     Jan 2022 – May 2022

Job: Taught Computational Physics using Python for Physics Undergrad students

- To give instruction on and provide practice in the use of computers to develop basic data handling skills required by physical scientists (e.g., graphing and data analysis skills).
- To develop the basic numerical computing skills required by physics scientists.
- To develop proficiency in problem-solving by working through a series of examples which relate to the experimental and taught physics modules.

Project: Garbage volume estimation using multi-view photos

- Implemented segmentation algorithm with 72% accuracy, to draw bounding box and blur out the background.
- Implemented scripts to scrape images for the data set from google images.
- Deployed the trained model and provided documented API endpoint.

## Areas Of Expertise

- Hands-on Python & SQL experience.
- Linux distributions.
- Experience in using High Performance Computing (HPC)/ large computing clusters
- Skilled in optimizing CPU-bound and I/O-bound tasks through parallelization, effectively utilizing multiple cores and processors.
- Proficient use of data analysis software programs.
- Convolutional NN models.
- Time series data clustering Data processing, cleaning, and ML pipelines for model evaluation.
- Experience in implementing Scikit-learn, TensorFlow libraries.
- Experience in deploying GWPY, Astropy and PYCBC libraries.
- Excellent Verbal and written communication.

## Coursework

- Linear Algebra
- General Relativity
- Cosmology
- Numerical Relativity
- Data Analysis
- Computational Physics
- Gravitational Wave Astrophysics
- Experimental Gravitation

## Achievements

- INDIA-SINGAPORE Hackathon'2018

  Finalist in INDIA-SINGAPORE HACKATHON organised by" NTU SINGAPORE" for the project "EFFECTIVE LEARNING ON CAMPUS".

- SMART INDIA HACKATHON'2018

  Secured Second Runners up position for the project "GARAGE VOLUME ESTIMATION USING MULTI-VIEW PHOTOGRAPHS"

## References

1) Dr Ian Harrison (Thesis Advisor): harrisoni@cardiff.ac.uk
2) Prof Paul Roche (Academic Instructor): rochepd@cardiff.ac.uk
3) Dr Richard Lewis (Academic Instructor): lewisr54@cardiff.ac.uk