GWUniverse Workshop 6: Electromagnetic follow-up Strategy (EM-GW), Systematics in Parameter Estimation (PE), and Prospects of GRB/Kilonova modeling

Thursday, 24 November 2022 - Friday, 25 November 2022

SNU

Scientific Programme

2022.11.24 (Thursday)

9:00 -9:30 registration

9:30 -10:15 Invited speaker(45m)
Michael W.Coughlin (Minneapolis University)
Title: Ready for O4: low-latency infrastructure and observing scenarios
Abstract: With the detection of compact binary coalescences and their electromagnetic counterparts by gravitational-wave detectors, a new era of multi-messenger astronomy has begun. In this talk, I will describe the observing scenarios we are building within the IGWN to prepare for O4, as well as the alert system we are building, and what it means for electromagnetic follow-up. I will then discuss how current ground based optical surveys and dedicated follow-up systems are being used to identify more of these, and how we are developing models to test what we find. We will close with near-term prospects for the field.

10:15 - 10:45 Invited speaker(30m)
Theophile Jegou du Laz (Hanyang-France University)
Title: SkyPortal: A technical ecosystem enabling multi-messenger astrophysics
Abstract: Rapid and coordinated followup of neutrino and gravitational wave events require infrastructure to plan, command, and operate heterogeneous telescope networks. Beyond the initial Target of Opportunity coordination, however, such infrastructure must also be able to respond and adapt to the dynamic landscape of insights as candidates are observed, reported, and followed up. All of this must be done in a robust API-centric system with human friendly interfaces. In this talk, addressing these requirements, we present the status of SkyPortal and the universe of telescopes in its orbit planned for use in O4. We discuss developing technologies inside of SkyPortal required to enable multi-messenger discoveries in the next observing run and beyond.

10:45 - 11:00 Coffee break

11:00 - 11:45 Invited speaker(45m)
Myungshin Im (SNU)
Title: Gravitational-wave EM Counterpart Korean Observatory (GECKO) and 7-Dimensional Telescope for Multi-Messenger Astronomy
Abstract: The 2017 detection of the binary neutron star (BNS) merger event in both gravitational wave (GW) and electromagnetic wave (EM), GW170817, has shown the great potential for multi-messenger astronomy, allowing us to understand the link between neutron star mergers and gamma-ray bursts, physical mechanisms and environments of the EM counterpart, kilonova (KN), and cosmology with GW sources. Yet, GW170817 is still the only GW event for which MMA was possible. However, with the scheduled start of the O4 run in March 2023, the situation will soon change. The forecast is about 10 BNS merger event detections during O4, with many of them having a GW localization accuracy on par with GW170817. To capitalize on the anticipated GW source discoveries, we have been preparing an optical EM follow-up network of telescopes, named the Gravitational-wave EM Counterpart Korean Observatory (GECKO). We will outline the current challenges of optical/NIR counterpart observations for the KNe discovery, and outline GECKO and our past activities. In particular, we will focus on our observation program with KMTNet, a system of three, 1.6-m wide-field telescopes in the southern hemisphere, and a new facility in construction, the 7-Dimensional Telescope (7DT). 7DT is a multiple-telescope system that can perform a spectral mapping over a wide field of view (> 1 deg2) and will be efficient in catching KNe associated with future GW events. Our activity includes the application of the artificial intelligence technique for identifying KNe rapidly. A partial system of 7DT is expected to start its operation in late 2022

11:45 - 12:30 Invited speaker(45m)
Giuseppe Greco (INFN-Perugia University)
Title : Virtual Observatory (VO) interoperability for visualization of gravitational-wave sky localizations and strategies of EM follow-ups
Abstract : We present the main strategies and implementations for working with gravitational-wave sky localizations in the context of the Virtual Observatory (VO) framework. We show how gravitational-wave sky maps can be easily and efficiently visualized and processed using Multi Order Coverage (MOC) maps for fast tiling, catalog queries, transient localizations, visibility and sky map comparisons. MOC is a standard of the Virtual Observatory which provides a multi-scale mapping based on HEALPix (Hierarchical Equal Area isoLatitude Pixelation) sky tessellation.
Practical examples will be discussed in the framework of the low-latency alerts sent by LIGO-Virgo-KAGRA collaborations. Finally, we show the development of a new webtool emphasizing how the VO technologies allow us to apply the FAIR (Findable, Accessible, Interoperable and Reusable) principles in the context of gravitational-wave open science.

12:30 - 14:00 Lunch

14:00 - 14:45 Invited speaker(45m)
Hyung Won Lee (Inje University.)
Title : Parameter Estimation for Gravitational Wave Data and their Implementations
Abstract: The gravitational wave was predicted by Einstein at 1906 with general theory of gravity. After that there were many failed attempts to detect the gravitational wave until 14th of September 2015 when the first binary black hole event was detected by LIGO/Virgo collaboration. It took almost 100 years to detect the gravitational wave after the theoretical prediction due to its amplitude being extremely weak compared to other waves in nature, like electromagnetic waves. This was only possible with ingeneious configuarion of device and dedicated data process for signals. The obtained signal is essetnially a noise with smaller physical signal embedded in it. It is necessary to develop an intelligent method to extract the valid physical information from the noisy data. Hence it is one of the main challenges to find a good data processing pipe line to get physical source parameters within reasonable time scale. In this presentation, I will review the currently implemented parameter estimation pipe line used to analyze the recently observed 90 gravitational events. I will introduce the basic Bayesian methods for parameter estimation, then explain how it is implemented in LALSuite, the software package used to parameter estimation in LIGO/Virgo/KAGRA collaboration. I will also comment on the pros and cons for various methods implemented in LALSuite.

14:45 - 15:30 Invited speaker(45m)
Ajith Parameswaran (ICTS, Bangalore)
Title: survey of systematic errors in GW parameter estimation

15:30 - 15:50 Coffee break

15:50 - 16:35 Invited speaker(45m)
Mattia Bulla (Ferrara U., Italy)
Title: Let there be light: Illuminating neutron star mergers with kilonova modelling
Abstract: The detection of an electromagnetic counterpart to the gravitational-wave source GW 170817 marked year zero of the multi-messenger gravitational-wave era. This event was generated by the merger of two neutron stars and gave rise to an electromagnetic transient, dubbed a “kilonova”, which was intensively monitored with all the main ground-based and space-borne facilities. In this talk, I will present the code POSSIS and show how radiative transfer simulations of kilonovae can illuminate neutron star mergers and provide a natural connection between numerical

models and observational data. I will discuss a few applications showing how the prediction of viewing-angle dependent synthetic observables for kilonovae - as light curves, spectra and polarization - can be used to interpret data, place constraints on models and guide future follow-up campaigns of gravitational-wave triggers.

16:35 - 17:20 Invited speaker(45m)
Om Sharan Salafia (INAF-Observatory of Brera, Italy)
Title: "Gamma-ray burst afterglow modelling: challenges and opportunities"
Abstract: The main process behind the afterglow of short gamma-ray bursts involves the shocks that arise as the jet material expands into the interstellar medium that surrounds the progenitor binary. Diffusive particle acceleration at these shocks produces a non-thermal population of relativistic electrons, which interact with the local, small-scale magnetic fields and produce synchrotron radiation. Before escaping the shock downstream, the synchrotron photons can further interact with the relativistic electrons through inverse Compton scattering, giving rise to an additional emission component. The distribution of electron properties and the radiated spectrum are mutually interdependent and evolve together. On top of that, the shock properties evolve in time as it expands and sweeps an increasing amount of interstellar matter. In this talk, I will describe the main problems and opportunities in the modelling of this range of phenomena, pointing out how multi-messenger observations of binary neutron star mergers can help in addressing the present theoretical uncertainties and, conversely, how this kind of modelling can help us in extracting physical information about these events

2022.11.25 (Friday)

9:30 - 10:15 Invited speaker(45m)
Geoffrey Ryan (Perimeter Institute for Theoretical Physics)
Title: GRB Afterglows In Full View
Abstract: Gamma-ray Burst (GRB) afterglows are imprinted with valuable information about their progenitor (jet energy, structure, and inclination relative to Earth) and environment (local density, plasma properties), but disentangling this information from observations can be challenging. I will review recent theoretical advancements in our understanding of GRB afterglows, particularly how jet structure and off-axis viewing affect the observed emission, and how they can be modelled with our public Python code "afterglowpy". I will discuss how this has impacted our understanding of GW170817 and helped discover new kilonova candidates. Finally, we will look forward to what we may expect for non-thermal EM counterparts in O4.

10:15 - 11:00 Invited speaker(45m)
Donggeun Tak (KASI)
Title: **Temporal and spectral evolutionary features of GRB afterglows observed in a high-energy regime.**
Abstract: Gamma-ray bursts (GRBs) are the most powerful electromagnetic events in universe. From the progenitor systems, relativistic, collimated jets are launched, where short, bright gamma-ray flashes (prompt emission) and long-lived, fading emission (afterglow) are produced. The afterglow phase is observed in the broad energy band from radio to gamma-rays. Even though the characteristics of the GRB afterglow have been vigorously studied, many details of the physics remain uncertain. Recent multiwavelength observations of very-high-energy (VHE; > 100 GeV) GRBs open a new window for studying the emission mechanism of the GRB afterglow. In this talk, I will summarize our current understanding on the early phase of the afterglow emission observed from the X-ray to VHE energy bands.

11:00 - 11:15 Coffee break

11:15 - 11:45 Invited speaker(30m)
A. Gopakumar (TIFR)
Title: Fourier Domain inspiral templates for compact binaries in relativistic eccentric orbits and their data analysis implications

11:45 - 12:15 Invited speaker(30m)
Hemanta phurailatpam (CUHK)
Title: parameter estimation runs on GW170817 and its implications

12: 15 - 12:30 Discussion

12:30 Lunch