Author: Simone Mastrogiovanni

Title: The DNA of gravitational-waves from neutron stars: identifying signals with genetic coding

An undetected type of gravitational-waves signals not yet detected, which in the LIGO-Virgo sensitivity band are expected to be emitted by spinning asymmetric neutron stars. The most important feature of such kind of signals is in their phase evolution, which can be treated as a continuous function over the entire observing run. It is well known that the phase evolution of long-coherent signals is needed to define how to build a proper template grid in order to gain the best signal-to-noise ratio possible. This information can be encoded in the topology of a matrix called *phase metric*, which characterizes the geometry for the posterior probability density functions of the inferred physical parameters. Most of the times, the metric for long coherent signals is a non-diagonal ill-conditioned matrix which can be computed only numerically, the physical parameter space possible signal is highly correlated and difficult to sample with algorithms. In this poster we will show a general phase decomposition technique able overcome these limits implemented in a genetic code. Moreover we will also show how this variables can be employed for distinguish among astrophysical signals and non-stationary noise artifacts that may affect analysis pipelines.

X-PIPELINE: Gravitational-Wave Burst search applied to LIGO data

Elena Massera[1], Maxime Fays[1]

[1] Dept. of Physics and Astronomy, University of Sheffield, Western Bank, Sheffield, UK

The rapid analysis of gravitational-wave data is not trivial for many reasons, such as the non- stationary nature of the background noise in gravitational-wave detectors and the lack of a definite and exhaustive waveform models, especially for gravitational-wave burst signals. One active research area is based on the use of X-PIPELINE [1], a software package designed for performing autonomous searches for un-modelled gravitational-wave bursts (GWBs). Functions in X-PIPELINE such as automated running, including background estimation, efficiency studies, unbiased optimal tuning of search thresholds and prediction of upper limits, are all performed automatically without requiring human intervention. X-PIPELINE has a novel approach based on spherical radiometry [2]. This engine, called X-SPHRAD, transforms the problem of computing correlations between time series data streams into the spherical harmonic domain and allows correlation between detectors (in a network) to be performed quickly. X-SPHRAD is focused on optimising the sensitivity of the search. Moreover, we are improving and testing a method, based on the spherical harmonic coefficients, which could be a valid approach to reject glitches, that affect data processed with X-PIPELINE [3].

[1] P.J. Sutton et al. New Journal of Physics 12 (2010)
[2] K. Cannon Physical Review D 75, 123003 (2007)
[3] M. Edwards, P. Sutton. Journal of Physics: Conference Series, 363(1):012025, 2012.

Keywords: Gravitational-wave Burst; X-PIPELINE; Spherical harmonic function.

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AUTHOR
Roberto Aloisio

TITLE

Theoretical overview on high-energy neutrinos and ultra-high energy cosmic rays

ABSTRACT
We will review the main channels for the production of high energy neutrinos, with particular emphasis on the production mechanisms involving ultra-high energy cosmic rays. We will also discuss the limits on ultra-high energy cosmic rays sources that come from the observations of high energy neutrinos and the connection of these observations with gamma rays observations.

Continuous gravitational-wave data analysis with General Purpose Computing on Graphic Processing Units

Iuri La Rosa[1,2]

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[2] *Max Planck Institute for Gravitational Physics (Albert Einstein Institute), D-30167 Hannover, Germany*

Abstract

The first direct detection of gravitational waves by the LIGO and Virgo collaborations has opened a new window in the observation of the Universe. All the signals detected were transients produced by compact binary coalescences. Neutron stars, however, can also emit continuous signals. The search for such signals is computationally very challenging when the source parameters are not accurately known or completely unknown, due to the large volume of the source parameter space that must be explored. Parallel computing on GPU appears very promising for this task: we present a new approach to the search for continuous signals, using the high parallel computing efficiency and computational power of modern GPUs through the high-level TensorFlow framework. Specifically, the porting of the computationally heaviest part of two analysis pipelines (FrequencyHough [arXiv 1407.8333] and Weave [arXiv 1804.03392]) is illustrated. Using a single GPU brought significant improvements in the performance of the FrequencyHough pipeline, with respect to a CPU multi-core system of the same class. Next we want to evaluate the performance score of a similar operation in Weave. More generally GPU programming with a general purpose high-level framework could open then new perspectives on wide-parameter searches of gravitational waves.

The discovery of the gravitational wave signals from compact binary coalescences by the Advanced LIGO-Virgo detector network and the association of GW170817 and GRB170817A have allowed to probe the genuinely strong-field dynamics of general relativity and perform tests on fundamental physiscs. We will describe the tests performed focusing on the inspiral-merger-ringdown dynamics and the propagation of gravitational and electromagnetic radiation over large distances.

Status of the KAGRA detector

Raffaele Flaminio on behalf of the KAGRA collaboration

CNRS/LAPP and NAOJ

KAGRA is a gravitational wave detector based on a laser interferometer with arms 3 km in length. The detector is currently being installed underground in the Kamioka mine (Japan). It will be the first laser interferometer with km-scale arms to use mirrors made of sapphire and operated at cryogenic temperature. During this talk the detector design, the status of the installation and the future plan will be described.

Using merged BHs spins and masses to infer the formation history of their progenitors

***Manuel Arca Sedda*[1]*, Matthew Benacquista*[2]**

[1]*Zentrum fur Astronomie der Universitat Heidelberg, Astronomisches Rechen-Institut, Monchhofstr. 12-14, 69120 Heidelberg*

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In this talk we investigate how the observed remnant masses and spins of merged black holes (BHs) can be used to constrain the progenitor binary black hole (BBH) formation history. Exploring different models, we found that the observed population of merged BHs is hard to reconcile with high-mass stellar BHs formed in metal poor environments. We find that if the LIGO sources were isolated BBHs, their components should have been characterised by mildly misaligned spins.
The sources GW170104 and GW170814 may have formed through this channel. On another hand, a dynamical origin does a better job of explaining the origin of GW170608 and GW151226, likely formed from stars with nearly solar metallicities. Finally, we discuss the possibility that GW150914 may have originated from multiple merger events in a dense cluster.

Connections between neutrinos and dark matter at the cosmological level

(Andres Olivares-Del Campo, Celine Boehm, Silvia Pascoli and Sergio Palomares-Ruiz)

Dark Matter (DM) and neutrinos provide the two most compelling pieces of evidence for new physics beyond the Standard Model of Particle Physics but they are often treated as two different sectors. Nevertheless, an interaction between DM and neutrinos can have important cosmological consequences and even explain the mechanism that generates neutrino masses. In this talk, I will explain the impact that DM-neutrino interactions have in the formation of large structures in our universe and how these interactions might alter the number of effective neutrino species. In turn, cosmological measurements can be used to set strong bounds in models that generate DM-neutrino interactions. By following a simplified model approach, I will show how the complementary between cosmological constraints and indirect detection DM searches can be used to exclude a large fraction of the parameter space for such models.

Kilonovae: the cosmic foundries of heavy elements
(Elena Pian on behalf of a large collaboration)

The long-sought optical/infrared counterpart of a binary neutron star merger has been first detected in August 2017 following the gravitational event of 17 August 2017 that triggered the LIGO-Virgo interferometers. This radioactive source bears the signature of atoms heavier than iron, thus proving that neutron star mergers are privileged sites of r-process nucleosynthesis and contribute critically to the history of chemical evolution of the Universe. All relevant facts and conclusions about this discovery will be reviewed.

A historical perspective on the 3rd generation GW detectors: the early attempts for a joint European effort (1986-1994)

Adele La Rana

Sapienza University of Rome, Centro Fermi and TERA Foundation

The advent of long-base-line interferometric detectors projected the field of GW research in the cosmos of Big Science, a gradual transformation taking place at the turn of the '80s and 90s. Particularly engaging is the European context of this transformation. The present talk focuses on the origins of the Virgo endeavor, rooted in the 80s, critically analyzed in the European and international context. The first proposals for large based interferometric detectors were then being discussed and presented in Europe and in USA, strongly bound to the need of creating a coordinated network of antennas, including the optimistic plan of building an array of three interferometers in Europe.

A comparable change of scale is needed today, at the dawn of 3G interferometric antennas and an attempt of comparative analysis can be made between the past and the present negotiations for a joint European project.

Neutrino and Gravitational-wave Signatures of Core-Collapse Supernovae
(Kei Kotake)

Based on our three-dimensional neutrino radiation-hydrodynamics simulations, we summarize the features of neutrino and gravitational-wave emission from core-collapse supernovae. We discuss how we can extract the information of the central engine by deciphering the multi-messenger observables.

Ranking the galaxies within a gravitational-wave sky localization

G. Greco, F. Brighenti, G. Guidi, F. Piergiovanni, F. Marion, B. Mours, D. Buskulic, F. Aubin

The recent detection of a binary neutron star merger by the LIGO and Virgo collaborations and its corresponding electromagnetic counterpart from several astronomer teams marks the birth of gravitational astronomy.

Due to the size of the error regions, which can span tens to thousands of square degrees, there are significant benefits to rank the galaxies inside these large sky areas to maximize the probability of counterpart detection.

Here we present a new procedure to query the galaxy catalogs, rank the galaxies and eventually define a prior for time allocation and scheduling algorithms.

speaker: Valerio Ippolito

Status of Dark Matter searches in final states with missing transverse momentum and Higgs bosons, photons or vector bosons at ATLAS and CMS

Unlike direct detection experiments, the Large Hadron Collider offers the possibility to study a wide range of Dark Matter production mechanisms, testing its interaction with Standard Model particles through the exchange of both spin-0 and spin-1 mediators. The recent discovery of the Higgs boson opens significant pathways for the understanding of Dark Matter, whose interaction with the Higgs and electroweak sector of the Standard Model still remains an unsolved mystery of particle physics. This talk will present the status and perspective of Dark Matter searches in final states with Higgs bosons or vector bosons at ATLAS and CMS.

Overview: gamma-ray burst prompt and afterglow theory and models

Om Sharan Salafia
INAF – Osservatorio Astronomico di Brera - Merate

GEMMA workshop – 2018 June 4-7, Lecce (Italy)

Abstract

Despite more than sixty years have passed since their discovery, gamma-ray bursts have never stopped being surprising, with almost every observational breakthrough having been accompanied by unexpected features that raised more questions than answers. In this review talk, I will introduce very briefly some of the main ideas that form the basis for the present understanding of these sources, the physical processes involved, the properties of the population as a whole and of the progenitors, and I will put some emphasis on unaswered questions and how gravitational waves could help in shedding some new light on them.

Gravitational-wave searches using the time-domain F-statistic method

Sieniawska, M.[1], Bejger, M.[1], Królak, A.[2] & Ciecieląg, P.[1]

[1] Nicolaus Copernicus Astronomical Center, Polish Academy of Sciences, Warsaw, Poland
[2]Institute of Mathematics, Polish Academy of Sciences, Warsaw, Poland

Abstract

Gravitational waves astronomy allows us to observe and understand objects and events invisible in electromagnetic waves. It may be crucial to validate the theories and models of the most mysterious objects in the Universe - neutron stars. There are a few proposed mechanisms that can trigger radiation of long-lasting gravitational radiation in neutron stars, like e.g.: elastically and/or magnetically-driven deformations (mountains on the stellar surface supported by the elastic strain or magnetic field), or unstable oscillation modes (e.g. r-modes). The Polgraw all-sky time-domain F-statistic pipeline searches for continuous gravitational waves signals in time-domain data using the F-statistic and optimal grid methods on data from a network of detectors (currently the available detectors are H1 - Hanford, L1 - Livingston of LIGO and V1 - Cascina of Virgo). We present methodology, numerical algorithms and challenges of our hierarchical pipeline, especially the design and the tests results of the followup procedure - last stage of the time-domain F-statistic pipeline and final confirmation of the astrophysical origin of the promising candidates.

Sergey Klimenko: University of Florida
Gravitational wave bursts: Detection with minimal assumptions

Abstract

Discovery of gravitational waves by LIGO opens a new window on Universe. Soon LIGO will be complemented by other gravitational wave instruments to form a world-wide network of detectors. Combined with other astronomical instruments it will enable multi-messenger observations of astrophysical events dramatically expanding our means to study cosmos. Anticipated and possibly entirely new gravitational-wave sources are likely to be discovered – we should be ready for unexpected. I will talk about transient (burst) gravitational wave sources with poorly known or uncertain models, describe robust detection methods and discuss astrophysical implications of the source reconstruction.

The Transient High Energy Sky and Early Universe Surveyor (THESEUS)

(L. Amati, on behalf of the THESEUS International Collaboration)

The Transient High-Energy Sky and Early Universe Surveyor (THESEUS) is a mission concept developed in the last years by a large European consortium, with interest in prospective participation by research groups in USA and other non-European countries. As detailed in Amati et al. 2017 (arXiv:1710.04638) and Stratta et al. 2017 (arXiv:1712.08153), THESEUS aims at exploiting high-redshift Gamma-Ray Bursts for getting unique clues to the early Universe and, being an unprecedentedly powerful machine for the detection, accurate location and redshift determination of all types of GRBs (long, short, high-z, under-luminous, ultra-long) and many other classes of transient sources and phenomena, at providing a substantial contribution to multi-messenger astrophysics and time-domain astronomy. For instance, THESEUS will be able to detect and localize with an accuracy of ~a few arcmin short GRBs produced by NS-NS or NS-BH mergers and provide their redshift, as well as detect, localize and characterize the associated NIR kilonova emission and the possible soft X-ray emission predicted by several models. Under these respects, THESEUS will show a beautiful synergy with the large observing facilities of the future, like E-ELT, TMT, SKA, CTA, ATHENA, in the electromagnetic domain, as well as with next-generation gravitational-waves (aLIGO/ aVirgo, KAGRA, ILIGO, Einstein Telescope, LISA) and neutrino detectors, thus enhancing importantly their scientific return. Moreover, it will also operate as a flexible IR and X-ray observatory, thus providing an even larger involvement of the scientific community, as is currently the case for the Swift mission.

Title and Abstract

Title: A Unified Program of Argon Dark Matter Searches: DarkSide-20k and The Global Argon Dark Matter Collaboration

Abstract: Experimenters from four different argon dark matter searches have joined their forces in the the "Global Argon Dark Matter Collaboration" to carry out a unified program for dark matter direct detection. The participants are researchers currently working on the ArDM experiment at LSC; on the DarkSide-50 experiment at LNGS; on the DEAP-3600 experiment at SNOLab; and on the MiniCLEAN experiment at SNOLab.

In 2015/2016 The DarkSide-50 experiment at LNGS produced two zero-background science results, along with a comparison of the results obtained with both atmospheric and underground argon fills, demonstrating the ability of large experiments to eliminate background from betas/gammas at the tens of tonne-year exposure. Early in 2018, the DarkSide Collaboration announced results from a 2-years campaign with DarkSide-50, resulting again in a zero-background, null observation of heavy (>50 GeV/c^2) dark matter and in the best exclusion limits for light (<10 GeV/c^2) dark matter.

The DEAP-3600 experiment at SNOLAB is the first tonne-scale experiment to achieve both stable operations and an extended physics run. DEAP-3600 has been collecting physics data with over 3 tonnes of argon since late 2016 and published its first results in 2017.

Researchers from the four experiments will jointly carry out as the single next step at the scale of a few tens of tonnes the DarkSide-20k experiment. DarkSide-20k was approved in 2017 by the Italian INFN, by the host laboratory LNGS, and by the US NSF. DarkSide-20k is also officially and jointly supported by the three underground laboratories LNGS, LSC, and SNOLab.

DarkSide-20k is a 20-tonne fiducial volume dual-phase TPC to be operated at LNGS with an underground argon fill, designed to collect an exposure of 100 tonne×years, completely free of neutron-induced nuclear recoil background and all electron recoil background. DarkSide-20k is set to start operating by 2021 and will have sensitivity to WIMP-nucleon spin-independent cross sections of $1.2 \times 10^{-47}\ cm^2$ for WIMPs of 1 TeV/c^2 mass, to be achieved during a 5 year run. An extended 10 year run could produce an exposure of 200 tonne×years, with sensitivity for the cross-section of $7.4 \times 10^{-48}\ cm^2$, for the same WIMP mass. DS-20k will explore the WIMP-nucleon cross-section down to the edge of the 'neutrino floor', where coherent neutrino-nucleus scattering from environmental neutrinos induce nuclear recoils in the detector.

A second step in the program is the construction and operation of a detector with a fiducial mass of a few hundred tonnes, capable of collecting an exposure

of several thousands of tonne×years, completely free of all backgrounds on top of CNNS. This follow-up experiment would also be capable of performing a set of very high precision measurement of several solar neutrino sources (location and laboratory t.b.d.). This includes exquisitely precise measurements of pep, CNO, as well as low energy 8B neutrinos, all in the region of transition between the vacuum- and matter-dominated regions of solar neutrino oscillations.

Prospects for directed searches of continuous gravitational waves in Advanced detectors data

Ornella J. Piccinni for the Rome Virgo group*

*Alphabetic order: P. Astone, S. D'Antonio, S. Frasca, G. Intini, P. Leaci, S. Mastrogiovanni, A.L. Miller, C. Palomba, S. Singhal

Abstract:

Continuous waves (CW) are still undetected gravitational wave signals emitted by rotating neutron stars, isolated or in binary systems. The estimated number of isolated neutron stars in our Galaxy is 10^8-10^9. Information provided by electromagnetic observations are crucial to constrain the signal parameter space, lower the computational cost of a CW search and increase the number of potential targets. Accordingly to the information available about the source, different searches can be set up.

In this work we present prospects for the directed search of CW signals in advanced LIGO-Virgo data using the BSD-directed search method. A list of potentially interesting sources, which are present in the main astronomical catalogues, along with some young supernova remnants, is investigated and theoretical indirect upper limits are computed when possible. Estimate of the computational power needed to perform a directed search for the selected sources is also provided.

Title: LIGO Detector Status

Author: M. Landry for the LIGO Scientific Collaboration

We present an overview of the advanced detectors of the Laser Interferometer Gravitational-wave Observatory (LIGO). Situated 3000km apart in Richland WA and Livingston LA USA, the two interferometers comprise orthogonal 4km Fabry-Perot arms in a Dual-Recycled Michelson configuration. The detectors have achieved strain sensitivities of $10^{-23}/\sqrt{\mathrm{Hz}}$ at 100Hz and a reach into space for the coalescence of binary neutron stars (averaged over sky position and orbital inclination) of 100Mpc. Currently both interferometers are being incrementally upgraded, including the addition of better end mirrors and baffles for scattered light mitigation, 70W amplifiers to increase the main laser power, and the introduction of squeezed vacuum states of light to ameliorate detector noise at high frequencies. We report on the status of the LIGO detectors going into the LIGO-Virgo third observation run (O3) in late 2018, and the prospect for future upgrades and next-generation interferometers.

Gravitational waves from ultralight bosons

Maximiliano Isi (Caltech)

Gravitational waves can teach us not only about astrophysics and the fundamental nature of spacetime, but potentially also about particle physics. In this talk, I will address the exciting prospect of detecting traces of ultralight bosons (axions) using space and ground-based gravitational-wave detectors. I will review the basics of black-hole superradiance in the context of massive scalar fields, and how this can give rise to the formation of a gravitationally-radiating boson cloud around a black hole. I will finish by providing an overview of current and future efforts to search for these signals in LIGO and Virgo data, as well as prospects for LISA.

Generalized stroboscopic resampling methodology for binary pulsars

Akshat Singhal[a] (akshat.singhal@gssi.infn.it), Paola Leaci[a,b], Cristiano Palomba[a], S. Mastrogiovanni[a,b], P.Astone[a], S.D'Antonio[c], S.Frasca[a,b], G. Intini[a,b], A. Miller[a,d], O.J. Piccinni[a,b]

a: INFN, Sezione di Roma, b: University of Roma La Sapienza,
c: INFN, Sezione di Roma Tor Vergata, d: University of Florida

Rapidly rotating neutron stars with non-axisymmetric deformations are an interesting type of continuous-wave sources for the LIGO-Virgo detectors. Within the sensitivity band of these detectors, more than half of the known pulsars in our galaxy are in binary systems. Signals coming from binary sources are Doppler modulated due to the source orbital motion, which spreads the signal in several frequency bins, resulting in a significant loss of signal-to-noise ratio, making thus the signal much harder to be detected. In order to correct for this modulation, one would need to know the orbital parameters and source sky location with very high accuracy. For unknown parameters the correction would be very computationally expensive. Time domain correction using the generalized 5-vector methodology, in the context of directed/narrowband searches, is a relatively cheaper method, and we investigate its robustness over uncertainty in all orbital parameters and present the results based on software injections in the [100-200] Hz frequency band of the second observing LIGO-Virgo run.

Deep-Learning Continuous Gravitational Waves

Authors: Rahul Sharma, Reinhard Prix, Chris Messenger

Abstract: The search for continuous gravitational waves from unknown spinning neutron stars presents an open computational challenge: optimal fully-coherent matched filtering is computationally impossible, and empirical semi-coherent methods are the best current alternative known to deal with this problem. There has been promising progress recently in applying Deep Convolutional Neural Networks as a detection method for binary black-hole coalescence signals (George & Huerta (2017), Gabbard et al (2017), Gebhard et al (2017)). Here we present early results on the feasibility and potential of using similar techniques in the search for continuous gravitational waves.

Title: "Modelling of the EM counterpart of compact binary merger: ejecta, neutrinos and nucleosynthesis"

Speaker: Albino Perego (INFN MIlano Bicocca)

Abstract:
Compact binary mergers (CBM) are cosmic laboratory for fundamental physics. All four fundamental interactions play a key role in setting the properties of the observables associated with these powerful stellar collisions. Thus, they need to be taken into account to provide reliable multimessenger predictions. In this talk, I will focus on the role of neutrinos and weak interaction in setting the properties and the composition of the ejecta. The impact on the features of the electromagnetic counterparts from CBMs will be investigated through a multicomponent, anisotropic kilonova model. Finally, I will show how the application of this model to GW170817, in association with information derived from the analysis of the GW signal, sets constraints on the nature of the remnant and on neutron star equation of state in a genuine multimessenger framework.

Axions and General Relativity

Alfredo Urbano

The first direct detection of gravitational waves and the first observation of a binary black hole merger opened up new perspectives in astro-particle and theoretical particle physics. In this new and uncharted territory, present and upcoming data may play an important role in the quest for one of the most theoretically motivated, but experimentally elusive, particle: The axion. In this talk, I will discuss possible strategies and future prospects both from a theoretical and phenomenological viewpoint.

Search for neutrino counterparts to gravitational wave events with the ANTARES neutrino telescope

On August 17th 2017, the LIGO/Virgo interferometers have detected for the first time the coalescence of two neutron stars whose associated electromagnetic emission has been detected from radio to gamma-rays. A neutrino follow-up was performed using ANTARES data to search for a potential neutrino counterpart to this event. No neutrino candidate in both temporal and spatial coincidence with GW170817 had been detected within +/- 500 s from the event and over an extended time window of +14 days. The neutrino fluence and the total energy emitted in neutrinos have been constrained. More generally, by constantly monitoring at least one complete hemisphere of the sky, neutrino telescopes are well designed to detect neutrinos emitted by transient astrophysical sources. Searches for ANTARES neutrino candidates coincident with multi-wavelength astrophysical transient phenomena are performed by triggering optical, X-ray and radio observations immediately after the detection of an interesting event and also by performing time-dependent point-source searches applied to a list of variable objects. The latest results of these analyses will be presented.

Neutron stars may emit potentially detectable long-lived gravitational wave signals. In this talk I will discuss some of the important data analysis issues that arise when searching for these so-called continuous gravitational wave signals. I will describe how different sorts of astrophysical sources are best searched for using different techniques, depending upon the amount of prior information available form electromagnetic astronomy. I will also discuss the delicate issue of how sudden step-changes in spin frequency, known as glitches, may complicate the gravitational wave search.

TITLE: Search for Dark Matter with GAPS

AUTHOR: Dr. Martucci Matteo on behalf of the GAPS Collaboration

ABSTRACT

The GAPS experiment is designed to carry out dark matter studies by searching for low-energy cosmic-ray antideuterons.

The antideuteron flux coming from secondary interactions of primary cosmic rays with the interstellar medium is very low, but novel theories beyond the standard model of particle physics (i. e., SUSY etc.) predict dark matter candidates that could provide a significant enhancement of the antideuteron flux, in particular at low energies.

The detector itself will consist of 10 planes of semiconducting Si(Li) detectors and a plastic scintillator time-of-flight system.

Low-energy (< 0.25 GeV/n) antideuterons will be trapped in the Si(Li) material, forming an excited exotic atom that, after de-excitation through X-ray transitions, will create a characteristic annihilation pion star. This unique signature will be crucial for a nearly background-free event detection.

The GAPS experiment is designed to utilize long-duration balloon flights from Antarctica, and is currently scheduled by NASA for its first Antarctic flight in late 2020.

Speaker: Simone Mastrogiovanni

Title: Looking for gravitational waves from poorly known neutron stars

The era multi-messenger astronomy has officially begun with a joint electromagnetic and gravitational-wave (GW) detection of a binary neutron stars merger, GW170817. Asides from compact binary coalescence, another type of GW signals, quite promising for multi-messenger astronomy, are those emitted by axisymmetric spinning neutron stars. These type of long-lived continuous waves (CWs) are assumed to be phase-locked at two times the rotational phase evolution of the neutron star. In order to look for a CW with the best possible sensitivity, a precise knowledge of the neutron star rotational phase is needed. This type of information is accurately known from radio observations for some pulsars, such as the Crab and Vela pulsars, while for others it is not enough accurate. Narrow-band searches allow one to relax the condition for the phase locking, while offering a sensitivity comparable to optimal filtering techniques. These type of searches are able to analyse targets for which updated ephemeris are not available and they can take into account the possibility that the GW engine is not phase locked with their beam emission. The recent results of a narrow-band search for 11 known pulsars using O1 LIGO data will be presented. The prospects of Narrow-band searches in future runs will be also discussed.

Abstract

Dark matter search with the SABRE experiment

The SABRE (Sodium Iodide with Active Background Rejection) experiment will search for an annually modulating signal from Dark Matter (DM) using an array of ultra-pure NaI(Tl) detectors surrounded by an active scintillator veto to further reduce the intrinsic background. The expected rate of interactions between DM particles and the detector in fact modulates due to Earth's changing velocity relative to the DM halo.

The first phase of the experiment is the SABRE Proof of Principle (PoP), a single 5kg crystal detector operated in a liquid scintillator filled vessel at the Laboratori Nazionali del Gran Sasso (LNGS). The PoP installation is underway with the goal of running in 2018 and performing the first in situ measurement of the crystal background, testing the veto efficiency, and validating the SABRE concept.

As part of this effort, GEANT4-based Monte Carlo simulations have been developed to estimate the background in the PoP based on radio-purity measurements of the detector components. The most recent simulations include detailed versions of the detector part geometries.

The second phase of SABRE will be twin arrays of NaI(Tl) detectors operating at LNGS and at the Stawell Underground Physics Laboratory (SUPL) in Australia. By locating detectors in both hemispheres, SABRE will minimize seasonal systematic effects.

In this talk, the status report of the SABRE PoP activities at LNGS will be presented as well as results from the most recent Monte Carlo simulation.

Title: Prospects for joint GW and gamma-ray EM observations of binary neutron star mergers

Authors: Barbara Patricelli, Antonio Stamerra, Massimiliano Razzano, Giancarlo Cella

Abstract:
The recent detection of gravitational waves (GWs) from a binary neutron star (BNS) merger by Advanced LIGO and Advanced Virgo (GW 170817) and of its electromagnetic (EM) counterparts opened the era of multi-messenger astronomy and the possibility to detect gamma-ray emission from weak short GRBs in coincidence with GW signals. In the next years, when Advanced LIGO and Advanced Virgo will reach their final design sensitivity, many other BNS mergers are expected to be detected in GWs, and multi-messenger astronomy will be key to further probe the rich physics of these transient phenomena.

We have developed BNS merger simulations and worked out the expected associated EM emission that present generation of instruments like Fermi, and future observatories like eASTROGAM and the Cherenkov Telescope Array can detect and characterize. Our comprehensive study provides the prospects for joint GW and gamma-ray EM observations of merging BNSs with Advanced LIGO and Virgo and different gamma-ray telescopes.

LIGO-Virgo efforts to study the post-merger remnant of the GW170817 event

David Keitel for the LIGO & Virgo collaborations

March 14, 2018

Abstract

Despite the wealth of observational data on the binary neutron star merger GW170817, the nature of its post-merger remnant remains an open question, with the potential for strong additional constraints on the properties of dense nuclear matter. While there is some circumstantial evidence for a hypermassive remnant that quickly collapsed to a black hole, only direct observation of post-merger gravitational waves would yield a conclusively answer. The lower sensitivity of LIGO and Virgo at high frequencies limits the amount of information on the post-merger phase, but it is still instructive to analyse the data in particular for the kinds of signals expected from a putative neutron star remnant. I will summarise observational constraints on gravitational waves from the remnant of GW170817, including those reported in [Abbott et al., ApJL 851:L16] and additional more recent efforts. Beyond GW170817, the employed search methods will play a crucial role in future BNS observations with improved high-frequency detector sensitivity.

First Results from the DAMPE Mission

Andrii Tykhonov (for the DAMPE collaboration)

DAMPE (Dark Matter Particle Explorer) is a satellite mission of the Chinese Academy of Science aimed to probe high energy astro particle physics in a wide energy range. It was successfully launched in December 2015 and has been operating smoothly since, collecting about five million events per day. DAMPE consists of four sub-detectors, a plastic scintillator-strip detector, a silicon-tungsten tracker-converter, a 32 radiation-length thick BGO calorimeter and a boron-doped plastic scintillator.

It is designed to measure the flux of cosmic-ray electrons and positrons (CRE) up to 10 TeV with unprecedented energy resolution allowing it to reveal potential features in the CRE spectrum, such as the existence of local sources or more exotically to probe particle dark matter. It will also detect the cosmic-ray protons and nuclei up to 100 TeV with good energy precision, bringing new insights to their origin and propagation mechanisms. Thanks to a good pointing, new hints in the domain of gamma-ray astronomy are also expected. The spectral resolution capabilities of DAMPE would allow to probe exotic physics scenarios such as monochromatic features in the spectrum of gamma rays originating from our Galaxy.

In this talk the DAMPE experiment will be introduced and its in-flight operation details will be described. The first scientific results of the mission will be presented, including the exciting measurement of the CRE flux in the energy range from 25 GeV to 4.6 TeV.

ANTARES dark matter searches and perspectives for KM3NeT

S.R. Gozzini on behalf of the ANTARES and KM3NeT Collaborations

Abstract

Neutrino telescopes perform an indirect search for dark matter (DM) through its annihilation into standard model channels yielding neutrinos, for a broad range of WIMP masses. The ANTARES telescope, anchored to the Mediterranean seabed at a depth of about 2500 m, looks for a DM signal from two promising sources with high WIMP density: the Galactic Center and the Sun. We present the latest results of ANTARES on indirect detection for several WIMP masses and channels, and give a future prospect on sensitivities of DM searches with KM3NeT, the next-generation neutrino telescope, currently in deployment. These detectors have specific advantages, complementary to other strategies, and can provide a smoking-gun signal in the case of the Sun. The geographical location of ANTARES and KM3NeT is particularly suited for searches in the Galactic Center, allowing for the best limits in the world on annihilation cross-section for large WIMP masses.

Cosmological implications of the first LIGO and Virgo detections

Tania Regimbau

The first detections of colliding black holes in distant galaxies and more recently neutrons stars by LIGO and Virgo have already provided interesting informations about the rate of compact binaries and the mass distributions of their components. With the improvement of the sensitivity, many more detections are expected in the next few years, and there is also a chance that we can observe the gravitational-wave stochastic background formed by all the sources at higher redshift that are too faint to be seen individually.

In this talk, I will discuss how the two forms of observation (individual and stochastic) may help discriminate between different formation scenarios, constrain the physical properties of the population of compact objects and their evolution with redshift, as well as the star formation history of the Universe.

All-sky Frequency-Hough: pattern based vetoes

Autori: Giuseppe Intini, Paola Leaci, Pia Astone

All-sky searches for continuous gravitational waves (CW) require a very high computational cost. For this reason it is more convenient to perform a hierarchical search rather than a coherent one. The Frequency-Hough pipeline uses a tool -known as Hough transform- to achieve this goal. Anyway, the number of candidates returned by this pipeline is quite high ($O(10^{12})$). To solve this problem we have deeply studied the patterns that these candidates produce in the search parameter space (given by the source frequency, frequency derivatives and sky position) as a consequence of the Earth Doppler modulation. This has resulted into a novel veto algorithm, which is able to streamline all candidates not consistent with a CW signal.

Anisotropies in the astrophysical background of gravitational waves

authors: Giulia Cusin, Irina Dvorkin, Cyril Pitrou, Jean-Philippe Uzan

Unresolved and resolved sources of gravitational waves are at the origin of a stochastic gravitational wave background. While the computation of its mean density as a function of frequency in a homogeneous and isotropic universe is standard lore, the computation of its anisotropies requires to understand the coarse graining from local systems, to galactic scales and then to cosmology. I present a general framework to compute the anisotropies of the energy density of this background. In a homogeneous and isotropic universe with scalar perturbations, the final results depend both on cosmology and on the details of the astrophysical processes of gravitational waves production. I will present then the first numerical predictions for the angular power spectrum of the astrophysical gravitational wave background produced by binary systems and its correlations with lensing and galaxy distribution. These results pave the way to the study of a new observable at the crossroad between general relativity, astrophysics and cosmology.

“Multi-messenger astrophysics with the Pierre Auger Observatory”

João de Mello Neto for the Pierre Auger Collaboration

Ultra-high energy cosmic rays (UHECRs) are the highest energy messengers of the present universe, with energies up to 10^{20} eV. Studies of astrophysical particles (nuclei, electrons, neutrinos and photons) at their highest observed energies have implications for fundamental physics as well as astrophysics. The primary particles interact in the atmosphere and generate extensive air showers. Analysis of those showers enables one not only to estimate the energy, direction and most probable mass of the primary cosmic particles, but also to obtain information about the properties of their hadronic interactions at an energy more than one order of magnitude above that accessible with the current highest energy human-made accelerator. The Pierre Auger Observatory, located in the province of Mendoza, Argentina, is the biggest cosmic ray experiment ever built. The Observatory was designed as a hybrid detector covering an area of 3000 km^2 and it has been taking data for more than ten years. In this talk a selection of the latest results is presented: the cosmic ray energy spectrum, searches for directional anisotropy and studies of mass composition (including the photon and neutrino searches). Finally we will describe the search of neutrino emission from the binary neutron star merger GW170817 together with ANTARES and IceCube Observatories.

Abstract:
GW170817/GRB170817A demonstrated the importance of synergy between multi-messenger observatories and the ability to analyzed data in real-time for prompt emission. Possessing wide fields-of-view (FoV), these instruments' capabilities are critical to aiding smaller FoV instruments across the electromagnetic spectrum for follow-up observations. But also, the prompt emission (predominately at hard X-rays and soft gamma rays) provide insight for both astrophysics and standard physics. With these motivations in mind, we have developed a real-time analysis for the PICsIT instrument (~200 keV -2.6 MeV) on board INTEGRAL. IBIS/PICsIT has a FoV of ~70 degrees off-axis and a standard data type with ~16 ms time resolution in 8 broad energy bands. Because the INTEGRAL data is continuously telemetered, we are able to analyze the data on the ground to look for impulsive events. Here we report on current results and future prospects for our work.

Authors: RODI, James (IAPS-INAF); BAZZANO, Angela (IAPS-INAF); NATALUCCI, Lorenzo (IAPS-INAF); UBERTINI, Pietro et al on behalf of the INTEGRAL GW Team

INTEGRAL GW Team

A. Bazzano, E. Bozzo, S. Brandt, J. Chenevez, T. J.-L. Courvoisier, R. Diehl, A. Domingo, C. Ferrigno, L. Hanlon, E. Kuulkers, E. Jourdain, A. von Kienlin, P. Laurent, F. Lebrun, A. Lutovinov, A. Martin-Carrillo, S. Mereghetti, L. Natalucci, J. Rodi, J.-P. Roques, V. Savchenko, R. Sunyaev, and P. Ubertini

INTEGRAL observation of GW gamma ray counterparts and future perspectives

ABSTRACT

We will summarize the scientific implication of the INTEGRAL observations of the LVC O2 run and, in particular, of the first detection of the prompt electromagnetic counterpart coincident with a GW170817.

An unexpected result of the short gamma-ray bursts (SGRB) detected from this NS-NS merging was the extremely low isotropic luminosity of the event relative to other SGRBs with known redshifts, revealing a population of low luminosity SGRBs. The most popular interpretation has been that GRB 170817A was viewed off-axis, rather than that the event had an intrinsically low luminosity. In either case, this result has spurred off-line searches for SGRBs below instrument trigger thresholds in hopes of finding similar events. We will then present a data set from the INTEGRAL soft gamma-ray detector IBIS/PICsIT (~200 keV - 10 MeV) to corroborate the list of publicly available un-triggered SGRB candidates reported by Fermi/GBM.

Authors : UBERTINI, Pietro (IAPS-INAF), BAZZANO, Angela (IAPS-INAF) ; NATALUCCI, Lorenzo (INAF/IAPS) ; RODI, James (IAPS-INAF) et al on behalf of the INTEGRAL GW Team.

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Monolithic folded pendulum sensor for present and future interferometric detectors of gravitational waves

An effective low frequency sensitivity improvement of present and future generation of gravitational waves interferometric detectors requires the introduction of new ideas and the development of suitable technologies. Within this framework, the improvement of the suspension system is a crucial point.

An optimization of their performances can be obtained improving the quality of the control system, where the sensors play a relevant and critical role. In fact, they must be sensitive in a large frequency range (mainly at low frequency), but at the same time compact, robust, light and capable to operate at cryogenic temperatures for the new generation of detectors. Monolithic folded pendulum sensors appear to satisfy these requirements.

In this work, we present and discuss the performances of a standard UNISA monolithic folded pendulum as function of the temperature. Cryogenic measurements were performed to characterize the sensor, to find its main limit and to suggest possible upgrades. The experimental data show that this class of sensors could be already applied both to the present and to next generation of interferometric detectors of gravitational waves.

Novel technologies for direct dark matter detection.

E.Baracchini (GSSI), G. Cavoto (Sapienza), E. Di Marco (INFN Roma), G.Mazzitelli (INFN LNFN), D.Pinci (INFN Roma), A.D.Polosa (Sapienza), F.Renga (INFN Roma), C.Voena (INFN Roma)

The presence of dark matter particles in our Galaxy with a mass in the 10-1000 GeV range is currently being tested by multi-ton experiments in various laboratories. While a positive signal of the presence of such particles is still missing, there is a vast interest in exploring other dark matter mass ranges, below 10 GeV down to few MeV. I will discuss new detection scheme which are being followed in various experimental R&D programs to develop detectors for these relatively light dark matter particles. They are based on novel materials (such as graphene or carbon nanotubes) or on light gas mixtures, being used as dark matter target and all trying to exploit the apparent anisotropic distribution of the galactic dark matter particles, due to the motion of the Sun towards the Cygnus constellations.

(Towards) the 3rd generation of Gravitational Wave Observatories:

The Einstein Telescope project

Michele Punturo

INFN Perugia

The monumental sequence of the gravitational wave detections by the Advanced LIGO and Advanced Virgo interferometers generated a revolution in the way to observe the Universe, opening first the window of the gravitational wave astrophysics and then the era of the multi-messenger astronomy. Currently, a new generation of GW terrestrial observatories is under design, aiming to a large progress on the capability of observing new astrophysical phenomena and in the understanding of the Universe.

Einstein Telescope (http://www.et-gw.eu) is the pioneer project addressed to the realisation, in the next decade, of a 3^{rd} generation observatory in Europe. The science reaches, the technological challenges and the organisation are described.

The gravitational-wave sky so far

Alberto Vecchio

In less than two years of operation, gravitational-wave observatories – Advanced LIGO and Virgo – have directly detected gravitational waves, discovered binary black hole mergers, revealing an abundant population of these systems, and recently observed the first binary neutron star coalescence. The aftermath of this event was also observed across the electro-magnetic spectrum, from gamma rays to radio waves, providing evidence that binary neutron star mergers are engines behind (at least some) short gamma ray bursts and primary production sites of elements heavier than iron in the Universe. I will summarise the results so far, their main implications and touch upon prospects for the future.

Searching for long duration transient gravitational waves from a remnant of GW170817 using the generalized FrequencyHough

Andrew Miller on behalf of the Florida/Rome groups

We present a new algorithm to detect gravitational waves from isolated, quickly rotating neutron stars. Our method searches across different braking indices that describe the types of radiation an isolated neutron star could emit: r-modes, pulsar winds, pure electromagnetic emission, pure gravitational wave emission, and combinations of these mechanisms. To search for sources of these durations that have large and highly varying spindowns, we describe how we have modified the Rome continuous wave group's pipeline (the FrequencyHough) to search for signals with nonlinear time/frequency evolutions. We also discuss how we apply this method to search for binary neutron star remnants, such as from GW170817.

Barbara De Lotto on behalf of the MAGIC Collaboration

MAGIC multi-messenger results and perspectives

The MAGIC (Major Atmospheric Gamma-ray Imaging Cherenkov) telescopes are particularly suited for follow-up of transient events thanks to the low energy threshold and fast slewing. They are strongly involved in several multi-messenger programs, such as the follow-up observations of gravitational wave and astrophysical neutrino events.
The recent results and the plans for the future will be reviewed, also in view of the next-generation array of imaging atmospheric Cherenkov telescopes.

Supermassive Black Hole Formation as Revealed by LISA: How Gravitational Wave Astronomy Will Be a Game Changer

Kelly Holley-Bockelmann, Glenna Dunn, and Jillian Bellovary

Astronomers now know that supermassive black holes are in nearly every galaxy. Though these black holes are an observational certainty, nearly every aspect of their evolution -- from their birth, to their fuel source, to their basic dynamics -- is a matter of lively debate. Fortunately, LISA, a space-based gravitational wave observatory set to launch in 2034, will revolutionize this field by providing data that is complementary to electromagnetic observations as well as data in regimes that are electromagnetically dark. This talk will touch on our current understanding of how SMBHs form, evolve, and alter their galaxy host, and will outline the theoretical, computational and observational work needed to make the most of LISA observations.

Searches for Signatures of Dark Matter in the Cosmos

Regina Caputo
On behalf of the Fermi-LAT collaboration

The era of precision cosmology has revealed that ~80% of the total amount of matter in the universe is dark. Cosmic microwave background measurements, galactic rotation curves, and gravitational lensing each provide strong evidence for the existence of dark matter. Two leading candidates, motivated by both particle and astrophysics, are Weakly Interacting Massive Particles (WIMPs) and Weakly Interacting Sub-eV Particles (WISPs). Both the annihilation and decay of WIMPs and oscillations of WISPs have distinct gamma-ray signatures. Data from the Fermi Large Area Telescope (Fermi-LAT) continues to be an integral part of the search for these dark matter signatures spanning the 50 MeV to >300 GeV energy range in a variety of astrophysical targets. A detection of gamma rays from the interactions of dark matter would provide evidence of physics beyond the Standard Model. I present several recent results from the Fermi-LAT Collaboration from a variety of WIMP and WISP dark matter searches.

Towards observational run O3 with Virgo detector

E. Majorana on behalf of Virgo Collaboration

Several upgrades have been implemented in Virgo detector. Some of them, as the fused silica suspension adoption in test mass payloads, had been already foreseen since the initial phases of Advanced Virgo, but finally not implemented to join observational run O2. Other upgrades and improvements with respect to O2 arose through the commissioning phases of Advanced Virgo project. The overall activity performed after O2, sensitivity performance and science expectation for O3 will be reported.

Andrzej Krolak

Institute of Mathematics, Polish Academy of Sciences

Application of Feldman-Cousins upper limits to gravitational wave data analysis

A number of applications of classical frequentist approach due to Neyman to obtain upper limits leads to unphysical results like upper limit on gravitational wave amplitude being negative. Usually application of Bayesian methodology leads to satisfactory upper limits. There is however an alternative approach proposed by Feldman and Cousins within the frequentist approach to eliminate unphysical upper limits. As frequentist upper limits are continued to be used in gravitational wave data analysis we study Feldman-Cousins approach with a particular focus on upper limits in searches for gravitational waves from rotating neutron stars.
We present a code that calculates Feldman-Cousins upper limits for arbitrary data distribution. We compare the Feldman-Cousins upper limits with frequentist and Bayesian upper limits.

Title: Machine learning for transient discovery for GRAWITA and DLT40 project

Author: Sheng Yang on behalf of GRAWITA and DLT40 project

Abstract: With the expected increase in sensitivity of the LIGO-VIRGO detectors and the ZTF, LSST come into service in the near future, the big data astronomy era would begin: The wide field of view telescopes are supposed to capture images of almost the entire night sky every few days while reach very deep at the same time, which means more and more candidates would be achieved, together with bogus. A ranking algorithm is needed by astronomers to skip the bogus and remain the very real candidates for manual check. The most common used approach now is to compute photometric and geometric features of the candidate from the sub-images. However, due to high and variable image noise levels and image processing artifacts, this approach would remain lots of false alarms that humans must manually reject. The machine learning algorithm would be the complementary and even better choice for the real-time survey. In this presentation, I will show some examples for my machine learning approach from supervised, unsupervised learning to deep learning, based on DLT40 and GRAWITA images taken during the LIGO O1 and O2 period.

Title: Gravitational wave optical counterpart searching based on GRAWITA and DLT40 project

Author: Sheng Yang on behalf of GRAWITA and DLT40 project

Abstract: During the second run of the Laser Interferometer gravitational-wave(GW) Observatory and Virgo Interferometer collaboration(LVC), a gravitational-wave signal consistent with a binary neutron star coalescence(BNS) was detected on 2017 August 17th (GW170817), quickly followed by a coincident short gamma-ray burst(GRB170817a) trigger by the Fermi satellite. 11 hours later, DLT40 independently discovered a coincident optical transient (2017GFO/sss17a/DLT17ck),which was then identified as a kilonova by GRAWITA follow-up spectroscopy. An empirical limit on the kilonova rate was then calculated, which shows that DLT40-like search would discover one DLT17ck like fast transient by using 18 years without LVC information. In this presentation, I would like to talk about the discovery of the kilonova, DLT17ck. And since I'm also highly involved in the GRAWITA project which use a different approach to survey the high probability GW uncertainty area, I would compare the two different follow-up strategy: galaxy pointing strategy and the tiling strategy. With the expected increase in sensitivity of the LVC detectors in the future, more and more candidates would be achieved including a large amount of bogus. The machine-learning algorithm would be then very important in the future real-time survey. I would like to show some examples of the machine learning for transient images and light curves.

Title:

Enhancing Advanced Virgo sensitivity with the re-integration of monolithic payloads

Author:

L Naticchioni, on behalf of the Virgo Collaboration

Abstract:

After its first observation run (O2), Advanced Virgo has been subjected to an important upgrade of the detector in order to achieve an improved sensitivity in the next O3 run. To reduce the thermal noise due to the test mass suspension, the mirrors were finally reintegrated in the payload structures adopting the monolithic suspension originally designed for Advanced Virgo. Hydroxide catalysis bonding has been used to join the mirror with its suspension fused silica fibers, and the latter with the marionette body. The vacuum system was significantly upgraded, nevertheless the payloads have been equipped with fiber guards to avoid any possible failure due to high speed dust injected through vacuum pipes. Moreover, all the assembly and integration procedures have been reviewed to ensure the robustness and reliability of the overall system. In this talk I will give an overview of the monolithic payloads re-integration, and their preliminary characterization obtained during the commissioning activity.

Dark mater searches with IceCube

(C. de los Heros, for the IceCube Collaboration)

The IceCube Neutrino Observatory at the South Pole is the world's largest neutrino telescope. It instruments a kilometer cube of ice with more than 5000 optical sensors that detect the Cherenkov light emitted by particles produced in neutrino-nucleon interactions in the ice. Covering a wide range of neutrino energies, from few GeV to PeVs, its physics program is extremely rich.

The talk will concentrate in the searches for dark matter gravitationally accumulated at the center of the Sun, Earth or the galactic center, where dark matter self-annihilations to standard model particles can produce a detectable flux of neutrinos. The latest limits from IceCube on the dark matter-nucleon cross section and on the dark matter self-annihilation cross section, as well as on dark matter lifetime, will be presented, and the results discussed in the framework of multiwavelength searches with Cherenkov telescopes and gamma ray satellites.

Overview of Dark Matter

In this talk, I will discuss the aspects that make for a successful theory of particle dark matter and discuss the most popular visions for what the dark matter can be. I will also discuss how experimental observations inform our understanding of theories of dark matter, and can work in tandem to confirm them.

Title: Deep Neural Networks in the context of Gravitational-Wave searches

Abstract: We present a new paradigm for gravitational wave astrophysics that employs high performance computing simulations to train artificial intelligence algorithms, in particular deep learning with convolutional neural networks, which can exploit emerging hardware architectures such as deep-learning-optimized GPUs, to enable real-time analysis of data from gravitational wave detectors. We showcase the application of this framework in the context of gravitational wave detection with the LIGO observatories. We discuss current and future trends for innovative applications of artificial intelligence algorithms to push the frontiers of multi-messenger astrophysics.

Author: Eliu Huerta

Title: Astrophysical sources of continuous gravitational waves

Presenter: Brynmor Haskell

Abstract: Neutron stars are expected to be prolific emitters of gravitational waves and in particular it is thought that many will be visible as gravitational wave ‘pulsars’ that emit continuous gravitational signals. In this talk I will review the main mechanisms for continuous gravitational wave generation, namely quadrupolar `mountains’ sustained by the crust of the star and unstable modes of oscillation. I will discuss recent theoretical results, but also focus on assessing in which astrophysical systems these mechanisms may be active, and which systems would be the best targets for gravitational wave searches.

Aniello Grado & GRAWITA Team

The search of GW optical counterpart in the Multi-Messenger Astronomy Era

The gravitational event GW170817 on August 17th 2017 has started the Multi-Messenger astronomy showing the capability of the synergic searches to provide an incredible amount of new physical informations.

In spite of the substantial reduction of the sky error box, thanks to the detectors triangulation involving Virgo, the search of optical counterpart is challenging in particular if coming from GW sources far away that implies faint optical transients.

In order to maximize the probability to detect the optical transient associated to GW it is necessary to take into account several parameters, including the specific characteristics of the telescope used for the search. We describe the effort and the technics used for the optical surveys used for such searches considering in particular the case of the program based on the VLT Survey Telescope facility at ESO Cerro Paranal.

Title:
Multi-messenger Results from the IceCube Neutrino Observatory

Authors:
Chad Finley, on behalf of the IceCube Collaboration

Abstract:
Embedded in the glacier at the South Pole, IceCube uses one cubic kilometer of instrumented ice to detect high-energy neutrinos. IceCube has discovered a diffuse flux of astrophysical neutrinos with an energy spectrum extending beyond several PeV. A wide range of source objects have been proposed as the origin of this flux, with many searches ongoing. Transient sources are especially promising targets because of their lower background and also rich multi-messenger potential. A joint analysis effort between IceCube and LIGO-Virgo that began during their initial phase has taken on a new urgency with the first gravitational wave detections. Since 2016, IceCube has also been sending public alerts for its highest-energy events, to enable follow-up by ground-based and satellite telescopes which might be able to identify a transient counterpart to the neutrino emission. In this talk I will review recent results from neutrino source searches with particular focus on gravitational-wave and electromagnetic follow-up searches.

A semi-coherent method for all-sky searches of nearly monochromatic signals with a wandering frequency.

Authors: Sabrina D'Antonio on behalf of the Rome2 and Rome1 CW group

Continuous gravitational wave signals are among the most interesting targets for current and future detectors. Such kind of signals are expected to be emitted by rotating compact objects, like neutron stars and black holes. The search for these signals is challenging when the signal parameters are unknown. A further complication is present if the signal frequency varies in a random way. In this talk we present a robust data analysis method for the blind search of continuous gravitational waves with randomly varying frequency. In particular, we describe a possible setup for the search of the signals emitted by light boson clouds around black holes, formed following a super radiant instability process.

Status of Dark Matter searches in final states with jets at ATLAS and CMS

Di Marco Emanuele

Hadronic final states provide a unique handle for the investigation of the particle nature of Dark Matter within a plethora of theories beyond the Standard Model. The status and perspective of searches for weakly-interacting massive particles at ATLAS and CMS in events with hadronic jets will be presented, with particular emphasis on the complementarity between signatures with missing transverse momentum and resonance searches.

Gamma-ray Bursts - An Overview

Julie McEnery

Gamma-ray bursts are the brightest electromagnetic explosions in the Universe. They consist of a bright "burst" of gamma-rays lasting from a fraction of a second to thousands of seconds, followed by a faint fading afterglow seen at longer wavelengths. In this talk, I will summarize the observations of gamma-ray bursts and how they drive our understanding of emission processes, jets and progenitors of GRBs. Finally, I will also discuss the important role that Gamma-ray Bursts are playing in the emerging field of multimessenger astrophysics.

The broad-band afterglow and the merger remnant of GW170817

Luigi Piro, IAPS/INAF

I will review the radio to X-rays observations of GW170817, including the latest radio, HST, Chandra and XMM observations, and show how they display the telltale of a relativistic jetted outflow ejected from the central source, in agreement with the unification scenario of short GRB. Our latest data indicate that the flux has started to decay, thus allowing to set constraints on the key parameters of the relativistic outflow. I will then discuss the constraints set by our latest X-ray observations on the central source and conclude with future perspectives allowed by the large X-ray observatory Athena, the second ESA large mission.