GRAvitational-waves Science&technology Symposium

Report of Contributions

https://agenda.infn.it/e/grass2018

Contribution ID: **2** Type: **not specified**

Electromagnetic counterpart searching for gravitational wave

Friday, March 2, 2018 12:00 PM (20 minutes)

During the second science run(O2) of the Laser Interferometer gravitational-wave Observatory (LIGO) and Virgo Interferometer, 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. 10 hours later, 6 groups independently detected a coincident optical kilonovae (AT 2017GFO/sss17a/DLT17ck). The era of multi-messenger astronomy has truly begun. Two complementary approaches are used in order to search for electromagnetic(EM) counterpart of gravitational wave(GW) signal with large localization uncertainty: wide-field search on high probability GW region, e.g. Gravitational Wave Inaf Team(GRAWITA) project or pointed search of selected galaxies in high probability GW region, e.g. Distance Less Than 40 Mpc survey(DLT40) project. As one of the six groups independently detected the kilonova, DLT40 was designed as a one day cadence supernova search, which would use a Prompt 5 0.4m telescope to monitor around a sample of 2000 local galaxies including NGC4993, the host galaxy of the kilonova. Since DLT17ck is the first confirmed kilonova detected, we also reported the kilonova rate for the BNS system based on DLT17 light curve and the one year DLT40 survey log. With the expected increase in sensitivity of the LVC detectors, in LIGO O3 the volume where BNS mergers can be detected will reach 150 Mpc. At this distance, current galaxy catalogs are incomplete. The wide FoV strategies, like GRAWITA, would play more important role. From the wide FoV searching process, we found that the difficulty would be the large amount of consuming time for running pipelines and choose the best source as soon as possible during thousands of candidates. The parallel computing would increase the computing speed while the machine learning algorithm would be employed to make transient search much more efficient.

Primary author: Dr YANG, Sheng (Observatory of Padova, INAF)

Presenter: Dr YANG, Sheng (Observatory of Padova, INAF)

Session Classification: Gravitational wave Data Analysis: Strategies and Challenges

Contribution ID: **3** Type: **not specified**

GW170817 Falsifies Dark Matter Emulators

Friday, March 2, 2018 11:40 AM (20 minutes)

The gravitational wave (GW) signal (GW170817) from the coalescence of binary neutron stars was simultaneously seen throughout the electromagnetic (EM) spectrum from radio waves to gamma-rays. We point out that this simultaneous detection rules out a class of modified gravity theories, and provides another indirect evidence for the existence dark matter.

Primary author: Prof. KAHYA, Emre (Istanbul Technical University)

Co-authors: Prof. WOODARD, Richard (University of Florida); Prof. DESAI, Shantanu (Indian Institute of Technology, Hyderabad); Ms BORAN, Sibel (Istanbul Technical University)

Presenter: Prof. KAHYA, Emre (Istanbul Technical University)

Session Classification: Gravitational wave Data Analysis: Strategies and Challenges

Contribution ID: **4** Type: **not specified**

GW optical counterpart search in the Multi-Messenger Astronomy Era

Thursday, March 1, 2018 6:10 PM (20 minutes)

The discovery of the GW170817's optical counterpart has shown the wealth of information and science that can be gathered from such findings.
As foreseen from theories and verified with the last GW event on the O2 run, the merging of two binary neutron stars produce a bright optical counterpart. The same is expected in the BH-NS coalescence while more controversial is the case of merging of two Black Holes. In spite of the substantial reduction of the sky error box, thanks to the detectors triangulation envolving Virgo, still the search of optical counterpart is challenging in particular if coming from GW sources far away that implies faint optical transients.
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.

Primary author: Dr GRADO, Aniello (INAF-Osservatorio Astronomico di Capodimonte)

Presenter: Dr GRADO, Aniello (INAF-Osservatorio Astronomico di Capodimonte)

Session Classification: Impact of Gravitational-Wave Surveys and Multi-messenger Observations on Astrophysics, Cosmology and Other Branches of Fundamental Physics

Contribution ID: **5** Type: **not specified**

Gravitational wave detection using cavity-assisted atom interferometry

Friday, March 2, 2018 2:30 PM (20 minutes)

Atom interferometers employing optical cavities to enhance the beam splitter pulses promise significant advances in science and technology, notably for future gravitational wave detectors. Long cavities, on the scale of hundreds of meters, have been proposed in experiments aiming to observe gravitational waves with frequencies below 1 Hz, where laser interferometers, such as LIGO, have poor sensitivity. The Atom Interferometry group at the Birmingham Institute of Gravitational Wave Astronomy has explored the fundamental limitations of two-mirror cavities for atomic beam splitting, and established upper bounds on the temperature of the atomic ensemble as a function of cavity length and three design parameters: the cavity g-factor, the bandwidth, and the optical suppression factor of the first and second order spatial modes. A lower bound to the cavity bandwidth which avoids elongation of the interaction time and maximizes power enhancement was found. An upper limit to cavity length is also found for symmetric two-mirror cavities. These key limitations impact the feasibility of long-baseline detectors, which suffer from a naturally larger bandwidth and worse optical suppression of higher order optical modes. Our findings will aid the design of current and future experiments using this technology, such as the MIGA experiment in France. In the future we aim to fully model the effect that the imperfect (but cavity-filtered) optical wavefronts have on the atomic transitions.

Primary author: Mr DOVALE-ALVAREZ, Miguel (University of Birmingham)

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Presenter: Mr DOVALE-ALVAREZ, Miguel (University of Birmingham)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **6** Type: **not specified**

Low temperature performances of a monolithic folded pendulum sensor for the third generation of interferometric detectors of gravitational waves

Thursday, March 1, 2018 3:30 PM (20 minutes)

An effective low frequency sensitivity improvement of the next generation of gravitational waves interferometric detectors requires the introduction of new ideas and the development of suitable technologies. Within this framework, the cryogenic suspensions represent a very good synthesis and effective approach to this problem, as already demonstrated by the KAGRA interferometric detector.
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 and large band (at low frequency), but at the same time compact, robust and light, and capable to operate at cryogenic temperatures.
Monolithic folded pendulum sensors appear to satisfy these requirements. The ultimate limitation in terms of sensitivity of this class of mechanical sensors, configurable both as seismometers or as accelerometers, is their mechanical thermal noise, function of their resonance frequency and temperature.
In this paper we present and discuss the performances of a standard UNISA monolithic folded pendulum as function of the temperature. The experimental data show its sensitivity improvement along with the temperature decrease, sensitivity limited only by the material dissipation. These results show also that this class of sensors could be already applied both to the present and to next generation of interferometric detectors of gravitational waves.

Primary authors: MARCHESONI, Fabio (PG); Prof. BARONE, Fabrizio (NA); TRAVASSO, Flavio (PG); Dr GIORDANO, Gerardo (NA); Dr VOCCA, Helios (PG)

Presenter: TRAVASSO, Flavio (PG)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **7** Type: **not specified**

Modelling the ejecta and electromagnetic counterparts from binary neutron star mergers

Friday, March 2, 2018 9:40 AM (20 minutes)

The first detection of GWs from a binary neutron star merger (GW170817) marked the beginning of the multimessenger astronomy era. A few hours after the GW detection, the observation of an associated electromagnetic counterpart compatible with a kilonova/macronova emission remarkably confirmed our basic picture concerning the ejection of matter and the nucleosynthesis occurring in such a kind of events. At the same time, it gave a first demonstration of the power of a multimessenger analysis in exploiting binary compact mergers as laboratory of fundamental physics. In this talk, I will present the status of kilonova/macronova modeling in terms of the different ejection mechanisms, and of the associated r-process nucleosynthesis. I will show the impact of the variety of ejecta (both in terms of microphysical properties and spatial distributions) on the light-curves, with a particular application to the case of GW170817. This modeling provides complementary information to the GW signal and is crucial to ser multimessenger constraints, for example for the equation of state of nuclear matter.

Primary author: PEREGO, Albino (MIB)

Presenter: PEREGO, Albino (MIB)

Session Classification: Gravitational wave Data Analysis: Strategies and Challenges

Contribution ID: **8** Type: **Invited**

Recent results and future challenges for Continuous waves and Stochastic background searches with a network of gravitational wave detectors

Friday, March 2, 2018 10:50 AM (30 minutes)

Continuous gravitational waves and stochastic background searches are among the main targets of present and future gravitational wave searches. These sources have not been detected so far, anyhow important progresses have been made in the development of search procedures and significant constraints on source characteristics have, in some cases, been put. I will highlight the most recent results obtained and discuss the challenges and future perspectives with the network of gravitational wave detectors .

Primary author: ASTONE, Pia (ROMA1)

Presenter: ASTONE, Pia (ROMA1)

Session Classification: Gravitational wave Data Analysis: Strategies and Challenges

Contribution ID: **9** Type: **not specified**

SAR-GRAV: the Sardinia Underground Laboratory, a first module for the Einstein Telescope infrastructure

Thursday, March 1, 2018 3:50 PM (20 minutes)

Since 2010 the site of Sos Enattos, a former mine in the North-East Sardinia - Italy, was studied with long term seismic investigations in the framework of the site selection for the Einstein Telescope (ET). The site proved to be one of the seismically quietest places in Europe, given the local geological features and the low population density of the island. In particular, in 2012 we realized three seismic stations, one on the surface and two underground, with the deepest at -110m, providing seismic data for the following years. It allowed to characterize the local microseisms, correlating their RMS variability with meteorological and satellite data, investigating the connection with the sea waves of the near Tyrrhenian sea. The results demonstrated the compatibility with the ET site seismic requirements. Following these studies, thanks to the collaboration between Regione Sardegna, IGEA SpA, The Sassari University, INFN and INGV, a pilot laboratory named SAR-GRAV will be realized in a new cave about 5m tall, hosting a laboratory of 120m^2, that will be excaved at a depth of -110m in the next months. SAR-GRAV will be completed with a surface laboratory of about 200m^2, hosting the control room, officies, services, and the mechanical and electronic workshops. This new undergound laboratory will host experiments that require low seismic noise and controlled environment, such as ARCHIMEDES. Moreover, it can be considered a first module toward the larger ET underground infrastructure to be realized in the next decade.

Primary authors: GENNAI, Alberto (PI); CHINCARINI, Andrea (GE); PASSUELLO, Diego (PI); CALLONI, Enrico (NA); MAJORANA, Ettore (ROMA1); FIDECARO, Francesco (PI); FRASCONI, Franco (PI); RICCI, Fulvio (ROMA1); OGGIANO, Giacomo (Università di Sassari); CELLA, Giancarlo (PI); GEMME, Gianluca (GE); LOSURDO, Giovanni (PI); LODDO, Luca (IGEA SpA); NATICCHIONI, Luca (ROMA1); DI FIORE, Luciano (NA); CARPINELLI, Massimo (LNS); Dr PUPPO, Paola (ROMA1); CALIA, Paolo (IGEA SpA); RAPAGNANI, Piero (ROMA1); PASSAQUIETI, Roberto (PI); DE ROSA, Rosario (NA)

Presenter: NATICCHIONI, Luca (ROMA1)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **10** Type: **not specified**

Star Cluster Disruption by a Super-massive Black Hole Binary

Friday, March 2, 2018 5:50 PM (20 minutes)

Super-massive black hole binaries (BHBs) are expected to be one of the most powerful sources of low-frequency gravitational waves (GWs) accessible to the forthcoming LISA mission. BHBs are believed to form in the late stages of galaxy mergers, then harden by close encounters with interacting stars, until GWs lead the BHBs to coalescence. In this talk, I will discuss how the encounter between a BHB and a star cluster (SC) in a galactic nucleus influences the BHB shrinking rate. I will present the results of highly-accurate, GPU-accelerated N-body simulations exploring the effect of different orbits for the SC infall onto the BHB; in particular, I will show that SCs reaching the BHB on non-zero angular momentum orbits (with eccentricity ~ 0.7) do not enhance the binary shrinking, while SCs approaching the BHB on nearly radial orbits considerably contribute to its shrinking, and may efficiently shorten the BHB path towards GWs.

Primary author: Ms BORTOLAS, Elisa (INAF-OAPd / University of Padova)

Co-authors: Dr SPERA, Mario (INAF - Astronomical Observatory of Padova); MAPELLI, Michela (MIB)

Presenter: Ms BORTOLAS, Elisa (INAF-OAPd / University of Padova)

Session Classification: Impact of Gravitational-Wave Surveys and Multi-messenger Observations on Astrophysics, Cosmology and Other Branches of Fundamental Physics

Contribution ID: **11** Type: **not specified**

INTEGRAL observation of GW gamma ray counterparts and future perspectives: searching for Fermi/GBM un-triggered SGRB Candidates with INTEGRAL/PICsIT

Thursday, March 1, 2018 5:30 PM (20 minutes)

The first detection of the prompt electromagnetic counterpart coincident with a GW170817 has been a forward step in our knowledge of NS-NS merging.
An unexpected result was the extremely low isotropic luminosity of the event relative to other short gamma-ray bursts (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 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.

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Co-authors: Dr BAZZANO, Angela (IAPS-INAF); RODI, James (INAF-IAPS); Dr NATALUCCI, Lorenzo (INAF/IAPS)

Presenter: RODI, James (INAF-IAPS)

Session Classification: Impact of Gravitational-Wave Surveys and Multi-messenger Observations on Astrophysics, Cosmology and Other Branches of Fundamental Physics

Contribution ID: **12** Type: **not specified**

PETER: a torsion pendulum facility to study small forces/torques on free falling instrumented masses

Friday, March 2, 2018 3:30 PM (20 minutes)

We will describe realization and tests of a two stage torsion pendulum facility (nicknamed PETER, from Italian PEndolo Traslazionale E Rotazionale, namely translational and Rotational Pendulum) for the measurement of GRS actuation Cross Talks (CT) and its possible evolution. This project started within the ground testing activities for the characterization, before flight, of the Gravitational Reference Sensor (GRS) of LISA-Pathfinder, where it showed results consistent with what observed on flight. The apparatus could easily evolve to a facility to test small forces/torques on free falling instrumented masses, for future next generation space missions.
Here, we will discuss the principle of operation of the double torsion pendulum and the initial goal of the activity, the description of the PETER apparatus, cross -talk measurement technique and results and possible extension to more than 2 DOF

Primary author: GARUFI, Fabio (NA)

Co-authors: DI FIORE, Luciano (NA); DE ROSA, Rosario (NA)

Presenter: GARUFI, Fabio (NA)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **13** Type: **not specified**

Thermal noise in complex systems

Thursday, March 1, 2018 2:30 PM (20 minutes)

Thermal noise is known to be a crucial limitation for high precision sensing devices like future gravitational wave detectors or lasers with extreme narrow linewidths. Mitigating Brownian thermal noise as an important issue requires the reduction of the mechanical loss of involved materials and/or their deliberate spatial distribution. In this contribution we discuss the influence of mechanical losses and their spatial distribution on thermal noise in complex optical systems. In these systems virtual pressures must be applied on differently oriented parts of the surface. We show how thermal noise of such systems can be described by finite element analysis and semi-analytic approaches.

Primary author: Mrs KROKER, Stefanie (PTB and TU Braunschweig)

Co-authors: ROJAS HURTADO, Carol Bibiana (PTB); HEINERT, Daniel (FSU Jena); DICKMANN, Johannes (PTB); GLASER, Rene (FSU Jena); Dr NAWRODT, Ronny (Friedrich-Schiller-University Jena); Prof. VYATCHANIN, Sergey (Moscow state university, Physics faculty); DICKMANN, Walter (TU Braunschweig); LEVIN, Yuri (Columbia State University)

Presenter: Mrs KROKER, Stefanie (PTB and TU Braunschweig)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **14** Type: **not specified**

Archimedes experiment: weighing the vacuum

Friday, March 2, 2018 3:50 PM (20 minutes)

One of the oldest questions concerning quantum mechanics and gravitation is whether vacuum fluctuations do gravitate. The question of the weight of vacuum was raised soon after the birth of quantum mechanics
and many theoretical attempts were performed to explore the motivations and consequences of assuming or discarding such hypothesis, and jet today there no a complete theretical agreement.
From an experimental point of view it is remarkable that no direct measurement has been carried out to date. Considering that nowadays the scientific community interpretes the
Casimir effect as a macroscopic manifestation of vacuum fluctuations, we recently proposed an the ARCHIMEDES experiment
to test the interaction of vacuum fluctuations with gravity by weighing in a suitable rigid Casimir cavity.

Our goal is to weight the zero point energy by weighing the condensation energy of a layered type II superconductor, where Casimir Energy is expected to sensibily contribute to the condensation energy.
In this talk, the experimental scheme and the sensitivity needed for the final measurement will be illustrated.
Moreover the present preliminary results reached with the first prototype (realized in the Gravitation Physics Laboratory in Naples)
will be presented, showing a torque sensitivity of about $10^{-11}\ Nm\sqrt{Hz}$ in the frequency range from 50 mHz up to 150 mHz;
the major upgrades needed and the derived hints to realize the next
ARCHIMEDES prototype, aimed at the desired final sensitivity, will be discussed. This will be the first experiment hosted in the under-construction Sos-Enattos SAV-GRAV laboratory in the North-East
of Sardinia - Italy. This site, which has been studied over long-term seismic investigations in
the framework of the site selection for the Einstein Telescope (ET), is particulary suited for the ARCHIMEDES experiment, being one of the lowest seismic noise location in Europe.

Primary author: DE LAURENTIS, Martina (NA)

Presenter: DE LAURENTIS, Martina (NA)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **15** Type: **not specified**

LISA as a probe for particle physics

Friday, March 2, 2018 11:20 AM (20 minutes)

In this talk we review why the measurement of the stochastic gravitational wave background can shed light on the particle content of the Universe. We moreover sketch some popular particle physics theories for which LISA can prove the existence of new physics before colliders.

Primary author: NARDINI, Germano (University of Bern)

Presenter: NARDINI, Germano (University of Bern)

Session Classification: Gravitational wave Data Analysis: Strategies and Challenges

Contribution ID: **16** Type: **not specified**

The Virgo Coating Collaboration: a new deposition facility and preliminary results on nano-layered coatings

Thursday, March 1, 2018 12:20 PM (20 minutes)

Thermal noise in the coatings of the test masses of the ground-based interferometric detectors of gravitational waves is the dominant noise contribution in the most sensitive frequency band, where the first gravitational signals have been detected and where several cosmic sources are deemed to exist. Hence developing coatings with reduced thermal noise is among the primary tasks of the Virgo and LIGO experiments. Several strategies have been proposed and/or implemented so far in order to reduce coating thermal noise, e.g. using amorphous co-sputtered or nanolayered mixtures of two different materials as high-index constituent, optimizing layers'thickness (non-QWL multilayers), using crystalline coatings, etc. Multilayers, where the high and/or low index material are nanometer-scale stratified glassy oxides mixtures - consisting of stacked layers of two (or more) different materials with sub-wavelength thickness - behave macroscopically as homogeneous films, whose properties are amenable to simple modeling, which makes them easily engineerable. Furthermore, composites made of alternating layers of an optically dense material, like Titania, Hafnia or Zirconia, and a good glass-former, like Silica or Alumina, are stable against crystallization in the post-deposition annealing treatment and cryo-friendly. Special focus is given to the deposition facility recently installed at University of Sannio based on plasma-assisted e-beam evaporator, and to the first deposited samples. The current and planned work of the Virgo Coating Collaboration groups on nm-layered composite deposition and characterization is presented.

Primary author: Dr PRINCIPE, Maria (SA)

Presenter: Dr PRINCIPE, Maria (SA)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **17** Type: **not specified**

Massive stars as progenitors of merging black hole binaries

Friday, March 2, 2018 5:10 PM (20 minutes)

The recent detection of gravitational waves has proven the existence of massive stellar black hole binaries (BHBs), but the formation channels of BHBs are still an open question. Population-synthesis codes are one of the most powerful tools to investigate the origin of BHBs. In this talk, I describe my new code MOBSE, which is an updated version of the widely used binary population synthesis code, BSE (Hurley et al. 2002). In MOBSE, I have included the most recent models of star evolution, wind mass-loss and core-collapse supernovae, which are the key ingredients to determine the fate of massive stars. Based on the results of MOBSE, I show that only massive metal-poor stars ($Z < 0.002$) can be the progenitors of gravitational-wave events like GW150914. Finally, I show that most of the binary systems leading to the formation of BHBs pass through the common envelope phase.

Primary author: GIACOBBO, Nicola (University of Padova)

Presenter: GIACOBBO, Nicola (University of Padova)

Session Classification: Impact of Gravitational-Wave Surveys and Multi-messenger Observations on Astrophysics, Cosmology and Other Branches of Fundamental Physics

Contribution ID: **18** Type: **not specified**

Scientific challenges with LISA

Thursday, March 1, 2018 10:10 AM (30 minutes)

The excellent results of the LISAPathfinder mission gave the green light for LISA mission. ESA approved the LISA mission as the large mission on the theme "The Gravitational Universe". This future observatory will observe gravitational wave from space between 0.02mHz and 1Hz, opening a new window on the Universe complementary to LIGO/Virgo and Pulsar Timing Array. The expected sources are SuperMassive Black Hole Binaries until very high redshift, tens of thousands of Galactic Binaries, Extreme Mass Ratio Inspiral, Stellar Mass Black Hole Binaries, stochastic backgrounds from the very early Universe plus all the unexpected sources.
In this talk, I will present LISA mission and its expected performances. I will review the scientific goals of LISA in astrophysics, physics and cosmology. I will show in particular the main scientific challenges of this mission.

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Presenter: Dr PETITEAU, Antoine (APC - Université Paris-Diderot)

Session Classification: Future Generation Detectors

Contribution ID: **19** Type: **not specified**

THESEUS: a future key mission for multi-messenger astrophysics

Thursday, March 1, 2018 5:50 PM (20 minutes)

The Transient High-Energy Sky and Early Universe Surveyor (THESEUS) is a space mission concept aimed at exploiting Gamma-Ray Bursts for investigating the early Universe and at providing a substantial advancement of multi-messenger and time-domain astrophysics. These goals will be achieved through a unique combination of instruments allowing GRBs and X-ray transients detection over a broad FOV (more than 1sr) with 0.5-1 arcmin localization, an energy band extending from several MeVs down to 0.3 keV and high sensitivity to transient sources in the soft X-ray domain, as well as on-board prompt (few minutes) follow-up with a 0.7 m class IR telescope with both imaging and spectroscopic capabilities. In addition to early Universe science, THESEUS will be perfectly suited for the detection, accurate localization and identification of the electromagnetic counterparts to sources of gravitational radiation, which will be routinely detected in the late ‘20s / early ‘30s by next generation facilities like aLIGO/ aVirgo, ILIGO, KAGRA, eLISA and Einstein Telescope. In particular, it 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. THESEUS will thus provide an ideal sinergy with second and third generation GW detectors and with the large multi-wavelength observatories of the near future (e.g., LSST, ELT, SKA, CTA, ATHENA).

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Presenter: Dr AMATI, Lorenzo (INAF - IASF Bologna)

Session Classification: Impact of Gravitational-Wave Surveys and Multi-messenger Observations on Astrophysics, Cosmology and Other Branches of Fundamental Physics

Contribution ID: **20** Type: **not specified**

Large optics for next generation gravitational wave detectors

Thursday, March 1, 2018 11:10 AM (30 minutes)

Upgrade from second generation interferometers and third generation ones will require larger size optics as well as new material substrates to handle low temperatures. In parallel to this technological challenges, a worldwide intensive research is underway to lower the coating thermal noise from the mirrors.

In this presentation, we will review the technological development and future plans regarding the substrates, polishing and coating for those future large mirrors.

Primary author: Mr DEGALLAIX, Jerome (Laboratoire des Matériaux Avancés - CNRS)

Presenter: Mr DEGALLAIX, Jerome (Laboratoire des Matériaux Avancés - CNRS)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **21** Type: **not specified**

Un-modeled search for stellar mass binary black hole mergers in LIGO-VIRGO interferometers

Friday, March 2, 2018 5:30 PM (20 minutes)

Detections of stellar mass binary black holes (BBHs) system in the observing run of LIGO and VIRGO interferometers has started an exciting new era of black hole astrophysics. For understanding the formation channels of BBH a detected population of BBH will be required, with various parameters like masses, spins and orbital properties like eccentricity and precession. Hence, there is a strong motivation to search for BBH systems in a large parameter space. Some of the possible formation channels allow BBH to have eccentric and/or precessing orbits, waveform models for such system are not yet available preventing the modelled search. Hence an un-modeled targeted towards detecting BBH will be important if not just necessary to detect such sources until reliable and accurate waveform models are available.

Here we outline the un-modeled search on LIGO-Virgo data, which targets BBH and employs the "coherent WaveBurst" algorithm. We discuss the sensitivity of this search for the case of BBH with eccentric orbits and possible astrophysical implications

Primary author: DRAGO, Marco (TN)

Presenter: DRAGO, Marco (TN)

Session Classification: Impact of Gravitational-Wave Surveys and Multi-messenger Observations on Astrophysics, Cosmology and Other Branches of Fundamental Physics

Contribution ID: **22** Type: **not specified**

LISA Optical Metrology Challenges

Thursday, March 1, 2018 11:40 AM (20 minutes)

The space-borne gravitational wave observatory LISA aims to measure sources in the 0.1 mHz to 1 Hz frequency range. Core to this measurement is the optical readout of differential path lengths between free-floating test masses aboard three satellites orbiting the sun in a tilted cartwheel formation. On average, the satellites'positions form an equilateral triangle of 2.5 million km arm-length, but the enormous distances paired with orbit dynamics give rise to continuous arm-length changes on the order of 1% as well as angular variations of about 2 degrees over the period of a year. The overall displacement readout noise goal of about 10pm/sqrt(Hz) within this 'breathing' interferometer entails a number of challenges for the required optical metrology. In this presentation we will give an update on current investigations at the Albert Einstein Institute in Hannover, Germany that focuses on high dynamic range phase readout for the long-arm interferometry and on the compensation of the breathing angle, which requires an intra-satellite phase comparison between two optical benches, often referred to as backlink.

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Presenter: PENKERT, Daniel (AEI Hannover)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **23** Type: **not specified**

Exploiting binary neutron star mergers with a network of advanced gravitational-wave detectors.

Friday, March 2, 2018 10:00 AM (20 minutes)

The unprecedented observation of a binary neutron star coalescence by the Advanced Virgo and Advanced LIGO gravitational-wave detectors offers the opportunity to cast new light on neutron stars and matter under the most extreme conditions. Furthemore, for the first time we were able to observe the engine that powers events such as gamma ray bursts.
After such a merger, a compact remnant is left over and its nature depends primarily on the masses of the inspiralling objects and on the equation of state of nuclear matter. The gravitational-wave signature of this remnant can give us a unique insight on the neutron stars equation of state.

Primary author: DI GIOVANNI, Matteo (TIFP)

Presenter: DI GIOVANNI, Matteo (TIFP)

Session Classification: Gravitational wave Data Analysis: Strategies and Challenges

Contribution ID: **24** Type: **not specified**

Status of Kagra and TAMA300 squeezing experiment

Thursday, March 1, 2018 2:50 PM (20 minutes)

Kagra is the first 2.5G gravitational wave (GW) detector and it incorporates some very challenging new technologies such as underground facility and cryogenic sapphire mirrors. Another new technology that was not in the base road-map of any GW detector but nowadays is addressed as a crucial upgrade is frequency dependent squeezing.
I'll give some highlights on the Kagra detector and describe the R&D activity about frequency dependent squeezing that is being pursued in the TAMA300 facility.

Primary author: Dr LEONARDI, Matteo (NAOJ)

Presenter: Dr LEONARDI, Matteo (NAOJ)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **25** Type: **Invited**

Formation and evolution of merging black-hole binaries

Friday, March 2, 2018 4:40 PM (30 minutes)

The first confirmation of the existence of merging stellar-mass
black holes (BHs) came on September 14 2015, when the LIGO interferometers observed the gravitational-wave signal from the merger of two BHs with mass larger than 25 Msun (GW150914). Since then, four additional BH mergers were observed, and two of them have BHs with mass larger than 30 Msun. From the theoretical point of view, the models that predict the formation and evolution of binary BHs are still uncertain. In this talk, I will present the BH mass spectrum obtained from up-to-date population-synthesis simulations and I will also discuss the effect of stellar dynamics on the evolution of binary BHs.

Primary author: Dr SPERA, Mario (University of Innsbruck)

Co-authors: MAPELLI, Michela (MIB); GIACOBBO, Nicola (University of Padova)

Presenter: Dr SPERA, Mario (University of Innsbruck)

Session Classification: Impact of Gravitational-Wave Surveys and Multi-messenger Observations on Astrophysics, Cosmology and Other Branches of Fundamental Physics

Contribution ID: **26** Type: **not specified**

The Virgo Coating Collaboration: research lines and preliminary results of a detailed study on thermoelasticity in crystalline materials

Thursday, March 1, 2018 12:00 PM (20 minutes)

The visibility distance of interferometric gravitational wave detectors is limited by mirror thermal noise at mid-range frequency, where the first coalescence GW signals have been detected and where many others are expected in the next future. In particular, for 2G+ and 3G we need to increase the performance of the test mass multilayer reflective coatings. The Virgo collaboration is setting a coating R&D group on many issues, including especially metrology (loss angle measurements, thermoelastic effect modeling) new materials (new oxides, nitrates, fluoride, new cosputtered mixing and nanolayered composites) completely characterized (optically, mechanically and morphologically), optimized deposition parameters with the aim of developing new coating materials and technologies for the AdVirgo upgrades and for future detectors. Another objective is to understand the losses in amorphous materials, framing coating research in the more general context of the physics of glasses and amorphous materials. One of the developed research lines is the study of thermoelastic damping in crystalline materials, that are promising candidates for cryogenic test masses and particularly suitable substrates for coating research. A detailed discussion on models, based on a semi-analytical calculation starting from the heat diffusion equation, for silicon and sapphire substrates will be reported. A new study on the changes in thermoelastic loss after coating deposition, with some preliminary results, will be also reported.

Primary author: Dr CESARINI, Elisabetta (Centro Studi e Ricerche Enrico Fermi)

Presenter: LORENZINI, Matteo (GSGC)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **27** Type: **not specified**

Adaptive optics methods in GW interferometric detectors, a perspective

Thursday, March 1, 2018 12:40 PM (20 minutes)

The performance of present and future gravitational wave detectors is limited by fundamental factors, such as thermal noise, seismic or newtonian noise and quantum nature of light. Besides, technological factors impact the reach of advanced detectors through status of art limits in the implementation of upgrade strategies. In the realm of optics, the quantum limit to sensitivity will be addressed by injecting higher laser power and by exploiting the capabilities of squeezed light. In turn, technological efforts in the preparation of suitable optics able to meet more and more demandig requirements are ongoing. Moreover, solutions to mitigate the effect of known showstoppers such as parametric instablities are being studied.
The present day strategy to correct for residual cold defects in the core optics and to counteract the thermal effects due to power absorption is embedded in a set of sensors and actuators integrated in the Advanced Virgo design, the so called Thermal Compensation System (TCS). This system is designed to be focussed on the needs of high power operation of the detector, nonetheless it is highly versatile and can deal with a bunch of foreseen and unexpected issues. We discuss the features of the TCS with emphasis on its versatility and portability to upgraded detectors; we also present the status of the R&D activity in the Tor Vergata labs, highlighting new applications where the methods of TCS can have a relevant impact, such as adaptive mode matching for squeezing and damping of parametric instabilities.

Primary author: LORENZINI, Matteo (GSGC)

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Presenter: LORENZINI, Matteo (GSGC)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **28** Type: **not specified**

Low frequency sensitivity of future ground based interferometers

I review the scientific motivation to improve the sensitivity of earth bound interferometric detectors of gravitational waves in the low frequency region. I discuss the main issues and obstacles expected, with some possible solutions.

Primary author: CELLA, Giancarlo (PI)

Presenter: CELLA, Giancarlo (PI)

Contribution ID: **29** Type: **not specified**

The Free-fall Experiment Results: measuring subfemto-g acceleration noise in LISA Pathfinder and fN force variations on ground with torsion pendulum, in intermittent control mode

Friday, March 2, 2018 3:10 PM (20 minutes)

The relative acceleration between two test masses free falling in orbit is perturbed by the presence of a larger constant relative acceleration that must be actively compensated in order to keep the test bodies centered inside the orbiting apparatus. The actuation force applied to compensate this effect can be applied continuously or can be limited to brief impulses, with test masses in a parabolic free fall in between two "kicks". The actuation-free motion is then analyzed for the remaining sources of acceleration noise.

We report on the implementation and results of the on-board free-fall experiment that allows to test a LISA-like actuation configuration, free from the actuator noise and its force calibration, achieving the measurement of the residual acceleration at the subfemto-g level. The challenging data analysis method of the experiment and its reliability have been also tested with an on-ground torsion pendulum test bench, measuring fN force variation at level nearing the subfemto-g/Hz^1/2 performance required for LISA Pathfinder.

Primary author: RUSSANO, Giuliana (Università di Trento/TIFPA)

Co-authors: MARTIN, Hewitson (Albert-Einstein-Institut, Max-Planck-Institut für Gravitationsphysik und Universität Hannover); THORPE, James Ira (NASA Goddard Space Flight Center); SARA, Paczkowski (Albert-Einstein-Institut, Max-Planck-Institut für Gravitationsphysik und Universität Hannover); GIUSTERI, Roberta (Università di Trento/TIFPA); VITALE, Stefano (Università di Trento/TIFPA); WEBER, William Joseph (Università di Trento/TIFPA)

Presenter: RUSSANO, Giuliana (Università di Trento/TIFPA)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **30** Type: **not specified**

LISA Pathfinder last results

Friday, March 2, 2018 2:50 PM (20 minutes)

The LIGO first detection officially opened the era of gravitational waves observation.
Few weeks ago, the LISA Pathfinder team published its last results in which it was shown that the residual force noise between two test-masses in a single spacecraft can be reduced and measured at the level required by LISA, the Laser Interferometry Space Antenna.
This result represents a milestone in the route to the low frequency gravitational wave observation.
In this talk, I will briefly report on these last published results, how they were obtained and what are the opened questions to be studied for the future which can impact on LlSA.

Primary author: VETRUGNO, Daniele (T)

Presenter: VETRUGNO, Daniele (T)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **31** Type: **Invited**

Electromagnetic facilities and observing strategies for multimessenger science: situation and future perspectives.

Thursday, March 1, 2018 4:40 PM (30 minutes)

In the advanced LIGO/Virgo era, a huge, world-wide effort have been put into the search of electromagnetic counteparts of gravitational wave (GW) events. Such effort has been carried out optimizing the use of the different observing facilities operating at all electromagnetic wavelengths and improving the data reduction and analysis procedures. This ultimately led to the hystorical detection and characterization of the electromagnetic counterpart of the gravitational wave event GW 170817 originated by the merger of a binary neutron star system.
In this talk I will provide a review of the current and future facilites and observational stategies for the search and follow-up of the electromagnetic counterparts of GW sources.

Primary author: CAPPELLARO, Enrico

Presenter: CAPPELLARO, Enrico

Session Classification: Impact of Gravitational-Wave Surveys and Multi-messenger Observations on Astrophysics, Cosmology and Other Branches of Fundamental Physics

Contribution ID: **32** Type: **not specified**

Quantum noise in the NextG of GW detectors and how to suppress it.

Thursday, March 1, 2018 2:00 PM (30 minutes)

It is hard to overestimate the scientific significance of the 6 confirmed detections of gravitational waves from compact binary sources that Advanced LIGO and Advanced Virgo have jointly made. However, it is still a long way ahead until the sensitivity of GW detectors is high enough to make them fully fledged astronomical tools. The main hindrance on this way remains the quantum noise, the fluctuations of light phase and amplitude stemming from the very foundations of Quantum Mechanics that will be soon limiting the existing instruments in almost entire frequency band above 30 Hz. In this talk, I will try to give an outlook at known avenues and trails towards the desired 10-fold quantum noise suppression benchmark set by the design goals of the NextG GW interferometers. The main methods of increasing the signal-to-noise ratio of GWDs by means of advanced quantum measurement techniques will be reviewed.

Primary author: Dr DANILISHIN, Shtefan (University of Glasgow)

Presenter: Dr DANILISHIN, Shtefan (University of Glasgow)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **33** Type: **not specified**

Mode matching for the next generation of Gravitational Wave detectors

Thursday, March 1, 2018 3:10 PM (20 minutes)

The Laser Interferometer Gravitational-wave Observatory (LIGO) and Virgo have recently opened a new window for astronomy by detecting gravitational-waves from coalescing black holes and from neutron star merger. The LIGO/Virgo Scientific Collaboration is exploring ways to increase range and sensitivity by applying promising new techniques for current and next generation gravitational-wave detectors.
One is the squeezed light technology, which will reduce quantum noise that is the ultimate limiting noise source for gravitational wave detectors.
The achievement will be possible only when the interferometer presents low losses for the laser light. Mode mismatch between optical cavities in LIGO cause losses that limit the potential benefit of future upgrades like squeezing. An adaptive mode matching system is needed to provide better than 98% mode matching and thus the best conditions for squeezed light technologies to operate in. Here the analysis of mode mismatch and future strategy will be presented.

Primary author: Dr PERRECA, Antonio (TIFP)

Presenter: Dr PERRECA, Antonio (TIFP)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **34** Type: **Invited**

LISA data challenge

Thursday, March 1, 2018 5:10 PM (20 minutes)

The LISA is an approved L3 ESA-NASA mission which aims at detecting gravitational wave signal in the milli-Hertz band. We are organizing set of LISA data challenges. The objectives of these challenges are 3-fold: (i) to release the data set which respects the latest changes in the LISA design and follows certain standards, this data will be open to anyone who wants to try their own data analysis methods (ii) to build and organize a community interested in the LISA science (iii) to build the prototype of the end-to-end pipeline for the LISA data analysis. In this talk I will describe the first data challenge in details.

Primary author: Dr BABAK, Stanislav (APC)

Presenter: Dr PETITEAU, Antoine (APC - Université Paris-Diderot)

Session Classification: Impact of Gravitational-Wave Surveys and Multi-messenger Observations on Astrophysics, Cosmology and Other Branches of Fundamental Physics

Contribution ID: **36** Type: **Invited**

Challenges in Astroparticle Physics, the APPEC roadmap

Thursday, March 1, 2018 9:10 AM (30 minutes)

I will review the recently published roadmap of Astroparticle Physics by the AstroParticle Physics European Consortium (APPEC). I will in particular concentrate on the future challenges for European and Global Astroparticle Physics, with a special emphasis on the impact of the discovery of gravitational waves.

Primary author: Prof. KATSANEVAS, stavros (university Paris 7/IN2P3/CNRS)

Presenter: Prof. KATSANEVAS, stavros (university Paris 7/IN2P3/CNRS)

Session Classification: Future Generation Detectors

Contribution ID: **37** Type: **not specified**

(Toward) the 3rd generation of GW observatories: Einstein Telescope

Thursday, March 1, 2018 9:40 AM (30 minutes)

(Toward) the 3rd generation of GW observatories: Einstein Telescope

Primary author: PUNTURO, Michele (PG)

Presenter: PUNTURO, Michele (PG)

Session Classification: Future Generation Detectors

Contribution ID: **38** Type: **Invited**

MIGA and ELGAR : towards the observation of low frequency gravitational waves using atom interferometry

Friday, March 2, 2018 2:00 PM (30 minutes)

I will review the progress towards large-scale differential gravitational measurement is using an array of Atom Interferometers (AIs) configured to differentiate Newtonian Noise, geodetic signal and GW detection. In this gravitation antenna, each of the AIs measures the local gradient of gravitational acceleration and the correlation between distant sensors enables to cancel out fluctuations of the terrestrial gravitational forces. With the foreseen cold atom technology developments in the next decade, strain sensitivities down to 10-19 in the 0.1-10 Hz band are within reach, offering interesting complementary observations to optical GW detectors operating at other frequencies

Primary author: Dr BOUYER, Philippe (CNRS - IOGS)

Presenter: Dr BOUYER, Philippe (CNRS - IOGS)

Session Classification: Development of Enabling Technologies for Gravitational Wave Detectors

Contribution ID: **39** Type: **not specified**

Constraining extreme matter with gravitatonal waves

Friday, March 2, 2018 9:20 AM (20 minutes)

Gravitational waves from neutron star collisions carry key information about matter at extreme densities. Advanced LIGO and Virgo can, for example, constrain the properties of zero-temperature neutron star's equation of state by estimating the tidal polarizability coefficients that parametrize the neutron stars' tidal interactions in the inspiral-merger phase. Third generation detectors might also probe higher densities and temperatures by taking advantage of the enhanced sensitivity at kiloHertz frequencies and detecting signals from the merger remnant.
I will talk about the realization of such measurements from a theoretical point of view. In particular, I will discuss recent advances in the modeling of strong-field dynamics and radiation from neutron star collision in general relativity. Prospects and open problems for third-generation detectors will be discussed.

Primary author: BERNUZZI, Sebastiano (PR)

Presenter: BERNUZZI, Sebastiano (PR)

Session Classification: Gravitational wave Data Analysis: Strategies and Challenges

Contribution ID: **40** Type: **not specified**

General Relativity Tests

Friday, March 2, 2018 9:00 AM (20 minutes)

Presenter: PRODI, Giovanni Andrea (TIFP)

Session Classification: Gravitational wave Data Analysis: Strategies and Challenges

Contribution ID: **41** Type: **not specified**

Social Dinner

Contribution ID: **42** Type: **not specified**

Guided visit to Palazzo Bo

Contribution ID: **43** Type: **not specified**

Welcome Address

Thursday, March 1, 2018 9:00 AM (10 minutes)

Presenter: MEZZETTO, Mauro (PD)

Session Classification: Welcome Address