Belgian Gravitational-Wave Meeting (ULB/VUB), Nov 3, 2021

Report of Contributions

https://indico.global/e/13067

Contribution ID: **1** Type: **not specified**

UCLouvain

Wednesday 3 November 2021 09:50 (10 minutes)

Presenter: BRUNO, Giacomo (UCLouvain)

Session Classification: Update by group leaders

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

UGent

Wednesday 3 November 2021 10:00 (10 minutes)

Presenter: GHOSH, Archisman (UGent)

Session Classification: Update by group leaders

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

ULiège

Wednesday 3 November 2021 10:10 (10 minutes)

Presenter: FAYS, Maxime (ULiège)

Session Classification: Update by group leaders

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

UAntwerp

Wednesday 3 November 2021 10:20 (10 minutes)

Presenter: VAN REMORTEL, Nick (University of Antwerp)

Session Classification: Update by group leaders

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

UNamur

Wednesday 3 November 2021 10:30 (10 minutes)

Session Classification: Update by group leaders

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

VUB

Wednesday 3 November 2021 10:40 (10 minutes)

Presenters: MARIOTTI, Alberto (VUB); SEVRIN, Alexandre (Vrije Universiteit Brussel)

Session Classification: Update by group leaders

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

KULeuven

Wednesday 3 November 2021 09:40 (10 minutes)

Presenter: TJONNIE, Li (KULeuven)

Session Classification: Update by group leaders

Contribution ID: **8** Type: **not specified**

ULB

Wednesday 3 November 2021 10:50 (10 minutes)

Presenters: COMPÈRE, Geoffrey (ULB); CHAMEL, Nicolas; CLESSE, Sébastien (Université Libre de Bruxelles (ULB))

Session Classification: Update by group leaders

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

Exploring the Phase Camera at Adv. Virgo and in the Lab

Wednesday 3 November 2021 11:30 (20 minutes)

Phase cameras (PCs) - developed at Nikhef and recently installed at Advanced Virgo - are capable of probing wavefront amplitude and phase in 2D for any frequency. This allows for monitoring the frequencies used to generate the error signals to lock the interferometer. Additionally, the PC has been used in the past to inform on wavefront distortions due to thermal defects in the mirrors. Despite this, the total amount of information made available by the PC is still untapped, as for example the phase images have yet to be used. We layout the status and plan for the efforts of understanding and making the most of the PCs installed at Virgo. In parallel, a table-top set-up is being assembled in the lab at UC Louvain to test the use of the PC to generate Mode Mismatch error signals.

Presenter: CABRITA, Ricardo (UCLouvain)

Session Classification: Detectors, instrumentation and new methods of data analysis

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

A superconducting inertial sensor for low-frequency and cryogenic gravitational wave detectors

Wednesday 3 November 2021 11:50 (20 minutes)

We are developing a Cryogenic Superconducting Inertial Sensor (CSIS) to be employed in the forthcoming Einstein Telescope (ET). The designed displacement sensitivity for this device is a few fm/√Hz at 0.5 Hz, which is 3 orders of magnitude more sensitive than the state-of-the-art. The sensor will open pathways to monitor low-vibration motions of cryocoolers applied to the penultimate stage of ET as well as possibly assist in the suspension control, helping to detect gravitational waves (GWs) from 2 Hz onwards. CSIS can also be deployed on the Moon surface to measure the response of Moon's normal body modes to passing GWs. We present the design of CSIS, a monolithic Watt's linkage with high mechanical quality factor, a long-range Rasnik readout, an interferometric readout system and superconducting coil actuators. The talk will focus on low-noise superconducting actuators which help reduce the thermal noise thus increasing the sensor low-frequency performance.

Presenter: FERREIRA, Elvis (UCLouvain)

Session Classification: Detectors, instrumentation and new methods of data analysis

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

ALBUS : Anomaly detector for Long duration BUrst Searches

Wednesday 3 November 2021 12:10 (20 minutes)

Presenter: BOUDART, Vincent (ULiège)

Session Classification: Detectors, instrumentation and new methods of data analysis

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

Detecting planetary-mass primordial black holes with resonant electromagnetic gravitational-wave detectors

Wednesday 3 November 2021 12:30 (20 minutes)

The possibility to detect gravitational waves (GW) from planetary-mass primordial black hole (PBH) binaries with electromagnetic (EM) detectors of high-frequency GWs is investigated. We consider two patented experimental designs, based on the inverse Gertsenshtein effect, in which incoming GWs passing through a static magnetic field induce EM excitations inside either a TM cavity or a TEM waveguide. The frequency response of the detectors is computed for post-Newtonian GW waveforms. We find that such EM detectors based on current technology may achieve a strain sensitivity down to h ~ 1 0 − 30 , which generates an EM induced power of 1 0 − 10 W . This allows the detection of PBH binary mergers of mass around 1 0 − 5 M ⊠ if they constitute more than 0.01 percent of the dark matter, as suggested by recent microlensing observations. We envision that this class of detectors could also be used to detect cosmological GW backgrounds and probe sources in the early Universe at energies up to the grand unified theory scale.

Presenter: HERMAN, Nicolas (UNamur)

Session Classification: Detectors, instrumentation and new methods of data analysis

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

A boosted gravitational wave background for primordial black holes with broad mass distributions and thermal features

Wednesday 3 November 2021 14:00 (20 minutes)

Primordial black holes (PBHs) with a wide mass distribution imprinted by the thermal history of the Universe, which naturally produces a high peak at the solar mass scale, could explain the gravitational-wave events seen by LIGO/Virgo and up to the totality of the dark matter. We show that compared to monochromatic or log-normal mass functions, the gravitational wave backgrounds (GWBs) from early PBH binaries and from late binaries in clusters are strongly enhanced at low frequency and could even explain the NANOGrav observations. This enhancement comes from binaries with very low mass ratios involving solar-mass and intermediate-mass PBHs. LISA could distinguish the various models, while in the frequency band of ground-based detectors, we find that the GWB from early binaries is already well above the current LIGO/Virgo limits if they also explain black hole mergers, independently of their total contribution to the dark matter. We therefore exclude that the observed black hole mergers are early PBH binaries. However, if some mechanisms further suppress their merging rates, such as Poisson clustering from solar-mass PBHs accounting for a significant fraction of the dark matter, binaries in clusters may dominate. Their GWB has a different spectral index than for neutron stars or astrophysical black holes and is detectable with Einstein Telescope or even with the LIGO/Virgo design senstivity.

Presenter: BAGUI, Eleni (ULB)

Session Classification: Gravitational-wave backgrounds: sources and analysis

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

Direct constraints on planetary-mass primordial black holes using data from LIGO/Virgo's third observing run

Wednesday 3 November 2021 14:20 (20 minutes)

We present new constraints on the merging rates and abundance of planetary-mass and asteroid-mass inspiraling primordial black hole binaries using limits on continuous waves (quasi-monochromatic, quasi-infinte duration signals) derived from from all-sky searches for isolated compact objects in the first half of the third observing run (O3a) of LIGO/Virgo. We derive these rates in a model-independent way, and convert them to constraints on the primordial black hole abundance with minimal modelling assumptions. Our results show that we are sensitive to sources at most O(10 pc) away for systems with chirp masses of O(1e-5) solar masses with gravitational-wave frequencies around 30-40 Hz. Furthermore, we derive constraints on an effective parameter that relates to the fraction of dark matter that primordial black holes could compose, which is of O(1e5) for equal-mass systems with chirp masses of O(1e-5) solar masses; for systems with an asymmetric mass ratio of O(1e10) we constrain this parameter to be, at best, less than O(10). Though these results are not yet physically meaningful, they highlight that continuous-wave searches could in the future directly probe the existence of primordial black holes, especially those in binaries with asymmetric mass ratios. Furthermore, they show that searches for higher-mass systems, and therefore new methods, are needed to derive physical constraints on primordial black holes in these mass ranges.

Presenter: MILLER, Andrew (UCLouvain)

Session Classification: Gravitational-wave backgrounds: sources and analysis

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

Interferences in the Stochastic Gravitational Wave Background

Wednesday 3 November 2021 14:40 (20 minutes)

I will report the findings of 2104.14231. We computed the all-length scales unequal-time strain power spectrum and the energy density parameter of gravitational waves generated by various scaling sources, such as Cosmic Strings, showing that these exhibit a fine structure.

Presenter: CUNHA, Disrael (UCLouvain)

Session Classification: Gravitational-wave backgrounds: sources and analysis

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

Jointly setting upper limits on multiple components of a stochastic gravitational wave background

Wednesday 3 November 2021 15:00 (20 minutes)

With the increasing sensitivities of the gravitational wave detectors and more detectors joining the international network, the chances of detection of a stochastic GW background (SGWB) are progressively increasing. Different astrophysical and cosmological processes are likely to give rise to backgrounds with distinct spectral signatures and distributions on the sky. The observed background will therefore be a superposition of these components. Hence, one of the first questions that will come up after the first detection of an SGWB will likely be about identifying the dominant components and their distributions on the sky. Both these questions were addressed separately in the literature, namely, how to separate components of isotropic backgrounds and how to probe the anisotropy of a single component. In this presentation, we address the question of how to separate distinct anisotropic backgrounds with (sufficiently) different spectral shapes. We show that the joint analysis accurately separates and estimates backgrounds with different spectral shapes and different sky distributions with no major bias. This does come at the cost of increased variance. Thus making the joint upper limits safer, though less strict than the individual analysis.

Presenter: SURESH, Jishnu

Session Classification: Gravitational-wave backgrounds: sources and analysis

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

A Search for Intermittent Gravitational Wave Backgrounds

Wednesday 3 November 2021 15:20 (20 minutes)

A gravitational wave background is expected to arise from the superposition of unresolved sources. Among these sources are black hole binaries, whose time domain signal is expected to be popcorn like, i.e. intermittent. The current search within the LVK collaboration does not consider this intermittent nature. We propose a new method to properly model the intermittency and thus, improve the sensitivity of the search.

Presenter: TURBANG, Kevin

Session Classification: Gravitational-wave backgrounds: sources and analysis

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

Ringing of rotating black holes in higher derivative gravity

Wednesday 3 November 2021 16:10 (20 minutes)

Rotating black holes in general relativity are notoriously simple objects. They can be fully fixed by measuring a single dominant (complex) characteristic frequency. Having determined this 'quasi-normal mode' (QNM) frequency for the endstate of a binary merger, any additional information, from earlier binary dynamics or other QNMs, can serve as a test of our understanding of general relativity and/or black holes. I will discuss how quasinormal modes of rotating black holes are modified by higher derivative curvature corrections to the Einstein-Hilbert action, up to quartic order and including parity-violating term. After introducing the problem, its relevance and its difficulties, I will schematically describe a convenient perturbative approach. I conclude with a trick, a wish and a caveat.

Presenter: FRANSEN, Kwinten (KULeuven)

Session Classification: Early Universe cosmology and Black Hole Theory

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

Observable effects of equatorial symmetry breaking for EMRIs

Wednesday 3 November 2021 16:30 (20 minutes)

Equatorial symmetry –flipping the sign of the z coordinate –is a somewhat accidental symmetry of the Kerr black hole. There is no theorem guaranteeing its existence for a stationary black hole, as opposed to axisymmetry. Indeed, in many string theory black holes and horizonless compact objects, equatorial symmetry is generically broken. Somehow surprisingly, however, the possible observable effects of breaking equatorial symmetry have been largely unexplored in bottom-up parametrizations of deviations from classical Kerr black holes. I will describe some interesting and surprising effects on EMRI inspiral events that occur when the central large object does not satisfy equatorial symmetry, and discuss the potential observability with LISA. Concretely, I will discuss the effects of deforming a (Kerr) black hole by the lowest order equatorial symmetry breaking multipoles, namely the current quadrupole and mass octopole.

Presenter: MAYERSON, Daniel

Session Classification: Early Universe cosmology and Black Hole Theory

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

Exploring the early Universe with numerical General Relativty

Wednesday 3 November 2021 16:50 (20 minutes)

In this talk, I will motivate the usage of numerical relativity for studies on the early universe. In particular, I will show simulations of the preinflationary epoch to prove the robustness of Higgs inflation to inhomogeneous initial conditions. Also, I will show ongoing preliminary results: full GR simulation of the reheating, and investigations on primordial black hole formation during the radiation domination epoch, both being of potential interest regarding current (and future) gravitational wave experiments.

Presenter: JOANA, Cristian

Session Classification: Early Universe cosmology and Black Hole Theory

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

Discussion on GW school, outreach, grants, etc...

Wednesday 3 November 2021 17:10 (30 minutes)

Session Classification: Discussion, final words