Belgian Gravitational Wave Meeting - October 27 2020

Report of Contributions

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

Welcome

Tuesday 27 October 2020 09:00 (5 minutes)

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

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

UCLouvain group

Tuesday 27 October 2020 09:10 (10 minutes)

Presenters: BRUNO, Giacomo (UCLouvain); VAN HEIJNINGEN, Joris (UCLouvain)

Session Classification: Presentation of research groups

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

UAntwerp group

Tuesday 27 October 2020 09:20 (10 minutes)

Presenter: VAN REMORTEL, Nick (U Antwerp)

Session Classification: Presentation of research groups

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

Discussion on doctoral training in Gravitational Waves

Tuesday 27 October 2020 13:40 (20 minutes)

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

Closing

Tuesday 27 October 2020 17:30 (15 minutes)

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

ULB - Precision Mechatronics Laboratory

Tuesday 27 October 2020 09:40 (10 minutes)

Presenter: DING, Binlei (ULB)

Session Classification: Presentation of research groups

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

ULB - Astrophysics group

Tuesday 27 October 2020 09:50 (10 minutes)

Presenter: CHAMEL, Nicolas (ULB)

Session Classification: Presentation of research groups

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

ULiège group

Tuesday 27 October 2020 09:30 (10 minutes)

Presenter: CUDELL, Jean-René

Session Classification: Presentation of research groups

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

KULeuven group

Tuesday 27 October 2020 10:00 (10 minutes)

Presenter: HERTOG, Thomas (KULeuven)

Session Classification: Presentation of research groups

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

ULB - Theory / Cosmology group

Tuesday 27 October 2020 10:30 (10 minutes)

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

Session Classification: Presentation of research groups

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

VUB Group

Tuesday 27 October 2020 10:10 (10 minutes)

Presenter: SEVRIN , Alexander

Session Classification: Presentation of research groups

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

Search for long-duration bursts in LIGO/Virgo data

Tuesday 27 October 2020 11:00 (20 minutes)

Astrophysical phenomena originating around the death of massive stars are predicted to generate minute-long gravitational-wave transients for which robust predictive models are not readily available.
As searches looking for such signals must rely on minimal assumptions, they are also sensitive to gravitational waves emitted from unpredicted sources and have strong potential for discovering as yet unobserved physical processes.
After introducing potential sources of minute-long gravitational-wave transients, I will give an overview of the methods used to probe this exciting regime. I will describe the challenges faced during the data analysis and discuss areas of active development that would benefit from new contributions.

Presenter: FAYS, Maxime (ULiège)

Session Classification: Data analysis and detectors

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

Performance of custom chips for ET and LISA

Tuesday 27 October 2020 12:20 (20 minutes)

Advanced gravitational wave detectors operate under extreme conditions of temperature and/or radiation. We will discuss both the advantages and challenges of employing custom chips for these systems. Specific challenges are highlighted for the Einstein Telescope and LISA design cases with the current techniques and work done to ensure reliable performance in each of the environments.

Presenters: GATTI, Alberto (KULeuven); BARRETTO, Ciana (KULeuven)

Session Classification: Data analysis and detectors

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

Stochastic searches with LIGO/Virgo

Tuesday 27 October 2020 11:20 (20 minutes)

The stochastic searches of the LIGO/Virgo collaborations will be discussed. We start with a general introduction to the searches, the sources we might observe in the future and the different search-types that are performed. Afterwards we have a look at the current state of the art and the outlook when the latest results might be expected. In the second part of the presentation we will focus on the advances made concerning noise characterization and noise modelling. More specifically global correlated magnetic noise (Schumann resonances) will be discussed as well as the concept of gravitational wave geodesy.

Presenter: JANSENS, Kamiel (UAntwerp)

Session Classification: Data analysis and detectors

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

BMS balance laws in Einstein GR

Tuesday 27 October 2020 14:00 (20 minutes)

In this talk, I will present the generalized BMS symmetries and their associated charges. Then I will explain the corresponding balance equations which quantify the non-conservation of these charges as a result of the gravitational waves. I will also briefly mention their relationship with the gravitational memory effect.

Presenter: SERAJ, Ali (ULB)

Session Classification: Theory / Cosmology

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

Low Energy SUSY-breaking and Gravitational Waves

Tuesday 27 October 2020 15:20 (20 minutes)

We begin the exploration of calculable SUSY-breaking hidden sectors delivering Gravitational Wave (GW) signals from first order phase transitions (FOPT). We discuss an extensive class of models where the FOPT is tied to the breaking of R-symmetry along the pseudo-flat direction universally related to SUSY-breaking. Once a mediaton scheme is specified, the frequency of the GW peaks correlates with the super-partner spectrum. For SUSY particles beyond the reach of the LHC, our construction predicts GW signals at future high-frequency interferometers and, vicev-ersa, seeing a GW signal at these interferometers would imply super-partners within the reach of future colliders.

Presenter: MARIOTTI , Alberto (VUB)

Session Classification: Theory / Cosmology

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

Modular invariant partition function of gravitational waves with Casimir-type boundary conditions

Tuesday 27 October 2020 14:20 (20 minutes)

I would like to present a computation I have done. It is the partition of the quantum partition function at non-zero temperature of a spin-2 field (gravitational field at linearized level) in a setup close to the usual electromagnetic Casimir computation with perfectly conducting plates. The 3D geometry is a flat manifold with boundaries at z=0 and z=L (and infinitely extended in the two other directions). The computation essentially consists in a one-to-one reformulation of the dynamics of the two physical polarizations (+ and \times) in terms of two massles scalar fields (one Dirichlet and one Neumann). The partition function is then easily computed.

Presenter: BONTE, Martin (ULB)

Session Classification: Theory / Cosmology

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

Gravitational Waves from Super-Heavy Dark Matter

Tuesday 27 October 2020 14:40 (20 minutes)

As a way of an introduction, I will briefly discuss some recent work on models of the early universe in which the abundance of dark matter is set by a period of late-time thermal inflation. Such scenarios terminate in very strong phase transitions which can be detected by upcoming gravitational wave interferometers.

Presenter: BLADES, Iason (ULB)

Session Classification: Theory / Cosmology

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

Gravitational Waves from the inhomogeneous pre-inflationary era

Tuesday 27 October 2020 15:00 (20 minutes)

We use of the 3+1 formalism of numerical relativity to investigate the robustness of Starobinsky and Higgs inflation to inhomogeneous initial conditions dominated by either scalar field gradients or by the kinetic energy density. Strong Sub-Hubble fluctuations generically lead to inflation after a dynamical phase driven by an oscillatory equation of state. On the other hand, Super-Hubble sized inhomogeneities may produce contracting regions that end up in the formation of primordial black holes, which do not prevent inflation, and are subsequently diluted during the inflationary phase. We carefully analyse the dynamics of the pre-inflation era and show that metric vector and tensor fluctuations might have been sourced during this epoch. Nonetheless, our analysis further supports the robustness of inflation to any size of inhomogeneity, in the field, velocity or equation-of-state. The pre-inflation dynamics only marginally depends on the field potential and it is expected that such a behaviour is universal and applies to any inflaton potential of plateau-type, favored by CMB observations after Planck.

Presenter: JOANA, Cristian (UCLouvain)

Session Classification: Theory / Cosmology

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

The \nu_R-philic scalar: its loop-induced interactions and Yukawa forces in LIGO observations

Tuesday 27 October 2020 16:10 (20 minutes)

Right-handed neutrinos (νR) are often considered as a portal to new hidden physics. It is tempting to consider a gauge singlet scalar (ϕ) that exclusively couples to νR via a νRνRϕ term. Such a νR-philic scalar does not interact with charged fermions at tree level but loop-induced effective interactions are inevitable, which are systematically investigated in this work. The magnitude of the loop-induced couplings coincidentally meets the current sensitivity of fifth-force searches. In particular, the loop-induced coupling to muons could be tested in the recent LIGO observations of neutron star mergers as there might be a sizable Yukawa force in the binary system mediated by the νR-philic scalar.

Presenter: XU, Xunjie (ULB)

Session Classification: Neutron Star mergers and Fundamental Physics

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

Resonant Electromagnetic Detection of High-Frequency Gravitational Waves from Planetary-mass Primordial Black Holes Mergers

Tuesday 27 October 2020 12:00 (20 minutes)

Electromagnetic detectors (and generators) of gravitational waves have been considered since the early 70s, besides of the mechanical detectors and laser interferometers. The so-called Gertsenshtein effect describes the generation of gravitational waves when light passes through some constant magnetic field. However, it is the reverse phenomena –electromagnetic waves arising when incoming gravitational waves interact with a constant magnetic field –that can be used to design electromagnetic detectors of high-frequency gravitational waves. We will present a numerical design of recently patented experimental setups, made of waveguide or cavity immersed into a strong external magnetic field, and its application for the detection of gravitational waves from inspiralling primordial black holes. We will show some typical shapes and amplitudes of the expected signal inside such detectors, including the induced electromagnetic power spectrum. For example, a binary system of two 1e-5 solar mass primordial black holes located at distance of 1 GPc generates a gravitational wave of strain 1e-28 which, once passing through a detector of size 1m inside a 5T external magnetic field, produces a rms electromagnetic power of about 1e-13 W, on a time scale of 50 microseconds. We will also analyse the expected response of the detector as a function of the mass of the PBH merger and glimpse at the application to detection of stochastic GW backgrounds from the early Universe.

Presenters: FÜZFA, André (UNamur); HERMAN, Nicolas (UNamur)

Session Classification: Data analysis and detectors

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

Search for dark photons with continous wave methods

Tuesday 27 October 2020 11:40 (20 minutes)

We adapt a method, originally developed for continuous gravitational-wave searches, to directly detect dark photon dark matter. The method involves optimally choosing the analysis coherence time as a function of the frequency band analyzed, such that all of the signal's power will be confined to one frequency bin during the observation time. We describe the dark photon signal in detail, and show that due to its narrowband and continuous nature, methods used to search for isolated neutron stars can be powerful tools to search for dark photons. We derive a theoretical estimate of the sensitivity, and show that it is consistent with both the empirical sensitivity determined through software injections, and a cross-correlation method already developed. Additionally, we provide an end-to-end search design and estimate its computational cost, and show how follow-up techniques used in continuous wave searches are adapted to confirm or rule out dark photon dark matter candidates.

Presenter: MILLER, Andrew (UCLouvain)

Session Classification: Data analysis and detectors

Contribution ID: **25** Type: **not specified**

Properties of the secondary component of GW190814

Tuesday 27 October 2020 16:30 (20 minutes)

We study the odds for the secondary component of GW190814 being a neutron star incorporating a large spin while also employing a stiff high density equation of state of nuclear matter. Since its mass resides $\in (2.50, 2.67) M_{\odot}$, it could be the heaviest neutron star or the lightest black hole ever observed. Therefore, finding its true nature has far reaching implications on the properties of dense matter. Assuming it to be a neutron star, we try to constrain its spin assuming certain universal relation and also taking into account the constraints from other observations. We find it to be very fast spinning where rotational instabilities can appear. Therefore, we conclude that unless there could be a mechanism that could suppress the rotational instabilities inside the star, the secondary of GW190814 would most likely be a black hole.

Presenter: CHAR, Prasanta (ULiège)

Session Classification: Neutron Star mergers and Fundamental Physics

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

The source of secondary peaks in the GW power spectral density from neutron star post-mergers

Tuesday 27 October 2020 16:50 (20 minutes)

Although the main features of the evolution of binary neutron star (NS) systems are now well established, many details are still subject to debate, especially regarding the merger and post-merger phase. For instance, the precise mechanism responsible for the production of the secondary peaks in the observable gravitational wave (GW) power spectral density is still unclear. Thus, in order to address this issue, in this talk I will present the results of a soon-to-be-published paper (in JHEAp) where we construct and validate a simple toy model that is capable of reproducing the whole angular momentum evolution of the post-merger remnant, from merger to collapse. As a result, from the remarkably close overlap between the model predictions and the employed reference simulations we are able to systematically shed light on the aforementioned open debate regarding the source of the low-frequency peaks of the GW power spectral density. More in general, this also shows how toy models can be a very powerful tool not only to simplify the interpretation of the post-merger dynamics, but also to gain insights into the physics behind it. Finally, I will also briefly touch upon another quantity which has revealed very hard to predict: the lifetime of the hypermassive NSs formed after the merger. In particular, I will present a simple analytic relation found in Lucca & Sagunski 2019 (arXiv:1909.08631) to connect the lifetime of the merger remnant to the mass of the progenitor NSs, as well as its application to the GW event GW170817 to constrain the equation of state of dense matter.

Presenter: LUCCA, Matteo (ULB)

Session Classification: Neutron Star mergers and Fundamental Physics

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

Effects of dense matter properties on the tidal deformability and GW waveforms of neutrons star mergers

Tuesday 27 October 2020 17:10 (20 minutes)

Formed in gravitational core-collapse supernovae explosions, neutron stars are the most compact stars known in the universe: their average density exceeds than that found in atomic nuclei. The properties of the dense matter contained in their core are still poorly known. In this talk, I will present my first results about the role of the dense matter properties on the tidal deformability and the gravitational waveform during the inspiral phase of binary neutron stars using a set of unified equations of state. These equations of state are based on the nuclear energy-density functional theory and provide a thermodynamically consistent treatment of all regions of the star (the core and the crust). They were calculated using functionals that were precision fitted to experimental and theoretical nuclear data.

Presenter: PEROT, Loïc (ULB)

Session Classification: Neutron Star mergers and Fundamental Physics

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

UGent group

Tuesday 27 October 2020 10:20 (10 minutes)

Presenter: GOSCH, Archisman (UGent)

Session Classification: Presentation of research groups