Workshop on Gravitational Wave Modelling

Report of Contributions

https://indico.icc.ub.edu/e/165

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

Overview of gravitational-wave modelling

Monday, 10 October 2022 09:30 (45 minutes)

To date, all gravitational-wave detections accomplished by the LIGO-Virgo-KAGRA collaboration are compatible with compact binary merger events involving black holes and neutron stars in all three possible combinations. Signals from binary black hole (BBH) coalescences, however, are by far the most common and their modelling will be the focus of this presentation. The detection of BBH merger signals strongly relies on the use of template waveform banks against which conduct matched-filtering searches. Likewise, those templates are essential to infer the astrophysical properties of the sources generating the gravitational waves. This talk will present an overview of the approaches routinely employed in the complicated task of waveform modelling of BBH coalescences, both involving analytical relativity and numerical relativity, and will briefly discuss on possible alternative routes and the challenges awaiting just around the corner.

Presenter: FONT, Jose Antonio (University of Valencia)

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

Rates and populations of dynamically formed binary black holes

Monday, 10 October 2022 10:15 (45 minutes)

In this contribution I present a fast population synthesis code for binary black holes (BBHs) formation and evolution in globular clusters (GCs) and use it to determine the redshift evolution of the merger rate density and masses of BBHs, with a particular focus on eccentric BBHs. A comparison to the merger rate reported by LIGO-Virgo shows that a scenario in which most of the detected BBH mergers with primary masses > 20Msun are formed in GCs is consistent with current constraints and requires initial GC half-mass densities >10^4 Msun/pc^3. The models can reproduce the masses in the pair-instability gap (> 50 Msun) with hierarchical mergers, if initial BH spins are negligible.

Presenter: Prof. GIELES, Mark (ICC)

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

Numerical information in analytical models

Monday, 10 October 2022 11:30 (45 minutes)

Presenter: ALBANESI, Simone (University of Turin, INFN section of Turin)

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

Understanding analytical uncertainties within effective-one-body models

Monday, 10 October 2022 14:00 (45 minutes)

Presenter: NAGAR, Alessandro (INFN Torino)

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

Status TEOBResumS

Monday, 10 October 2022 12:15 (45 minutes)

Presenter: GAMBA, Rossella (Friedrich Schiller University Jena)

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

Hands on

Monday, 10 October 2022 14:45 (1 hour)

Presenter: GAMBA, Rossella (Friedrich Schiller University Jena)

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

A numerical-relativity gravitational-wave catalogue of spinning Proca-star collisions

Tuesday, 11 October 2022 09:30 (45 minutes)

I will present a systematic study of the dynamics and gravitational-wave emission of head-on collisions of spinning vector boson stars, known as Proca stars. To this aim we build a catalogue of about 800 numerical-relativity simulations of such systems. We have found that the wave-like nature of bosonic stars has a large impact on the gravitational-wave emission. In particular, we show that the initial relative phase Δ\epsilon = \epsilon_1 − \epsilon_2 of the two complex fields forming the stars (or equivalently, the relative phase at merger) strongly impacts both the emitted gravitational-wave energy and the corresponding mode structure. This leads to a non-monotonic dependence of the emission on the frequency of the secondary star ω2, for fixed frequency ω1 of the primary. This phenomenology, which has not been found for the case of black-hole mergers, reflects the distinct ability of the Proca field to interact with itself in both constructive and destructive manners. We postulate this may serve as a smoking gun to shed light on the possible existence of these objects.

Presenter: Dr SANCHIS-GUAL, Nicolas

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

Parameter estimation using the Newman-Penrose scalar and its applications: searching for boson-star mergers in LIGO-Virgo data

Tuesday, 11 October 2022 10:15 (45 minutes)

The detection and analysis of gravitational-wave signals relies on the comparison of the gravitational strain observed by the detectors (e.g. LIGO and Virgo) to theoretical templates for strain produced by given sources, e.g. black-hole mergers. Numerical simulations of compact-mergers, however, do not typically output the gravitational strain but a quantity known as the Newman-Penrose (NP) scalar. The obtention of the strain from the NP scalar is subject to well known systematic errors that are not trivial to ease. In this talk I will present a formalism that allows for the comparison of the detector data to the NP templates outputted by numerical simulations, which qualitatively removes a complete layer of errors. As an observational application, I will show a systematic comparison of high-mass events from LIGO and Virgo to numerical simulations of exotic compact objects known as (vector) boson stars, or Proca stars, providing estimates of the mass of the ultra-light bosons building up the stars together with a preliminary population study.

Presenter: CALDERON BUSTILLO, Juan (University of Santiago de Compostela)

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

Numerical simulations for highly eccentric black hole binaries

Tuesday, 11 October 2022 12:15 (45 minutes)

Presenter: ANDRADE, Tomas

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

Discussion

Tuesday, 11 October 2022 14:00 (1h 30m)

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

Black Hole Close Hyperbolic Encounters

Tuesday, 11 October 2022 11:30 (45 minutes)

There is evidence and theoretical reasons to believe that Black Holes can be densely clustered. Black holes in these dense clusters can gravitationally scatter off each other in hyperbolic encounters, emitting gravitational waves that could be observed by current detectors. In this talk we will discuss about the properties of these encounters as well as about the gravitational waves that are emitted and the signal we expect to observe in the network of gravitational wave detectors currently on Earth. We will also talk about how black holes can acquire a significant spin during these close hyperbolic encounters and its possible implications

Presenters: MORRÁS GUTIÉRREZ, Gonzalo (Universidad Autonoma de Madrid); JARABA, Santiago (IFT UAM-CSIC)