Winter Meeting 2022

Report of Contributions

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

Simulating black hole binaries

Monday, 7 February 2022 11:45 (25 minutes)

Our recently acquired ability to detect gravitational waves has expanded our senses and our possibilities of inquiring the Universe. As a new era of gravitational wave detections rapidly unfolds, the importance of having accurate models for their signals becomes increasingly important. In this context, we will discuss numerical simulations of black hole binaries. In particular, we will focus on how they are made, what they help us achieve, and what are the current challenges in this research area.

Primary author: Dr ANDRADE, Tomas (University of Barcelona)

Presenter: Dr ANDRADE, Tomas (University of Barcelona)

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

Anomalies in flavour physics

Monday, 7 February 2022 10:50 (25 minutes)

Over the last few years there have been various measurements where the Standard Model fails to agree with experiment.

I will attempt to give a summary of the different places where the disagreements occur, why we do (or why not) these are believable signs of physics beyond the Standard Model, and what the current results can tell us about how to go beyond the Standard Model.

Primary author: KIRK, Matthew (ICCUB, Barcelona)

Presenter: KIRK, Matthew (ICCUB, Barcelona)

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

Smallsats, a new opportunity for research

Tuesday, 8 February 2022 16:15 (25 minutes)

Space research has usually been based on big missions. Their development times (~decades) and associated budgets (~100M€) require a strong commitment, implying that only a small number of research missions are finally implemented.
In the last decades, the Smallsats, and specifically the Cubesats have changed the situation. The usage of consumer technologies allows to make research with state of the art instrumentation, a budget < 1M€ and development times of years. The limiting factors in this case are: volume < 10l, power consumption (<10W), and quantity of data transmitted.
We will explain the experience with big and small missions, including the Catalan NewSpace strategy.

Primary author: GOMEZ CAMA, Jose Maria

Presenter: GOMEZ CAMA, Jose Maria

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

Binary black hole mergers from star clusters

Monday, 7 February 2022 16:15 (25 minutes)

The LIGO and Virgo interferometers have detected gravitational waves (GW) from several dozens of coalescing binary black holes (BBHs). Several formation channels are able to explain the BBH merger rate, leaving their origin an open question. The dynamical formation of BBHs in dense stellar systems is a promising model and it predicts that a fraction of BBHs have measurable orbital eccentricities, making this a "smoking gun" signal.

The goal of my research is to understanding the dynamical formation of binary black hole mergers in star clusters. In particular, understand the relative contributions of the various pathways that can lead to BBH mergers and their dependence on cluster properties such as initial mass and density.

Primary author: MARIN PINA, Daniel (ICCUB)

Presenter: MARIN PINA, Daniel (ICCUB)

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

Searching for new physics with neutrinoless double-beta decay

Tuesday, 8 February 2022 10:25 (25 minutes)

Neutrinoless double-beta ($0\nu\beta\beta$) decay is a hypothetical nuclear process in which two neutrons turn into protons (or vice versa) but, unlike in the standard double-beta decay, no neutrinos are emitted. Several large-scale experiments worldwide are dedicated to observing it. When observed, the lepton-number-violating process would provide unique vistas beyond the Standard model of particle physics. It would not only shed light on the unknown mass-scale of neutrinos but also prove that neutrinos are their own antiparticles, hence explaining the matter-antimatter symmetry of the Universe. However, the half-life of the process depends on coupling constants whose effective values are under debate, and nuclear matrix elements (NMEs) that have to be extracted from nuclear theory. Unfortunately, at present different many-body calculations probe matrix elements whose values disagree by more than a factor of two. Hence, it is crucial to gain a better understanding on the NMEs in order to plan the future experiments and to extract the intriguing beyond-standard-model physics from the experiments.

I will discuss how these NMEs have recently been improved by the nuclear theory group of the UB. Furthermore, I will discuss how other nuclear processes – that have been or can be measured – can be utilized to constrain the values of the $0\nu\beta\beta$ NMEs.

Primary author: JOKINIEMI, Lotta (University of Barcelona)

Presenter: JOKINIEMI, Lotta (University of Barcelona)

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

M-dwarf flares and their impact on exoplanet habitability

Monday, 7 February 2022 12:10 (25 minutes)

M dwarfs are the smallest and coolest stars on the main sequence. They are the most common stars in the Galaxy and are known to show the highest rocky planets occurrence. As a result, they may host most of the Universe's Earth-sized planets orbiting in the Habitable Zones of main sequence stars. Among several parameters to determine if an exoplanet could possibly host life, one of them is the flaring capacity of its host star. A flaring host star is a double-edged sword in regard of exoplanet habitability. On one hand, the increased flux during flare events can trigger chemical reactions that are necessary to build the basis of prebiotic chemistry. On the other hand, sufficiently strong flares may erode exoplanets'ozone layers and reduce their UV protection. M dwarfs stellar flares are particularly interesting to study in the UV range since they can display peak amplitudes of x14.000 with respect to the quiescent flux compared to x90 in the optical. CubeSats are small, cheap, and accessible satellites allowing to perform astrophysical measurements. Thanks to them, the study of M dwarf flares is now feasible on small scale and time frame. Thus, the main objective of this PhD will be to study data on stellar flares from M dwarfs, collected with a dual-band (UV and optical) camera onboard of a CubeSat.

Primary author: POYATOS, Julien (ICCUB)

Presenter: POYATOS, Julien (ICCUB)

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

Electroweak Dark Matter and Direct Detection

Monday, 7 February 2022 15:20 (25 minutes)

The existence of Dark Matter (DM) is one of the most important indications of physics beyond the Standard Model of particle physics. One promising approach is to consider DM as Weakly Interacting Massive Particles. These candidates have evoked a prominent interest; many experiments explore Weakly Interacting Massive Particles, one of the approaches to detect them is Direct Detection which is favored when the candidate is above the Electroweak Scale.

On this talk we will introduce Direct Detection experiments and discuss an overview of present constraints. We will finally explain the approach to predict the possible phenomenology of different candidates to DM in the context of Direct Detection.

Primary author: CABO ALMEIDA, David (ICCUB-Universitat de Barcelona)

Presenter: CABO ALMEIDA, David (ICCUB-Universitat de Barcelona)

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

Dynamical characterization of the Magellanic Clouds using Gaia data

Tuesday, 8 February 2022 11:45 (25 minutes)

The Large Magellanic Cloud is a satellite galaxy of the Milky Way at a distance of about 50 kpc visible from the southern hemisphere. Together with its companion, the Small Magellanic cloud, form a perfect laboratory to test methodologies and models designed for external galaxies. Their proximity to the Milky Way makes them suitable to study their morphology and interaction using Gaia (ESA) data. In this talk, some of the latest results regarding the dynamical characterization of the Large Magellanic Cloud and its interaction with the Small Magellanic Cloud will be presented.

Primary author: JIMÉNEZ ARRANZ, Óscar

Presenter: JIMÉNEZ ARRANZ, Óscar

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

Ghostbusters! A perspective on neutrino oscillations

Monday, 7 February 2022 14:30 (25 minutes)

The phenomenon of neutrino oscillations is the first confirmed experimental evidence that the Standard Model needs to be extended. Thus, they are an excellent door to address new physics beyond the Standard Model.

However, what do we mean when we say that a neutrino oscillates? What kind of new physics could there be? What experimental evidence is there of such new physics? In this brief (and hopefully light) lecture we will try to answer these questions.

Primary author: BERTÓLEZ MARTÍNEZ, Antoni (Institute of Cosmic Sciences, Universitat de Barcelona)

Presenter: BERTÓLEZ MARTÍNEZ, Antoni (Institute of Cosmic Sciences, Universitat de Barcelona)

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

Search for new gamma-ray binaries using Gaia

Tuesday, 8 February 2022 10:00 (25 minutes)

Gamma-ray binaries are extreme accelerators that display gamma-ray emission up to multi-TeV energies. These systems are composed of a massive OB-type star and a compact object that show a non-thermal spectral energy distribution that peaks in the MeV-GeV band and is modulated with the orbital period. Currently, only 9 of such extreme accelerators are known. However, some properties of these systems are not fully understood, and the discovery of new gamma-ray binaries will help to answer many questions. On the other hand, binary systems containing a massive star and a compact object can present a peculiar velocity with respect to their environment due to the kick produced by the supernova explosion in the formation of the compact object. If the velocity is high enough these binary systems are called runaways. All gamma-ray binaries containing O-type stars are runaways, which can be identified as such by means of optical astrometry. Therefore, to discover new gamma-ray binary systems first we search for runaway massive stars within the GOSC Catalog of O-type stars using Gaia astrometric data. We present here the current status of the project and initial promising results, together with an outlook of the next steps to be conducted before assessing the gamma-ray binary nature of these systems. These sources will be studied in the future with CTA.

Primary author: CARRETERO-CASTRILLO, Mar (ICCUB, Universitat de Barcelona)

Co-authors: Dr RIBÓ, Marc (Universitat de Barcelona, ICCUB, IEEC); PAREDES, Josep Maria (Universitat de Barcelona)

Presenter: CARRETERO-CASTRILLO, Mar (ICCUB, Universitat de Barcelona)

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

A multi-scale and multi-wavelength view of the star formation process

Tuesday, 8 February 2022 15:20 (25 minutes)

In the last few years, the field of star formation has experienced significant advances thanks to the major improvement in instrumentation. The increase in angular resolution and sensitivity make now possible to study with unprecedented detail the obscured regions in the Milky Way, the protostellar embryos, unveiling the physical processes that give rise to the formation of Sun-like stars as well as of more distant regions harboring high-mass stars.
In this talk I will present a compilation of several ongoing observational projects aimed at understanding how the large-scale molecular cloud material fragments into multiple cores that will eventually further collapse to form a protostar. In particular, I will focus this talk on how we can characterise the very young members in nascent open clusters following a multi-scale and multi-wavelength approach, with particular emphasis on ALMA and JVLA observations.

Primary author: BUSQUET, Gemma (ICCUB)

Presenter: BUSQUET, Gemma (ICCUB)

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

Characterising the Milky Way through Gaia, IGAPS and WEAVE

Tuesday, 8 February 2022 12:35 (25 minutes)

The Gaia satellite (ESA) is revolutionising our view of the Milky Way providing information for over 1500 million sources. However, further data is requested to complete the picture, in the shape of photometric and spectroscopic surveys. I will review the main characteristics of the IGAPS photometric and the WEAVE spectroscopic survey, describe the main results we have obtained so far using these data (mainly for OBA stars) and the plans for the future.

Primary author: Dr MONGUIÓ, Maria (ICCUB)

Presenter: Dr MONGUIÓ, Maria (ICCUB)

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

Doubly charm and doubly bottom systems from D^*D and B^*B molecules.

Monday, 7 February 2022 14:55 (25 minutes)

We study the exotic doubly charmed D^*D system providing a natural explanation for the T_{cc}^+ recently seen by LHCb, in terms of $D^{*+}D^0$ and $D^{*0}D^+$ with isospin $I = 0$. The width is evaluated accurately based on the decay widths of the D^* states. The $D^0D^0\pi^+$ decay mode of the bound state formed is studied in detail, showing a narrow peak below the $D^{*+}D^0$ threshold and some strength above it, as observed in the experiment, supporting strongly the molecular picture of this state, the first example of a meson with two open charmed quarks. This study can be naturally extended to the bottom sector giving interesting features for the $B^*B(I = 0)$ counterpart found there.

Primary author: FEIJOO ALIAU, Albert (Instituto de Física Corpuscular (IFIC), CSIC-UV)

Presenter: FEIJOO ALIAU, Albert (Instituto de Física Corpuscular (IFIC), CSIC-UV)

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

Experimental overview of B anomalies

Tuesday, 8 February 2022 12:10 (25 minutes)

The concept of lepton universality, where the muon and tau particles are simply heavier copies of the electron, is a key prediction in the Standard Model (SM). In models beyond the SM, lepton universality can be naturally violated with new physics particles that couple preferentially to the second and third generation leptons. Over the last few years, several hints of lepton universality violation have been seen in both b->c and b->s semileptonic beauty decays. This presentation will review these anomalies and give an outlook for the near future.

Primary author: VAZQUEZ GOMEZ, Ricardo (Universitat de Barcelona)

Presenter: VAZQUEZ GOMEZ, Ricardo (Universitat de Barcelona)

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

Current and future activities on computing and software engineering at the ICCUB Technological Unit

Tuesday, 8 February 2022 17:05 (25 minutes)

The ICCUB Technological Unit is contributing to the software development and data processing of several projects. The most important one is Gaia, both on its data processing and on its catalogue validation and data mining aspects, as well as Virgo, where our contributions are ramping up. Besides these, we also participate on several other projects, and we expect to get more manpower soon to consolidate these and to provide support to other ICCUB activities. In this talk I will present and briefly describe all these software engineering and data processing activities.

Primary author: Dr PORTELL DE MORA, Jordi (ICCUB)

Presenter: Dr PORTELL DE MORA, Jordi (ICCUB)

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

Development of instrumentation at the Technology Unit: Science and beyond

Tuesday, 8 February 2022 16:40 (25 minutes)

The Technological Unit of the ICCUB is actually providing several currently groups of ICCUB with services, such as instrumentation and software development, in order to support their contributions to international collaborations. Many developments on instrumentation are related to sensitive photosensor readout technology with key contributions in international projects as LHCb, CTA, HERD and IAXO. Furthermore, this technology is also being applied in medical imaging technology in cooperation with academic and industrial partners.

Presenters: PICATOSTE OLLOQUI, Eduardo (ICCUB); GASCON FORA, David (ICCUB. Universitat de Barcelona)

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

Axionic waves as dark matter: potential detection with physical experiments and astronomical observations

Tuesday, 8 February 2022 14:30 (25 minutes)

Axions are the best dark matter candidate, as the only one that solves a fundamental particle physics problem (the strong QCD problem) unrelated to any dark matter observation and, at the same time, naturally predicts the production of cold dark matter with a density consistent with the observed one.
A summary of detection methods is presented: in physics experiments, axions in the dark matter may be directly detected via the inverse Primakoff effect, with resonant cavities placed in strong magnetic fields; high-energy axions produced in the Sun can also be detected in the same experiments with X-ray detectors. In astronomical observations, axions produced in stars may have measurable effects for the evolution of stars, and radio observations may detect stimulated decay of axions to photon pairs. Most theories for the production of axions in the early Universe predict the formation of bound minihalos of axions with masses as low as those of asteroids, which may be detectable in special observations of gravitational lensing with advanced observatories like the James Webb Space Telescope or the Extremely Large Telescope.

Primary author: MIRALDA, Jordi (ICCUB)

Presenter: MIRALDA, Jordi (ICCUB)

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

Primordial black holes as dark matter

Tuesday, 8 February 2022 10:50 (25 minutes)

Primordial black holes (PBHs) are one of the current most interesting candidates to be the dark matter. Not only they fulfill the basic criteria needed for dark matter, they do so without the need to invoke a new set of existing particles. While this might make them look ideal, their formation is not so simple and often requires some form of new physics too. Furthermore a large number of constraints exist coming from the observational consequences they would bring.
In this talk I will give a basic introduction on the topic, putting an emphasis on the constraints on their abundances and on the last remaining window where they could be all the dark matter.

Primary author: ONCINS, Marc (ICCUB)

Presenter: ONCINS, Marc (ICCUB)

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

Challenges in Hadron Spectroscopy

Monday, 7 February 2022 10:25 (25 minutes)

In the Standard Model, hadron resonances emerges from the interaction between quarks and gluon. The nucleon matter is composed of baryons, three quarks states, interacting via the exchange of mesons, quark-antiquark pairs.
Quantum chromodynamics predicts the existence of other types of quark configurations. They are generically called “exotic hadrons”.
During the last 15 years, experimental collaborations (LHCb, COMPASS, BESIII, GlueX,…) have observed several exotic hadrons candidates: potential tetraquarks, pentaquarks and hybrid mesons resonances.
In this talk, I will review challenges and prospect in discovering exotic hadrons and studying their properties.

Primary author: MATHIEU, Vincent (UB)

Presenter: MATHIEU, Vincent (UB)

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

The Higgs boson: a promising portal to New Physics

Monday, 7 February 2022 12:35 (25 minutes)

The Higgs boson, responsible for the mass of the SM fundamental particles, plays a central role in propounding New Physics (NP) that might shed some light on the still unanswered questions present within the standard frame of particle physics. For example, the appearance of resonances in the scattering of longitudinally polarized vector bosons (intimately related to the Higgs mechanism) would be a clear indication of the presence of such NP.

In this presentation I will talk about the importance of the Higgs particle to unravel the questions that we do not get to understand using the standard framework and then focus on the advances in my research on vector boson scattering (VBS) to look for new heavy resonant states.

Primary author: ASIÁIN, Íñigo (ICCUB - UB)

Presenter: ASIÁIN, Íñigo (ICCUB - UB)

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

How can we help?

Monday, 7 February 2022 09:55 (30 minutes)

The manager of the Institute is going to explain the different services the secretariat provides for the researchers.

Presenter: PALLARES, Esther

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

Welcome!

Monday, 7 February 2022 09:45 (10 minutes)

Presenter: LURI, Xavier

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

Neutron stars as physics laboratories

Tuesday, 8 February 2022 14:55 (25 minutes)

Neutron stars are fascinating astrophysical objects, which provide insight into some of the most extreme properties of matter. In this talk, I will discuss two different theoretical instances of exotic physics in the interior of neutron stars: superfluidity and dark matter interactions. I will discuss how observations on neutron stars can provide insight into some of these formal developments, what they can tell us about the strong interactions and which, if any, constraints they place on new theoretical ideas.

Presenter: RIOS, Arnau

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

Mapping the gravitational wave sky with the LVC

Monday, 7 February 2022 17:05 (25 minutes)

The LIGO and Virgo gravitational wave detectors have opened a new window to the universe. We already have over 50 gravitational wave detections. I will briefly mention what we have learned from these events, and how we are preparing for an era when gravitational wave detections are expected on a daily basis. In particular, I will discuss gravitational wave lensing, when another object interposes between the binary inspiral and Earth, and eccentric and hyperbolic merger events.

Primary author: Dr BONDARESCU, Ruxandra (ICC)

Presenter: Dr BONDARESCU, Ruxandra (ICC)

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

Relic Cosmic Axion Background

Monday, 7 February 2022 16:40 (25 minutes)

QCD Axions can be produced in various ways in the Early Universe by scatterings and decays from Standard Model particles, forming thus a Cosmic Axion Background that contributes to the abundance of relativistic relics (N_eff). We review in various setups how this is already constrained by present experiments and how it could be observed by future CMB experiments, in particular focusing on the coupling to quarks and leptons and on the bounds on the DFSZ model.

Primary author: NOTARI, Alessio

Presenter: NOTARI, Alessio