

Winter Meeting 2024



Report of Contributions

Contribution ID: 52

Type: **not specified**

Simulations of Relativistic Heavy Ion Collisions in Multi Modular Model

Wednesday, February 7, 2024 5:15 PM (25 minutes)

Relativistic Heavy Ion Collisions (RHIC) allow one to create ultra hot and dense systems where a phase transition from hadronic matter to quark-gluon plasma is expected to occur. Studying RHICs is crucial to understand what happened the first moments of the universe when temperatures and densities were so high that matter was only able to be found in the form of quark and gluons. RHICs are also important to understand the QCD phase diagram and to find the critical point. In RHICs simulations we clearly separate the evolution of the reaction into three different stages, each one being described with a most suitable model:

- initial stage, before the equilibration and fluidization are reached;
- intermediate stage, typically described by relativistic hydrodynamics;
- and final stage, after hadronization, which is described via hadron cascades, like UrQMD or SMASH.

It is also very important that these different modules are coupled to each other correctly.

I will present a Multi-Modul Model which is used in our group. As the first step of my PhD project, I modified the model, used to describe the initial stage of the collision, by taking into account initial state fluctuations, what allows to describe RHICs on an event-by-event basis. This modified model is known as Generalize Effective String Rope Model [1] and in our simulations it generates the initial conditions for further hydrodynamics evolution, for which I adapted a relativistic hydrodynamics code based on the Particle in Cell method. Results from the first and second stage of the collision will be presented and discussed. The last and most difficult step of my PhD project, which is in progress right now, is to couple the hydrodynamics module with the hadronic cascade one through an intermediate step called 'particlization' process.

[1] A. Reina, V.K. Magas, L.P. Csernai, and D.D. Strottman, Phys. Rev. C 107 (2023) 3, 034915.

Primary authors: Prof. MAGAS, Volodymyr (University of Barcelona & ICC, Spain); REINA RAMÍREZ, Ángel (Universitat de Barcelona)

Presenter: REINA RAMÍREZ, Ángel (Universitat de Barcelona)

Contribution ID: 53

Type: **not specified**

b -> c tau nu bar_tau semileptonic decays: visible distributions and tests of lepton flavour universality

Wednesday, February 7, 2024 10:50 AM (25 minutes)

One of the features of the SM is Lepton Flavour Universality. This property gives rise to a lepton flavour symmetry in the SM that is only broken by the differences in the charged lepton masses. There is experimental evidence in B-meson semileptonic decays that points to the possibility of LFUV affecting the $b \rightarrow c\tau\bar{\nu}_\tau$ transition. To explain present data one can adopt a phenomenological strategy and take an effective Hamiltonian that includes the full set of dimension-6 semileptonic $b \rightarrow c$ operators. The NP effects are encoded in a set of Wilson coefficients fitted to data. In this talk, we will propose and discuss some observables for discriminating between different NP models, which otherwise would give the same results for observables as $R(D)$ and $R(D^*)$. We will focus on the observables that can be extracted from the kinematics of the charged particle that originates in the subsequent tau decay since the final tau momentum is difficult to reconstruct.

Primary author: PENALVA MARTÍNEZ, Neus (ICC-UB)

Presenter: PENALVA MARTÍNEZ, Neus (ICC-UB)

Contribution ID: 54

Type: **not specified**

Studying nuclear interactions with lattice QCD

Wednesday, February 7, 2024 10:25 AM (25 minutes)

Understanding the strong interactions between baryons is a central goal of nuclear physics. Beyond the clear value of this knowledge in its own right, such information is essential to optimize our experimental sensitivity to new physics. Lattice quantum chromodynamics (LQCD) offers the prospect of studying nuclear systems from first principles. In this talk, I will present results from recent NPLQCD collaboration spectroscopy studies of multi-baryon systems including two nucleon and two hyperon systems. I will explain how these spectroscopy results may be used to extract information about nuclear systems.

Primary author: Dr PERRY, Robert (University of Barcelona)

Presenter: Dr PERRY, Robert (University of Barcelona)

Contribution ID: 55

Type: **not specified**

Experimental overview of Lepton Flavour Universality tests

Tuesday, February 6, 2024 12:35 PM (25 minutes)

In the Standard Model (SM), the coupling between the gauge bosons and the charged leptons is independent of their generation. This feature is called Lepton Flavour Universality (LFU). Many models beyond the SM foresee a violation of LFU and recent experimental results hints LFU violation. An overview of the experimental techniques and results studying LFU in $b \rightarrow c\ell\nu_\ell$ transitions is presented.

Primary author: GIOVENTÙ, Alessandra (ICCUB - Universitat de Barcelona (ES))

Presenter: GIOVENTÙ, Alessandra (ICCUB - Universitat de Barcelona (ES))

Contribution ID: 57

Type: **not specified**

Hyperfine splittings of heavy quarkonium hybrids

Wednesday, February 7, 2024 4:25 PM (25 minutes)

The structure of heavy quarkonium hybrids at leading order in the framework of the Born-Oppenheimer Effective Field Theory expansion is determined by two potentials.

We estimate those potentials by interpolating between the known short distance behavior, obtained from a lattice calculation of the lower lying charmonium hybrid multiplets, and the long distance behavior calculated in the QCD Effective String Theory. Both behaviors depend, at leading order, by two parameters.

This allows us to predict the hyperfine splitting both of bottomonium hybrids and of higher multiplets of charmonium hybrids and compare with other approaches.

Primary author: TOMÀS VALLS, Sandra (ICCUB)

Co-author: Dr SOTO, Joan (ICCUB)

Presenter: TOMÀS VALLS, Sandra (ICCUB)

Contribution ID: 58

Type: **not specified**

Probing low-energy QCD and BSM searches with light mesons

Tuesday, February 6, 2024 2:55 PM (25 minutes)

Hadronic and radiative decays of light mesons offer a privileged environment to test QCD and search for physics beyond the Standard Model.

A new generation of precision experiments in hadron physics will soon offer new data that will have an impact on determinations of fundamental QCD parameters, such as the ratio of light quark masses or the η - η' mixing parameters, and provide important test of chiral symmetry breaking in QCD.

This new data will also provide sensitive probes to test potential new physics including searches for dark photons, light scalars and axion-like particles that will complement worldwide efforts to detect new light particles in the MeV-GeV mass range.

In this talk, I will give an update on the theoretical developments and discuss the experimental opportunities in this field

Primary author: GONZALEZ-SOLIS, Sergi (Universitat de Barcelona & ICCUB)

Presenter: GONZALEZ-SOLIS, Sergi (Universitat de Barcelona & ICCUB)

Contribution ID: 59

Type: **not specified**

On the growth of diffuse light from simulations of galaxy clusters

Tuesday, February 6, 2024 11:45 AM (25 minutes)

The diffuse light is a pervasive feature of groups and clusters consisting of an extended low-surface-brightness component that permeates the intergalactic medium of these large galaxy associations. It is formed by stars stripped from their host galaxies or created in-situ during disruptive interactions experienced by members of these galaxy systems, primarily in the course of the gravitational collapse that precedes their formation. It is often found concentrated around the central, most luminous object.

Our aim in this work is to make use of controlled numerical simulations of pre-virialized clusters to study the formation of the diffuse intracluster light (ICL) and investigate its potential to describe the assembly history of such systems of galaxies.

We are currently using our simulations to track the growth of the ICL over cosmic time, tracing its evolution across clusters spanning a range of masses and galaxy memberships. I will present our first results, where we analyzed the relationship of ICL formation with the mass and size of the brightest cluster galaxy and with the total stellar mass of the system.

Primary authors: BILATA WOLDEYES, Betelehem (Instituto de Astrofísica de Andalucía (IAA-CSIC)); PEREA, Jaime D.; SOLANES, José M.

Presenter: BILATA WOLDEYES, Betelehem (Instituto de Astrofísica de Andalucía (IAA-CSIC))

Contribution ID: 60

Type: **not specified**

Deflection of gravitational waves by astrophysical objects

Tuesday, February 6, 2024 4:40 PM (25 minutes)

What happens when gravitational waves encounter a massive astrophysical object? Gravitational lensing, traditionally seen with light, bends and distorts gravitational waves as a result of the object's gravity. Gravitational lensing can be a useful tool to learn more about the nature and the properties of these astrophysical objects (termed gravitational lenses). Although ~150 gravitational wave events have been detected since 2015, a gravitationally-lensed signal has not been observed yet, but it is expected to arrive at any moment. I will discuss how these events can be modelled: in particular, how interference and diffraction around the lens affect the signal, giving rise to characteristic features. I will also discuss how lensing of gravitational waves in their formation environment can help us distinguish their origin.

Primary author: UBACH RAYA, Helena (Universitat de Barcelona, ICCUB)

Presenter: UBACH RAYA, Helena (Universitat de Barcelona, ICCUB)

Contribution ID: 61

Type: **not specified**

Radio observations of star-forming regions

Tuesday, February 6, 2024 4:15 PM (25 minutes)

The field of star formation has experienced great progress in the last years thanks to significant improvements in instrumentation. The next generation of radio telescopes (ngVLA and SKA) will significantly improve the sensitivity and angular resolution of current radio interferometers. These improvements will allow us to study regions of our Galaxy in greater detail and to complement observations at other wavelengths.

In this talk, I will discuss ongoing projects focused on characterizing the young stellar population and tracing the evolutionary sequence of star-forming regions, as well as the importance of studying the early stages of protostars to determine the final properties of stars and their planetary systems. I will also talk about source detection and classification algorithms needed to deal with the large amount of data that will be obtained from the new generations of telescopes.

Primary author: DÍAZ MÁRQUEZ, Elena

Presenter: DÍAZ MÁRQUEZ, Elena

Contribution ID: **62**

Type: **not specified**

Welcome!

Tuesday, February 6, 2024 10:00 AM (10 minutes)

Presenter: LURI, Xavier (ICCUB)

Contribution ID: **63**

Type: **not specified**

How can we help?

Tuesday, February 6, 2024 10:25 AM (25 minutes)

Presenter: PALLARES, Esther

Contribution ID: 71

Type: **not specified**

Instrumentation activities of the ICCUB Tehcnology Unit

Wednesday, February 7, 2024 12:10 PM (25 minutes)

The Technological Unit of the ICCUB is currently providing several 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 photosensor, microelectronics and space technology with key contributions in international projects such as LHCB, CTA, HERD, LISA, ARIEL and Axion detectors. Furthermore, this technology is also being applied in medical imaging and other fields in cooperation with academic and industrial partners.

Primary author: Dr GASCON FORA, David (ICCUB. Universitat de Barcelona)

Presenter: Dr GASCON FORA, David (ICCUB. Universitat de Barcelona)

Contribution ID: 73

Type: **not specified**

Software and data processing activities of the ICCUB Technology Unit

Wednesday, February 7, 2024 12:35 PM (25 minutes)

The ICCUB Technological Unit is contributing to the software development and data processing of several projects of the Institute. The most important one is Gaia, where we develop data processing pipelines and catalogue validation tools, and research on data mining solutions including cloud computing. Gaia has even led to spin-off projects, related to light pollution or even cybersecurity, and we keep an eye on a possible successor, GaiaNIR. We also participate in other projects such as Virgo, the Einstein Telescope, PLATO, nanosatellites (including IEEC's PhotSat), and recently, LISA. In this talk I will present and briefly describe these software engineering and data processing activities at the ICCUB.

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

Presenter: Dr PORTELL DE MORA, Jordi (ICCUB)

Contribution ID: 78

Type: **not specified**

The Galactic Habitable Zone

Wednesday, February 7, 2024 4:50 PM (25 minutes)

With more than 5000 confirmed exoplanet detections since 1995, it is now established that planets are very common in our galaxy: almost every star in the galaxy is thought to harbour at least one planet. Kepler, PLATO, and other planet-hunting missions are particularly interested in Earth-like exoplanets, which could in certain cases host liquid water and maybe life.

From a Galactic point of view, it is interesting to determine if this kind of exoplanet can exist everywhere in the Milky Way, or if they are preferentially found in certain regions of the Milky Way: the Galactic Habitable Zone (GHZ).

I will present a quick overview of current knowledge on the Milky Way's exoplanet population and the evolution of the GHZ research over the past 30 years.

Primary author: PADOIS, Chloé (Universitat de Barcelona - ICCUB)

Presenter: PADOIS, Chloé (Universitat de Barcelona - ICCUB)

Contribution ID: 79

Type: **not specified**

Status of Direct Determination of Solar Neutrino Fluxes after Borexino

Tuesday, February 6, 2024 3:20 PM (25 minutes)

We determine the solar neutrino fluxes from the global analysis of the most up-to-date terrestrial and solar neutrino data including the final results of the three phases of Borexino. The analysis are performed in the framework of three-neutrino mixing with and without accounting for the solar luminosity constraint. We discuss the independence of the results on the input from the Gallium experiments. The determined fluxes are then compared with the predictions provided by the latest Standard Solar Models. We quantify the dependence of the model comparison with the assumptions about the normalization of the solar neutrino fluxes produced in the CNO-cycle as well as on the particular set of fluxes employed for the model testing.

Primary author: PINHEIRO, Joao Paulo (UB)

Presenter: PINHEIRO, Joao Paulo (UB)

Contribution ID: **80**

Type: **not specified**

Concerto in D Major RV93, A. Vivaldi

Wednesday, February 7, 2024 4:10 PM (15 minutes)

Cristiano Germani (guitar), Matteo Palassini (violin), Arianna Palassini (violin), Gregori Astrakharchik (cello), Concerto in D Major RV93, A. Vivaldi

Primary author: GERMANI, Cristiano

Presenters: PALASSINI, Arianna (ICCUB); GERMANI, Cristiano; ASTRAKHARCHIK, Gregori (ICCUB); PALASSINI, Matteo (ICCUB)

Contribution ID: **81**

Type: **not specified**

Nyx: a new computing cluster at the ICCUB

Tuesday, February 6, 2024 10:10 AM (15 minutes)

Presenter: LURI, Xavier (ICCUB)

Contribution ID: 82

Type: **not specified**

Probing cosmic inflation via gravitational waves

Tuesday, February 6, 2024 12:10 PM (25 minutes)

We will explain how cosmic inflation generates density waves, responsible for the observed temperature fluctuations on the cosmic microwave background radiation, and gravitational waves (GWs). We will then explore how the new generations of GW detectors can provide us invaluable insights into inflation, inaccessible through cosmic microwave background radiation.

Primary author: GORJI, Mohammad Ali (University of Barcelona)

Presenter: GORJI, Mohammad Ali (University of Barcelona)

Contribution ID: 83

Type: **not specified**

The SIF-Gaia data from engineering images taken in the omega Centauri region, and future data

Wednesday, February 7, 2024 10:00 AM (25 minutes)

In addition to standard Gaia observations, full Sky Mapper images were recorded for nine selected regions in the sky. An adapted version of Gaia's Source Detection and Image Parameter Determination software located sources in the 2D images. These source detections were clustered and assigned to new or existing Gaia sources by Gaia's cross-match software. This new pipeline produced half a million additional Gaia sources in the region of the omega Centauri cluster, which were published with latest Gaia Focused Product Release. In this talk, I will present the methods used and the results of this new pipeline for omega Centauri, and briefly demonstrate what to expect for the fourth Gaia catalogue.

Primary author: TORRA CLOTET, Ferran (ICCUB)

Presenter: TORRA CLOTET, Ferran (ICCUB)

Contribution ID: 84

Type: **not specified**

Anomalous quantum transport in fractal lattices

Tuesday, February 6, 2024 10:50 AM (25 minutes)

Fractal lattices are self-similar structures with repeated patterns on different scales. Here, we study the dynamical properties of one fractal lattice, the Sierpiński gasket. This system exhibits an inverse power-law behavior in the level spacing distribution. We find that the Sierpiński gasket has a sub-diffusive transport in certain regimes. From the point of view of technological applications, we demonstrate that the sub-diffusive behavior in the gasket can be used as a quantum memory.

Primary author: ROJO-FRANCÀS, Abel (Universitat de Barcelona)

Presenter: ROJO-FRANCÀS, Abel (Universitat de Barcelona)

Contribution ID: 85

Type: **not specified**

From Binary Interaction to Luminous Red Novae

Wednesday, February 7, 2024 2:30 PM (25 minutes)

Multiple systems, and in particular binary systems of massive stars, are much more the norm than the exception in our Universe, and this is especially true when looking early in stellar formation. The interaction within these systems greatly defines the evolution and fate of their members. In some cases, two binary stars can enter a so-called common envelope phase when they both orbit within the same atmosphere of gas. This envelope is then partially or completely ejected, leading to either a merger or the formation of a compact binary system. The ejection of this envelope results in light emission that we detect as transient events: the Luminous Red Novae. Studying these events is highly important because they represent the observables of a stellar interaction mechanism that can explain a wide variety of energetic phenomena, such as Type Ia supernovae (SN Ia), neutron star mergers, cataclysmic variables, and other sources of gravitational waves. In this presentation, we will explore the nature of the observations used to refine the main models describing the Luminous Red Novae and how these observations are linked to the theory.

Primary author: WAVASSEUR, Maxime (ICCUB)

Presenter: WAVASSEUR, Maxime (ICCUB)

Contribution ID: 86

Type: **not specified**

Dark matter spirals in Milky Way-like galaxies

Tuesday, February 6, 2024 2:30 PM (25 minutes)

In the study of the dynamics of the Milky Way, a traditional assumption is that the inhomogeneities of the disk are decoupled from the dark matter halo. However, the complex kinematics revealed by Gaia show that the disk-halo interaction could play a much more important role than we imagined in the understanding of our Galaxy.

In this talk, we will discuss the coupling between the spiral arms and the dark matter halo of simulated Milky Way-like galaxies. We will show its ubiquitous presence for spiral arms with different origins in pure N-Body and cosmological simulations. Additionally, we present a possible explanation for this coupling, in the framework of Dynamical Friction.

Finally, we will discuss the impact of this coupling in the dynamics and evolution of spiral arms and the possible impact on the estimations of local dark matter density.

Primary author: BERNET, Marcel (Universitat de Barcelona - ICCUB)

Presenter: BERNET, Marcel (Universitat de Barcelona - ICCUB)

Contribution ID: 87

Type: **not specified**

Investigating non-leptonic two body B-decays in and beyond the Standard Model

Wednesday, February 7, 2024 3:20 PM (25 minutes)

In the light of the observed discrepancy between theoretical predictions and experimental measurements of the branching ratios of the non-leptonic decays $\bar{B}^0 \rightarrow D^+ K^-$ and $\bar{B}_s^0 \rightarrow D_s^+ \pi^-$, we investigate possible beyond Standard Model interpretations.

To this end, we revisit the calculation of the one-loop hard-scattering kernels and present the sub-leading three-particle contributions to those decays for the full basis of beyond Standard Model operators.

Our calculation makes use of the QCD factorization framework. We find that we can reproduce the one-loop hard scattering kernels for all possible operators.

For the three-particle Fock states we are able to reproduce the result for the Standard Model operator up to a constant factor, which, however, does not change the fact that these contributions can be neglected.

For the other operators we find that the contributions either vanish up to twist-4 or are highly suppressed as in the Standard Model case, so that we need not consider them at the required accuracy. Furthermore, the results obtained have been implemented in the EOS software to facilitate a variety of pheno-analyses.

Our results are an important cross check for published pheno-analyses and will extend the scope of previously published analyses.

Primary author: MEISER, Stefan (UB/ICCUB)

Presenter: MEISER, Stefan (UB/ICCUB)

Contribution ID: 88

Type: **not specified**

Black Holes & Stars : an intriguing dynamical relationship

Wednesday, February 7, 2024 11:45 AM (25 minutes)

The dynamical interplay between stars and stellar mass black holes (BHs) in star clusters can lead to a broad spectrum of outcomes which range from peculiar binary systems, as those recently discovered with the astrometric Gaia measurements (Gaia DR3), to micro-tidal disruption events. The former are the first dormant (i.e. X-ray silent), BH-star binaries discovered with Gaia DR3. The latter are multi-messenger transients, predicted to be detected by next generation gravitational waves detectors, that occur when a star that passes closely to a BH is disrupted and its debris create an observable (i.e. X-ray-UV-optical) accretion disc around the BH. In this talk I will give an overview on these topics introducing my project which aims to investigate bh-star dynamical interactions with N-body simulations. My results will be crucial to give an astrophysical interpretation to the data that will come with next transient surveys and astrometric measurement with Gaia DR4.

Primary author: RASTELLO, Sara (Universitat de Barcelona)

Presenter: RASTELLO, Sara (Universitat de Barcelona)

Contribution ID: 89

Type: **not specified**

Emission of gravitational waves from strongly-coupled plasmas

Wednesday, February 7, 2024 2:55 PM (25 minutes)

I explore the strong-coupling effects on the emission of primordial gravitational waves. I start by analyzing the emission from a primordial plasma in thermal equilibrium, both in the weakly-coupled and in the strongly-coupled regimes. Additionally, I overview the emission of gravitational waves resulting from first-order cosmological phase transitions. Traditionally, the dynamics of these transitions are expected to occur via bubble nucleation, with the collision between bubbles generating gravitational waves. However, spinodal instability is starting to be considered as an alternative mechanism to realize the phase transition. I address both scenarios and the insights into distinguishing the spectra emitted by each of them.

Primary author: CASTELLS TIESTOS, Lucía (University of Barcelona)

Presenter: CASTELLS TIESTOS, Lucía (University of Barcelona)