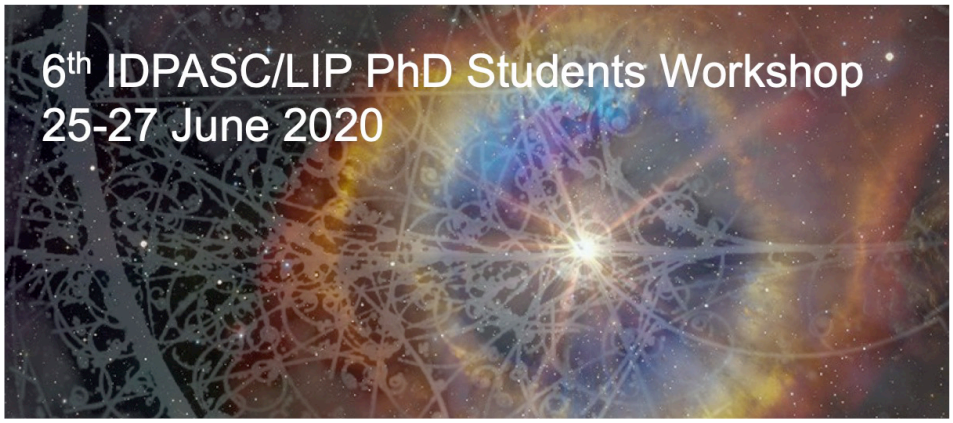
6th IDPASC/LIP PhD Students Workshop



Report of Contributions

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

Opening and welcome

Thursday, 25 June 2020 09:30 (10 minutes)

Presenter: GONÇALO, Ricardo (UC/LIP)

Session Classification: Session 1

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

Keynote talk 1: Multi-messenger astrophysics with gravitational waves

Thursday, 25 June 2020 09:40 (30 minutes)

Recent detections of gravitational waves provide a new, exciting tool to observe the Universe. I will introduce this new method of directly studying the spacetime distortions produced by massive objects, and focus on recent findings of the LIGO-Virgo detector network, reporting on the binary systems of black holes and neutron stars, the latter also observed in electromagnetic waves.

Presenter: BEJGER, Michal (Nicolaus Copernicus Astronomical Center, Warsaw)

Session Classification: Session 1

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

Keynote talk 2: Higgs sector - a perspective

Thursday, 25 June 2020 15:45 (30 minutes)

Significant progress has been made in the study of the Higgs boson in the last few years, and in the search of additional scalars. The large datasets already collected by the Large Hadron Collider experiments allow for ever more precise measurements, while the development of innovative tools and novel theoretical ideas open new windows in the exploration of the Higgs sector. Highlights of the LHC Higgs physics programme will be discussed, along prospects for the future.

Presenter: NIKOLOPOULOS, Kostas (University of Birmingham)

Session Classification: Session 4

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

Keynote talk 3: Cloudy Thoughts: Opportunities and Challenges in Scientific Distributed Computing

Thursday, 25 June 2020 14:00 (30 minutes)

Why should PhD students in particle physics, astrophysics and cosmology worry about the current and future challenges of distributed computing? Should not we all focus on core scientific problems, and then let others deal with how to find, provision and exploit the technologies that are required? This talk will show how that was not the case in the past and will likely not be the case also for upcoming scientific experiments and needs, pointing to some of the opportunities and challenges that lie ahead of us.

Presenter: SALOMONI, Davide (INFN - CNAF, Bologna, Italy)

Session Classification: Session 3

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

Keynote talk 4: A (brief) Introduction to Non-perturbative Quantum Field Theory

Friday, 26 June 2020 09:30 (30 minutes)

Presenter: LOWDON, Peter (École Polytechnique, Paris)

Session Classification: Session 5

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

Transferable skills: career development

Friday, 26 June 2020 15:45 (30 minutes)

The idea of this talk is making the audience aware and reflect on skills that are important for a career in science and elsewhere. They are proposed from the perspective of someone more experienced, without any claim of specific expertise. We will start by presenting the Vitae Researcher Development Framework. This framework classifies several useful transversal skills both in scope and in depth. We will then focus on skills mostly voted in the pool: https://doodle.com/poll/8g6yu8tausv42wqp

Presenter: GARCIA, Paulo (Universidade do Porto)

Session Classification: Session 8

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

Keynote talk 5: Fourteen billion years in thirty minutes

Friday, 26 June 2020 14:00 (30 minutes)

I will review the main theoretical aspects of the standard cosmological model, commonly known as the “Big Bang theory”, its observational achievements and finally its main open problems, describing some of the leading solutions that have been proposed in the literature.

Presenter: ROSA, João (Universidade de Coimbra)

Session Classification: Session 7

Contribution ID: **32** Type: **not specified**

Research and society: women in physics

Friday, 26 June 2020 16:30 (30 minutes)

Presenter: RAMOS, Àngels (University of Barcelona)

Session Classification: Session 8

Contribution ID: **37** Type: **not specified**

Closing and farewell

Saturday, 27 June 2020 11:50 (10 minutes)

Presenter: PIMENTA, Mário (LIP)

Session Classification: Session 9

Contribution ID: **39** Type: **PhD student talk**

Search for new interactions on the top quark sector

Thursday, 25 June 2020 12:00 (12 minutes)

The study of the top quark properties provides not only an important test of the Standard Model (SM) of particle physics but also an excellent way of probing physics beyond it. In the SM the top quark decays via Flavour Changing Neutral Currents (FCNC) have extremely small branching ratios but some extensions predict a significant enhancement of the probability for such decays. The PhD thesis is devoted to the study of the FCNC processes through the single top quark production with a Z boson using data collected by the ATLAS detector which is a highly sensitive process to probe the Flavour Changing Neutral (FCN) coupling tqZ (with q being an up or charm quark). Furthermore, the combination with the results from the t->qZ decay are foreseen. The performed phenomenological study of the interference between tZq (FCNC in top decays) and tZ (production via FCNC) will also be presented. The phenomenological study of rare top decays with a new scalar S particle will be part of the presentation as well.

Primary author: PEIXOTO, Ana (LIP)

Presenter: PEIXOTO, Ana (LIP)

Session Classification: Session 2

Contribution ID: **40** Type: **PhD student talk**

A semi-linear wave model for critical collapse

Friday, 26 June 2020 14:55 (12 minutes)

In spherical symmetry compelling numerical evidence suggests that in general relativity solutions near the threshold of black hole formation exhibit critical behavior. One aspect of this is that threshold solutions themselves are self-similar and are, in a certain sense, unique. To an extent yet to be fully understood, the same phenomena persist beyond spherical symmetry. It is therefore desirable to construct simple non-linear models that exhibit such symmetry at the threshold of blow-
up. This can help understand both the structural requirements on the non-linearities and the extent to which nearby solutions may display critical behavior. Presently, starting with deformations of the wave equation, we discuss models which have discretely self-similar threshold solutions. We study the behavior of threshold solutions in the past light cone of the blow-up point and show that in spherical symmetry there is a clear sense in which a unique critical solution exists. Near threshold spherical numerical evolutions are also presented for more general models, and exhibit similar behavior. Uniqueness at the threshold of blow-up is, however, completely lost in general.

Primary author: Ms ISABEL, Suárez Fernández (CENTRA / Instituto Superior Técnico)

Co-authors: Mr RODRIGO, Vicente (CENTRA / Instituto Superior Técnico); Dr DAVID, Hilditch (CENTRA / Instituto Superior Técnico)

Presenter: Ms ISABEL, Suárez Fernández (CENTRA / Instituto Superior Técnico)

Session Classification: Session 7

Contribution ID: **41** Type: **PhD student talk**

Dark Matter in Stars: Capture uncertainties and RGB stars

Thursday, 25 June 2020 10:20 (12 minutes)

Dark Matter (DM) particles from the galactic halo can get gravitationally trapped inside stars. Once these particles settle in the interior of the star, DM-DM and DM-nucleon interactions can have an impact on the standard stellar evolution and the observations associated with it. These effects can in turn be used to probe the nature of galactic DM.

In this work I will discuss the underlying uncertainties associated with the process of Dark Matter capture, not only in the case of the Sun, but also for other types of stars located in different regions of the galaxy which are also relevant from an experimental point of view. We accomplish this by using a robust and consistent description of the DM halo phase space obtained by *Eddington Inversion* of the underlying galactic mass profile.

I will also discuss the preliminary results obtained for the effects of DM energy transport inside stars in the Red Giant Branch (RGB), and the implication these can have in current and future observations.

Primary author: Mr LOPES, José (CENTRA, IST, UL)

Co-author: Prof. LOPES, Ilídio (CENTRA, IST, UL)

Presenter: Mr LOPES, José (CENTRA, IST, UL)

Session Classification: Session 1

Contribution ID: **42** Type: **PhD student talk**

Georgi-Machacek model: A benchmark for Higgs triplets

Thursday, 25 June 2020 11:45 (12 minutes)

The measurements of the Higgs signal strengths are turning out to be very SM-like at LHC experiments. As the precision increases, the parameter space of several BSM models is starting to shrink considerably. This is puzzling, as there is evidence that the SM cannot be the whole story: the massiveness of neutrinos, the strong hypothesis of Dark Matter, the small amount of CP-violation for baryogenises, the lack of a strong first order EW phase transition, among others. All of the aforementioned are forcing theoreticians to either do more precise loop calculations or tame more elaborate models. In this talk it will be done the later, it will be presented the Georgi-Machacek model. This model is arguably the simplest to include Higgs triplets and preserve the pho-parameter=1 at tree-level, naturally. It also provides new features not present in doublets or singlet models: it allows for stronger Higgs to Gauge bosons couplings than the SM at tree-level, it allows for more complex symmetry breaking patterns, etc. In this project, we are exploring all of its phenomenological phases, one of which is a DM phase. We are checking the global stability of each phase against all coexisting others. We want to provide theoretical bounds to the parameter space and, in turn, check new and unique signatures for phenomenological searches.

Primary authors: Mr AZEVEDO, Duarte (CFTC-UL); Mr FERREIRA, Pedro (CFTC-UL, ISEL); Mr SANTOS, Rui (CFTC-UL); Mrs LOGAN, Heather (Carleton University)

Presenter: Mr AZEVEDO, Duarte (CFTC-UL)

Session Classification: Session 2

Contribution ID: **43** Type: **PhD student talk**

Measurement of Te130 Two-Neutrino Double Beta Decay Half-life with the SNO+ Experiment: Analysis during the Partial Fill

Friday, 26 June 2020 11:20 (12 minutes)

Searching for the neutrinoless double beta decay (0νββ) is of major interest to understand the fundamental characteristics of neutrinos. If observed, it would prove the Majorana nature of neutrinos, i.e. they are their own anti-particles, and allow the measurement of their effective mass.
SNO+ is a large volume liquid scintillator neutrino experiment that will search for this decay using ~3900 kg of natural tellurium. This search requires very low backgrounds and an accurate knowledge of the detector's energy response, achieved by detailed calibrations.
One of the main backgrounds for the 0νββ search is the 2νββ-decay. The anti-neutrinos emitted in this process are not detected, and the summed kinetic energy of the two electrons forms a continuous spectrum from 0 MeV up to the Q-value of 2.527 MeV. Measuring the 2νββ half-life allows to experimentally verify the theoretical models used for the calculation of Nuclear Matrix elements (NME), which can improve the NME calculation for the 0νββ mode, necessary to extract the effective neutrino Majorana mass. Due to the limited energy resolution, the 2νββ spectrum tail will leak into the 0νββ region-of-interest (ROI), forming an irreducible background for this signal. It is thus fundamental to know very well the detector's energy response, in particular the energy scale, to predict the 2νββ contamination in the 0νββ signal.
At present, the detector is being filled with liquid scintillator, an important phase to understand the scintillator properties and the background contaminations. This talk will present a short summary of the work developed during the first two years of this PhD project, and will focus on the on-going analysis of the partial scintillator fill data.

Primary author: INÁCIO, Ana Sofia (LIP)

Presenter: INÁCIO, Ana Sofia (LIP)

Session Classification: Session 6

Contribution ID: **44** Type: **PhD student talk**

Probing the CP nature of the top-Higgs coupling in ATLAS

Thursday, 25 June 2020 16:45 (12 minutes)

The observation of the Higgs boson production in association with a top quark pair (ttH) by ATLAS and CMS in 2018 directly confirmed the existence of the top quark Yukawa coupling. The Standard Model (SM) predicts a CP-even structure to this coupling, but a CP-odd component can arise in models beyond the SM (BSM). Recently, ATLAS and CMS searched for such a component in analyses targetting ttH events in which the Higgs decays to 2 photons. However, the Higgs-photon coupling is loop-induced and could be affected by BSM effects.
We will probe the CP nature of the top-Higgs interaction by analyzing ttH events in the H->bb decay channel, using the full Run-2 data collected by the ATLAS experiment. I will present the analysis strategy for the measurement, the main challenges in modelling signal and background processes and the expected sensitivity for discovery or exclusion of new physics.

Primary author: GOUVEIA, Emanuel (LIP)

Presenter: GOUVEIA, Emanuel (LIP)

Session Classification: Session 4

Contribution ID: **45** Type: **PhD student talk**

Cosmological and astrophysical applications of modified theories of gravity

Friday, 26 June 2020 11:50 (12 minutes)

In this work, we study cosmological and astrophysical applications of the recently proposed generalized hybrid metric-Palatini gravity theory, which combines features of both the metric and the Palatini approaches to the variational method in f(R) gravity. This theory arises as a natural generalization of the hybrid metric-Palatini gravity which has been proven to be the first theory to unify the cosmic acceleration with the solar system constraints, without resource to the chameleon mechanism.
In the cosmological point of view, we show using reconstruction methods that the usual power-law and exponential scale factor behaviors in FLRW universes exist for various different distributions of matter, along with solutions for collapsing universes. Using the dynamical system approach, we also show that no global attractors can exist in the cosmological phase space and that stable universes can either be described by scale factors that diverge in finite time or asymptotically approach constant values. Furthermore, we also study the cosmological phase space of theories of gravity with terms of order six and eight in the derivatives of the metric and we conclude that the higher-order terms are not neglectable.
In the area of astrophysics, we show that using the junction conditions of the theory it is possible to obtain solutions for compact objects supported by thin-shells, such as self-gravitating shells with and without perfect fluids on their exteriors, and also traversable wormhole solutions which satisfy the null energy condition for the whole spacetime, thus not needing the support of exotic matter. Furthermore, we show that there exist specific forms of the action for which the massive s

Primary author: ROSA, João (Instituto Superior Técnico)

Presenter: ROSA, João (Instituto Superior Técnico)

Session Classification: Session 6

Contribution ID: **46** Type: **PhD student talk**

Functional renormalization group study of the critical region of the quark-meson model with vector interactions

Friday, 26 June 2020 10:40 (12 minutes)

The critical region of the two flavour quark-meson model with vector interactions is explored using the Functional Renormalization Group, a non-perturbative method that takes into account quantum and thermal fluctuations. Special attention is given to the low temperature and high density region of the phase diagram, which is very important to construct the equation of state of compact stars.
As in previous studies, without repulsive vector interaction, an unphysical region of negative entropy density is found near the first order chiral phase transition. We explore the connection between this unphysical region and the chiral critical region, especially the first order line and spinodal lines, using also different values for vector interactions. We find that the unphysical negative entropy density region appears because the $s = 0$ isentropic line, near the critical region, is displaced from its $T = 0$ location. For certain values of vector interactions this region is pushed to lower temperatures and high chemical potentials in such way that the negative entropy density region on the phase diagram can even disappear. In the case of finite vector interactions, the location of the critical end point has a non-trivial behaviour in the $T - \mu_B$ plane, which differs from that in mean field calculations.

Primary authors: PEREIRA, Renan (Centre for Physics of the University of Coimbra); Dr STIELE, Rainer; Dr COSTA, Pedro (Centre for Physics of the University of Coimbra)

Presenter: PEREIRA, Renan (Centre for Physics of the University of Coimbra)

Session Classification: Session 5

Contribution ID: **47** Type: **PhD student talk**

A Taste of the Flavour Problem - Is Symmetry the Missing Ingredient

Friday, 26 June 2020 10:10 (12 minutes)

In this talk I will present some generalities on the paradigm of flavour symmetries, and the benefits that it encompasses. Given the large multiplicity of scenarios in which this paradigm is included, I will focus on two specific works (in progress): approximate Yukawa symmetries in the context of 2HDMs; and subgroup-preserving points (stabilizers) in the context of discrete modular symmetries (Γ_N). The first scenario follows a bottom-up approach to BSM theories, leading to hitherto unstudied 2HDMs, which feature a very characteristic and predictive flavour structure. The second work is based on a top-down approach, since modular symmetries often play a role in string theories, allied to the fact that small N modular symmetries have been established as fruitful scenarios for both quark and lepton mixing. As such, a comprehensive study of symmetry breaking paths of the modular symmetries is of interest for model building.

Primary author: LEVY, Miguel (CFTP, Instituto Superior Técnico)

Presenter: LEVY, Miguel (CFTP, Instituto Superior Técnico)

Session Classification: Session 5

Contribution ID: **48** Type: **PhD student talk**

Stirred and shaken: dynamical behavior of boson stars and dark matter cores

Thursday, 25 June 2020 10:35 (12 minutes)

The nature and properties of dark matter are arguably among the most important open issues in science. Interesting candidates for dark matter include light bosonic fields. Such scalar fields can give rise to confined structures, as boson stars or Q-balls. Boson stars are interesting hypothetical new "dark matter stars", but also good descriptions of dark matter haloes when the fields are ultralight. In this talk, I'm going to focus on the the dynamical response of Newtonian bosonic structures when excited by external matter (stars, planets or black holes) in their vicinities. The study of the dynamics of such bodies is important for a number of reasons, ranging from stability to the way they interact with surrounding objects (stars, planets or black holes etc.). Among others issues, I am going to describe the local changes in the density of a dark matter halo triggered by the presence of a massive black hole or a star, the drag exerted by the bosonic clump on stars moving within it, the flux of energy and momentum induced by coalescing binaries, etc. I will provide a complete picture of the interaction between black holes or stars and the ultralight dark matter environment they live in.

Primary author: ANNULLI, Lorenzo

Presenter: ANNULLI, Lorenzo

Session Classification: Session 1

Contribution ID: **49** Type: **PhD student talk**

Background Characterisation for Water and Scintillator Phases of SNO+

Friday, 26 June 2020 11:35 (12 minutes)

SNO+ is a liquid scintillator-based experiment located 2km underground at SNOLAB in Canada. The primary motivation of the experiment is the observation of neutrinoless double beta decay; with other aims of detecting: geo and reactor antineutrinos, invisible nucleon decays and low energy solar neutrinos. The detector will operate in 3 main phases, using: ultra pure water, pure scinitllator and Tellurium 130 loaded scintillator. Due to the rare nature of these physical phenomena, it is vitally important to comprehensively characterise the background signals inherent in the detector. This PhD concerns itself with such characterisation and, thus far, has focused on the following:

During the detector's water phase, the beta decay of Bismuth 214 had the potential to fall within nucleon decay and solar neutrino studies' regions of interest. This background was therefore monitored on a day by day basis; now that this phase is complete, the same techniques will be retroactively applied to the data used in the aforementioned studies.

In scintillator, Alpha-Neutron reactions are caused by Carbon 13 atoms absorbing alpha particles (emitted by Radon daughter isotopes). These imitate inverse beta decay signals which are characteristic of an antineutrino interaction. A coincidence technique is currently being developed and used in an attempt to tag these events during SNO+'s current transitionary stage.

Primary author: COX, Matthew (LIP & University of Liverpool)

Presenter: COX, Matthew (LIP & University of Liverpool)

Session Classification: Session 6

Contribution ID: **50** Type: **PhD student talk**

Hyperbolicity of General Relativity in Bondi-like gauges

Friday, 26 June 2020 14:40 (12 minutes)

Bondi-like (single-null) characteristic formulations of general relativity are used for numerical work in both asymptotically flat and anti-de Sitter spacetimes. Well-posedness of the resulting systems of partial differential equations, however, remains an open question. The answer to this question affects the accuracy and reliability of conclusions drawn from numerical studies based on such formulations. A numerical approximation can converge to the continuum limit only for well-posed systems; for the initial value problem this is characterized by strong hyperbolicity. We find that, due to a shared pathological structure, the systems arising from the aforementioned formulations are however only weakly hyperbolic. We present numerical tests for toy models that demonstrate the consequence of this shortcoming in practice for the characteristic initial boundary value problem.

Primary author: GIANNAKOPOULOS, Thanasis (Instituto Superior Técnico)

Co-authors: Dr HILDITCH, David (Instituto Superior Técnico); Dr ZILHÃO, Miguel (Instituto Superior Técnico)

Presenter: GIANNAKOPOULOS, Thanasis (Instituto Superior Técnico)

Session Classification: Session 7

Contribution ID: **51** Type: **PhD student talk**

Search for CP-odd ttH production in the H->bb decay channel with ATLAS

Thursday, 25 June 2020 16:30 (12 minutes)

Following the observation of associated production of a Higgs boson with a pair of top-anti-top quarks (ttH), it is now essential to explore the detailed properties of the Higgs-Top coupling to test the predictions of the Standard Model of Particle Physics and search for clues of new physics that can modify this interaction. This talk describes the search to constrain odd charge-parity (CP) components in the ttH coupling through ttH production in the H->bb decay channel, using 139 \fb of pp collision data collected with the ATLAS detector at a center of mass energy of 13 TeV.

Primary author: CARVALHO, Ana Luisa (LIP)

Presenter: CARVALHO, Ana Luisa (LIP)

Session Classification: Session 4

Contribution ID: **52** Type: **PhD student talk**

Study of the Spin/CP properties of the Higgs coupling to W bosons with ATLAS at the LHC

Thursday, 25 June 2020 17:00 (12 minutes)

In my presentation, I will motivate the use of angular observables as a probe of anomalous Spin/CP components in the HWW interaction vertex. I will present the results of the first ATLAS search of associated WH production in the boosted regime, where the sensitivity to these components is higher. I will also motivate and present some of my work as part of the ATLAS jet trigger group.

Primary author: BARRUÉ, Ricardo (LIP)

Presenter: BARRUÉ, Ricardo (LIP)

Session Classification: Session 4

Contribution ID: **53** Type: **not specified**

Muon Tomography applied in the Lousal Mine (Portugal)

Saturday, 27 June 2020 10:45 (12 minutes)

Muon Tomography is an imaging technique that uses muons as a means of observing the earth's subsurface and with it obtain muographs that display the column density distribution of the surveyed region. The University of Évora and the LIP intend to develop muon telescopes and apply the muon tomography in the geophysics field.
The detection will take place inside the Lousal Mine, about 18 m below the surface. The telescope will do a geological reconnaissance of the well-known ground above the mine to test its performance and sensitivity. A working prototype was put in place to gather preliminary information and establish the requirements of the equipment to build a muon telescope.
Simulations of the muon detection have been made using GEANT4 software. The simulations allow to study the expected result of muographs produced by the muon flux passing through a simulated ground with different characteristics.
A preliminary geophysical survey was carried out on the surface above the mine to test the response of the ground to the geophysical methods employed.
The aim of this work is to apply the muon tomography in Lousal Mine and define this technique as a suitable probe technique in the geophysical field. We also want to combine muography and gravimetry information, from a gravimetric survey that will be carried on site, through a joint inversion of both data sets to obtain 3D density profiles of the observed region.

Primary authors: TEIXEIRA, Pedro (LIP / UÉvora); ANDRINGA, Sofia (LIP); ASSIS, Pedro (LIP); BEZZEGHOUD, Mourad (University of Évora); BLANCO, Alberto (LIP); BORGES, José (University of Évora); CALDEIRA, Bento (University of Évora); CAZON, Lorenzo (LIP); FERREIRA, Miguel (LIP Lisboa); LOPES, Luis (LIP Coimbra); NOGUEIRA, José (LIP Lisboa); PIMENTA, Mário (LIP); PINTO, Álvaro (CCV Lousal); RELVAS, Jorge (CCV Lousal); TOMÉ, Bernardo (LIP)

Presenter: TEIXEIRA, Pedro (LIP / UÉvora)

Session Classification: Session 9

Contribution ID: **54** Type: **PhD student talk**

Hints of new physics from CHMs

Thursday, 25 June 2020 11:30 (12 minutes)

In this talk, I will discuss non-minimal predictions from the composite Higgs framework and the corresponding phenomenology. I will focus on collider signals of heavy leptons and novel top decays via a FCNC interaction.

Primary author: RAMOS, Maria (LIP)

Presenter: RAMOS, Maria (LIP)

Session Classification: Session 2

Contribution ID: **55** Type: **PhD student talk**

Reducing the Computational Cost of MCRT via Bayesian Upscaling

Thursday, 25 June 2020 14:40 (12 minutes)

Dust grains are key ingredients in understanding the interstellar medium (ISM) and the largests effect of dust on astronomical observations: the extinction of light in the line of sight and the wavelength dependent reddening it causes, both affecting distance measurements for cosmology when using extragalactic sources such as supernovae. Size, shape and distribution of the dust grains may also polarize light as it traverses the ISM.
Monte Carlo Radiative Transfer (MCRT) constitutes a family of algorithms that given a photon source and a dust envioronment models simulate the interaction between the photons and the medium until it reaches the observer.
SKIRT is an MCRT program that includes several galaxy physical models library, which relieves the user from the mathematical description of the object and medium to simulate having only to choose, using an interface, from a set of parameters. The simulation process suffers nevertheless from the same computational limitations associated with MCRT, with the computational time scaling linearly with the amount of photons simulated.
Singular extended astronomical observations or multiple interacting sources present spatially-correlated structures which can be exploited by non-classical statistical methodologies to upscale property inference. Using output data from SKIRT, I'll present a pipeline that employs the Integrated Nested Laplace Approximation (INLA) method to reconstruct astronomical scalar and vector fields regarding unobserved sections of galactic properties maps.

Primary author: RINO-SILVESTRE, João

Presenter: RINO-SILVESTRE, João

Session Classification: Session 3

Contribution ID: **56** Type: **PhD student talk**

High-performance timing detector for the HL-LHC Upgrade of the CMS experiment at CERN

Thursday, 25 June 2020 15:10 (12 minutes)

In the High-Luminosity phase of the LHC physics program, the accelerator will provide an additional integrated luminosity of 3000 fb-1. One of the main challenges that must be overcome is the very high pileup (PU) originated by the high luminosity.

Each of the colliding beams at the LHC consists of many intense bunches of protons. At the HL-LHC, the average number of interactions in a single bunch crossing is 200 (named 'pileup interactions'). Most of these interactions are not interesting in the searches for New Physics at the TeV scale. Nevertheless, the presence of tracks and energy from 200 extra collisions degrades the reconstruction of the hard scatter. Pileup produces many hits in the tracking detectors, leading to mismeasured or misidentified tracks. In general, pileup confuses the reconstruction and interpretation of events. The development of a new Timing Detector to be integrated in the CMS experiment aims at fighting the pileup background, substantially improving the sensitivity to New Physics.

The subject of this talk is to present these difficulties, our solution at LIP-CMS and the result of tests where I've been directly involved.

Primary author: BASTOS, Diogo (LIP)

Presenter: BASTOS, Diogo (LIP)

Session Classification: Session 3

Contribution ID: **57** Type: **PhD student talk**

Constraints on the chi_c1 and chi_c2 polarizations

Friday, 26 June 2020 10:25 (12 minutes)

Hadron formation is a rather complex problem in the realm of non-perturbative QCD and remains an open question in HEP, despite the significant progress recently made through detailed phenomenological studies of several quarkonium production measurements made at the LHC. A new piece in the global panorama of quarkonium production data has recently been added by CMS: the first measurement of the polarizations of P-wave quarkonia. This is the first clear observation of significantly polarized quarkonium production, the χ_{c1} and χ_{c2} polarizations being almost maximally different. This remarkable observation provides a clean and non-trivial test of any theoretical attempt to explain the mechanisms behind hadron formation, including the widely used approach of NRQCD, which survives the test with flying colours.

Primary author: ARAÚJO, Mariana

Co-authors: FACCIOLI, Pietro (LIP); SEIXAS, João (LIP / IST); LOURENÇO, Carlos (CERN)

Presenter: ARAÚJO, Mariana

Session Classification: Session 5

Contribution ID: **58** Type: **MSc student poster**

Search for CP-odd ttH production in the H->bb decay channel

Thursday, 25 June 2020 17:15 (40 minutes)

In the Standard Model (SM), the Higgs boson is predicted to be a scalar with no CP-violating interactions. After the observation of the Higgs boson production in association with a top quark pair (ttH), the measurement of an odd charge-parity (CP) component in one of the Higgs boson couplings would constitute an important discovery of physics beyond the SM. This poster describes the search for a CP-odd contribution in the ttH production in the H->bb decay channel, based on the 139 fb^{-1} of proton-proton collision data at center-of-mass energy of 13 TeV collected with the ATLAS detector.

Primary authors: Mr COELHO, Luis (LIP); GOUVEIA, Emanuel (LIP); CARVALHO, Ana Luisa (LIP); GONÇALO, Ricardo (UC/LIP); ONOFRE, António (LIP)

Presenter: Mr COELHO, Luis (LIP)

Session Classification: MSc Students

Contribution ID: **59** Type: **PhD student talk**

Phenomenology of Little Higgs Models

Thursday, 25 June 2020 10:47 (12 minutes)

Little Higgs Models are a compelling solution to the hierarchy problem, avoiding quadratically divergent contributions to the Higgs mass through collective symmetry breaking. A signature of this model (and other composite Higgs models) would be the existence of heavy vector like fermions. In this talk we will explore the phenomelogical signatures of a heavy vector like lepton with exotic decays.

Primary author: Mr GUEDES, Guilherme (LIP)

Presenter: Mr GUEDES, Guilherme (LIP)

Session Classification: Session 1

Contribution ID: **60** Type: **MSc student poster**

Development of an FPGA-accelerated clustering for the ATLAS trigger system

Thursday, 25 June 2020 17:15 (40 minutes)

This project makes part of the planned upgrade work for the years 2025-26 of the ATLAS experiment, one of the four experiments located at the Large Hadron Collider (LHC), at CERN, the biggest proton - proton collider ever built. Due to the expected increasing levels of luminosity, leading to a higher amount of data generated per bunch crossing, an improvement in the trigger system, which is the online event selection and filtering system, is required. The algorithm analyzed in this context is the TopoCluster, a three-dimensional topological calorimeter cluster reconstruction algorithm. With improvements on the software, combined with dedicated hardware (HW) devices, and the possibility of parallelization, the algorithm is expected to improve its time performance on the ATHENA framework.

Firstly, the algorithm was first replicated in a C++ standalone version, being then adapted to a C version with no dynamic memory allocations (when processing different events). Secondly, the algorithm was partitioned into different parts to profile the algorithm. After identifying the critical parts, improvements were done in those parts and evaluated.

Given the capabilities of dedicated HW such as Field Programmable Gate Arrays (FPGAs), an initial architecture is being currently developed to increase the processing speed of the slowest parts of the algorithm. Later, that algorithm developed will be reshaped to split its processing into different FPGAs, reducing its execution time.

Primary author: Mr CORDEIRO, José

Presenter: Mr CORDEIRO, José

Session Classification: MSc Students

Contribution ID: **61** Type: **MSc student poster**

Search for Dark Matter in a Monotop Setup at the LHC

Thursday, 25 June 2020 17:15 (40 minutes)

The Standard Model can be considered an approximation at a lower energy of a more fundamental theory which encourages the search for new physics. One evidence supporting that new particles beyond the SM might exist comes from astrophysical measurements that point to the existence of a kind of matter that does not interact with the electromagnetic force, usually referred to as Dark Matter (DM). Although the particles associated with this DM are not expected to interact significantly with detectors, the proton-proton collisions at the Large Hadron Collider (LHC) can produce new particles that couple both to DM candidate particles and to SM particles allowing the detection of these processes. The monotop setup searches for events with one top quark and large missing transverse energy from the DM candidates. The purpose is to present a detailed study on the search for DM in a monotop setup and also contribute to the analysis being done by the ATLAS experiment at the LHC.

Primary authors: BARROS, Maura (LIP); CRISPIM ROMAO, Miguel (LIP); CASTRO, Nuno (LIP and University of Minho)

Presenter: BARROS, Maura (LIP)

Session Classification: MSc Students

Contribution ID: **62** Type: **PhD student talk**

Search for vector-like quarks with the ATLAS Experiment

Friday, 26 June 2020 15:10 (12 minutes)

A search for vector-like quarks is presented, which targets their decay into a Z boson and a third-generation Standard Model quark. In the case of a vector-like quark T (B) with charge +2/3e (−1/3e), the decay targeted is T ⟶ Zt (B ⟶ Zb). A dataset corresponding to 139/fb of pp collisions at √s = 13 TeV, collected between 2015 and 2018 with the ATLAS detector during Run 2 with the Large Hadron Collider, is used for this search. The targeted final state is characterised by the presence of a Z boson with high transverse momentum, which is reconstructed from a pair of opposite-sign same-flavor leptons, as well as b-tagged jets.
A study about the transferability of deep learning models in searches for new physics will also be shown. In it may be seen that using deep neural networks in search for new physics still leads to sensitivity for other BSM signals not present during training.

Primary author: VALE, Tiago (LIP)

Presenter: VALE, Tiago (LIP)

Session Classification: Session 7

Contribution ID: **63** Type: **PhD student talk**

Neural networks on a budget: Speed without sacrificing performance

Thursday, 25 June 2020 14:55 (12 minutes)

As machine-learning and deep-learning techniques become more and more ingrained in academic research tasks, two problems that researchers invariably face are:
1) How to train and apply models in a timely manner without sacrificing performance;
2) And how to do so with only a limited hardware-budget.

In my recent paper \[1\], I explore how recent techniques for neural network training and architecture can be used to match state-of-the-art performance on a HEP benchmark dataset (2014 Kaggle HiggsML) in just 14 minutes on a standard laptop CPU, as opposed to the previous time of 12 hours on a top-of-the range GPU (~100 minutes accounting for hardware advancements between 2013 and 2017).

Developed partly alongside the above referenced investigation, LUMIN \[2\] is an open-source PyTorch wrapper and data-analysis framework designed specifically for HEP usage, providing implementations of many recent and state-of-the-art methods for deep learning. The main aim is to allow HEP researchers to apply easily optimal approaches to standard tasks in HEP (i.e. classification & regression), whilst being modular enough to be adapted to more novel and investigative problems (e.g. studying the applicability of HEP-specific graph-nets to top-tagging).

This presentation would include: a quick overview of the techniques studied; and a call for contributors to help grow LUMIN to meet better the requirements of the HEP community.

\[1\] Strong 2020, https://iopscience.iop.org/article/10.1088/2632-2153/ab983a
\[2\] LUMIN https://lumin.readthedocs.io/

Primary author: STRONG, Giles (LIP)

Presenter: STRONG, Giles (LIP)

Session Classification: Session 3

Contribution ID: **64** Type: **PhD student talk**

Testing cosmological structure formation in Unified Dark Matter-Energy models

Saturday, 27 June 2020 11:35 (12 minutes)

Future cosmological data from the Euclid space mission will allow us to test many hypotheses of the nature of Dark Energy. In this talk I present an alternative approach to ΛCDM, a class of models where dark matter and dark energy exist as a single fluid, usually called Unified Dark Matter-Energy models (UDM). I will present the results of testing an UDM model implemented in the Boltzmann code CLASS against weak lensing, CMB, SNe IA and BAO tests.

Due to a unsmooth matter power spectrum caused by a speed of sound bigger than zero, the traditional sampling methods used in MCMC codes known as annealing methods, like Metropolis-Hastings, are not very efficient. In this talk, I will present the results obtained when using the Nested Sampling algorithm, explain the second method and why it is considerably better. At last, I will show the results of model comparison against ΛCDM and enumerate some topics in the line of work for UDM models to be tested with Euclid future data.

Primary author: CASTELÃO, Diogo (IA)

Presenter: CASTELÃO, Diogo (IA)

Session Classification: Session 9

Contribution ID: **65** Type: **MSc student poster**

One-loop corrections to Higgs decay to dark matter

Thursday, 25 June 2020 17:15 (40 minutes)

The Standard Model of Particle Physics (SM) is one of the most successful theories in Physics. However, it has failed to explain some observed phenomena as is the case for dark matter. To address this issue, particle physicists turn to models Beyond the Standard Model (BSM). The Next-to-minimal 2-Higgs Doublet Model (N2HDM) is a Standard Model extension that provides phenomenology compatible with the existence of dark matter candidates. From this model we are specially interested in the decay of the Higgs boson to dark matter which could provide a way of detecting dark matter in a particle accelerator. To study this process with high precision we want to calculate the observables to Next-to-leading order (NLO) of perturbation theory, which is achieved by considering the additional one-loop Feynman diagrams for the process.

Primary authors: Mr AZEVEDO, Duarte (CFTC-UL); GABRIEL, Pedro (CFTC-UL); SAKURAI, Kodai (KIT-ITP); MUEHLLEITNER, M. Margarete (KIT-ITP); Mr SANTOS, Rui (CFTC-UL)

Presenter: GABRIEL, Pedro (CFTC-UL)

Session Classification: MSc Students

Contribution ID: **66** Type: **MSc student poster**

Radiation damage of the optical components of the ATLAS TileCal calorimeter at the High-Luminosity LHC

Thursday, 25 June 2020 17:15 (40 minutes)

The TileCal is an hadronic calorimeter and an essential part of the ATLAS experiment at the LHC. The active material is made of plastic scintillating tiles. The light is produced in the scintillators and transmitted to the photomultiplier tubes by optical fibres.
The current plans foresee a second high luminosity LHC phase where the luminosity can reach a value seven times higher than the one that the TileCal was designed for. Two critical points that affect the detector performance are the increased exposure to radiation that will degrade the TileCal optics and natural ageing. Since the optic components of the TileCal can not be replaced, the radiation damage must be evaluated. A previous study as shown that the Laser calibration systematics are contributing to limiting the precision of the evaluation of the optics radiation damage and need careful understanding. The evaluation of the Laser systematics led to an improvement in the precision, about 20% for the Long Barrel and 50% for Extended Barrel.

Primary authors: PINHEIRO PEREIRA, Beatriz; PEDRO, Rute (LIP); CONDE MUÍÑO, Patricia (LIP)

Presenter: PINHEIRO PEREIRA, Beatriz

Session Classification: MSc Students

Contribution ID: **67** Type: **PhD student talk**

The nervous system of the LUX-ZEPLIN detector

Saturday, 27 June 2020 10:30 (12 minutes)

The LUX-ZEPLIN (LZ) detector, currently in the final stage of development, is being assembled in the Davis Laboratory at SURF (Sanford Underground Research Facility, South Dakota, USA), at a depth of 1500m.
This presentation will focus on the key aspects of the Control group whose mission is to ensure the detector safety, monitorization and control during operations.

Primary author: PEREIRA, Guilherme (LIP)

Co-authors: SOLOVOV, Vladimir (LIP); CABRITA, Ricardo (LIP)

Presenter: PEREIRA, Guilherme (LIP)

Session Classification: Session 9

Contribution ID: **68** Type: **PhD student talk**

Top quark physics and search for physics beyond the Standard Model at the Large Hadron Collider

Saturday, 27 June 2020 11:20 (12 minutes)

A measurement of the production cross section of the top quark pair decay with a tau lepton in the final state that is carried out in the 13TeV proton-proton collisions data collected with the Compact Muon Solenoid detector at Large Hadron Collider. The ratio to the cross section in the light dilepton final states and the partial width of the top quark decay to tau lepton are also estimated. The top quark pairs provide access to high energy states in Standard Model and possible interactions with Beyond Standard Model particles. In particular, the symmetry of the decay chain is convenient in the study of W boson decay, including the case with a tau in the final state. The ratio between branching ratios of the lepton plus tau and of dilepton final states is studied as a possible test of Lepton Universality in Standard Model.

Primary authors: TOLDAIEV, Alex (CMS LIP); GALLINARO, Michele (LIP); VARELA, João (LIP)

Presenter: TOLDAIEV, Alex (CMS LIP)

Session Classification: Session 9

Contribution ID: **69** Type: **not specified**

Debate: Research and Diversity

Friday, 26 June 2020 17:05 (55 minutes)

Presenters: BARRUÉ, Ricardo (LIP); ANDRINGA, Sofia (LIP)

Session Classification: Session 8

Contribution ID: **70** Type: **MSc student poster**

Analytic Structure of the Gluon Propagator

Thursday, 25 June 2020 17:15 (40 minutes)

In a quantum filed theory, the determination of the analytic structure of the propagators, i.e., the position of poles and branch cuts for complex momenta, can be obtained within the perturbative solution of the theory. The analytic structure has information on the properties of the associated quanta and, particularly, if they are or not confined particles. In Quantum Chromodynamics the computation of the complete propagators resorts in numerical calculations and, typically, only a limited range of momenta is obtained. Herein, we use Padé approximates to explore the analytic structure of the gluon propagator as computed in lattice QCD.

Primary authors: FALCÃO, Alexandre (University of Coimbra); Prof. OLIVEIRA, Orlando (University of Coimbra); Dr SILVA, Paulo (University of Coimbra)

Presenter: FALCÃO, Alexandre (University of Coimbra)

Session Classification: MSc Students

Contribution ID: **71** Type: **MSc student poster**

Gluon self-interaction vertices

Thursday, 25 June 2020 17:15 (40 minutes)

Observables extracted from lattice computations are usually described using continuum tensors. However, continuum symmetries only partially survive the discretization of spacetime. This leads to the need to consider appropriate tensor bases to characterize lattice correlation functions. We investigate the gluon propagator for pure Yang-Mills formulation using lattice tensors..

The analysis of the infrared region for the three-gluon vertex is also considered, namely the form factors associated with its one particle irreducible Green function. The main objective of this analysis is to improve the precision on the zero-crossing, which is traced back to the masslessness of the ghost in the Landau gauge.

A preliminar result of the computation of the four-gluon vertex is also shown for a simple momentum configuration which simplifies the tensor description of this correlation function.

Primary author: CATUMBA, Guilherme

Presenter: CATUMBA, Guilherme

Session Classification: MSc Students

Contribution ID: **72** Type: **not specified**

Quiz material

Friday, 26 June 2020 18:00 (1h 30m)

Presenter: BASTOS, Diogo (LIP)

Session Classification: Students time