C^{2}AM SCHEDULE

All times are in Eastern Daytime Timezone (EDT).

AUGUST 2, 2022, TUESDAY

Contents

9:00 – 10:00 Keynote Speaker: Dr. Petra Rudolf

Title: *A PhD is not enough ... - how to prepare for a career in academia*

Abstract: The first step after the PhD towards a permanent job in academia is a temporary one, namely becoming a postdoctoral research fellow. I shall discuss what a young researcher needs to achieve in their postdoctoral period and what consequently they have to consider in making their choice where to go (place, topic, type of supervisor,...). After one or two postdoc appointments it will be time to go for the second step, a tenure track assistant professorship. Now not only the scientific productivity is an important criterion, but the selection committee will want to know about teaching experience, whether the candidate has been the daily supervisor of bachelor's, master's and PhD students and if they have ever attracted any funding, done any outreach or done anything to serve/influence the community in their field. They might also like it if the candidate has already been distinguished with a prize. I shall give tips on what a young researcher at the PhD and postdoc level can do to acquire experience and skills in all these areas. In the last part of my talk I shall discuss how to prepare for the application for a tenure track assistant professorship, what is important in the negotiation if chosen and what to pay attention to in the first months on the job. For extra info I recommend two books: "Survival Skills for Scientists" by Federico Rosei and Tudor Johnston. "A PhD is not enough" by Peter J. Feibelman if you want to spend part of your career in the USA. And a good

guide for grant proposal writing: "Art of Grantmanship" by Jack Kraicer, on https://www.hfsp.org/node/5761 gives an outline of what to do from 1 year before the deadline until the actual grant proposal submission.

10:00 – 11:30 Session 1A: Gravitational Physics

- Turkuler Durgut (Memorial University - Canada)

  Title: *Are gravitational solitons as interesting as black holes?*

  Abstract: The theory of General Relativity is our mathematical framework to describe gravity. Recent experiments, e.g., the detection of the gravitational waves, have verified many of its striking predictions, such as the existence of black holes. A black hole is characterized by its event horizon; a boundary nothing can escape. However, Einstein's Field Equations also admit a class of solutions, which behaves much like black holes but does not have event horizons or singularities. In this talk, I will introduce these solutions, called "gravitational solitons," and explain why they are interesting to physicists and mathematicians. I will also briefly discuss my ongoing Ph.D. research project on constructing new families of gravitational solitons and exploring their instability by studying wave equations in such backgrounds.

- Juan Margalef (Memorial University - Canada)

  Title: *Visualizing Misner space-time*

  Abstract: The Taub-NUT space-time is a 4-dimensional solution to Einstein's equations that has very interesting but strange properties. In order to have a better understanding, Misner came up with another example, the now so-called Misner space-time, that has some of these pathological behaviour but it is easier to visualize since it is 2-dimensional. In this talk, I will introduce this space-time and some of its properties in a visual way (tons of images, very few formulas).

- Martin Javier Nava-Callejas (Instituto de Astronomía, UNAM - Mexico)

  Title: *Neutron Star Cooling in Modified Theories of Gravity*

  Abstract: Due to their physically extreme properties, Neutron Stars are excellent laboratories for testing microphysical models (Equation of State, Superfluidity), as well as alternative theories of gravity (ATG). In spite of the relative success of thermal evolution, within the framework of General Relativity (GR), on adjusting observations with current microphysical models, some fittings and predictions are still sources of active debate. In this short talk I will describe the predictions of thermal evolution within two ATG, their similitudes and differences with the results of GR, and the prospects for future works on this novel subject.

- Samantha López Pérez (Institute of Cybernetics, Mathematics and Physics - Cuba)

Title: *Influence of the magnetic field in gravitational waves from magnetized strange stars*

Abstract: The macroscopic structure of magnetized Compact Objects is deformed due to the anisotropy of pressures as a consequence of the magnetic field. In this work, we study the impact of the magnetic deformation in the moment of inertia and mass quadrupole moment of strange stars. We also discuss the implication of the magnetic deformation in gravitational wave emissions.

- Athanasios Kogios (Perimeter Institute - Canada)

Title: *On the continuum limit of spin foams: graviton dynamics and area metric induced corrections*

Abstract: The semi-classical limit of spin foams leads to the Area Regge action. It was long thought that this action leads to flatness and does, in particular, not allow for propagating gravitons. I will present the first systematic studies of the continuum limit of the Area Regge action, using different versions of regular hypercubic lattices. These studies have shown that the Area Regge action does in its continuum limit, lead to leading order to general relativity, and thus to propagating gravitons. The higher order corrections depend on the choice of triangulation for the hypercubic lattice. However, there seems to be a preferred choice, for which the Area Regge action is not singular. In this case the correction term approximates the square of the Weyl curvature tensor, and can be interpreted to arise from an area metric dynamics. We therefore conjecture that the continuum limit of spin foams is described by an area metric theory.

10:00 – 11:30 Session 1B: Biomedical Physics

- Sandra Costa González (The National Research Institute on Metrology - Cuba)

Title: *An agent-base model of metastasis: Secondary tumor growth and immune response*

Abstract: A two-dimensional Cellular Automaton applied to tumor growth study in metastasis. We analyze the spatio-temporal development based on parameters that characterize the evolution, the tumor growth rate and the interaction with external environment. We proposed characteristics that establish, in a quantitative way, the degree of aggressiveness and malignancy of tumor patterns, such as the fractal dimension.

- Barbara Ariane Perez Fernandez (University of Havana - Cuba)

Title: *Continuous cell culture optimization*

Abstract: Due to its potential impact on the biotech industry, continuous cell cultures have attracted great interest in recent years. However, this type of culture remains expensive and, in some aspects, inefficient. They are often optimized based on the empirical experience of the personnel involved in their development and maintenance, but this is time-consuming and leads to material and nutrients waste that could be reduced with a deeper understanding of the process. We propose two optimization methods for continuous cell culture, one focused on the optimization of the external parameters of the system, and the other on cell genetic modification to maximize the production of recombinant protein. Using Control Theory, we estimate the dilution protocol that maximizes the cell density in the steady state of the system. On the other hand, we experimentally study the impact of Sodium Acetate on HEK-293 cell protein production, with the aim of making a stable genetic modification that enhances this production.

- Roberto Herrero Pérez (National Institute for Research on Metrology, INIMET - Cuba)

  Title: *A one-dimensional parameter-free model for carcinogenesis in gene expression space*

  Abstract: A small portion of a tissue defines a microstate in gene expression space. Mutations, epigenetic events or external factors cause microstate displacements which are modeled by combining small independent gene expression variations and large Levy jumps, resulting from the collective variations of a set of genes. The risk of cancer in a tissue is estimated as the microstate probability to transit from the normal to the tumor region in gene expression space. The formula coming from the contribution of large Levy jumps seems to provide a qualitatively correct description of the lifetime risk of cancer in 8 tissues, and reveals an interesting connection between the risk and the way the tissue is protected against infections.

- Carlos Alberto Gandarilla Perez (Universidad de la Habana - Cuba)

  Title: *Combining phylogeny and coevolution improves the inference of interaction partners among paralogous proteins*

  Abstract: Predicting protein-protein interactions from sequences is an important goal of computational biology. Various sources of information can be used to this end. Starting from the sequences of two interacting protein families, one can use phylogeny or residue coevolution to infer which paralogs are specific interaction partners within each species. We show that these two signals can be combined to improve the performance of the inference of interaction partners among paralogs. For this, we first align the sequence-similarity graphs of the two families through simulated annealing, yielding a robust partial pairing. We next use this partial pairing to seed a coevolution-based iterative pairing algorithm. This combined method improves performance over either separate method. The

improvement obtained is striking in the difficult cases where the average number of paralogs per species is large or where the total number of sequences is modest.

- José Noé Zavala Cuéllar (Universidad de Guanajuato - Cuba)

  Title: *The effect of heat treatment on the optical properties of alkaline earth fluorides*

  Abstract: In this work, the effect of heat treatment on alkaline earth metal fluorides was studied, using Mg, Ca, Sr, and Ba as metal synthesized by the chemical coprecipitation method using alkaline earth metal chlorides as synthesis precursors and ammonium fluoride as precipitating agent. They were characterized using UV-Vis absorption spectroscopy, photoluminescence and thermoluminescence techniques, with the aim of studying how the color centers formed in the fluoride are affected by the heat treatment as the size of the cation increases, since these are responsible for to provide the thermoluminescent properties to the material. The UV-Vis absorption spectra indicate the appearance of a wide absorption region between 220 nm and 400 nm, with a maximum at 250 nm, corresponding to the F color center and a shoulder located between 290 and 390 nm corresponding to the color center M, the photoluminescence spectra show an emission region between 420 nm and 750 nm corresponding to the different arrangements of the color centers F. The samples were irradiated with UV light at a wavelength of 254 nm and obtained brightness curves in which an increasing trend was observed both in the intensity and in the maximum temperature of the signal as the size of the cation decreased. Finally, it was found that if there is a change in the optical properties of the samples when subjected to a heat treatment of 500 ° C.

12:00 – 13:30 Session 2A: Gravitational Physics

- José Luis Fajardo Montenegro (University of Lethbridge and Universidad del Valle – Canada and Colombia)

  Title: *Coherent states in loop quantum gravity: an undergraduate view*

  Abstract: Coherent states are prolific: they show up in many fields in physics, from quantum optics to superconductivity, one-dimensional condensed matter systems, and loop quantum gravity (LQG). In the context of the latter, these states are important in the search for semi-classical canonical quantum general relativity. This talk aims to present an undergraduate view of the construction of semi-classical coherent states within the LQG framework. We start by presenting Hall's construction of coherent states for any compact, connected Lie group G, and we show how for G=R this mathematical construction reduces to the well-known physical case of semi-classical states for the quantum harmonic oscillator. Next, by taking G=SU(2) we can define the building blocks for a semi-classical

state in LQG. Finally, we address some of the subtleties present when working with these states.

- Erickson Tjoa (University of Waterloo/Institute for Quantum Computing - Canada)

  Title: *When entanglement harvesting is not really harvesting*

  Abstract: We revisit the entanglement harvesting protocol when two detectors are in causal contact. We study the role of field-mediated communication in generating entanglement between the two detectors interacting with a quantum field. We provide a quantitative estimator of the relative contribution of communication versus genuine entanglement harvesting. For massless scalar fields in flat spacetime, we show that when two detectors can communicate via the field, the detectors do not really harvest entanglement from the field, and instead they get entangled only via the field-mediated communication channel. In other words, in these scenarios the entanglement harvesting protocol is truly "harvesting entanglement" from the field only when the detectors are not able to communicate. In contrast, for massive scalar fields both communication and genuine harvesting contribute equally to the bipartite entanglement when the detectors are causally connected. These results emphasize the importance of taking into account the causal relationships between two parties involved in this relativistic quantum information protocol before we can declare that it is truly entanglement harvesting

- Viraj Meruliya (McGill University - Canada)

  Title: *Resurgence in AdS/CFT*

  Abstract: In this talk, I will present some ideas about resurgence that allows one to understand non-perturbative physics from the knowledge of perturbation theory. Standard perturbation theory leads to a series expansion in small coupling constants for observable quantities. However, such an expansion is not convergent and only asymptotic for generic systems. To make sense of such quantities one needs the addition of non-perturbative effects. After a brief introduction, I will explain how one can apply these tools to study the non-perturbative phenomenon in field theories, specifically, Conformal Field Theories (CFT) and Gravity in Anti-de Sitter (AdS) spacetime which are related via holography. These will lead to some interesting results in both cases.

- Karen Macias Cardenas (Queen's University - Canada)

  Title: *Dark Matter-neutrino interactions through a 1-loop diagram*

  Abstract: The nature of Dark Matter is an ongoing and relevant object of study in astroparticle physics. Despite our best efforts to identify its possible particle properties, the results have been null, which has led to a plethora of models describing viable connections to the Standard Model. In particular, loop models of Dark Matter, like the scotogenic model, have received attention in the last decade but their phenomenology in regard to Dark Matter interactions with neutrinos in the Early Universe has not been widely studied. We aim to explore whether parameters of a one-loop model of scalar Dark Matter-neutrino interactions such as the Dark Matter mass, the thermally averaged cross-section, and the couplings can be constrained by Early Universe data like the Lyman-alpha forest, Cosmic Microwave Background anisotropies and the Matter Power Spectrum, and give rise to the observed relic abundance.

- Everett Avison Patterson (University of Waterloo - Canada)

  Title: *Probing BTZ Black Hole via Fisher Information*

  Abstract: Relativistic quantum metrology is a framework that not only accounts for both relativistic and quantum effects when performing measurements and estimations, but further improves upon classical estimation protocols by exploiting quantum relativistic properties of a given system. The primary measure used to quantify an estimation protocol in relativistic quantum metrology is the Fisher information. Here I present results of the first investigation of the Fisher information associated with a black hole. While previous work has provided an analysis of the thermal Fisher information in (3+1)-dimensional de Sitter and Anti-de Sitter (AdS) spacetimes, we extend these results to (2+1)-dimensional AdS and BTZ black hole spacetimes. We use Unruh-DeWitt detectors coupled to a massless scalar field to act as probes of the thermal parameter of the underlying spacetime. We compare the AdS and BTZ black hole spacetimes allowing us to identify qualitative behaviours unique to the black hole. In so doing, we enable the use of the thermal Fisher information as a discriminant of the vacuum spacetime. We further explore the Fisher information's dependence on the BTZ mass parameter.

- Mustafa Saeed (University of New Brunswick - Canada)

  Title: *Spin model on black hole space*

  Abstract: In this presentation the procedure to construct a spin model on a black hole space will be outlined. Following this the macroscopic properties of spins - such as alignment and entropy - will be numerically investigated for different values of the black hole mass which is a parameter in the metric.

12:00 – 13:30 Session 2B: Particle and High Energy Physics

- América Noemí Morales Anda (University of Guanajuato - Mexico)

  Title: *Extensions of the scotogenic model for neutrino mass generation*

Abstract: Several decades after Pauli proposed the existence of an electrically neutral and massless particle that we now know as neutrinos, it was discovered that they behave in a way not predicted by the Standard Model (SM), since they show an oscillatory character that only can be explained if we consider neutrinos to be massive. Unlike the rest of the leptons, in the SM it is not possible to construct mass terms for neutrinos through the Higgs mechanism, so it is necessary to extend the description of this particle so that its nature is described and at the same time is in concordance with the SM. In this talk I will review extensions to the Scotogenic model, which in addition to explaining the mass of neutrinos provides us with a connection to the other big question in physics: dark matter.

- Elías Natanael Polanco Euán (Instituto de Ciencias Nucleares, UNAM - Mexico)

  Title: *The 3d O(4) model as an effective approach to the QCD phase diagram*

  Abstract: In Quantum Chromodynamics (QCD) the phase diagram is one of the important topics that is still unexplored. We refer to 2-flavor QCD, which we describe by an O(4) non-linear sigma-model. This is an effective theory that has the same universality class as 2-flavor QCD in the chiral limit since it performs spontaneous symmetry breaking with the same Lie group structure. As pointed out by Skyrme, Wilczek and others, its topological charge takes the role of the baryon number. Hence the baryon chemical potential μ_B appears as an imaginary vacuum angle, which can be included in the lattice simulation without any sign problem. We present numerical results for the critical line in the chiral limit, and for the crossover in the presence of light quark masses. Their shapes are compatible with other predictions, but up to the value of about μ_B ≈ 300 MeV we do not find the notorious Critical Endpoint (CEP).

- Ho Chun Lau (University of Alberta - Canada)

  Title: *Phenomenology study of Clockwork graviton at sqrt(s) = 13 TeV*

  Abstract: After the discovery of the Higgs Boson, the graviton has become one of the interests in the ATLAS(CERN) experiment. Many theories attempted to solve the hierarchy problem, tried to explain why the strength of the gravitational force is much weaker than the other three known forces. In particular, Clockwork model provided a mechanism that generates gravitons and others known particles, offering an alternative explanation to hierarchy problem and elevating itself into a strong candidate in beyond standard model physics. However, there are two undetermined parameters that define the theory, the Higgs-curvature k, and 5D fundamental gravity scale M5. To provide experimental evidence to the model, we are seeking the detector response of the graviton in ATLAS. A phenomenology study of k and M5 is performed at centre of mass energy = 13 TeV. We expect many different closely space mass modes to be produced which appears as oscillation in the graviton mass spectrum because gravitons may take on different mass modes. We simulate the gravitons decay and obtained the invariant mass spectrum of the diphoton and the dielectron final states by capturing the two highest transverse momentum final state particles of both channels correspondingly. Our result indicates that the spectrum indeed exhibits oscillation properties. To improve the sensitivity toward gravitons which has a small cross-section, we studied the spectrums with Fourier Analysis. At this stage, we studied part of the phenomenology and determined the range of M5 and k that is sensitive to ATLAS detector.

- Ali Usman (University of Regina - Canada)

Title: *Measurement of Charged Pion Form Factor at Jefferson Lab*

Abstract: Hadronic structure is poorly understood as the properties of constituent quarks and gluons (e.g. spin, mass) do not explicitly add up to the properties of hadrons. The form factor describes the transverse position of partons inside a hadron. Perturbative QCD (pQCD) uniquely predicts the form factor at very high Q^2, which is experimentally inaccessible. Different non-perturbative QCD models give the same prediction for the value of form factor at low Q^2, but these predictions vary at moderate Q^2 where published experimental data is limited. The pion is an excellent candidate for the study of the hadronic form factor as it is the lightest charged meson and has only two valence quarks. In this research, an exclusive reaction p(e,e′ π+)n is studied at Thomas Jefferson National Accelerator Facility in Newport News, VA. The cross-section is dictated by the polarization of virtual photon. A unique technique, Rosenbluth Separation, is used to precisely separate the longitudinal and transverse components of the cross-section. The form factor is then extracted from longitudinal cross-section. The precision of separation of cross-section depends on accurate determination of small systematic uncertainties. This includes Particle Identification (PID), Particle reconstruction, dead time estimation etc. In this talk, I will discuss importance of the Rosenbluth separation technique and show the status of Pion form factor measurements performed at Jefferson Lab.

- Nakul Aggarwal (University of Alberta - Canada)

Title: *Search for neutrino trident events with IceCube*

Abstract: Neutrino Trident Production (NTP) is a sub-dominant process where an incoming neutrino interacts in the Coulomb field of a nucleus and produces three outgoing leptons (two charged leptons and an accompanying neutrino). Incoming neutrinos with high energies can significantly increase the NTP event rate due to on-shell W-boson production. NTP events are a powerful probe into Beyond Standard Model (BSM) physics. If an excess of NTP events is determined than that predicted by SM, it can serve as an indicator of BSM. Since a neutrino telescope like IceCube has detected high energy neutrinos, it is an excellent candidate for trident search. The IceCube Neutrino Observatory is a cubic kilometre Cherenkov detector with ice as an active medium, situated near the Amundsen-Scott South Pole Station in Antarctica. As muons leave a track-like Cherenkov signature in

IceCube, we discuss only the NTP channel where the two outgoing leptons are muons. For the purposes of this work, our primary focus is to therefore search for double-track events in IceCube. An important background is the dominant deep inelastic scattering process which produces a single muon as the outgoing lepton. Our task is to thus classify double-track events from single-track events. This search is highly sensitive to double track separation and detector resolution. We have developed features based on event and detector properties and subsequently used boosted decision trees (BDT) for their classification. We will present these results.

14:00 – 15:00 Keynote Speaker: Dr. Katepalli Sreenivasan

Title: *The Impact of Abdus Salam - A Great Scientist and an Inspirational Humanitarian*

Abstract: TBA

15:00 – 16:30 Session 3A: Gravitational Physics

- Wilfredo Yupanqui Carpio (Universidad de Guanajuato - Mexico)

  Title: *Deformed algebra and the effective dynamics of the interior of black holes*

  Abstract: We consider the classical Hamiltonian of the interior of the Schwarzschild black hole in Ashtekar-Barbero connection formalism. Then, inspired by generalized uncertainty principle models, we deform the classical canonical algebra and derive the effective dynamics of the model under this modification. We show that such a deformation leads to the resolution of the singularity of the black hole and a minimum nonzero radius for the infalling 2 spheres, provided that the deformation parameters are chosen to be negative.

- Robie Hennigar (University of Barcelona - Spain)

  Title: *The fate of apparent horizons in black hole collisions*

  Abstract: The common picture of a binary black hole merger is the “pair of pants” diagram for the event horizon, which has been understood for over half a century. However, in many circumstances, such as those encountered in numerical simulations, the event horizon may not provide the most convenient description. In such cases, it is more practical to work with quasi-local definitions of black hole boundaries, such as marginally outer trapped surfaces (MOTS). The analog of the pair of pants diagram for the apparent horizons has only recently been understood. In this talk, I will discuss the rich structure that emerges for, and principles that govern the evolution of, the apparent horizons during a binary black hole merger.

- Johanna Borissova (Perimeter Institute for Theoretical Physics - Canada)

  Title: *Formation and evaporation of black holes in quantum gravity*

  Abstract: Quantum counterparts to classical black holes provide an exciting ground for phenomenology of quantum gravity. Within the functional renormalization group approach to quantum gravity, we propose a novel method to account for quantum effects in classical spacetimes. At the core of our construction is decoupling mechanism: when a physical low-energy scale overcomes the effect of the artificial regulator implementing the Wilsonian integration of fluctuating modes, the effective average action freezes out and approximates the standard quantum effective action. Starting from the Einstein-Hilbert truncation, we use the decoupling mechanism to explore the dynamics of quantum black holes in the stages of collapse and evaporation.

- Kam To Billy Chan (Memorial University of Newfoundland - Canada)

  Title: *Marginally outer-trapped surfaces (horizons) inside black holes*

  Abstract: The advent of gravitational wave detectors had facilitated a constant stream of black hole merger observations. Despite this, black hole mergers are not fully understood. The details of the two apparent horizons becoming one is unclear due to the non-linear nature of the merger process. Recent numerical work has shown that there is an appearance and involvement of self-intersecting marginally outer-trapped surfaces (MOTS) during the black hole merger [Pook-Kolb et. al. arXiv:1903.05626]. Following papers have found similarly behaving MOTS in a simpler and static scenario, that of a Schwarzschild black hole, where a seemingly infinite number of self-intersecting MOTS were found [Booth et. al., arXiv:2005.05350]. This talk introduces new phenomena that occur in the presence of an inner horizon. For Reissner-Nordstrom and Gauss-Bonnet black holes, we find that the maximum number of self-intersections becomes finite dependent on the interior structure of the black hole [Hennigar et. al., arXiv:2111.09373].

- Sarah Mime MacDonald Muth (Memorial University of Newfoundland - Canada)

  Title: *Marginally Outer Trapped (Open) Surfaces in 4+1D Rotating Black Holes*

  Abstract: In astrophysically realistic black holes – for instance, binary black hole mergers – the surface of most obvious interest is the Event Horizon, which characterizes the size and shape of the black hole. However, this surface is often computationally difficult to locate, because it is defined globally. Instead, it is useful to turn to quasi-local characterizations of black hole boundaries, such as Marginally Outer Trapped Surfaces (MOTS), which have the benefit of being defined for a single instant in time, while the outermost of which also (generally) shares some analogous and relevant traits to the event horizon. My talk, which was the subject of my master's thesis, will describe work which seeks to understand MOTS in the interior of five-dimensional black holes; in particular, I will focus on our results in studying the rotating case (Myers-Perry). Similar to the four- and five-dimensional static cases previously studied, we find self-intersecting MOTS, and in doing so provide further support for the claim that self-intersecting behaviour is rather generic. I will conclude by discussing new oscillating MOTS-like surfaces, first seen in this study of 5D rotating black holes, and now reproduced for other types of rotating black holes in other dimensions.

- Daine L. Danielson (The University of Chicago - United States of America)

Title: *Black Holes Decohere Quantum Superpositions*

Abstract: We show that if a massive body is put in a quantum superposition of spatially separated states, the mere presence of a black hole in the vicinity of the body will eventually destroy the coherence of the superposition. This occurs because, in effect, the gravitational field of the body radiates soft gravitons into the black hole, allowing the black hole to acquire "which path" information about the superposition. A similar effect occurs for quantum superpositions of electrically charged bodies. We provide estimates of the decoherence time for such quantum superpositions. We believe that the fact that a black hole will eventually decohere any quantum superposition may be of fundamental significance for our understanding of the nature of black holes in a quantum theory of gravity.

15:00 – 16:30 Session 3B: Particle and High Energy Physics

- Ailier Rivero Acosta (Universidad de Guanajuato - Mexico)

Title: *Renormalization of a model for spin-1 matter fields*

Abstract: In this work, the one-loop renormalization of a theory for fields transforming in the $(1,0)\oplus(0,1)$ representation of the Homogeneous Lorentz Group is studied. The model includes an arbitrary gyromagnetic factor and self-interactions of the spin 1 field, which has mass dimension one. The model is shown to be renormalizable for any value of the gyromagnetic factor.

- Guillermo Gambini (McGill University - Canada)

Title: *Recasting constraints on Heavy Neutral Leptons interacting with a singlet scalar*

Abstract: MeV-GeV right-handed neutrinos are commonly known as Heavy neutral leptons (HNL), and their mixing with active neutrinos can satisfactorily explain small neutrino masses. We note that beam-dump and other published limits on these mixings U cannot be directly applied to HNLs that interact with a light singlet scalar s that mixes with the Higgs boson, for the latter can alter the number of events registered by detectors. With that in mind, we reinterpret the limits from the DELPHI, Belle, and CHARM experiments taking into account the new decay channel N -> sv which could be dominant causing some ruled-out regions in the m_N – U parameter space to reopen.

- Moises Zeleny Mora (Meritorious Autonomous University of Puebla - Mexico)

  Title: *Lepton flavour violation Higgs decays with neutrino masses*

  Abstract: After the Higgs boson was discovered, new theoretical and experimental phenomenological frontiers are investigated. We concentrate on the Lepton Flavor Violation (LFV) of the Higgs decays in models incorporating neutrino masses. The main contribution to these processes is radiative corrections at one loop, mediated by charged scalars and vector bosons. We obtain a generic structure for the form factors in this generic models and propose a straightforward Python code to evaluate the form factor in this context.

- Melissa Almanza Soto (McGill University - Canada)

  Title: *Study of the combined performance of the Digital Hadronic Calorimeter and Si-W Electromagnetic Calorimeter for the CALICE R&D Collaboration*

  Abstract: The Digital Hadronic Calorimeter (DHCAL) and the Silicon-Tungsten Electromagnetic Calorimeter (Si-W ECAL) are both CALICE prototypes originally meant for the International Linear Collider (ILC) experiments. The analysis of the combined response to different particles will be presented. The data was obtained from test runs at Fermilab in 2011. The linearity, energy and spatial resolutions results will be shown, as well as the calibration and alignment of the detectors. Both DHCAL and Si-W ECAL are fine-layered high-granularity detectors with 1cm x 1cm pixel sizes, which allows for much improved tracking and particle identification, thus for the application of modern particle flow algorithms.

- Manuel Eduardo Barredo Alamilla (Instituto de Ciencias Nucleares, UNAM - Mexico)

  Title: *Radiation in an ideal Weyl Semimetal: the Cherenkov case*

  Abstract: We present the spectral distribution of the Cherenkov radiation in an ideal Weyl semimetal. The electromagnetic response of Weyl semimetals (chiral media) is described by a modified Maxwell theory developed by Carroll, Field and Jackiw (CFJ) [1], which is based on the addition of a Lorentz-violating Chern-Simons term to the electromagnetic Lagrangian density, $\mathcal{L}_{LV}=\ \frac{1}{8\pi}\ {\widetilde{b}}^\mu{\widetilde{F}}_{\mu\nu}A^\nu\$, where the LIV coefficient ${\widetilde{b}}^\mu=(b_0,\vec{b})$ corresponds to precise physical terms in chiral matter, with b_0 and $\vec{b}$ accounting for the separation of the corresponding Weyl nodes in energy and momentum space, respectively. We implement the Green's function (GF) method, considering only the spatial components of the violating coefficient in the Chern-Simons Lagrangian. Using the GF in the far-field approximation we analyze the emitted radiation of a fast-moving charge travelling parallel to the vector $\vec{b}$. From the spectral distribution we find out that chiral media produces a splitting of the Cherenkov radiation with each cone corresponding to the two different phase velocities of the two polarizations of the light (birefringence).

- Pouya (Laurentian University - Canada)

  Title: *SNO+ Calibration with N16 Source*

  Abstract: SNO+ is a multi-purpose scintillator based neutrino experiment located 2 km underground at SNOLAB, Sudbury, Ontario. SNO+ reuses the Sudbury Neutrino Observatory (SNO) detector, consisting of a 12 m diameter acrylic vessel that is filled with a cocktail of organic liquid scintillator known as Linear alkylbenzene (LAB) along with wavelength shifters. The primary goal of the experiment is a search for neutrino-less double beta decay with 130Te loaded into the liquid scintillator. In addition, SNO+ aims to measure low energy solar neutrinos, reactor and geo- antineutrinos as well as neutrinos from a supernova event. Prior to the scintillator filling the detector was filled with ultra-pure water. During its water phase SNO+ had an extensive calibration program using various deployed and embedded sources. The primary energy calibration source in the water phase was the de-excitation of Oxygen-16 from the decay of Nitrogen-16 gas. The locally produced N16 undergoes beta-decay and can produce excited O16. The produced beta is used to tag the calibration events inside the decay chamber. The produced O16 is most likely in an excited state and decays by emitting a 6.1 MeV gamma that can easily penetrate through the container and produce Cherenkov radiation and isotropic scintillation light in water and liquid scintillator respectively. The N16 calibration data was used to tune the global efficiency of the detector, verify the energy and position reconstructions, and identify the systematics and position bias and resolutions. Furthermore, N16 has been deployed externally throughout the scintillator fill and the data was used to study the scintillator light yield, timing studies and the mixing effects. Also the data was used to study the position dependencies and identify the Cherenkov signal in scintillator. This presentation will describe the N16 calibration system, and will also discuss some of the calibration results and analyses for scintillator.

17:00 – 18:30 Session 4A: Cosmology

- Jonathan Tot (Dalhousie University - Canada)

  Title: *The dynamics of scalar-field Quintom cosmological models*

Abstract: We present a complete (compactified) dynamical systems analysis of the Quintom model comprised of an interacting quintessence scalar field and a phantom scalar field. We find that there is a range for the model parameters λ, κ such that there are expanding Quintom cosmologies that undergo two inflationary periods, and that this behaviour is not destabilized by spatial curvature. We also discuss a class of bouncing cosmologies.

- Mitja Fridman (University of Lethbridge - Canada)

  Title: *Baryon Asymmetry from the Generalized Uncertainty Principle*

  Abstract: The unexplained observed baryon asymmetry in the Universe is a long-standing problem in physics, with no satisfactory resolution so far. To explain this asymmetry, three Sakharov conditions must be met. An interaction term which couples space-time and the baryon current is considered, which satisfies the first two Sakharov conditions. Furthermore, it is shown that the Generalized Uncertainty Principle (GUP) from quantum gravity induces corrections to the Friedmann equations in cosmology, via the holographic principle. GUP also induces variations of energy and pressure density in the radiation dominated era, which satisfies the third Sakharov condition. Therefore, this construction provides a viable explanation for the observed baryon asymmetry. This also fixes the GUP parameters to $\alpha_0\approx10^4$ and $\beta_0\approx-10^8$.

- Sabrina Berger (McGill University - Canada)

  Title:

  Abstract: The Global Navigation Satellite System (GNSS) is an umbrella term for the many constellations of satellites used in localization and atmospheric observations, including the Global Positioning Systems (GPS). GNSS could be especially useful in radio astronomy calibration because we understand the GNSS beam and signal better than astrophysical calibrators. Where lines of sight are not blocked, we can see up to 40 satellites as a time. We prototype the use of GNSS to calibrate both the phase and beam of radio telescopes for the upcoming Canadian Hydrogen Observatory and Radio-transient Detector (CHORD). With a precise understanding of CHORD's beam, we may be able to better extract information about the early universe usually hidden in the noise.

- Julissa Sarmiento (DePaul University - United States of America)

  Title: *An Upper Limit to Active Galactic Nuclei (AGN) in Green Pea Galaxies*

  Abstract: Green Pea galaxies are low redshift, Lyman-Alpha emitting galaxies. They have low metallicity and high star formation rates and have been shown to be good analogs to high-redshift galaxies. Our goal is to determine the presence of active galactic nuclei (AGN), which can be identified by looking at their optical variability, in these galaxies. We used data from the Transiting Exoplanet Survey

Satellite (TESS) to create light curves to find optically varying AGN. TESS observes sections of the sky for roughly 30 days and takes high precision data every 30 minutes. This makes TESS a good candidate to find optically varying AGN in these galaxies on short time scales. Of our initial sample of over 1000 green pea galaxies, we found 220 in the TESS data that had no bright neighbors. We corrected the light curves for scattered light and found the mean magnitude and its standard deviation. We found that 7 galaxies showed optical variability between 10% and 1% within a 30-day period, and no galaxies with variability > 10%. It has been shown that about 10% of AGN show optical variability on the order of 10% on time scales of 30 days. Therefore, we suggest that there is an upper limit to the amount of AGN in green pea galaxies. Since we did not see any galaxies with variability on the order of 10%, that suggests that fewer than 10 galaxies in our sample might have optically varying AGN on 30-day time scales.

- Rodrigo Gonzalez Quaglia (UNAM - Mexico)

  Title: *Addition of Torsion in Brans-Dicke theories of Gravity*

  Abstract: General relativity is the go-to theory when one thinks about gravitation, its original formulation assumes that the covariant derivative of the metric and the torsion tensors are both zero but, al least until today, no good reason for this have been found. In this talk I will present a generic Brans-Dicke theory in which the connection is non symmetric (a non-vanishing torsion tensor is present), I will show how this new connection give rise to new terms in the gravitational action, the Holst term, and the Nieh-Yan invariant. Moreover, I will explain the way in which the contribution of these new terms together with the non-symmetric part of the Ricci scalar can be fully rewritten in terms of the scalar field present in the Brans-Dicke theories giving rise to a non-canonical kinetic term for the scalar field. After this effective metric theory is presented, I will study the Jordan frame of the model focusing on its dynamical behavior in order to ensure it possess the necessary fixed points for inflation to possibly take place. Finally, I will specialize our generic Brans Dicke theory to a scale invariant model and show that the inflationary predictions of such model are in agreement with the Planck measurements.

- Atalia Navarro-Boullosa (University of Guanajuato - Mexico)

  Title: *Bayesian analysis for rotational curves with ℓ-boson stars as a dark matter component*

  Abstract: The rotational curves were one of the first observable to give us evidence of the existence of dark matter, there for their use to fit the dark matter component in them is important. In this work we use scalar field dark matter, solving numerically the non-relativistic limit of the Einstein-Klein-Gordon system, the Schrödinger-Poisson system. These solutions, called ℓ-boson stars, are parametrized by an angular momentum number ℓ = (N 1)/2, an excitation number n, and a continuous parameter representing the amplitude of the fields. We perform a bayesian analysis modifying SimpleMC, a MCMC code to perform the parameter inference, for the cases with ℓ = 0, ℓ = 1 and multistates of ℓ- boson stars as a dark matter component, where we notice a better fitting for the multistates case. We choose Low Brightness Surface Galaxies (LBSG) to fit the free parameters in our model due to their characteristics allowed us to only considered the dark matter component.

- Greg Kaplanek (Imperial College London - United Kingdom)

  Title: *Decoherence in de Sitter space*

  Abstract: We assess the minimum, inevitable amount of decoherence induced by gravitational coupling between observable cosmological perturbations and small wavelength fluctuations. This is done by treating the long wavelength fluctuations as an open system, whose decoherence is driven by cubic interaction terms in the standard EFT of single-field inflation. At late times we find that the evolution of the reduced density matrix is Markovian (or time-local), and we make a prediction for the timescale of decoherence for each mode k of the field. We find that quantum coherence is unlikely to survive for any range of modes visible in the CMB today.