VII NATIONAL WORKSHOP ON QUANTUM FIELD THEORY

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CAPES

Instituto de Física da UFBA

Programa de Pós-Graduação em Física da UFBA

BOOK OF ABSTRACTS

VII NATIONAL WORKSHOP ON QUANTUM FIELD THEORY

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Virtual Meeting, Universidade Federal da Bahia, Brazil

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Contribution: Seminar

Bumblebee fluctuations in curved spacetimes

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The bumblebee field is a self-interacting vector field whose vacuum expectation value (vev) defines a privileged direction in spacetime. This spontaneous breaking of the Lorentz symmetry has been extensively studied in flat spacetimes, wherein the bumblebee fluctuations give rise to two Nambu-Goldstone transverse mode and one longitudinal massive mode. In flat spacetimes, the NG transverse mode behaves like a gauge vector field. In this talk, we discuss the features of the bumblebee fluctuations in curved spacetimes. By assuming a AdS_5 five dimensional spacetime and a cosmological Friedmann-Robertson-Walker (FRW) 3-brane embedded, we found a exponentially suppressed self-interacting constant with respect to the extra dimension. For a spacelike vev along the extra dimension, we employed a Kaluza-Klein (KK) dimensional reduction for both models. The transverse mode diverges along the extra dimension and then, an extended bumblebee-dilaton theory is required to trap the massless KK mode on the brane in the noncompact extra dimension model. The conservation of the bumblebee current prevents the longitudinal mode to acquire a KK mass. Along the brane, the massless KK transverse mode behaves like a Maxwell field whereas the longitudinal mode is suppressed by the cosmological expansion.

Contribution: Seminar

Non-linear causality in Israel-Stewart like fluid theories

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Israel-Stewart like theories (IS) describe relativistic viscous fluids that obey first order partial differential equations in its variables, being appealing theories from a numerical-modeling point of view. Furthermore, the IS theory is one of a few theories that has been proven to be causal and stable after small perturbations around equilibrium, both in the linear regime. After the detection of the quark-gluon plasma (QGP) in the 2000's (whose formation occurs in ultra-relativistic heavy-ion collisions resulting in a liquid behavior of the quarks, anti-quarks, and gluons that move independently in such high energy conditions), IS like theories have been widely used with great success to describe this kind of plasma. However, when dealing with a relativistic theory, nonlinear causality is essential, especially within far from equilibrium situations like the QGP. In this talk, I will present a recent result where, for the first time, sufficient conditions have been obtained for nonlinear causality and local well-posedness of IS like theories. Also, necessary conditions are obtained, imposing some strong constraint over the transport coefficients of the theory. In particular, these necessary conditions have been used in recent works to show that several results obtained so far for the QGP are based on numerical simulations that violate causality.

Contribution: Seminar

Extended multi-scalar field theories in (1 + 1) dimensions

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In this talk, I am going to present the explicit construction of some multi-scalar field theories in $(1+1)$ dimensions supporting BPS solutions. The construction is based on the ideas of the so-called extension method. In particular, I am going to discuss some interesting field theories constructed from non-trivial couplings between several sine-Gordon fields.

Contribution: Seminar

Color-kinematics duality, double copy and the unitarity method for higher-derivative theories

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In this talk we will discuss color-kinematics duality for higher-derivative Yang-Mills amplitudes. We will show how such amplitudes can be used to construct quadratic-gravity amplitudes from the double copy method. We will also illustrate the use of the generalized unitarity method for loop amplitudes containing resonances with a brief discussion on two specific one-loop examples.

Contribution: Video-poster

Critical Dynamics of Multiplicative Systems

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In this study we analyze the critical dynamics of a real scalar field in 2D near a continuos phase transition. We have computed and solved Dynamical Renormalization Group (DRG) equations to two loops order. We have found that, different from the case $d < 4$, characterized by a Wilson-Fisher fixed point with $z = 2 + O(\epsilon^2)$, the critical dynamics is dominated by a novel multiplicative fixed point.

The interest in critical dynamics is rapidly growing up in part due to the wide range of multidisciplinary applications deeply impacted by the use of criticality. For instance, the collective behavior of biological systems displays critical behavior with space-time correlation functions with non-trivial scaling laws[1].

The standart approach to deal with dynamics is the Dynamical Renormalization Group[2]. We assume that the evolution of the system near the critical point is governed by a dissipative process. Then we use the *Martin-Siggia-Rose-Janssen-DeDominicis* formalism[3] to transform the dynamical equation in to a functional generator. On top of that, one can add two Grassmann fields $\bar{\xi}, \xi$ in the functional generator in order to increase the supersymmetric

formulation for the dynamics[4,5]. This supersymmetric formalism enables the choice of a specific stochastic evolution.

In this work, we begin with the dynamical ϕ^4. We adopted the so called Generalized Stratonovich prescription parametrized by a real number $0 \leq \alpha \leq 1$ and present here the calculations for the Itô ($\alpha = 0$) prescription. For instance, $\alpha = 0$ is the Itô prescription, $\alpha = 1/2$ is the Stratonovich while $\alpha = 1$ is the Hangii-Klimontovich or anti-Itô prescription. We use the functional generator to compute the dynamical correlation functions. We perform a diagrammatic pertubation theory up to 2-loops and obtain the DRG equations. We fully calculated up to 2-loop corrections for the flux equations using an "Wilsonionan approach". Here we are presenting only the 1-loop corrections since the analysis for the 2-loop equations is still ongoing. The 1-loop DRG equations has fixed points, depending essentially on dimensionality. For $d > 4$, the Gaussian fixed point, with $z = 2$ correctly describes the phase transitions. However, for $d < 4$, a Wilson-Fisher fixed point[6] shows up. At this level of approximation, g is an irrelevant variable and the dynamics is driven by a usual additive noise stochastic process recovering the results from Ref. [2]. However, at d = 2 the dynamical behavior changes and the former Wilson-Fischer point is transfered to a relevant multiplicative fix point with $g \neq 0$. Thus creating a critical plane for the transition. We also notice, in 1-loop, the appearance of an anomalous dimension originatad from the multiplicative interaction.

We thank the financial support from CAPES and CNPq.

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Contribution: Video-poster

Newtonian and Carrollian limits of gravity theories in the first order formalism

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In this video, I will talk about a work I did when I was an undergraduate student in physics at Federal Fluminense University (UFF). This work lead to two papers, that are available online on the links:

First: https://dx.doi.org/10.1007/JHEP03%282021%29104
Second: https://arxiv.org/abs/2107.10129v3

We considered the non-relativistic (NR) and the ultra-relativistic (UR) limits of the four-dimensional Mardones-Zanelli action. This provided a generalization of the Newtonian and the Carrollian theories known in literature, that usually have its dynamics described by the NR and the UR limits of the Einstein-Hilbert action. Allowing torsion terms to enter in the action, we found some interesting results. For example, in the NR limit we were able to completely determine the boost connection by solving the new field equations, in contrast to the old ones that didn't provide any information about this field; we also obtained conditions for which we can define the Newtonian absolute time in this new theory. In the UR limit, we found almost general solutions in the presence of matter and were able to prove the validity of birkhoff's theorem in this limit. The full list of the results are available on the papers.

Contribution: Video-poster

Considerations on the photon-photino mixing in presence of fermion condensates and space-time anisotropies

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In this contribution, we reassess a supersymmetric model that takes into account the photon-photino sector in presence of a supersymmetric, but Lorentz-symmetry violating (LSV), background. The photon and photino fields appear mixed due to the presence of a constant background Majorana fermion that, as a by-product of supersymmetry, induces the mixing . Two real four-vectors, which represent possible space-time anisotropies, are included that violate Lorentz symmetry and affect the photon and photino masses. In this scenario, we have worked out the mass spectra for the photon and photino in terms of the complete background-fermion condensates and the anisotropies and show how the photon-photino mass degeneracy is lifted. Actually, it is shown how the LSV background supermultiplet yields supersymmetry breaking . As a step further, it is investigated how the LSV background and space-time anisotropies affect the Gordon decomposition of the photino spin current. Finally, we turn into another issue and focus our attention on a number of results that illustrate how the space-time anisotropies considered here may affect properties of Dirac fermions, by pursuing an analysis of the modified dispersion relation and group velocity, deriving the extended fermionic propagator, working out the Gordon decomposition of the electromagnetic current, obtaining the positive- and negative-energy solutions and reconsidering the Kleins's Paradox and the phenomenon of *Zitterbewegung*.

Contribution: Seminar

TFD formalism and applications in a gravitational theory

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The theory of Gravity is classical by its origin while other fundamental forces describing microscopic aspects of nature are quantum mechanical. There are several attempts to unify gravity with forces in the Standard Model. The search to unify gravitation and electromagnetism has a long history. The first studies were carried out by Faraday, Maxwell, Heaviside, Weyl, Kaluza-Klein, among others. A formal analogy between the gravitational and the electromagnetic fields led to the notion of Gravitoelectromagnetism (GEM) to describe gravitation. GEM allows scattering processes with gravitons as an intermediate state like the photon for electromagnetic scattering. The GEM has been extended from a theory of classical gravity to a quantized theory that allows a perturbative approach to calculating phenomena in gravity. In order to investigate the gravitational effects at finite temperature, the Thermofield Dynamics (TFD) formalism is considered. TFD is a real-time formalism of quantum field theory at finite temperature. There are two necessary basic ingredients to construct this formalism: (i) the doubling of degrees of freedom in a Hilbert space and (ii) the Bogoliubov transformations. So, after a brief introduction of these two theories, GEM and TFD, we will

study some gravitational effects at zero and finite temperature. Furthermore, the analogy between gravity and electromagnetism will be explored in the context of the Lorentz-violating standard model extension.

Contribution: Seminar

A quantum field theory approach to critical dynamics: the role of multiplicative noise

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Quantum Field Theory has proven to be a very powerful tool for describing continuous phase transitions. The spontaneous symmetry breaking paradigm, complemented with the Renormalization Group (RG), allows us to classify phase transitions into "universality classes"\footnote{J. L. Cardy, {\it Scaling and renormalization in statistical physics}, Cambridge lecture notes in physics (1996).}. In this way, it is possible to determine different correlation functions and the associated observables in the neighborhood of a critical point. However, the dynamics of a phase transition, when the system is taken out of thermodynamic equilibrium, is still an open research problem. This problem is placed in a much wider context, which is the theoretical formulation of out-of-equilibrium statistical mechanics.

The interest in critical dynamics is rapidly growing up in part due to the wide range of multidisciplinary applications in which criticality is a central issue. For instance, the collective dynamics of biological systems presents critical behavior displaying space-time correlation functions with non-trivial scaling laws\footnote{A. Cavagna, {\it et.\ al.\ }, Phys. Rev. Lett. {\bf 123}, 268001 (2019).}. Other interesting examples come from epidemic spreading models where dynamic percolation is observed near multicritical points\footnote{H. K. Janssen, M. Muller, and O. Stenull, Phys. Rev. {\bf E70}, 026114 (2004)}. Moreover, strongly correlated systems, such as antiferromagnets in transition-metal oxides present a very rich phase diagram including ordered as well as topological phases. These compounds are generally described by quantum field theory models~\footnote{B. Hsu and E. Fradkin, Phys. Rev. B {\bf 87}, 085102 (2013).} (Quantum Lifshitz and related Sine Gordon models) that seem to have anomalous critical dynamics.

The usual approach to critical dynamics is the "Dynamical Renormalization Group (DRG)", early described in a seminal paper by Hohenberg and Halperin\footnote{P. C. Hohenberg and B. I. Halperin, Rev. Mod. Phys. {\bf 49,} 435 (1977).}. The simplest starting point is to admit that, very near a critical point, the dynamics of the order parameter is governed by a dissipative process driven by an overdamped additive noise Langevin equation. The critical point is approached by integrating out short distance (high momentum) degrees of freedom in order to obtain the dynamics of an equivalent effective long distance (small momentum) model.

As usual in RG theory, the integration over higher momentum modes generates all kind of couplings, compatible with the symmetry of the problem. For this reason a consistent study of a RG flux should begin, at least formally, with the most general Hamiltonian containing all couplings compatible with symmetry. Interestingly, in a similar way, DRG transformations generate couplings that modify the probability distribution of the original stochastic process. In particular, we will show that one loop perturbative corrections generates couplings compatible with a multiplicative noise stochastic processes, even in the case of assuming an additive processes as a starting point.

In this presentation, we show how to deal with the dynamics of an order parameter near criticality, assuming a dissipative process driven by a general multiplicative noise Langevin equation. We will analyze a simple model of a not conserved real scalar order parameter, $\phi(\mathbf{x}, t)$ with quartic coupling $\phi^4(\mathbf{x}, t)$. We assume, as a starting point, a multiplicative noise Langevin equation, modeled by a general dissipation function $G(\phi) = G(-\phi)$, with the same symmetry of the Hamiltonian, Z_2.

To compute dynamical correlation functions, we use a generalized Martin-Siggia-Rose-Janssen-DeDominicis formalism (MSRJD) that represents the Langevin dynamics by a quantum field theory. We use a recently developed approach to deal with multiplicative noise in a general stochastic prescription\footnote{Z. G. Arenas and D. G. Barci, Phys. Rev. {\bf E85}, 041122 (2012); Journal of Statistical Mechanics: Theory and Experiment {\bf 2012}, P12005 (2012); M. V. Moreno, Z. G. Arenas and D. G. Barci, Phys. Rev. {\bf E91}, 042103 (2015).}. In this formalism, the generating functional is written in terms of a functional integral over four fields, two bosonic and two fermionic that, in certain conditions, display Supersymmetry.

As it is well known, the upper critical dimension of this model is $d_c = 4$. For $d > 4$, the Gaussian fixed point with dynamical critical exponent $z = 2$ is stable. For, $d < 4$, the Gaussian fixed point becomes unstable and the Wilson-Fisher fixed point shows up in a first order expansion around $\epsilon = 4 - d$. In this case, the dynamics is governed by $z = 2 + O(\epsilon^2)$, and all multiplicative noise coupling constants are irrelevant. In this sense, we recover very well known old results. However, the dynamic dramatically changes at $d = 2$. Here, all multiplicative noise couplings are marginally relevant, flowing to a novel stable fixed point dominated by a multiplicative noise stochastic process\footnote{Nathan Silvano and Daniel G. Barci, {\it Critical Dynamics: multiplicative noise fixed point in 2D systems}, to be published, 2022}.

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Contribution: Video-poster

Master equations governing the coupling between spin-currents and gravity

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In this work we consider the Einstein-Hilbert action in the first order order formalism coupled to Dirac spinors. From the little group symmetry, we derive the corresponding Bargmann-Wigner current which is conserved but not gauge invariant. Therefore, we construct a gauge invariant version of the Bargmann-Wigner current which is not conserved but potentially observable. Because it is not conserved we split this current into fermionic and gravitational sectors and derive their broken continuity equations for each sector. These equations compose the master equations governing the interaction of spin-currents with gravity. Furthermore, we derive the corresponding master equations in the weak field approximation.

Contribution: Seminar

Spontaneous chiral symmetry breaking in holographic QCD

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We describe the emergence of spontaneous chiral symmetry breaking in holographic QCD via a non-linear extension of the soft wall model with non-minimal couplings. We investigate the behaviour of meson masses and decay constants as a function of the quark mass. In the chiral limit we show the emergence of Nambu-Goldstone bosons in the pseudo-scalar sector and reproduce the Gell-Mann-Oakes-Renner (GOR) relation.

Reference: 2107.10983 (accepted in Phys. Rev. D).

Contribution: Seminar

Towards to the Yang-Mills ensemble

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We review our recent work on the new procedure to quantize the Yang-Mills theories in the continuum, which points towards the existence of a Yang-Mills ensemble. In the new approach, the idea is to divide the configuration space into sectors labeled by different topological degrees of freedom and fix the gauge separately on each one of them. To implement this mechanism, the gauge fields are mapped into an auxiliary field space used to initially determine sectors labeled by center vortices, and then separately fix the gauge on them. The whole procedure results into a BRST-invariant local action which turns out to be renormalizable to all orders. We provide examples of configurations belonging to sectors labeled by center vortices and we discuss the importance of the mapping injectivity, and show that this property holds infinitesimally for typical configurations of the vortex-free sector and for the simplest example in the one-vortex sector. Finally, we show that these configurations are free from Gribov copies.

Contribution: Seminar

Pion observables in Minkowski space

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We present a dynamical model for describing the pion structure. We based our analysis considering the pion as a bound state of a quark anti-quark pair interacting through a one-gluon exchange. Using the Nakanishi integral representation, we solve the Bethe-Salpeter equation directly in Minkowski space. We obtain the pion weak decay constant, the LF-momentum distributions, the valence probability, the distribution amplitudes, the probability densities and the electromagnetic form factor, with a good agreement with available experimental data.

Contribution: Seminar

Localized solutions of inhomogeneous nonlinear systems: dimensional reduction and similarity transformation

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Solitary waves or solitons are a special type of solution that emerge due to a perfect balance between the nonlinear and dispersive/diffusive effects of the system. Depending on their form these solutions can be classified as bright, dark, breathers, rogue waves, etc. Various systems are described by the nonlinear Schrödinger (NLS) equation and its generalizations, and the interest includes nonlinear optics [1], Bose-Einstein condensates (BECs) [2], plasmas [3], hydrodynamics [4], photorefractive problems [5], nematic liquid crystals [6], and electrical line transmission [7]. In particular,
new interesting solutions are possible when the NLS equation admits variable coefficients modulated in the spatial and/or temporal coordinates [8-13]. In the case of BECs, inhomogeneity can be easily controlled using Feshbach resonance [14]. Additionally, laser beams can be used to control the pattern of the confinement profile of the system.
BECs can be tightly confined in one or two transverse directions by a strong potential, allowing us to study, respectively, the dynamics of quasi-two-dimensional or quasi-unidimensional of such a system. In this sense, one can apply some approximations to reduce the 3D NLS equation, alias Gross-Pitaevskii equation, to effective 1D [15-18] and 2D [19-21] equations. In particular, the use of the variational approximation for the transverse profile of the wave function, presented in [15, 16], helps to derive an effective 1D nonpolynomial Schrödinger equation, which accurately models the axial dynamics of the cigar-shaped BECs. This method can also be applied for the derivation of effective 2D- NPSEs, when BEC is strongly confined in the axial direction [15, 20]. In addition, by applying the standard adiabatic approximation and using an accurate analytical expression for the corresponding local chemical potential, the authors of Ref. [19] derived an effective 1D equation that governs the axial dynamics of mean-field cigar-shaped condensates with repulsive interatomic interactions, accounting accurately for the contribution from the transverse degrees of freedom. Next, in Ref. [17] was proposed a generalization of Ref. [19] for BECs trapped with anharmonic transverse potentials.
In this presentation, we will briefly review the works on dimensional reduction and on the modulation of localized solutions obtained analytically through the similarity transformation technique.

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Contribution: Seminar

Recent results on localized structures

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Localized structures usually appear in Field Theory under the action of scalar fields. In 2003, a new class of global defects was introduced by D. Bazeia, J. Menezes and R. Menezes in [Phys. Rev. Lett. 91, 241601 (2003)], where they presented a procedure to circumvent Derrick's theorem in $(D, 1)$ spacetime dimensions. This motivated us to use the scalar field to modify other localized structures. In this talk, we present some recent results in this direction. In particular, we consider the study of planar vortices in models with $U(1) \times Z_2$ symmetry, in which the magnetic permeability of the system is controlled by a neutral scalar field [D. Bazeia, M.A. Marques and R. Menezes, Phys. Lett. B 780, 485 (2018)]. In this case, using first order differential equations, the neutral scalar field decouples from the other ones, working as an independent structure, so it can be seen as a source for the vortex. In this sense, we show that it may modify the geometry of the vortex in a significant manner, generating an internal structure in its magnetic field, with ringlike configurations. Using a similar approach, and also considering a model with $U(1) \times U(1)$ symmetry, we can also get multilayered vortices, with several rings in the magnetic field [D. Bazeia, M.A. Liao, M.A. Marques and R. Menezes, Phys. Rev. Research 1, 033053 (2019)]. Other investigation to be presented in the talk concerns the inclusion of the neutral scalar field to control the dynamical terms in the Lagrangian density associated to magnetic monopoles, with $SU(2) \times Z_2$ models [D. Bazeia, M.A. Marques and R. Menezes, Phys. Rev. D 97, 105024 (2018)]. In this situation, using first order differential equations, we have found that not only the additional scalar field is capable of inducing an internal structure in the magnetic monopole, but also of modifying the behavior of its tail, leading to compact monopoles. These results also encouraged us to investigate novel configurations of monopole. In [D. Bazeia, M.A. Marques and Gonzalo J. Olmo, Phys. Rev. D 98, 025017 (2018)] we have found minimum energy solutions that leads to unusual monopole profiles, being small or hollow. In particular, the small monopole is described by analytical solutions. We also show some results of the work done in [D. Bazeia, M.A. Marques and R. Menezes, Phys. Rev. D 98, 065003 (2018)], in which we have replaced the additional Z_2 symmetry by a $SU(2)$ one, so the scalar fields was exchanged by a set of scalar and gauge fields. In this case, the additional fields are decoupled, so they can be understood as an independent monopole that interacts with the other one and modify it. Using small, hollow and the standard monopoles, we proposed composite structures, formed by a core and a shell or by two shells, which we have called bimagnetic monopoles. We also present the recent investigation in electrically charged structures, where the scalar field is used to control the electric permittivity of the medium in which a single charge is placed [D. Bazeia, M.A. Marques and R. Menezes, Eur. Phys. J. C 81, 94 (2021)].

Contribution: video-poster

Feynman amplitudes in compact spaces up to all orders

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One crucial step to discuss general aspects of the perturbative expansion in quantum field theories is the definition and use of parametric representations of Feynman amplitudes. However, even though the usual zero temperature scenario is well-known and textbook material, a complete discussion of a parametric representation considering finite temperature and finite-size effects is absent in the standard literature. In previous work, we developed a parametric representation for the scalar field. Now we extend it to consider field theories with nonzero spin $(0,\frac{1}{2},1)$ and also quasiperiodic boundary conditions in space. There are two valid and equivalent representations, one useful for the small-box limit (near dimensional reduction) and another useful for the large-box limit (near the bulk).

Contribution: video-poster

Time-dependent quantum harmonic oscillator: a continuous route from adiabatic to sudden changes

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In this work, we give a quantitative answer to the question: how sudden or how adiabatic is a frequency change in a quantum harmonic oscillator (HO)? We do that by studying the time evolution of a HO which is initially in its fundamental state and whose time-dependent frequency is controlled by a parameter (denoted by ϵ) that can continuously tune from a totally slow process to a completely abrupt one. We extend a solution based on algebraic methods introduced recently in the literature that is very suited for numerical implementations, from the basis that diagonalizes the initial hamiltonian to the one that diagonalizes the instantaneous hamiltonian. Our results are in agreement with the adiabatic theorem and the comparison of the descriptions using the different bases together with the proper interpretation of this theorem allows us to clarify a common inaccuracy present in the literature. More importantly, we obtain a simple expression that relates squeezing to the transition rate and the initial and final frequencies, from which we calculate the adiabatic limit of the transition. Analysis of these results reveals a significant difference in squeezing production between enhancing or diminishing the frequency of a HO in a non-sudden way.

Contribution: video-poster

Properties of Mesons in a Dense and Hot Medium

Authors: Elenilson Santos Nery[1]; Luciano Abreu[1]

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In this work, we investigate the combined effects of temperature, external magnetic field and finite size of the system on the properties of neutral mesons in a dense and hot medium, in the context of the Nambu-Jona-Lasinio (NJL) model. In particular, we use the mean-field

approximation, Schwinger's proper time method and the Matsubara series treated through the of Jacobi's theta functions, to study the chiral phase transition, the constituent quark mass and light neutral mesons under the change of the finite size of the system, temperature, chemical potential and strength of the external magnetic field. The studied phase diagrams indicate that the observables are strongly affected by these parameters, and that the net result will depend on the balance of these concurrent phenomena. Furthermore, they agree with others found in the literature described by different tools.

Contribution: video-poster

An effective field theory approach to the interactions of the doubly charmed state T_{cc}^{+} with a hadronic medium

Author: Hildeson Paulo Lessa Vieira[1]

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The recently observed doubly charmed state T_{cc}^{+} belongs to the family of the multiquark states called exotic hadrons. One of main goals of modern hadron physics is to determine the strucutre of these exotic hadrons. Nucleus-nucleus collisions at the LHC offer a possibility to achieve this goal. The yield of T_{cc}^{+}'s produced at the end of the quark-gluon plasma phase of nuclear collisions is related to the internal structure of the state. However this yield may be affected by the interactions in the hadron gas phase. We investigate the absorption and production processes of this new state in a hadronic medium, considering the reactions $T_{cc}^{+}\pi, T_{cc}^{+}\rho \to D^{(*)}D^{(*)}$ and the corresponding inverses reactions. We use effective field Lagrangians to account for the couplings between light and heavy mesons. The absorption cross sections are found to be larger than the production ones. We compare our results with the only existing estimate of these quantities, presented in a work of J. Hong, S. Cho, T. Song and S. H. Lee, in which the authors employed the quasi-free approximation. We find cross sections which are one order of magnitude smaller. The subject deserves further investigation.

Contribution: video-poster

BPS solitons in a Maxwell baby Skyrme model with a non-trival dielectric function

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In this presentation, we describe the construction of gauged BPS baby skyrmions inherent to a model in which the dynamics of the gauge field is controlled by the usual Maxwell term now multiplied by a nontrivial dielectric function. We introduce the theoretical context in which this investigation is inserted and present the lagrange density which defines the so-called Maxwell baby Skyrme model. We write the corresponding Gauss law for time-independent configurations and fix a particular gauge choice which leads to BPS skyrmions with no electric field and electric charge. By focusing our attention on structrures with radial symmetry, we point out that the expression for the total energy of the effective theory must be enlarged in order to support the existence of BPS solutions. We then proceed with the minimization of the enlarged energy via the implementation of the BPS prescription, from which we get not only the lower bound for the energy itself, but also the first-order equations whose solutions

saturate the aforecited bound. In the sequence, we fix an specific form for the superpotential which is known to give rise to well-behaved BPS skyrmions in the simplest Maxwell baby Skyrme scenario (i.e. in the absence of the dielectric function). Moreover, in order to generate solutions with internal structures, we also choose a particular mathematical form for the dielectric function which contains a positive real parameter α. From this point on, we focus our attention on the effects caused by α on the profiles of the corresponding BPS configurations, from which we fix the values of the additional parameters of the model. We solve the effective first-order equations for different values of α and depict the numerical BPS solutions. As a result, we get that α controls the magnetic field's shape, which eventually differs from its standard profile in a dramatic way. In particular, it is possible to define five different scenarios according to the magnetic profile the values of α engender. Similar dependence can also be identified in the solution to the magnetic energy density, which stands for the portion of the energy distribution which is proportional to the magnetic field. Finally, we summarize the main results and enumerate our perspectives regarding future investigations based on the developments discussed in this presentation.

Contribution: video-poster

BPS Maxwell Chern Simons vórtices with internal structures the abelian Higgs case

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We investigate the existence of first-order vortices inherent to both the Maxwell-Chern-Simons-Higgs model extended via the inclusion of an extra scalar
sector which plays the role of a source field. For this case, we focus our attention on the time-independent configurations with radial symmetry which can be obtained through the implementation
of the so-called Bogomol'nyi-Prasad-Sommerfield (BPS) prescription. In this sense, in order to solve the corresponding first-order differential equations, we introduce some particular scenarios which are driven by the source field whose presence, we expect, must change the way the resulting
vortices behave. After solving the effective first-order system through a finite-difference algorithm,
we comment about the main new effects induced by the presence of the source field in the shape of
the final configurations.

Contribution: Seminar

Towards hidden symmetries in gauge theories

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The non-abelian generalization of the gauge symmetry proposed by C. N. Yang and R. Mills in 1954 was done à la Maxwell, i.e., in terms of a set of partial differential equations.

However, the integral formulation counterpart of this generalization was not known until quite recently.

The critical problem in constructing the integral Yang-Mills equations is the need for a consistent definition of the flux of the non-abelian electric and magnetic fields with which we can build a relationship with the dynamically conserved charges in such a way that these charges are invariant under gauge transformations. Indeed, the naive definition of the flux of the non-abelian fields $\Phi(F) = \int_\Sigma F_{\mu\nu} \frac{\partial x^\mu}{\partial \sigma} \frac{\partial x^\nu}{\partial \tau} d\sigma d\tau$ is strongly dependent of the gauge choice since under a local gauge transformation $g(x)$, $F_{\mu\nu}(x) \to g(x) F_{\mu\nu}(x) g^{-1}(x)$ and therefore, the flux through a closed surface cannot be directly associated to gauge-invariant charges inside.

The problem of finding the gauge-invariant charges in non-abelian gauge theories is therefore linked to the problem of formulating the integral version of the Yang-Mills equations.

By scanning the $3+1$ dimensional Minkowski space-time with closed 2-dimensional surfaces based at a reference point x_R, which are in turn scanned by a family of homotopically equivalent loops based at x_R, it can be shown that the flux of the "conjugate field-strength" $F^W_{\mu\nu}(x) = W^{-1} F_{\mu\nu}(x) W$ through that closed surface, with W being the holonomy defined along a loop from x_R to x, will transform, under a local gauge transformation $g(x)$, as $\Phi \to g(x_R) \Phi g(x_R)^{-1}$, i.e., bringing the gauge group element to that defined at the reference point.

A relation between the flux of the conjugate field through the closed surface $\partial\Omega$ and quantities evaluated inside the volume Ω can be established and expanding this construction for the dual field strength $\widetilde{F}_{\mu\nu} = \frac{1}{2}\epsilon_{\mu\nu\sigma\rho} F^{\sigma\rho}$, with the use of the (differential) Yang-Mills equations

$$
\begin{aligned}
D_\mu F^{\mu\nu} &= J^\nu_{\mathrm{e}} & (1)\\
D_\mu \widetilde{F}^{\mu\nu} &= J^\nu_{\mathrm{m}}, & (2)
\end{aligned}
$$

with $D_\mu \star = \partial_\mu \star + ie[A_\mu, \star]$ the covariant derivative, $F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu + ie[A_\mu, A_\nu]$ the field strength and $J^\mu_{\mathrm{e,m}}$ the electric and magnetic currents, we obtain their integral formulation:

$$
\oint_{\partial\Omega} W^{-1} F_{\mu\nu} W \frac{\partial x^\mu}{\partial \sigma} \frac{\partial x^\nu}{\partial \tau} d\sigma d\tau = \int_\Omega \epsilon_{\lambda\mu\nu\gamma} W^{-1} J^\gamma_{\mathrm{m}} W \frac{\partial x^\lambda}{\partial \zeta} \frac{\partial x^\mu}{\partial \sigma} \frac{\partial x^\nu}{\partial \tau} d\sigma d\tau d\zeta
$$
$$
+ \int_\Omega \int_0^\sigma [F^W_{\mu\nu}(\sigma), F^W_{\alpha\beta}(\sigma')] \left(\frac{\partial x^\beta}{\partial \zeta}(\sigma') \frac{\partial x^\nu}{\partial \tau}(\sigma) - \frac{\partial x^\beta}{\partial \tau}(\sigma') \frac{\partial x^\nu}{\partial \zeta}(\sigma) \right) \frac{\partial x^\alpha}{\partial \sigma'} \frac{\partial x^\mu}{\partial \sigma} d\sigma' d\sigma d\tau d\zeta \qquad (3)
$$

$$
\oint_{\partial\Omega} W^{-1} \tilde{F}_{\mu\nu} W \frac{\partial x^\mu}{\partial \sigma} \frac{\partial x^\nu}{\partial \tau} d\sigma d\tau = \int_\Omega \epsilon_{\lambda\mu\nu\gamma} W^{-1} J^\gamma_{\mathrm{e}} W \frac{\partial x^\lambda}{\partial \zeta} \frac{\partial x^\mu}{\partial \sigma} \frac{\partial x^\nu}{\partial \tau} d\sigma d\tau d\zeta
$$
$$
+ \int_\Omega \int_0^\sigma [\tilde{F}^W_{\mu\nu}(\sigma), F^W_{\alpha\beta}(\sigma')] \left(\frac{\partial x^\beta}{\partial \zeta}(\sigma') \frac{\partial x^\nu}{\partial \tau}(\sigma) - \frac{\partial x^\beta}{\partial \tau}(\sigma') \frac{\partial x^\nu}{\partial \zeta}(\sigma) \right) \frac{\partial x^\alpha}{\partial \sigma'} \frac{\partial x^\mu}{\partial \sigma} d\sigma' d\sigma d\tau d\zeta. \qquad (4)
$$

In order to obtain the conserved charges, we consider the generalization of the holonomy operator by assigning to each loop parameterized by τ, scanning a closed 2-dimensional surface with base-point at x_R, the quantity $\mathcal{B} = \oint_\gamma W^{-1} B_{\mu\nu} W \frac{\partial x^\mu}{\partial \sigma} \frac{\partial x^\nu}{\partial \tau} d\sigma$ and define the 2-holonomy by the differential equation

$$
\frac{dV}{d\tau} + ieV\mathcal{B} = 0, \qquad (5)
$$

whose solution is the ordered series

$$
V[\partial\Omega] = V_\circ \, P_2 \, e^{-ie \oint W^{-1} B_{\mu\nu} W \frac{\partial x^\mu}{\partial \sigma} \frac{\partial x^\nu}{\partial \tau} d\sigma d\tau}. \qquad (6)
$$

This same operator can be obtained if we consider the 2-dimensional surface where it is calculated to be the result of continuous deformations from an infinitesimal surface at x_R. This leads to a definition of the 2-holonomy as the ordered series

$$
V[\Omega] = P_3 \, e^{ie \int_0^{2\pi} \mathcal{A}(\zeta) d\zeta} \, V_\circ \qquad (7)
$$

with

$$\begin{aligned}\mathcal{A} &= \int_\Sigma VW^{-1}\left(D_\lambda B_{\mu\nu} + D_\mu B_{\nu\lambda} + D_\nu B_{\lambda\mu}\right)WV^{-1}\frac{\partial x^\mu}{\partial\sigma}\frac{\partial x^\nu}{\partial\tau}\frac{\partial x^\lambda}{\partial\zeta}d\sigma d\tau \\ &+ ie\int_\Sigma V\int_0^\sigma\left[\mathcal{F}^W_{\mu\nu}(\sigma'), B^W_{\mu\nu}(\sigma)\right]\left(\frac{\partial x^\mu}{\partial\sigma}\frac{\partial x^\nu}{\partial\zeta}\frac{\partial x^\alpha}{\partial\sigma'}\frac{\partial x^\beta}{\partial\tau} - \frac{\partial x^\mu}{\partial\sigma}\frac{\partial x^\nu}{\partial\tau}\frac{\partial x^\alpha}{\partial\sigma'}\frac{\partial x^\beta}{\partial\zeta}\right)V^{-1}d\sigma d\tau\end{aligned}$$

where $\mathcal{F}_{\mu\nu} = F_{\mu\nu} - B_{\mu\nu}$.

The fact that the operator V can be calculated in these two different but equivalent approaches lead us to the identity

$$P_3\, e^{ie\int_0^{2\pi}\mathcal{A}(\zeta)d\zeta} = P_2\, e^{-ie\oint W^{-1}B_{\mu\nu}W\frac{\partial x^\mu}{\partial\sigma}\frac{\partial x^\nu}{\partial\tau}d\sigma d\tau}. \tag{8}$$

For $B_{\mu\nu} = \alpha F_{\mu\nu} + \beta\widetilde{F}_{\mu\nu}$, the above equation, which is the non-abelian Stokes theorem, leads to the integral Yang-Mills equations.

Two given closed surfaces in space-time can be regarded as points in the loop space $L^2\Omega$ and the volume between them will define a path in this space.

A consequence of the integral Yang-Mills equations is that the operator $V[\Omega]$ is path-independent in $L^2\Omega$, i.e., it does not change under a reparameterization of the volume enclosed by $\partial\Omega$. By appropriately splitting space-time into space and time one can then show that V evolves from a $t = 0$ volume Ω_0 to a $t > 0$ volume Ω_t as

$$V[\Omega_t] = UV[\Omega_0]U^{-1}, \tag{9}$$

i.e., it undergoes a unitary tranformation, thus preserving its eigenvalues which can be identified with the conserved charges.

The integral Yang-Mills equations can be regarded as a zero-curvature equation in the loop space $L^2\Omega$ and the conserved charges are a consequence of the hidden gauge symmetry there.

Contribution: Seminar

Suppression of two-bounce windows and solitary oscillations in kink-antikink collisions

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In this talk, I will address the kink-antikink collisions in (1,1)-dimensions. For this, we start to briefly review of the ϕ^4 and ϕ^6 models, as well as the standard mechanism of a resonant effect between the vibrational and translational modes. The role of extra vibrational modes in the scattering process will then be discussed, with particular emphasis on the total suppression of two-bounce windows, despite the presence of a vibrational mode, the production of multiple antikink-kink pairs and appearance of solitary oscillations.

Contribution: Video-poster

Topological BPS vortices in a Chern-Simons-CP(2) model in the presence of magnetic impurities

Authors: Marcos Vinícius C. Almeida[1]; Carlos Eduardo da Hora Santos[1]; Rodolfo Alvan Casana Sifuentes[1]; Steffen Krusch[2]

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We study the existence of BPS vortices in a Chern-Simons-CP(2) model in the presence of magnetic impurities. The minimization of the energy via the Bogomol'nyi-Prasad-Sommerfield (BPS) formalism allows us to obtain the first-order differential equations (or BPS equations) and the corresponding Bogomol'nyi bound. The magnetic impurity chose for our study is a Gaussian-type, then the numerical solutions of the BPS equations through the finite-difference technique verifies the occurrence of nonmonotonic regular solutions. Such a nonmonotonicity produced by the magnetic impurity induces the flipping of the magnetic field, and consequently, it also affects the electric sector.

KEYWORDS: TOPOLOGICAL, BPS VORTICES, CHERN-SIMOS, CP(2) MODEL.

Contribution: Video-Poster

Vertex ν–e^{-}–ϕ^{+} of neutrino autoenergy in external magnetic field using the Ritus method

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The presence of a magnetic field in a specific direction compromises the isotropy, so that particles subject to this field are no longer described by plane waves. Therefore, the propagator assumes a non-diagonal form, which does not allow us to write it as a Fourier transform. In order to find the propagators of charged particles subject to external magnetic field, onde can use Ritus eigenfunction method to diagonalize differential operators and, consequently, Green's functions. The latter become similar to free propagators. From Weinberg-Salam model, spontaneous symmetry breaking and Ritus method applied to both electron and Higgs propagators subject to a constant magnetic field, the term ν–e^{-}–ϕ^{+} of 1-loop neutrino self-energy in a magnetic field is calculated in the lowest Landau level for the electron. The external magnetic field gives rise to an anisotropy in the propagation of the neutrino, which also appears at the self-energy vertex. In turn, it passes to rely only on momentum parallel to the magnetic field applied. Also, it is important to note that there is a linear dependency of the autoenergy vertex with respect to the magnitude of magnetic field.

Contribution: Video-poster

Boundary Effects on Constituent Quark Masses in a four-fermion interaction model

Authors: Elenilson Nery[1]; Emerson Correa[2]; Luciano Abreu[1]

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We investigate the finite-size effects on the constituent quark masses of a two-flavor four-fermion interaction model with a flavor-mixing in the presence of a magnetic background.

Contribution: Seminar

Some Higher-Derivative Theories in Practical Terms

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Since the final decades of the last century it has become clear that quantum field theory (QFT) represents a major framework for describing fundamental nature phenomena. The generalization of this framework for models containing higher-order derivative terms, however an old subject, still poses itself as a challenging one with many open problems and subtleties. The relevance of higher-derivative models relies not just on abstract mathematical points, actually many modern approaches to quantum gravity allow for higher-order derivatives, besides its importance on the description of interacting models with room for more degrees of freedom. We present here a brief overview of some specific aspects of higher-derivative theories. Rather than entering on the fundamentals of important open issues such as unitarity, positiveness and causality, we focus instead on particular historical facts and pinpoint a few practical feasible issues present in recent published works. Starting from the 1950 well-known Pais-Uhlenbeck groundbreaking paper, we discuss the higher-derivative models of Bopp-Podolsky, Lee-Wick, Pais-Uhlenbeck oscillator and possible higher-order generalizations for the Klein-Gordon action. By performing a comparative analysis among those models, we show that it is possible to infer properties and behavior for ones from the others, in this way shedding some light in the whole higher-derivative problem in QFT. The fourth-order Pais-Uhlenbeck oscillator is perhaps the simplest instance of a nontrivial and relevant higher-order model. Defined in the realm of quantum mechanics, it comes from the quantization of a fourth-order classical oscillator system and already displays the mains characteristics of its more robust cousin models in QFT. The Boppy-Podolsky and Lee-Wick models describe higher-derivative theories with vector gauge fields. We discuss the gauge-fixing process for those models and show how clever gauge choices can lead to neat handy propagators which can considerably simplify perturbative calculations. Concerning higher-order generalizations for the Klein-Gordon equation, we discuss the classical solutions for a recently proposed natural action containing arbitrarily higher powers of the d'Alembertian operator acting on a scalar field. Along with the mentioned comparative analysis among those models, we also consider the interesting approach of reducing the order of the derivatives at the cost of introducing extra variables, weighing pros and cons, and provide a few arguments regarding their physical interpretation. To concretely illustrate the ideas, we discuss a reduced-order version for the Bopp-Podolsky model which has appeared recently in the literature, with both advantages of lower-order derivatives and sensible physical interpretation in terms of massive and massless propagating modes.

Contribution: Video-poster

Bottom-charmed meson spectrum from a QCD approach based on the TDA

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The bottom-charmed meson spectrum is studied via an effective version of the Coulomb gauge QCD Hamiltonian. The Tamm-Dancoff approximation is employed to estimate the energies of the low-lying and radial-excited Bc states. In particular, we analyze the effects of incorporating an effective transverse hyperfine interaction and spin mixing. The Regge trajectories and hyperfine splitting of both S- and P-wave states are also examined. The numerical results are compared with available experimental data and the theoretical predictions of other models.

Contribution: Seminar

Dynamical symmetry breaking from derivative four-fermion models

Author: Tiago Mariz[1]

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This work investigates the dynamical symmetry breaking from derivative four-fermion models by calculating the one-loop effective potentials. We demonstrate that they are positively defined and possess a continuous set of minima. We finally calculate the effective action of the corresponding models.

Contribution: Video-poster

Geometrically constrained kinklike configurations

Authors: Dionísio Bazeia[1]; Matheus Lião[1]; Matheus Araújo Marques[1]

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In this work we study kinklike structures, which are localized solutions that appear in models described by real scalar fields. The model to be considered is characterized by two real scalar fields and includes a function of one of the two fields that modifies the kinematics associated to the other field. The investigation brings to light a first order framework that minimizes the energy of the solutions by introducing an auxiliary function that directly contributes to describe the system. We explore an interesting route, in which one field acts independently, entrapping the other field, inducing important modifications in the profile of the localized structure. The procedure may make the solution to spring up as a kinklike configuration with internal structure, engendering the important feature that also appears directly connected with issues of current interest at the nanometric scale, in particular in the electronic transport in molecules in the presence of vibrational degrees of freedom.

Contribution: Video-poster

Linearity and Uniqueness in One Loop Fermionic Odd Amplitudes at Even Dimensions

Author: José Fernando Thuorst[1]

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The "puzzling" matter of anomalies at linearly diverging tensors at all even dimensions is being explored with a strategy developed at the end of the '90s, sometimes called implicit regularization. The main focus is not the divergences that are at all avoided but is the role played by the appearance of the epsilon tensor in the traces with the chiral matrix in these amplitudes. Different display of indexes among the terms to be integrated that is generated by the use of different identities leads to specific violations of Ward identities when the surface terms present at the core of these amplitudes are set to zero. The connection with uniqueness and kinematic behavior shows up an interesting interaction among the finite integrals and diverging ones. The case of two and partially four dimensions is used to illustrate the working of these ideas.

Contribution: Video-poster

Remarks on nonlocality: Field theories and gravitation

Author: Rodrigo Bufalo[1]

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In this talk we present an overview of non-local field theories, discussing its mains aspects, motivation and properties: we give some highlights on some application in QFT and also gravitational model.

Contribution: Seminar

Zamolodchikov's c function in the study of the stability of non-Abelian topological phases

Authors: Carlos Hernaski[1]; Pedro Gomes[2]; Rodrigo Corso[2]

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We use the Zamolodchikov's c function to study the stability of non-Abelian 2+1 dimensional topological phases of matter. We show in the seminar that we can construct an interpolating function that connects UV fixed points with interesting classes of topological spin liquid phases of matter in the IR regime.

Contribution: Seminar

Effective field theories applied to studies of hadron physics

Authors: Alberto Martinez Torres; Kanchan Khemchandani; Brenda Bertotto Malabarba

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I use effective field theories to study low energy interactions among hadrons and the consecutive formation of resonant/bound states in hadronic systems. The states formed in such systems are often referred to as dynamically generated or molecular states. In such studies, we consider the hadrons to be the degrees of freedom and the corresponding Lagrangians are constructed by requiring the symmetries appropriate and applicable to a given system. In this talk I will present the details and results of our recent works.

Contribution: Seminar

QCD effective charges and the proton structure function at small-x

Author: Emerson Luna[1]

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In this talk we will briefly review the application of QCD effective charges, whose infrared behavior is constrained by a dynamical mass scale, in phenomenology. We illustrate the power of effective charges for studying the effect of higher twist operators of the Wilson operator product expansion in the proton structure function F_2 at small-x

Contribution: Seminar

Brane inflation models

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In this talk I will revisit recent studies of brane inflation models and their viability with respect to observational data.

Contribution: Seminar

Quantum fluctuations, dispersive forces, some related effects and recent research

Author: Danilo Teixeira Alves[1]

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We give an overview of quantum fluctuations and dispersive forces, briefly discussing, for example, the van der Waals, Casimir-Polder, Casimir, and dynamical Casimir forces. We make a brief discussion on some main articles on these phenomena, also presenting some contributions to the knowledge of these effects obtained by our research group in UFPA-Brazil. For instance: our prediction of the peak, valley, and intermediate regimes in the lateral van der Waals force;

of a repulsive lateral van der Waals force; the possibility of generating motion of an object, induced by asymmetric excitation of the quantum vacuum; the existence of relativistic (non-parabolic) bands in the discrete spectrum of created particles in an oscillating cavity; the prediction of an enhancement of the dynamical Casimir effect by decreasing the mirror reflection.

Contribution: Seminar

Qubitization of Quantum Field Theories

Author: Paulo Bedaque

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Simulation of quantum field theories by quantum computers
requires not only the discretization of spacetime but also of field space. Naive truncations of field space break symmetries and change the universality class of the theory, complicating the continuum limit. We discuss how one can have finite dimensional Hilbert spaces that "fit" into a quantum computer while, at the same time, reproducing the correct continuum physics. This is demonstrated in the solvable 1+1 dimensional O(3) sigma-model where the qubitization is accomplished using ideas of non-commutative geometry.

Contribution: Video-poster

Magnetic monopoles in a nutshell

Author: Philipe De Fabritiis[1]

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In this contribution, we present a short overview (in portuguese) about magnetic monopoles. We highlight the monopole solutions given by Dirac (1931), 't Hooft-Polyakov (1974) and Cho-Maison (1997). We conclude stating recent results.

Contribution: Video-poster

Anderson localization induced by interaction

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In this work, we investigate the existence of Anderson localization induced by a specific component of a binary Bose-Einstein condensate. We use a mean-field approach, such that only one type of particle is subject to a disordered quasiperiodic potential, which induces a localization in the partner field. Numerical simulations confirm the existence of Anderson localization in the partner field for certain parameters, even in the absence of direct "contact" with the disordered potential. Unstable solutions containing many peaks were found. These fragmented profiles were studied by using the mean width of the solutions, showing a phase transition.

Contribution: Video-poster

Dark Monopoles in Grand Unified Theories

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We consider a Yang-Mills-Higgs theory with gauge group $G = SU(n)$ broken to $G_v = [SU(p) \times SU(n-p) \times U(1)/Z$ by a Higgs field ϕ in the adjoint representation. We obtain monopole solutions whose magnetic field does not lie in the Cartan Subalgebra. And, since their magnetic field vanishes in the direction of the $U(1)_{em}$ electromagnetic group, we call them Dark Monopoles. These Dark Monopoles must exist in some Grand Unified Theories (GUTs) without the need to introduce a dark sector. We calculate the general hamiltonian and equations of motion, while we also obtain approximate analytical solutions when $r \to 0$ and $r \to \infty$. We show that their mass is given by $M = \frac{4\pi v}{e}\tilde{E}(\lambda/e^2)$, where $\tilde{E}(\lambda/e^2)$ is a monotonically increasing function of λ/e^2, with the lower and upper bounds depending on specific parameters of each possible symmetry breaking. For the particular case of the $SU(5)$ GUT, we obtain that $\tilde{E}(0) = 1.294$ and $\tilde{E}(\infty) = 3.262$. In addition, we give a geometrical interpretation to their non-abelian magnetic charge and we show that our monopole solution has a conserved magnetic current J^{μ}_{M}, which is quantized and lies in a non-abelian direction. Finally, we proceed with an asymptotic stability analysis of these $SU(n)$ Dark Monopole solutions, where we show that there are unstable modes associated with them. We obtain the explicit form of the unstable perturbations and the associated negative-squared eigenfrequencies.

Contribution: Video-poster

Effects of CPT-odd terms of dimensions three and five on electromagnetic propagation in continuous matter

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In this work we study how CPT-odd Maxwell-Carroll-Field-Jackiw (MCFJ) electrodynamics as well as a dimension-5 extension of it affect the optical activity of continuous media. The starting point is dimension-3 MCFJ electrodynamics in matter whose modified Maxwell equations, permittiv- ity tensor, and dispersion relations are recapitulated. Corresponding refractive indices are achieved in terms of the frequency and the vector-valued background field. For a purely timelike background, the refractive indices are real. Their associated propagation modes are circularly polarized and exhibit birefringence. For a purely spacelike background, one refractive index is always real and the other can be complex. The circularly polarized propagating modes may exhibit birefringence and dichroism (associated with absorption). Subsequently, we examine a dimension-five MCFJ- type electrodynamics, previously scrutinized in the literature, in a continuous medium. Following the same procedure, we find the refractive indices from a sixth-order dispersion equation. For a purely timelike background, three distinct refractive indices are obtained, one of them being real and two being complex. They are associated with two circularly polarized propagating modes that exhibit birefringence or dichroism, depending on the frequency range. Scenarios of propagation and absorption analogous to those found in dispersive dielectrics are also observed for purely spacelike background configurations. We conclude by comparing the dimension-three and five results and by emphasizing the richer phenomenology of the propagating modes in the higher-derivative model. Our results are applicable in the realm of Weyl semimetals.

Contribution: Video-poster

Investigation of magnetized plasmas in Maxwell-Carroll-Field-Jackiw electrodynamics

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The present work discusses elements of Appleton's model for magnetized plasmas in the context of the Maxwell-Carroll-Field-Jackiw (MCFJ) theory, endowed with a fixed 4-vector of Lorentz symmetry violation. We begin by reviewing the essential aspects of electromagnetic (EM) wave propagation in plasmas, analyzing scattering relations, refractive index, propagation modes, and the birefringence effect. In the sequel, we revisit some basic aspects of Carroll, Field, and Jackiw's electrodynamics, such as the derivation of the modified Maxwell equations and extended scattering relations, which leads to birefringence in vacuum. Finally, we study Appleton's model in the context of MCFJ electrodynamics in order to verify the effects of the CPT- odd term on the propagating modes. Using the same procedure, we find the relations of scattering, refractive index, propagating modes, and the birefringence effect. We highlight how the CFJ term alters the propagation indices and alters the propagating modes.

Contribution: Video-poster

Effective field model for the description of the strong decays of the B_c meson

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In the 1970s, heavy mesons like the quarkonia J/Ψ and Υ were discovered, yielding a revolution in hadron physics. Since then, the hadron spectroscopy has gained a lot of attention, with the observation of several states in the charmonium and bottomonium sectors of the spectrum, as well as heavy mesons with open flavors. From the theoretical perspective, we have witnessed the development of several approaches in the context of effective theories to describe the hadron properties. However, the open flavor bottom-charmed meson (B_c) sector is not as exhaustively studied as the others. At the best of our knowledge, there are only two B_c's confirmed in the Particle Data Group (PDG 2021). With this in mind, in this work we will study the strong decay properties of the bottom-charm meson B_c via the effective model $^3P_0$.