Workshop on Electromagnetic Effects in Strongly Interacting Matter

ICTP-SAIFR, Sao Paulo, Brazil

October 25-28, 2022

List of Abstracts

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Invited talks

Anisotropic photon emission from gluon fusion and splitting in peripheral heavy-ion collisions with a strong magnetic background

Alejandro Ayala

(UNAM)

Having in mind a pre-equilibrium stage in peripheral heavy-ion collisions as a possible scenario for the production of electromagnetic radiation, we compute the two-gluon one-photon vertex in the presence of an intense magnetic field at one-loop order. The quarks in the loop are taken such that two of them occupy the lowest Landau level, with the third one occupying the first exited Landau level. When the field strength is the largest of the energy (squared) scales, the tensor basis describing this vertex corresponds to two of the three vector particles polarized in the longitudinal direction whereas the third one is polarized in the transverse direction.

However, when the photon energy is of order or larger than the field strength, the explicit one-loop computation contains extra tensor structures that spoil the properties of the basis, compared to the case when the field strength is the largest of the energy scales, which signals that the calculation is incomplete. Nevertheless, by projecting the result onto the would-be basis, we show that the squared amplitude for processes involving two gluons and one photon exhibits the expected properties such as a preferred in-plane photon emission anda slightly decreasing strength for an increasing magnetic field strength. We comment on possible venues to improve the one-loop calculation that include accounting for progressive occupation of the three quarks of the lowest and first excited Landau levels such that, still working in the large field limit, a more complete description can be achieved when the photon energy increases.

Searches for the chiral magnetic effect and strong electromagnetic fields in heavy ion collisions with the CMS detector at the LHC

Cesar A. Bernardes

(Universidade Federal do Rio Grande do Sul (IF - UFRGS))

In this presentation, we describe measurements from the CMS experiment on the search for possible signatures of the chiral magnetic effect (CME). The CME is usually associated with a possible strong local parity violation in the quark-gluon plasma in the presence of the extremely strong magnetic fields created mostly by collision spectators. Since a correlation between the direction of the magnetic fields and the collision reaction plane is expected, such investigations are performed by analyzing electric charge-dependent azimuthal correlations. These studies are performed in pPb collisions at 5.02 TeV and 8.16 TeV and in PbPb collisions at 5.02 TeV per-nucleon pair centre-of-mass energy. In addition, the search for possible strong Coulomb fields, predicted to be created mainly by collision participants, is performed. To investigate such effects, the difference between the elliptic flow of D^0 and $\bar{D^0}$ mesons is measured as a function of rapidity using PbPb data collected in 2018 by the CMS detector. Prospects for future measurements are also discussed.

Weak magnetic field corrections to low energy light vector and axial mesons couplings and mixings

Fabio Braghin

(Universidade Federal de Goiás)

By considering vacuum quark polarization to a quark-antiquark interaction mediated by a non-perturbative gluon exchange, weak magnetic field contributions to different types of couplings of light vector ρ and ω mesons (and correspondingly axial mesons), with the corresponding form factors, will be presented. Besides the usual (minimal gauge coupling) vector (axial) coupling of vector (axial) mesons to the vector (axial) constituent quark current, anomalous couplings respectively to the axial (vector) quark currents are also found as Wess-Zumino-Witten type. Weak magnetic field contributions for the $\rho-\omega$ vector mixing and a_1-f_1 axial mesons mixings are also presented in the limit in which they reduce to the same structure provided by the Nambu-Jona-Lasinio model. Consequences for the vector mesons dominance (VMD) couplings will be presented by considering the low energy pion form factor and the charge symmetry breaking nuclear potential. Contributions for the averaged quadratic radii (a.q.r.) of the vector (axial) mesons are also calculated including their anomalous axial (vector) a.q.r.

Studying the electromagnetic fields of heavy-ion collisions with photon-mediated processes

Daniel Brandenburg

(Brookhaven National Laboratory)

Ultra-relativistic heavy-ion collisions are expected to produce the strongest electromagnetic fields in the known Universe. These highly-Lorentz contracted fields can manifest themselves as linearly polarized quasi-real photons that can interact via the Breit-Wheeler process to produce lepton anti-lepton pairs. In so-called photo-nuclear interactions, a photon from the field of one nucleus may fluctuate into a quark anti-quark pair and thereby interact directly with the other nucleus. The production rates of these processes provide insight into the strength of the electromagnetic fields produced in heavy-ion collisions. Recently it has been realized that detailed measurements of the produced particles' kinematics can further elucidate the strength and distribution of the colliding fields. For instance, in the two-photon process, the energy and momentum distribution of the produced dileptons provide pristine information about the strength and spatial distribution of the colliding fields. Recently it has been demonstrated that photons from these fields can interact even in heavy-ion collisions with hadronic overlap, providing a purely electromagnetic probe of the produced medium. Therefore, these events provide an in-situ probe of the electromagnetic fields produced simultaneously with a quark-gluon plasma, potentially useful for studying the lifetime of the electromagnetic fields and electrical properties of the quark-gluon plasma.

In this talk I discuss the recent theoretical progress and experimental advances for mapping the ultra-strong electromagnetic fields produced in heavy-ion collisions via measurement of the Breit-Wheeler process and photo-nuclear interactions. Finally, I will present new results from the STAR experiment employing some of these ideas and techniques to investigate the electromagnetic field at play in the recent isobar collisions, Zr+Zr and Ru+Ru.

A possible half-integer Quantum Hall Effect: RQED bulk perspective and more

David Dudal

(KU Leuven-Kulak)

We consider a novel type of intrinsic half-integer Quantum Hall effect in 2D materials. We conjecture that it may occur in disturbed honeycomb lattices where both spin degeneracy and time reversal symmetry are broken, supplemented with an appropriately fine-tuned chemical potential. Evidence in favor is presented based on Reduced QED and its parity anomaly in (2+1)D, as driven by a specific gap structure. We make contact with a set of (DFT-simulated) materials and properties that might lead to exactly the desirable gap structure.

We also dissect the proposal from an edge perspective, highlighting certain subtleties and future research directions to establish whether (or not) the half-integer conductivity is robust from an edge perspective.

This talk is based on https://doi.org/10.1038/s41598-022-09483-4, the MSc thesis work of Lucas Levrouw (KU Leuven, 2022) and ongoing discussions.

QCD matter in strong magnetic and electric fields

Gergely Endrodi

(University of Bielefeld)

Strong electromagnetic fields have a significant impact on the physics of quarks and gluons and can be investigated via first-principles lattice QCD simulations. In this talk, I will briefly summarize recent lattice findings about the phase diagram and the equation of state at nonzero magnetic fields. Moreover, I will present first results for the similar situation involving electric fields. In the latter case, two well established methods are found to disagree on the electric permittivity.

Issues related to regularizing thermo and magnetic contributions within nonrenormalizable theories

Ricardo Luciano Sonego Farias

(Universidade Federal de Santa Maria)

The importance of implementing a proper regularization procedure in order to treat thermo and magnetic contributions within nonrenormalizable theories is investigated. Our recent works suggest that potential divergences should be isolated into the vacuum and purely magnetic contributions and then regularized, while the convergent thermomagnetic contributions should be integrated over the full momentum range. We call this procedure vacuum magnetic regularization (VMR) scheme, in which divergent quark mass independent contributions are not subtracted, thereby avoiding unphysical results e.g. for the renormalized magnetization. Our results are in very good agreement with lattice data indicating a paramagnetic behavior for quark matter. Within VMR scheme we also consider the effect of a constant anomalous magnetic moment (AMM) of quarks in the chiral symmetry restoration at strong magnetic fields.

Strange magnetars admixed with fermionic dark matter

Eduardo S. Fraga

(UFRJ)

We discuss strange stars admixed with fermionic dark matter in the presence of a strong magnetic field using the two-fluid Tolman-Oppenheimer-Volkov equations. We describe strange quark matter using the MIT bag model and consider magnetic fields in the range ∼1017−1018 G. For the fermionic dark matter, we consider the cases of free particles and strongly self-interacting particles, with dark fermion masses m=5,100,500 GeV. Even though strong magnetic fields contribute to decreasing the total mass of the star, they attenuate the rate of decrease in the maximum mass brought about by increasing the dark matter fraction in the admixed system.

Chiral anomaly and the interpretation with spacetime dependent electromagnetic fields

Kenji Fukushima

(University of Tokyo)

There are lots of investigations of electromagnetic effects assuming homogeneous field profiles. It is still challenging to cope with spacetime dependent electromagnetic fields systematically. As a simple but nontrivial example, I will introduce a standing wave that solves free Maxwell equations and nevertheless has nonzero inner product of electric and magnetic fields (and thus chiral anomaly). In this case, unlike homogeneous fields inducing particle production, the physical interpretation turns out to be quite nontrivial. I will also explain our recent efforts to try to approach such systems using the Floquet theory.

Electric and magnetic field effects, including temperature, on a scalar self interacting theory

λφ 4 theory

Marcelo Loewe

(Pontificia Universidad Católica de Chile)

We will analize different effects due to the presence of an external electric field, including also a magnetic field and temperature, on a self-interacting scalar charged field according to the λφ 4 theory. The physical scenario corresponds to heavy-light nuclei relativistic collisions (like Cu-Au) where, due to the imbalance in the number of protons, an electric field appears together with the usual external magnetic field generated during the collision. Thermal effects are also present. We will explore the occurrence of electric anti-catalysis, the dependence of the mass on the different effects mentioned above, discussing also the behavior of the residues of renormalons in the theory.

Effects of Strong Electric and Magnetic Fields in Superdense Matter

Manuel Malheiro

(Instituto Tecnologico da Aeronautica)

We will discuss the important effects of Strong Electric and Magnetic Fields in Superdense Matter inside neutron stars, white dwarfs, and possibly in quark stars. We will show that when these stellar fields are very strong, some others of magnitude larger than the ones at the star's surface, they can deform the stars. Electric fields - due to a quite small net difference between the number density of positive and negative charged particles when compared to the total particle number density presented inside these compact objects - can increase their masses and enlarge their radii. For the case of strong and constant magnetic fields in the star interior, their effects generate a pressure parallel to the magnetic field direction larger than the perpendicular one, breaking the spherical symmetry. These investigations are particularly relevant for magnetars, and also to very fast and magnetic white dwarfs, recently discovered in binary systems but also in isolated stars [1]. Finally, we will show that the electron capture nuclear process and pycnonuclear fusion reactions can impose limits on the intensity of these magnetic fields in the stellar interior [2].

[1] - E. Otoniel, M. Malheiro, j. Coelho, and F. Weber - "Fast-spinning and Highly Magnetized White Dwarfs", chapter 4 of the forthcoming volume "Astrophysics in the XXI Century with Compact Stars", Word Scientific, January 2023 - https://doi.org/10.1142/11848

[2] – M. Malheiro, E. Otoniel, and J. Coelho - "Relevance of Dynamical Nuclear Processes in Quantum Complex Systems of Massive White Dwarfs", Brazilian Journal of Physics volume 51, pages 223–230 (2021) - https://doi.org/10.1007/s13538-020-00840-0

Fermion mass and width in QED in a magnetic field

Enrique Munoz

(Pontificia Universidad Católica (PUC))

We revisit the calculation of the fermion self-energy in QED in the presence of a magnetic field. We show that, after carrying out the renormalization procedure and identifying the most general perturbative tensor structure for the modified fermion mass operator in the large field limit, the mass develops an imaginary part. This happens when account is made of the subleading contributions associated to Landau levels other than the lowest one. The imaginary part is associated with a spectral density describing the spread of the mass function in momentum. The center of the distribution corresponds to the magnetic-field modified mass. The width becomes small as the field intensity increases in such a way that for asymptotically large values of the field, when the separation between Landau levels becomes also large, the mass function describes a stable particle occupying only the lowest Landau level. For large but finite values of the magnetic field, the spectral density represents a finite probability for the fermion to occupy Landau levels other than the lowest Landau level.

Aspects of Chiral Symmetry Breaking in RQED.

Alfredo Raya Montaño

(Universidad Michoacana de San Nicolás de Hidalgo)

Mixed dimensional theories represent an excellent framework to study 2D materials. In this talk I discuss recent advances in the problem of Chiral symmetry breaking, parity violation and gauge invariance in Reduced QED.

Magnetic screening mass for neutral pions

Luis Alberto Hernández Rosas

(Universidad Autónoma Metropolitana-Iztapalapa)

In this talk, we will present the result of the magnetic screening mass for the neutral pion within the Linear Sigma Model with quarks. The results are valid for all ranges of magnetic field strength and are computed up to 1-loop order. We will discuss the isolation of the vacuum pieces in the computation of the self-energies and the relevance of including corrections in the coupling constants.

Mesons under strong magnetic field in the NJL model

Norberto Scoccola

(Comisión Nacional de Energía Atómica)

The effect of a strong magnetic field on the masses of pseudoscalar and vector mesons is analyzed using an extended version of the Nambu-Jona-Lasino model. The analysis takes into account the mixing effects induced by the magnetic field. The importance of a proper treatment of the Schwinger phase that appears in the calculation of the charged meson properties is discussed.

IFT-Colloquium: Electromagnetic probes of magnetized quark-gluon plasma

Igor Shovkovy

(Arizona State University)

Electromagnetic probes, such as photon and dilepton emission, are invaluable tools for characterizing the properties of quark-gluon plasma produced in heavy-ion collisions. Not only can they tell the temperature of the plasma but also its magnetic field. I will review recent results for the photon and dilepton emission from a strongly magnetized quark-gluon plasma. In the leading order, the corresponding rates are determined by the absorptive part of the photon polarization tensor. I will discuss the energy and angular dependence of the corresponding differential rates. The theoretical predictions reveal that the photon and dilepton emissions can be highly anisotropic. The rates also depend nontrivially on the transverse momentum and the invariant mass. I will argue that the observed large ellipticity of the direct photon emission may indicate the presence of a strong magnetic field in heavy-ion collisions. I will also claim that the future measurements of the dilepton rate in the region of small invariant masses can reconfirm this claim and constrain the value of the magnetic field in the plasma.

Vladimir Skokov

(North Carolina State University)

Search for the Chiral Magnetic Effect in Heavy-ion Collisions

Gang Wang

(University of California, Los Angeles)

The quark-gluon plasma created in high-energy heavy-ion collisions has been conject to exhibit a spontaneous electric-charge separation in the direction of a strong mag field through the chiral magnetic effect (CME). The experimental confirmation of the in heavy-ion collisions will uncover fundamental aspects of strong interaction physi such as the QCD chiral symmetry restoration and the topological configurations of no gauge fields. Over the past decade, the experiments at RHIC and the LHC have perform a series of charge-separation measurements in Pb+Pb collisions at $\sqrt{s_{\rm NN}} in Au+Au at various beam energies from 200 GeV down to 7.7 GeV, and in different col including p+Au, d+Au, Cu+Cu, Au+Au and U+U collisions, as well as the recent isobari Multiple analysis methods have also been developed to manifest the charge separation and suppress the flow related background. In this talk, we will review the aforement summarize our current understanding, and provide an outlook on future analyses.

Finite Energy Sum Rules at finite magnetic fields: advances and perspectives

Cristian Villavicencio

(Universidad del Bio-Bio (UBB) - Chillán, Chile)

During the last years we have been developing the Finite Energy Sum Rules (FESR) considering external magnetic fields, obtaining the magnetic evolution of different parameters, from both the QCD and hadronic sectors. In this presentation I will show the techniques developed by taking into account some of the advantages of FESR, challenges and limitations of this method as well as other kinds of sum rules.

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Contributed talks

Magnetising the N = 4 Super Yang-Mills plasma

Alfonso Ballon-Bayona

(Rio de Janeiro Federal University)

We investigate the thermodynamics of the 5d anisotropic magnetic AdS black brane solution found by D'Hoker and Kraus. This solution is the gravity dual of a strongly coupled N=4 Super Yang-Mills plasma in the presence of a magnetic field. Following the procedure of holographic renormalisation we calculate the Gibbs free energy and the holographic stress tensor of the conformal plasma. We evaluate several thermodynamic quantities including the magnetisation, the anisotropic pressures and the speeds of sound. We also perform a phenomenological analysis where we compare the thermodynamics of a magnetised conformal plasma against the lattice QCD results for the thermodynamics of the magnetised quark-gluon plasma.

Reference: https://link.springer.com/article/10.1007/JHEP06(2022)154

Probing electromagnetic field with charge dependence of directed flow in STAR experiment at RHIC

Ashik Ikbal Sheikh

(Kent State University)

Strong electromagnetic fields produced in the early stages of heavy-ion collisions can lead to splitting of the rapidity-odd directed flow (v_1) of positive and negative hadrons. However, the interpretation of such measurements with light hadrons is complicated by the low magnitude of directed flow at mid-rapidity or higher beam energy, as well as by ambiguities arising from transported quarks (u, d). In order to avoid such complications, we focus on the particle species where all constituent quarks are produced ($\bar{u}$, $\bar{d}$, s, $\bar{s}$), as opposed to possibly transported, and demonstrate using a novel analysis method that the coalescence sum rule holds for hadrons with identical quark content. We examine the coalescence sum rule as a function of rapidity for non-identical quark content having the same/similar mass at constituent level but different electric charge (Δq) and strangeness (ΔS). The difference in the directed flow of different quark and anti-quark combinations, e.g., $v_1(\Omega^{-}(sss)) – v_1(\bar{\Omega}^{+}(\bar{s}\bar{s}\bar{s}))$, is a measure of coalescence sum rule violation, and we call it directed flow splitting (Δv_1) between quarks and anti-quarks. First we measure v_1 as a function of rapidity; and then we estimate Δq and ΔS dependence of the Δv_1-slope ($d\Delta v_1/dy$) between produced quarks and anti-quarks in Au+Au collisions at $\sqrt {s_{NN}} =$ 27 GeV and 200 GeV. The $d\Delta v_1/dy$ increases when Δq and ΔS increase. This $d\Delta v_1/dy$ signal becomes stronger going from collision energy $\sqrt{s_{NN}}=$ 200 GeV to 27 GeV. We compare our measurements with the Parton-Hadron String Dynamics (PHSD) model calculations including electromagnetic field.

Statistical interaction for quasi-particles

Gabriel Brandao de Gracia

(Unesp-IFT)

In this paper we perform the analysis of the Chern Simons (CS) system coupled to topological two band models that arise in the low energy regime of planar materials. We show that the Hall conductivity due to an external magnetic field, modeled by the (CS) model, is shifted by a factor proportional to the topological Chern number of the matter field. We also calculate the renormalized propagator for the case in question in which the drift velocity of the quasi-particles (QP) are different from the light one. Regarding the fermionic response, we demonstrate that depending on the relative signal between the CS coefficient and the mass of the (QP) a fermionic response with non trivial topological properties may arise. In order to investigate these effects we use the Kugo-Ojima-Nakanishi formalism to obtain the model's complete commutators and, from them, using the energy positivity condition, we can build the relevant time ordered objects studied here. We explore the connection between the general non-perturbative constraints and the explicit results from the perturbative solution.

The magnetic field independent regularization applied to light meson masses: the neutral ρ meson case

William Rafael Tavares

(Universidade Federal de Santa Catarina)

The behavior of light meson masses under strong magnetic fields has attracted the attention of the theory and lattice QCD (LQCD) community in the last few years. These results can be important to investigate various aspects of the QCD under strong magnetic fields and to test the predictions of effective theories/models. In the context of the two flavor Nambu-Jona-Lasinio model (SU(2) NJL), it is possible to compute the masses of light mesons in the usual random phase approximation (RPA). Although there are good results from effective models available, these masses can be strongly affected by the choice of unsatisfactory regularization methods, which can induce several non-physical behaviors.

In this talk, we revisit some essential aspects of the regularization procedures in the context of the SU(2) NJL model under strong magnetic fields. Since it is a nonrenormalizable model, the vacuum contributions must be regularized. In the presence of magnetic fields, we can briefly classify two central procedures, the magnetic field independent regularization (MFIR) and the non-MFIR methods. In the first, the complete separation of the vacuum divergences from the magnetic field is performed, while in the second all contributions are entangled in the same scheme. Then, we show that the MFIR procedures are the most physically acceptable when applied to various physical quantities, e.g., the quark condensate. We present some results regarding the masses and properties of π, σ and ρ mesons as functions of the magnetic field.

Applying the MFIR procedure, we also investigate the case of the neutral ρ meson pole-mass for each spin polarization,$s_z=0,\pm 1$. We observe that the mass of neutral ρ meson with polarization $s_z=\pm 1$ increases as a function of the magnetic field in good agreement with different lattice QCD data and with a moderate intensity when compared with the previous calculation of the SU(2) NJL model with a non-MFIR method.

The mass of the neutral ρ meson with $s_z=0$, on the other hand, disagrees with available lattice QCD results, indicating that more sophisticated improvements in both model and lattice calculations should be made in the future. However, it is clear that MFIR avoids non-physical behavior in quark and meson masses compared with previous SU(2) NJL results. We also present an analysis of the dependence of model parameters on stable and resonance states of the neutral ρ meson.

Magnetic field effect on Higgs boson production rate through gluon fusion

Jorge Igor Jaber-Urquiza

(Facultad de Ciencias - UNAM)

In this talk, we explore the effects of a weak magnetic field on the Higgs boson production through gluon fusion cross section.

For this purpose, we define an “effective vertex” and analyze its tensorial structure and properties. We also show an alternative method to perform the momentum integrals to obtain a reduce and complete expression with no approximations.

Then, since the analytical computation of the cross section needs some approximation, we study the low transverse momentum limit.

QCD pressure at finite temperature and high magnetic fields

Tulio Eduardo Restrepo

(Universidade Federal do Rio de Janeiro)

We present the perturbative QCD pressure up to next to leading order at finite temperature and extremely high magnetic fields. For our calculations we used the physical quark masses and different magnetic field dependence of the coupling constant which significantly affects the results for lower temperatures and higher magnetic fields . We found that the exchange contribution to the pressure is relevant at intermediate temperatures, $T\lesssim 0.3$ GeV, and it increases with the magnetic field.

Exploring the effects of Delta Baryons in magnetars

Kauan Marquez

(Universidade Federal de Santa Catarina)

Strong magnetic fields can modify the microscopic composition of matter with consequences on stellar macroscopic properties. Within this context, we study, for the first time, the possibility of the appearance of spin-3/2 Δ baryons in magnetars. We make use of two different relativistic models for the equation of state of dense matter under the influence of strong magnetic fields considering the effects of Landau levels and the anomalous magnetic moment (AMM) proportional to the spin of all baryons and leptons. In particular, we analyze the effects of the AMM of Δ baryons in dense matter for the first time. {We also obtain global properties corresponding to the EoS models numerically and study the corresponding role of the Δ baryons.} We find that they are favored over hyperons, which causes an increase in isopin asymmetry and a decrease in spin polarization. We also find that, contrary to what generally occurs when new degrees of freedom are introduced, the Δs do not make the EoS significantly softer and magnetars less massive. Finally, the magnetic field distribution inside a given star is not affected by the presence of Δs.

Lattice QCD with an inhomogeneous magnetic background

Dean Valois

(Bielefeld University)

The magnetic fields generated in non-central heavy-ion collisions are among

the strongest fields produced in the universe, reaching magnitudes comparable to the scale of strong interactions. Model simulations indicate that the resulting field is spatially modulated, deviating significantly from the commonly considered uniform profile. In this work, we present the next step to improve our understanding of the physics of quarks and gluons in heavy-ion collisions by adding an inhomogeneous magnetic background to our lattice QCD simulations. We simulate 2 + 1 staggered quarks with physical masses for a range of temperatures covering the QCD phase transition. We assume a 1/ cosh(x)^2

function to model the field profile and vary its strength to analyze the impact on the chiral condensate and the Polyakov loop. These order parameters show non-trivial spatial features due to the interplay between the sea and the valence effects as the system approaches the crossover temperature. We extrapolate these quantities to the continuum limit, draw the phase diagram in the T-B plane and interpret the implications of an inhomogeneous B to heavy-ion collision physics.

Signatures of the Yang-Mills deconfinement transition from the gluon two-point correlator

Duifje van Egmond

(CPHT, Ecole Polytechnique)

We evaluate the longitudinal or (chromo-)electric Yang-Mills gluon propagator in the recently proposed center-symmetric Landau gauge at finite temperature [1]. To model the effect of the Gribov copies in the infrared, we use the Curci-Ferrari model which, in turn, allows us to rely on perturbative calculations. At one-loop order in the SU(2) case, the so-obtained longitudinal gluon propagator provides a clear signature for Z2 center-symmetry breaking with a singular behavior, characteristic of a continuous phase transition. This is in sharp contrast with what is found within the standard Landau gauge. We also identify various signatures for Z3 center-symmetry breaking in the SU(3) case in the form of genuine order parameters. Among those, we find that the gluon propagator, although degenerate along the diagonal color directions in the confining phase, becomes non-degenerate in the deconfined phase. Our results open new ways of identifying the transition from correlation functions both within continuum approaches and on the lattice.

Strange dwarfs and the question of their dynamical stability

José Carlos Jiménez Apaza

(USP)

The strange quark matter hypothesis opened up the possibility of having new families of compact and not too compact stars such as quark stars and strange dwarfs, respectively. In particular, the latter represents a generalization of the usual white-dwarf branch of stellar objects where quark matter is present at their cores.

Nevertheless, in spite of being proposed to exist in Nature in 1995 by Glendenning, Kettner and Weber, they are still studied in very simplified models for quark matter such as the bag model within a very narrow range of strong-interaction parameters having no direct theoretical justification for choosing them. Some recent works have proposed that these strange dwarfs might exist under some conditions and in other cases they are forbidden at all. In this presentation I will give results for their dynamical stability against radial oscillations when using instead an equation of state obtained from cold and dense perturbative QCD. For robustness, we have also explored the possibility for these objects to carry non-vanishing amounts of electric charge and their effects on the strange-dwarf stability.

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Posters

Magnetic field driven enhancement of the weak decay width of charged pions within NJL model

Maximo Coppola

(National Atomic Energy Commission)

The presence of a uniform magnetic field B gives rise to the emergence of four charged pion decay constants. Taking the values of these constants from a chiral effective Nambu-Jona-Lasinio (NJL) model, we study the effect of the magnetic field on the weak decays of charged pions.

It is seen that the total decay rate gets strongly increased with respect to the B=0 case, with an enhancement factor ranging from ~10 for eB=0.1 GeV^2 up to ~10^3 for eB=1 GeV^2. The ratio between electronic and muonic decays gets also enhanced, reaching a value of about 1 : 2 for eB=1 GeV^2. In addition, we find that for large B the angular distribution of outgoing antineutrinos shows a significant suppression in the direction of the magnetic field.

To be announced

JORGE CASTANO YEPES

(Institute of physics, Pontificia Universidad Católica de Chile)

To be announced

Linear response hydrodynamics of a relativistic dissipative fluid with spin

David Montenegro

(Joint Institute for Nuclear Research)

We formulate a lagrangian hydrodynamics including shear and bulk viscosity in the presence of spin density, and investigate it using the linear response functional formalism. The result is a careful accounting of all sound and vortex interactions close to local equilibrium.

Quark anomalous magnetic moment: effects on QCD phase diagram

Rafael Pacheco Cardoso

(Universidade Federal de Santa Catarina)

The Nambu--Jona-Lasinio (NJL) model is one of the most accepted effective models in Quantum Chromodynamics (QCD). Its role in understanding the dynamic chiral symmetry-breaking mechanism is one of its greatest features. The anomalous magnetic moment (AMM), described by Julian Schwinger in 1948 for the electrons, has been a major subject of discussion for the leptonic sector of the Standard Model until nowadays. How the AMM effect plays on QCD phase diagrams remains an open question, but recent works have shown that it can be related to the inverse magnetic catalysis effect. From some works on Quantum Electrodynamics and using the Schwinger--Fock gauge, we obtain an integral representation of the lagrangian density of the NJL--SU(2) model under strong electromagnetic fields. Applying different regularization schemes, we compute important quantities such as effective mass, the pseudocritical temperature and compare them with the case where the AMM is zero.

Study of the pole mass of mesons in strong magnetic fields through Ritus method of eigenfunctions

Joana Carolina Sodré

(UFSC)

In this work we use the Nambu--Jona-Lasinio model in $SU(3)$ with the 't Hooft determinant to calculate the pole mass of mesons of the mesonic octet in a constant magnetic field.

To do such calculations, we need first to bosonize the lagrangian, since this procedure emphasizes the relations between the physical quantities, like the quark condensate. We do this using the stationary phase approximation (SPA), which is more appropriate for the $SU(3)$ NJL model. After this, we do the mean field approximation and calculate the second order fluctuations, so we can find the polarization functions of the mesons. For the charged mesons, we use the Ritus eigenfunction method to diagonalize the polarization functions and for the neutral mesons, we apply the usual momentum basis.

As the NJL model is not renormalizable, we need a proper regularization method, and for this, we choose the Magnetic Field Independent Regularization (MFIR). From this, we can find numerically the pole masses of the mesons using the regularized polarization function. With such calculations, we can see that the masses of the charged mesons increase as a function of the magnetic field, while the neutral mesons show a non-monotonous behavior when we consider a constant coupling. If we use a magnetic field depending coupling, the pole masses of the neutral mesons decrease monotonously, while the behavior of the charged mesons is still the same. In the later, such behaviors agree with the results in the lattice (LQCD). These techniques can be extended for the future calculation of decay constants and also for the coupling constant between quarks and mesons.

Transport coefficients and quasinormal modes in Einstein-dilaton Holography

Nairy Aleximar Villarreal

(Universidad Federal do ABC)

In this work we study the thermodynamics and calculate the transport coefficients of a non-conforming plasma based on an effective holographic model for QCD, which arises from a 5-dimensional Einstein-Dilaton theory.

The model chosen here is characterized by an AdS black hole spacetime asymptotically coupled to a scalar or dilation field. The dilatonic field is considered dual to a deformation by an operator in the conformal field theory (CFT) of the limit. The inclusion of this field leads to an explicit breaking of the conformal symmetry. To account for finite temperature effects, we consider the solutions of the Einstein-Dilaton action, where the Hawking temperature of the black hole is identified with the plasma temperature of the dual theory. We show the existence of a minimum temperature T_{min}, above which two possible solutions appear: one identified with the large black holes and the other with the small black holes. The results found for thermodynamic quantities, such as entropy, specific heat and speed of sound, are consistent with other holographic models. Investigating perturbations in the metric and dilaton, we also obtained the shear coefficient of viscosity η from a direct comparison of the dispersion relations of the fluctuations with the modes of relativistic hydrodynamics and we obtained the quasinormal modes using the pseudospectral method in the tensor and vectorial sectors.We observe an increase in the real part of the frequency and a decrease in the values of the imaginary part, in particular the hydrodynamic mode in the vector sector compared to the conformal plasma value.