

# **XIV Hadron Physics 2018**

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## **Book of Abstracts**



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## Opening

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## Registration

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## Celebration session - 30th anniversary of the International Workshop on Hadron Physics

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**Summary:**

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## Poster Prizes & General Assembly

**Monday Posters / 13**

### Many-body forces in magnetic neutron stars

**Author:** Rosana Gomes<sup>1</sup>

**Co-authors:** Bruno Franzon<sup>1</sup>; Veronica Dexheimer<sup>2</sup>; Stefan Schramm

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In this work, we study in detail the effects of many-body forces on the equation of state and the structure of magnetic neutron stars.

The stellar matter is described within a relativistic mean field formalism that takes into account many-body forces by means of a non-linear meson field dependence on the nuclear interaction coupling constants. We assume that matter is at zero temperature, charge neutral, in beta-equilibrium, and populated by the baryon octet, electrons, and muons. In order to study the effects of different degrees of stiffness in the equation of state, we explore the parameter space of the model, which reproduces nuclear matter properties at saturation, as well as massive neutron stars.

Magnetic field effects are introduced both in the equation of state and in the macroscopic structure of stars by the self-consistent solution of the Einstein-Maxwell equations. In addition, effects of poloidal magnetic fields on the global properties of stars, as well as density and magnetic field profiles are investigated. We find that not only different macroscopic magnetic field distributions, but also different parameterizations of the model for a fixed magnetic field distribution impact the gravitational mass, deformation and internal density profiles of stars. Finally, we also show that magnetic fields affect significantly the particle populations of stars.

**Summary:**

**Monday Posters / 14**

## **Sigma resonance parameters from lattice QCD**

**Authors:** Raquel Molina Peralta<sup>None</sup>; Andrei Alexandru<sup>1</sup>; Dehua Guo<sup>1</sup>; Michael Doring<sup>1</sup>

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The sigma resonance has been a long standing puzzle in both, theory and experiment. Because its non-Breit Wigner shape, the extraction of its properties is not straightforward. Dispersive analysis techniques are needed to extract the properties of the resonance. Lately, several lattice data groups have performed a calculation of phase shifts for  $\pi\pi$  scattering in the Isospin = 0, Spin = 0 channel. Unitary Chiral Perturbation Theory provides a framework which is based in chiral symmetry and unitarity constraints useful to extract the properties of resonances from the lattice. The formalism is implemented in the finite volume to analyse the energy levels extracted from the lattice data. Then, the pion mass dependence is investigated providing extrapolations to the physical point.

**Summary:**

**Tuesday Posters / 15**

## **Exploring the decay probability of neutron-rich superheavy nuclei**

**Author:** Brett Vern Carlson<sup>1</sup>

<sup>1</sup> *Instituto Tecnológico de Aeronáutica (ITA), Sao Jose dos Campos 12228900, Sao Paulo, Brazil*

The modes of decay of the even-even isotopes of superheavy nuclei of  $Z = 118$  and  $120$  with neutron number  $160 \leq N \leq 204$  are investigated in the framework of the axially deformed relativistic mean field model. The asymmetry parameter  $\eta$  and the relative neutron-proton asymmetry of the surface to the center  $R_\eta$  are estimated from the ground state density distributions of the nucleus. We analyze the resulting asymmetry parameter  $\eta$  and the relative neutron-proton asymmetry  $R_\eta$  of the density, which play a crucial role in the mode(s) of decay and half-life. Moreover, the excess neutron richness on the surface is found to be an important factor for the  $\beta^-$  decay of a superheavy nucleus.

**Summary:**

**Tuesday Posters / 16**



## Extreme binding energy limit for a fermionic system.

**Authors:** Abigail Castro<sup>1</sup>; Eduardo Scaff<sup>None</sup>; Wayne de Paula<sup>None</sup>

<sup>1</sup> ITA

In this work we discuss the two-fermions bound state problem in the extreme binding energy limit. To this end, we solve the Bethe-Salpeter equation in Minkowski space for the Yukawa model, where the interaction boson is a vector particle. We use the Nakanishi Integral Representation, which simplifies the interaction Kernel of the system. Furthermore, we use the light-front projection which eliminates singularities from the Bethe-Salpeter amplitude. Finally, we obtain an integral equation which we solve numerically.

**Summary:**

Tuesday Posters / 17

## Thermodynamic consistency in magnetized neutron stars

**Authors:** Luiz Lopes<sup>1</sup>; Debora Menezes<sup>2</sup>

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In this work we show how to introduce the magnetic field in hadronic matter in a thermodynamically consistent way. We revisit the literature and show that several common results that are derived magnetic field on hadronic matter are thermodynamically inconsistent and that affects the mass-radius results.

Utilizing the so called chaotic magnetic field [1,2,3,4] we show that a thermodynamically consistent way is possible and give us more reliable results.

[1] Ya. B. Zel'dovich, I. D. Nivikov it Stars and Relativity, Dover, New York (1996)

[2] C. W. Misner, Kip S. Thorne, J. A. Wheeler Gravitation, Freeman and Company, San Francisco (1973)

[3] L. Lopes, D. Menezes, JCAP 08 (2015) 002

[4] L. Lopes, D. Menezes, Eur. Phys. J. A, 52 2 (2016) 17

**Summary:**

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## An effective holographic approach to QCD

**Authors:** Alfonso Ballon Bayona<sup>None</sup>; Henrique Boschi Filho<sup>None</sup>; Luis A H Mamani<sup>None</sup>; Alex S Miranda<sup>None</sup>; Vilson T Zanchin<sup>None</sup>

I will describe a holographic approach to QCD where conformal symmetry is broken explicitly in the UV by a relevant operator  $O$ . This operator maps to a five dimensional scalar field, the dilaton, with a massive term. Implementing also the IR constraint found by Gursoy, Kiritsis and Nitti, an approximate linear glueball spectrum is obtained which is consistent with lattice data. Finally, I will describe the evolution of the model parameters with the conformal dimension of  $O$ . This will suggest a map between the QCD anomaly and the trace anomaly of deformed Conformal Field Theories.

**Summary:****Monday Posters / 19****Covariant quark model for the electromagnetic structure of light nucleon resonances****Author:** Gilberto Ramalho<sup>1</sup><sup>1</sup> *Universidade Cruzeiro do Sul***Corresponding Author:** gilberto.ramalho2013@gmail.com

The Covariant Spectator Quark Model, successful in the description of the nucleon elastic form factors revealed by the Jefferson Lab polarization transfer experiments, has been extended to the calculation of transition form factors associated to several light nucleon resonances  $N^*$ . The electromagnetic structure of the  $N^*$  are characterized by the  $\gamma^* N \rightarrow N^*$  transition form factors. Combining the electromagnetic structure of the constituent quarks, calibrated by the nucleon data, with appropriated ansatz for the radial wave functions of the resonances, we are able to estimate the transition factors for the resonances  $N(1440)_{\frac{1}{2}}^+$ ,  $N(1535)_{\frac{1}{2}}^-$  and  $N(1520)_{\frac{3}{2}}^-$ , based on the parametrization of the nucleon radial wave function (nucleon shape) with no adjustable parameters. The calculations take into account exclusively the effect of the valence quarks and are in good agreement with the data for momentum transfer  $Q^2 > 2 \text{ GeV}^2$ , with a few exceptions. The exceptions are discussed in terms of the role of the valence quarks and the meson cloud. All the estimates are based on the parametrization of the nucleon structure, and can be tested in a near future for large transfer momentum at the Jefferson Lab (12 GeV upgrade).

The model can also be extended to the  $\Delta(1232)_{\frac{3}{2}}^+$ , with the assistance of the results from lattice QCD, to estimate the radial wave function of the  $\Delta(1232)$  valence quark core. The model estimates are in agreement with the empirical data when theoretical and phenomenological parametrizations of the pion cloud are taken into account.

**Summary:**

I wrote the abstract at the “content”

**Monday Posters / 20****Effects of Hyperons on the Structure of Neutron Stars****Author:** José Carlos de Oliveira<sup>1</sup>**Co-authors:** Hilário Rodrigues<sup>2</sup>; Sérgio B. Duarte<sup>3</sup>; Marcelo Chiapparini<sup>4</sup><sup>1</sup> *Federal University of Roraima*<sup>2</sup> *Centro Federal de Educação Tecnológica Celso Suckow da Fonseca (CEFET-RJ)*<sup>3</sup> *Centro Brasileiro de Pesquisas Físicas (CBPF/RJ)*<sup>4</sup> *Universidade do Estado do Rio de Janeiro - UERJ***Corresponding Author:** jctobvb@bol.com.br

In the present work we have obtained the equation of state and the population of baryons and leptons to the highly asymmetric dense stellar matter, with the purpose of studying the effects of hyperons on the structure of neutron stars. To this end, we adopted the Zimanyi-Moszkowski model in the mean field approximation. From the equation of state obtained with the model, we solve numerically the Tolman-Oppenheimer-Volkoff (TOV) equation to the internal structure of neutron stars.

**Summary:****Tuesday Posters / 21****Rescattering of  $J/\psi$  in the hadronic medium : an update using coupled channel unitarized amplitudes****Authors:** Erich Cavalcanti<sup>1</sup>; Adolfo P. C. Malbouisson<sup>1</sup>; Luciano Abreu<sup>2</sup><sup>1</sup> *CBPF*<sup>2</sup> *UFBA (Federal University of Bahia)***Corresponding Author:** erichcavalcanti@gmail.com

It is expected that the charmonium state  $J/\psi$  produced during the hadronization of the quark-gluon plasma suffers a rescattering process between the chemical freeze-out and the kinetical freeze-out. We present an updated study of the suppression and generation of the  $J/\psi$  meson due to its interaction with a hadronic medium composed of light pseudo-scalar (as  $\pi, K, \eta$ ) and vector mesons (as  $\rho, K^*, \omega$ ). The absorption (production) cross-sections are obtained considering s-wave processes with the channels  $J/\psi + (\pi, \rho, K, K^*, \eta, \omega)$  in initial (final) state.

The meson-meson interactions are described using a chiral unitary approach with a  $SU(4)$  effective Lagrangian. The symmetry is explicitly broken to  $SU(3)$  by suppression of the interactions driven by charmed mesons.

**Summary:****Nuclear Astrophysics in the new era of multi-messenger Astronomy / 23****Nuclear Astrophysics in the new era of multi-messenger Astronomy****Author:** Jorge Piekarewicz<sup>1</sup>

<sup>1</sup> *Florida State University*

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Neutron stars are unique cosmic laboratories for the exploration of matter under extreme conditions of density and neutron-proton asymmetry. Due to their enormous dynamic range, neutron stars display a myriad of exotic states of matter that are impossible to recreate under normal laboratory conditions. In this presentation I will discuss how the combination of nuclear physics insights together with modern theoretical approaches pave the way to our understanding of these fascinating objects. Finally, connections will be made to the historical first detection of gravitational waves from the binary neutron-star merger GW170817.

**Summary:**

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## **An empirical Equation of State for nuclear physics and astrophysics**

**Authors:** Debarati Chatterjee<sup>1</sup>; Francesca Gulminelli<sup>2</sup>

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<sup>2</sup> *LPC Caen*

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In order to describe astrophysical phenomena such as glitches, X-ray bursts or oscillations in neutron stars, it is essential to understand the properties of its crust and core as well as their interface. In order to achieve this, it is crucial to develop a unified and consistent scheme to describe both the finite nuclei in the crust and homogeneous matter in the core within the same framework. We employ a recently developed metamodel, based on the density functional theory, in which the Equation-of-State (EoS) of homogeneous matter is described in terms of empirical parameters measured in nuclear experiments. The metamodel is extended to describe non-homogeneous matter in the crust and tested against nuclear observables. This empirical EoS is then employed to study the liquid-phase phase transition that determines the crust-core interface of neutron stars.

**Summary:**

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## **A first survey of the ghost-gluon vertex in the Gribov-Zwanziger framework**

**Authors:** Bruno Mintz<sup>None</sup>; Leticia Palhares<sup>1</sup>; Antonio Duarte Pereira<sup>2</sup>; Silvio Paolo Sorella<sup>3</sup>

<sup>1</sup> *UERJ*

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In order to have a proper definition of a quantum nonabelian gauge theory, such as QCD, one needs to have a well-defined generating functional. In the perturbative regime at high energies, this can be achieved through the well-known Faddeev-Popov quantization procedure. For energy scales in which the coupling of the strong force becomes sufficiently high, the perturbative approach may

display some inconsistencies. One such problem is the so-called Gribov problem: in a gauge fixed theory, the ghost fields acquire a pole at finite (euclidean) momentum. Equivalently, the determinant of the Faddeev-Popov operator vanishes and the generating functional of the theory becomes void. In order to correct this problem (at least partially), Gribov suggested to restrict the functional integration of gauge fields to a subset of the field space, which is now called the Gribov region.

As this restriction of the gauge fields to the Gribov region is taken into account, it turns out that the resulting gauge field propagators display a nontrivial infrared behavior, being very close to the ones observed in lattice gauge field theory simulations. In this work, we explore for the first time a higher correlation function in the presence of the Gribov horizon: the ghost-anti-ghost-gluon interaction vertex, at one-loop level. Our analytical results (within the so-called Refined Gribov Zwanziger theory) are fairly compatible with lattice YM simulations, as well as with solutions from the Schwinger-Dyson equations. This is an indication that the RGZ framework can provide a reasonable description in the infrared not only of gauge field propagators, but also of higher correlation functions, such as interaction vertices.

**Summary:**

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## Probing soft QCD with exclusive reactions

**Author:** Roman Pasechnik<sup>1</sup>

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Exclusive diffractive reactions enable us to efficiently probe soft QCD dynamics in hadronic and nuclear collisions. The color dipole approach provides universal means to evaluate both the inclusive and diffractive particle production observables beyond the concept of QCD factorisation. I will overview the most recent developments in this research field, along with current theoretical and experimental studies.

**Summary:**

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## A quasi-particle equation of state with a phenomenological critical point for heavy-ion nuclear collisions

**Authors:** Wei-Liang Qian<sup>1</sup>; Honghao Ma<sup>2</sup>

<sup>1</sup> *University of Sao Paulo*

<sup>2</sup> *São Paulo State University*

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In this work, we propose a quasi-particle equation of state with a phenomenological critical point. The QGP phase of the model is determined by a quasi-particle model fitting to the Lattice QCD data. At zero baryon density, the model is smoothly connected to the hadronic resonance model. A phenomenological critical point is implemented in such a way when the baryon density increases and passes a critical value, the phase transition turns from a crossover into a first order phase transition. We apply the model to the study of relativistic heavy-ion collisions numerically by using a hydrodynamic model. The impact of the existence of the phenomenological critical point is addressed.

**Summary:**

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**Effects of strong magnetic fields on quark matter and neutral meson properties within nonlocal chiral quark models****Author:** Daniel Gomez Dumm<sup>1</sup><sup>1</sup> CONICET - University of La Plata, Argentina**Corresponding Author:** dgdumm@gmail.com

We study the behavior of strongly interacting matter under a strong external magnetic field in the context of chiral quark models that include nonlocal interactions. In particular, we analyze the influence of a constant magnetic field on the chiral quark condensates at zero and finite temperature, studying the deconfinement and chiral restoration critical temperatures and discussing the observed “magnetic catalysis” and “inverse magnetic catalysis” effects. In addition, we analyze in this framework the effect of the magnetic field on the properties of  $\pi^0$  and  $\sigma$  mesons. The predictions of nonlocal chiral quark models are compared with results obtained in lattice QCD.

**Summary:**

30

**Critical parameters of consistent relativistic mean-field models****Authors:** Odilon Lourenço<sup>None</sup>; Mariana Dutra da Rosa Lourenço<sup>1</sup>; Debora Menezes<sup>2</sup><sup>1</sup> Instituto Tecnológico de Aeronáutica<sup>2</sup> UFSC**Corresponding Author:** marianadutrarl@gmail.com

The critical parameters related to the liquid-gas phase transition are calculated for 34 relativistic mean-field models, which were shown to satisfy nuclear matter constraints in a comprehensive study involving 263 models. The compressibility factor was calculated and compared with the van der Waals equation of state. The critical temperatures were compared with experimental data and just two classes of models can reach values close to them. A correlation between the critical parameters and the incompressibility was obtained.

**Summary:**

31

**Precision QCD with tau decays****Author:** Diogo Boito<sup>1</sup><sup>1</sup> Universidade de São Paulo

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Hadronic tau decays remain an excellent laboratory for the study of many aspects of QCD. The inclusive decays have been used as a source of precise information about  $\alpha_s$  for the past 20 years. In the search for higher precision, partially triggered by the LHC, several aspects of this determination have been scrutinised in the recent past. The issues that arise are often of a fundamental nature. We will discuss problems pertaining to perturbative and non-perturbative QCD, with emphasis on renormalon singularities, scheme variations, and a novel approach to the violations of quark-hadron duality. The present status of  $\alpha_s$  from tau decays and perspectives for the future will be summarised.

**Summary:**

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## Implications of hadronic interactions in the Cosmic Ray and Neutrino Physics

**Author:** Victor Gonçalves<sup>1</sup>

<sup>1</sup> *Universidade Federal de Pelotas*

**Corresponding Author:** barros@ufpel.edu.br

A comprehensive study of the heavy quark production in ultra high energy cosmic ray interactions in the atmosphere is presented considering that the primary cosmic ray can be either a photon, neutrino or a proton. We show that the contribution of heavy quarks for cosmic ray interactions is in general non-negligible and can be dominant depending of the process considered. Moreover, we present a detailed mapping of the dominant kinematical domains contributing to the prompt atmospheric neutrino flux at high neutrino energies by studying its sensitivity to the cuts on several kinematical variables crucial for charm production in cosmic ray scattering in the atmosphere. We demonstrate that the production of neutrinos with energies larger than  $E_\nu > 10^7$  GeV is particularly sensitive to the center-of-mass energies larger than the ones at the LHC and to the longitudinal momentum fractions in the projectile  $10^{-8} < x < 10^{-5}$ , which are not currently under theoretical control. Our results indicate that the precision data on the prompt atmospheric neutrino flux can efficiently constrain the mechanism of heavy quark production and underlying QCD dynamics in kinematical ranges beyond the reach of the current collider measurements.

**Summary:**

**Magnetic catalysis in QCD in a superstrong magnetic field / 33**

## Magnetic catalysis in QCD in a superstrong magnetic field

**Author:** Igor Shovkovy<sup>1</sup>

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The study of quantum chromodynamics (QCD) in strong magnetic fields is a very popular direction of research. The interest to this topic is driven by the beauty of the underlying physics itself, as well as the promise of potential applications in studies of neutron stars, heavy-ion collisions, and the Early Universe. In particular, the magnetic catalysis and the inverse catalysis are the signature phenomena of QCD in superstrong magnetic fields. In this series of lectures, I will review the phenomenon of magnetic catalysis in a systematic way by starting from the basic underlying physics and an overview

of the key quantum-field theoretical techniques. Then, I will demonstrate how the general ideas apply to realistic gauge theories, such as QED and QCD. Finally, I will discuss the current state in the field and present an outlook for future studies.

**Summary:**

**Monday Posters / 34**

## Study In-Medium $K^+$ with a Symmetric Vertex in a Light Front Approach

**Author:** George Yabusaki<sup>1</sup>

**Co-authors:** Wayne de Paula<sup>2</sup>; João Pacheco De Melo<sup>3</sup>; Kazuo Tsushima<sup>4</sup>; Tobias Frederico<sup>2</sup>

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**Corresponding Author:** georgehy@ita.br

Using the light-front kaon wave function based on a Bethe-Salpeter amplitude model for the quark-antiquark bound state, we study the Electromagnetic Form Factor (EMFF) and other observables like charge radius and decay constant of the kaon in nuclear medium within the framework of light-front field theory. The kaon model we adopt is well constrained by previous and recent studies to explain its properties in vacuum. The in-medium kaon EMFF is evaluated for the + component of the electromagnetic current,  $J_+$ , in the Breit frame. In order to consistently incorporate the constituent up and anti-strange quarks of the kaon immersed in symmetric nuclear matter, we use the Quark-Meson Coupling (QMC) model, which has been widely applied to various hadronic and nuclear phenomena in a nuclear medium with success. We predict the in-medium modification of the kaon EMFF in symmetric nuclear matter. It is found that, after a fine tuning of the regulator mass, i.e.  $m_R = 0.600$  GeV, the model is suitable to fit the available experimental data in vacuum within the theoretical uncertainties, and based on this we predict the in-medium modification of the EMFF, charge radius and decay constant.

**Summary:**

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## Quark mass generation with Schwinger-Dyson equations

**Author:** A. C. Aguilar<sup>1</sup>

<sup>1</sup> *IFGW - Unicamp*

In this talk, I will present some the current efforts to understand the phenomenon of chiral symmetry breaking and the generation of a dynamical quark mass. To do that, we will use the framework of the Schwinger-Dyson equations. We will solve the coupled system of integral equations formed by the quark propagator and the complete non-transverse structure of the quark-gluon vertex, which is formed by four independent form factors. Particular attention is dedicated to guarantee the correct renormalization group behaviour of the quark dynamical mass and in the extraction of the phenomenological parameters such as pion constant decay.

**Summary:**



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## LHC measurements of QCD

**Author:** Arthur Moraes<sup>1</sup>

<sup>1</sup> CBPF - Brazilian Center for Physics Research (BR)

**Corresponding Author:** amoraes@cbpf.br

The talk will cover results from all LHC experiments (CMS, ATLAS and LHCb) on Z, photon and jet production in pPb and PbPb ion collisions, Heavy quark production Jet substructure and fragmentation, Double parton scattering.

**Summary:**

37

## BCS Pairing Gap in the Infrared Limit of the Similarity Renormalization Group

**Authors:** Sergio Szpigel<sup>1</sup>; Varese Salvador Timóteo<sup>None</sup>; Enrique Ruiz Arriola<sup>2</sup>

<sup>1</sup> Universidade Presbiteriana Mackenzie

<sup>2</sup> Universidad de Granada

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Effective interactions have been used to compute the pairing gap for nuclear and neutron matter in several schemes. Most often the BCS approach is based on having the scattering phase-shift as the basic input of the calculation. On the other hand, there is an arbitrariness in this procedure, as there are infinitely many interactions leading to the identical phase-shift. In this work we analyze the impact of phase-shift equivalent interactions within the BCS theory on the  $^1S_0$ -channel pairing gap for a translational invariant many-fermion system such as nuclear and neutron matter. We solve the BCS pairing gap equation on a finite momentum grid for a toy model separable Gaussian potential in the  $^1S_0$ -channel explicitly evolved through the Similarity Renormalization Group (SRG) transformation and show that in the on-shell and continuum limits the pairing gap vanishes. For finite size systems the momentum is quantized and the on-shell limit is realized for SRG cutoffs comparable to the momentum resolution. In this case the pairing gap can be computed directly from the scattering phase-shifts by an energy-shift formula

$$\Delta_{nn}(p_F) = \Delta\epsilon_F \delta_{nn}^{^1S_0}(p_F) / \pi,$$

where  $p_F$  is the Fermi momentum and  $\Delta\epsilon_F$  is the level spacing at the Fermi energy. While the momentum grid is usually used as an auxiliary way of solving the BCS pairing gap equation, we show that it actually encodes some relevant physical information, suggesting that in fact finite grids may represent the finite size of the system. For the harmonic oscillator shell model the level spacing at the Fermi energy becomes  $\Delta\epsilon_F = \hbar\omega \sim 41 A^{-1/3}$  MeV such that  $\Delta_{nn}(p_F) \sim 4 A^{-1/3}$  MeV. The comparison with double differences from binding energies of stable nuclei is satisfactory and the discrepancy with the large scale analysis may be attributed to three-body forces.

**Summary:**

Monday Posters / 38

## Surface tension of quark matter droplets in compact stars

**Authors:** Gabriela Grunfeld<sup>None</sup>; German Lugones<sup>1</sup>

<sup>1</sup> UFABC

**Corresponding Author:** ag.grunfeld@gmail.com

We study the surface tension and curvature energy of quark matter in astrophysical conditions, focusing specifically on the thermodynamic conditions prevailing in cold neutron stars and in hot lepton rich protonneutron stars. We analyze quark matter in chemical equilibrium under weak interactions, which is relevant for understanding the internal composition of hybrid stars, as well as “just deconfined” quark matter out of chemical equilibrium, which is the relevant thermodynamic state for describing the nucleation process of quark matter in compact stars. We explore the role of temperature, density, trapped neutrinos, droplet size and magnetic fields within the multiple reflection expansion formalism (MRE). Quark matter is described within the frame of different effective models: the MIT bag model and the SU(3)<sub>f</sub> Nambu-Jona-Lasinio model (NJL), including color superconductivity and neutrino trapping in both cases. We used as well a mixture of free Fermi gases composed of u, d, s quarks and electrons in chemical equilibrium under weak interactions, for studying magnetized quark matter. We explore some astrophysical consequences of our results.

**Summary:**

**Tuesday Posters / 39**

## Tracing the virtual nd state with Halo/cluster EFT

**Author:** Renato Higa<sup>1</sup>

<sup>1</sup> University of São Paulo

**Corresponding Author:** higa@if.usp.br

It is known that, at energies below the deuteron breakup, nd scattering in the doublet channel exhibits both a virtual state and a zero in the amplitude. We construct a halo/cluster EFT that takes both features into account, and follow the behavior of observables as we decrease the deuteron binding energy. Reaching the unitary limit, we demonstrate the nature of this virtual state associated to an excited Efimov state, confirming previous studies using phenomenological models.

**Summary:**

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## Confinement and deconfinement from lattice simulations

**Author:** Tereza Mendes<sup>None</sup>

**Corresponding Author:** mendes@ifsc.usp.br

We review methods and results for the study of color confinement in Yang-Mills theories using numerical simulations of infrared propagators in the lattice formulation. We discuss recent progress in considering finite-volume effects, different gauges and the finite-temperature case.

**Summary:**

**Monday Posters / 41****Effects of the ghost sector in gluon mass dynamics****Authors:** Clara Figueiredo<sup>None</sup>; Arlene Cristina Aguilar<sup>1</sup><sup>1</sup> UNICAMP, IFGW**Corresponding Author:** claratfigueiredo@gmail.com

In this work we investigate the effects of the ghost sector on the dynamical mass generation for the gauge boson of a pure Yang-Mills theory. The generation of a dynamical mass for the boson is realized by the Schwinger mechanism, which is triggered by the existence of longitudinally coupled massless poles in the fundamental vertices of the theory. The appearance of such poles occur by purely dynamical reasons and is governed by a set of Bethe-Salpeter equations. In previous studies, only the presence of massless poles in the background-gauge three-gluon vertex was considered. Here, we include the possibility for such poles to appear also in the corresponding ghost-gluon vertex. Then, we solve the resulting Bethe-Salpeter system, which reveals that the contribution associated with the poles of the ghost-gluon vertex is suppressed with respect to those originating from the three-gluon vertex.

**Summary:****Monday Posters / 42****Light-front wave functions for a two-fermion bound state in Minkowski space.****Authors:** Wayne de Paula<sup>1</sup>; Tobias Frederico<sup>1</sup>; Giovanni Salme<sup>2</sup>; Michele Viviani<sup>3</sup><sup>1</sup> Instituto Tecnológico de Aeronáutica<sup>2</sup> INFN - Universidade de Roma<sup>3</sup> Universidade de Pisa - INFN**Corresponding Author:** wayne@ita.br

Laboratories like JLAB, COMPASS and HERMES have dedicated programs focused on the investigations of Semi-inclusive DIS processes. Their results give an opportunity to reconstruct the 3D structure of the hadron, in particular, the Transverse Momentum Distributions (TMDs). Their findings can give insights about the internal hadron dynamics as quark-gluon correlations and final-state interactions. In order to obtain the TMDs for a two-fermion bound state system, one should solve the Bethe-Salpeter equation (BSE) in the physical space. Using the Nakanishi Integral Representation and the projection onto the null plane, we obtain the functional dependence between the coupling constant and the binding energy as well as the Bethe-Salpeter Amplitudes (BSA) in ladder approximation. From the BSA we present the light-front wave functions and some preliminar calculations of the TMDs for this fermionic system.

**Summary:****Tuesday Posters / 43****Radiative Corrections and Ward-Takahashi-Fradkin identities in GSDKP****Authors:** Rodrigo Bufalo<sup>1</sup>; Tatiana Cardoso<sup>1</sup>; Anderson Nogueira<sup>2</sup>; Bruto Pimentel<sup>3</sup>

<sup>1</sup> UFLA<sup>2</sup> UFABC<sup>3</sup> IFT-Unesp**Corresponding Author:** andsogueira@hotmail.com

We show explicit the first radiative correction for the vertex and photon-photon 4-point function in Generalized Scalar Duffin-Kemmer-Petiau Quantum Electrodynamics (GSDKP), utilizing the dimensional regularization method, where the gauge symmetry is manifest. As we shall see one of the consequences of the study is that the DKP algebra ensures the functioning of the WT identities in the first radiative corrections prohibiting certain UV divergences. This result leads us to ask whether this connection between DKP algebra, UV divergences, and quantum gauge symmetry (WTF) is a general statement.

**Summary:****High-energy heavy-ion collisions - Hot QCD in a lab / 44**

## High-energy heavy-ion collisions - Hot QCD in a lab

**Author:** Mateusz Ploskon<sup>1</sup><sup>1</sup> Lawrence Berkeley National Lab. (US)**Corresponding Author:** mploskon@lbl.gov

High-energy heavy-ion collisions provide a unique opportunity to study the properties of the hot and dense strongly-interacting system composed of deconfined quarks and gluons –the quark-gluon plasma (QGP) - in a laboratory conditions. The formation of a QGP is predicted by lattice QCD calculations as a crossover transition from hadronic matter (at zero baryochemical potential) and it is expected to take place once the system temperature reaches values above 155 MeV and/or the energy density above 0.5 GeV/fm<sup>3</sup>. The nature of such a strongly coupled QGP has been linked to the early Universe at some microseconds after the Big Bang. To characterize the physical properties of the short-lived matter (lifetime of about 10 fm/c) experimental studies at Relativistic Heavy-Ion Collider and the Large Hadron collider use auto-generated probes, such as high-energy partons created early in the hadronic collisions, thermally emitted photons, and a set of particle correlations that are sensitive to the collective expansion and the dynamics of the system. The lectures will introduce some of the experimental techniques used within these studies in heavy-ion collisions and provide an overview of the most interesting results. We will also discuss some of the intriguing phenomena found in smaller collision systems that may provide additional insight into the inner workings of the hot QCD matter.

**Summary:****Nuclear physics and its relation with lattice QCD / 45**

## Nuclear physics and its relation with lattice QCD

**Author:** Jaume Carbonell<sup>1</sup><sup>1</sup> CNRS Institut de Physique Nucléaire Orsay**Corresponding Author:** carbonell@ipno.in2p3.fr

In a first lecture we will consider the complexity of the conventional Nucleon-Nucleon interaction either in the traditional meson exchange or in the EFT framework.

The following lectures aim to be an introductory course to the Lattice techniques used to solve the Quantum Field Theory in a non perturbative regime, with special interest in the Quantum Chromodynamics (QCD).

This activity started 40 years ago when K. Wilson proposed a formulation of QCD in an euclidean discrete space-time lattice as a statistical mechanics problem in a way that exactly preserves the main symmetry property of the theory: its gauge invariance. This branch of theoretical physics, denoted by Lattice QCD (LQCD), constitutes nowadays –even with some limitations –a unique tool to solve ab initio the theory of strong interactions.

We will introduce the theoretical and numerical tools allowing to obtain the solution of a continuous theory formulated in a Minkowski space time on a discret euclidean 4-dimensional lattice. This challenging task has been possible using the Feynman path-integral formulation of the field theories, performing analytically the integral over the fermionic degrees of freedom and using the Monte-Carlo methods to evaluate the functional integral of the remaining bosonic fields in the configuration space.

The lectures will be addressed to PhD students, Postdocs and non specialists in the subject. Their ambition is to provide the audience with a road map of a standard lattice simulations and a key to decrypt the abundant literature in the subject.

The recent progress in Lattice QCD calculations applied to nuclear physics will be reviewed and we will show how this - a priori unlikely - approach results into a disarming simplicity for the description of light nuclei and even some simple nuclear reactions.

**Summary:**

**Tuesday Posters / 47**

## **A comparative study of Neutron Star structure using 3 models: Walecka Model, PAL Model and M.I.T. Bag Model**

**Authors:** Fábio Köpp<sup>1</sup>; Alex Quadros<sup>2</sup>; Magno Machado<sup>3</sup>; Guilherme Volkmer<sup>1</sup>; Dimiter Hadjimichef<sup>1</sup>; Moises Razeira<sup>4</sup>; Cesar Augusto Zen Vasconcelos<sup>None</sup>

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Neutron stars are the most compact objects in nature widely used in the study of dense matter physics. This kind of objects are described by nuclear physics, special relativity, general relativity and particle physics.

In the present work, the structure of neutron stars is studied from theoretical perspectives by using the Equations of State (EoS) derived from microscopic calculations. In the context of nuclear physics, since we are dealing with hadrons degrees of freedom, two classes of models for the nuclear potential that reproduces the general features of normal nuclear matter were used to derive a proper EoS of baryonic matter: the well know linear Walecka Model within the framework of the relativistic mean-field theory (RMF), and M. Prakash, T.L. Ainsworth, and J.M. Lattimer Model (PAL Model). However, in the context of particle physics, we choose the usual M.I.T Bag Model which is a QCD inspired model with 3-flavours quarks (u,d and s) degrees of freedom. In all the models studied in this work, the temperature is null and without the inclusion of electromagnetic fields.

Finally, we solved the Tolman-Oppenheimer-Volkov equations numerically and compared ours results with the actual pulsar data recently observed PSR J1614-2230 with a mass  $1.97 \pm 0.04 M/M_0$ .

**Summary:**

## Tuesday Posters / 49

## Study on the PDF comparisons for quarkonium + gamma production at the LHC and FCC energies

**Authors:** Mairon Melo Machado<sup>1</sup>; Gustavo Gil Da Silveira<sup>2</sup>

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<sup>2</sup> *Universidade do Estado do Rio de Janeiro (BR)*

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The quarkonium plus photon production in coherent hadron - hadron interactions at LHC is studied using the non-relativistic QCD (NRQCD) factorization formalism. We investigate a set of kinematic distributions and compute the total cross sections for  $M + \gamma$  ( $M = J/\Psi$  and  $\Upsilon$ ) production. Our results demonstrate the feasibility of such process in the LHC kinematic regime and explore the possibilities for the Future Circular Collider, where higher event yields can be achieved.

**Summary:**

## Tuesday Posters / 50

## A numerical simulation of Gravitational Collapse of a Neutron star

**Authors:** Mariana Gomes Pacheco de Sá<sup>1</sup>; Takeshi Kodama<sup>2</sup>

<sup>1</sup> *Universidade Federal Fluminense*

<sup>2</sup> *Universidade Federal do Rio de Janeiro*

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Gravitational collapse of a star occurs when the internal pressure cannot sustain the gravitational forces. There are two essentially different mechanisms. One is the collapse due to the relativistic effects in the degenerate Fermi Gas, known in the form of Chandrasekhar mass limit, associated with the collapse of white dwarfs or core of the massive stars in advanced stage. Other is due to the general relativistic effects which lead to the appearance of event horizon forming black holes. Oppenheimer and Volkoff in 1939 showed for the first time that stars with mass greater than  $0.7 M_{\odot}$  using the Fermi gas of neutrons will not have stable configurations from Einstein field equations. Such a phenomena could happen also under Newtonian gravitation with a relativistic Fermi gas equation of state if we include the internal energy into the gravitational mass. In this study we will simulate numerically the gravitational collapse of a neutron star under the Newtonian gravitation of forces. We first formulate the variational formalism within the post-Newtonian gravitation, using the Lagrange coordinate system and derive the dynamic equations for the smoothed particle hydrodynamics (SPH). In this way, we also discuss non-spherically symmetric dynamics. The present study is a preparative work of SPH approach to solve the Oppenheimer-Snyder equations.

**Summary:**

## Tuesday Posters / 51

## Perturbative QCD and Spin-1

**Authors:** Chueng Ji<sup>1</sup>; Tobias Frederico<sup>2</sup>; João Pacheco De Melo<sup>3</sup>

<sup>1</sup> North Carolina State University

<sup>2</sup> Instituto Tecnológico de Aeronautica

<sup>3</sup> Universidade Cruzeiro do Sul

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The annihilation or production process  $e^+ + e^- \rightarrow \rho^+ + \rho^-$  is studied with respect to the universal perturbative QCD (pQCD) predictions. Sub-leading contributions are considered together with the universal leading pQCD amplitudes such that the matrix elements of the  $\rho$ -meson electromagnetic current satisfy the constraint from the light-front angular condition. The data from the BaBar collaboration for the time-like  $\rho$ -meson form factors at  $\sqrt{s} = 10.58$  GeV puts a stringent test to the onset of asymptotic pQCD behaviour. The  $e^+ + e^- \rightarrow \rho^+ + \rho^-$  cross-section for  $s$  between 60 GeV<sup>2</sup> and 160 GeV<sup>2</sup> is predicted where the sub-leading contributions are still considerable.

References:

1. B. Aubert, et. al., Babar collaboration, Phys. Rev. D78 (2008) 071103
2. J. P. B. C. de Melo, C. R. Ji and T. Frederico, Phys. Lett. B 763 (2016) 87.

**Summary:**

**Monday Posters / 52**

## Exclusive photoproduction $J/\Psi$ in peripheral Pb-Pb

**Authors:** M.Beatriz Gay Ducati<sup>1</sup>; Sony Martins<sup>1</sup>

<sup>1</sup> UFRGS

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The exclusive photoproduction of the heavy vector mesons  $J/\Psi$  is investigated in the context of peripheral lead-lead collisions for the energies available at the LHC,  $s=2.76$  TeV and  $s=5.02$  TeV. Using the light-cone color dipole formalism, the rapidity distribution was calculated in two centrality bins at 50%–70% and 70%–90% in order to evaluate its robustness in extrapolating down to a smaller impact parameter. A modified photon flux is introduced, without change in the photonuclear cross section in relation to the ultraperipheral (UPC) case. Results were obtained for the two regions analyzed, which presented a maximum difference of 27% in frontal rapidity for the two regions. Comparing the results for  $s=2.76$  TeV and  $s=5.02$  TeV, an increase was verified of approximately half the one obtained in the ultraperipheral regime in the central rapidity region.

**Summary:**

**Monday Posters / 53**

## Effects of colour reconnection on resonance production

**Authors:** Renan Acconcia<sup>1</sup>; David Dobrigkeit Chinellato<sup>2</sup>; Rafael Derradi De Souza<sup>2</sup>; Jun Takahashi<sup>2</sup>; Giorgio Torrieri<sup>3</sup>

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Short-lived hadronic resonance production in high energy collisions is an important observable to investigate the properties of the system created in such collisions. Measurements of particle production yields have shown a suppression in the relative production of resonances with respect to non-resonance particles for high energy collisions in which a large amount of particles were produced. In this work, we explore the effects of colour reconnection (CR) in the hadrochemistry of high multiplicity pp events simulated with the PYTHIA 8 event generator, with special emphasis on ratios such as  $K^*/K$ ,  $\rho/\pi$  and  $\eta'/\pi$  as a function of charged particle multiplicity. The results obtained show that a suppression of hadronic resonance production relative to non-resonance in high multiplicity collisions, so far interpreted as being due to re-scattering of resonance decay daughters in a hadronic phase of the system evolution, might be caused by CR in the presence of multi-parton scatterings. Based on arXiv:1707.02075 (accepted for publication, PRD).

**Summary:**

**Monday Posters / 54**

## Optimized perturbation theory applied to the Nambu-Jona-Lasinio model with symmetry $SU_f(3)$

**Authors:** Juan Macías<sup>1</sup>; marcus benghi pinto<sup>None</sup>

<sup>1</sup> USP

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The *optimized perturbation theory* (OPT), is implemented in the Nambu-Jonna-Lasinio (NJL) model with flavor symmetry  $SU_f(3)$  to generate non-perturbative results beyond the large- $N_c$  approximation. Previous implementations of OPT, restricted to models with symmetry  $SU_f(2)$ , showed important repulsive vector contributions to the quark pressure stemming from Fock terms. These contributions are responsible for a better description of the lattice data in the regime of temperatures below the pseudo-critical temperature for the chiral transition  $T_c$ , but also create a maximum when  $T \geq T_c$  in the second order coefficient of the Taylor series expansion of the pressure around zero chemical potential. It is shown how this maximum, not observed by the lattice simulations, is corrected in our implementation of the OPT in the NJL model, when the strange quark is considered. In this case, the vector repulsive Fock terms, are canceled by opposite sign counterparts. The validity of this OPT implementation is verified by the recovery of the usual results of the large- $N_c$  approximation in the limit  $N_c \rightarrow \infty$  and also by observing that this method generates in a trivial way, the same results of the Hartree-Fock approximation.

**Summary:**

**Tuesday Posters / 55**

## Central Exclusive Production at LHCb

**Authors:** Daniel Johnson<sup>1</sup>; Kazuyoshi Carvalho Akiba<sup>2</sup>; Luiz Gustavo Silva De Oliveira<sup>2</sup>

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Central exclusive production (CEP) is a singular way to measure cross section as it presents a very clean environment on detector and can be calculated (almost) exactly in many cases. LHCb is one of the four big experiments in LHC accelerator. On LHCb we have a dedicated group to work and search for exclusive processes and the main purpose is to probe and search for new insights on perturbative QCD. My work concerns (i) the measurement of non resonant dimuons cross section in different center-of-mass energies (7, 8 and 13 TeV) and (ii) the measurement of cross section of associated CEP of J/psi and Phi mesons in the same range of energies. In this talk I intend to present the preliminary results of my research. In fact the dimuon search is already on final stage and we can compare with the main QED simulators and see a good agreement. The double meson on other side is almost not covered by the Monte Carlo simulators available but some theoretical previews are at hand.

**Summary:**

**Tuesday Posters / 56**

## Critical behavior of Walecka model in the presence of magnetic background and boundaries

**Authors:** Elenilson Santos Nery<sup>1</sup>; Luciano Melo Abreu<sup>2</sup>

<sup>1</sup> *Universidade Federal da Bahia/Senai-Cimatec*

<sup>2</sup> *Universidade Federal da Bahia*

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In this work, we investigate the thermodynamics of Walecka model, constituted of a fermionic field interacting with real scalar and vector fields, in the presence of an external magnetic field and boundaries. By making use of mean-field approximation, we analyze the phase structure of this model at effective chemical equilibrium, under change of values of the relevant parameters of the model, focusing on the influence of the boundaries and magnetic background on the phase structure. The findings reveal a strong dependence of the nature of the phase structure on temperature, magnetic background and size of compactified coordinate.

**Summary:**

**Tuesday Posters / 57**

## Massive gluon exchange potential in KN scattering

**Author:** Bruna Folador<sup>1</sup>

**Co-author:** Dimiter Hadjimichef<sup>1</sup>

<sup>1</sup> *UFRGS*

**Corresponding Author:** bru.folador@gmail.com

The Fock-Tani formalism is a first principle method to obtain effective interactions from microscopic Hamiltonians. Originally derived for meson-meson or baryon-baryon scattering, we present the corresponding equations for meson-baryon scattering. Then we include the gluon mass, a non-perturbative aspect, to the interaction potential between quarks with gluon exchange. In particular, we shall obtain the low energy differential cross sections for the  $K^- + p \rightarrow \Lambda + \eta$  channel.

**Summary:**

**Tuesday Posters / 58**

## Corrections to hadron effective couplings due to weak background magnetic field

**Author:** Fabio Braghin<sup>1</sup>

<sup>1</sup> *IF-Federal University of Goias*

**Corresponding Author:** braghin@ufg.br

In this work corrections to the usual SU(2)-flavor Nambu-Jona-Lasinio (NJL) coupling [1] and also to the chiral pion couplings to constituent quarks [2] due to a weak external magnetic field are calculated at the one loop level. A sea quark determinant is expanded for relatively large quark mass and weak electromagnetic field and magnetic-field-dependent low energy quark effective coupling constants are resolved. Corrections to the NJL and vector NJL effective couplings and to well known pion-constituent quark couplings that break isospin and chiral symmetries emerge.

[1] F.L. Braghin, Phys. Rev. D 94, 074030 (2016); arXiv:1606.05587.

[2] F.L. Braghin, Eur. Phys. Journ. A 52, 134 (2016), arXiv:1601.04916.

F.L. Braghin, arXiv:1705.05926, submitted to publication.

F.L. Braghin, Phys. Rev. D 95, 014022 (2018).

**Summary:**

**Monday Posters / 59**

## Low energy kaon-hyperon interaction

**Authors:** Marcelo Nogueira<sup>1</sup>; Celso Barros Jr.<sup>1</sup>

<sup>1</sup> *UFSC*

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Study of low energy interaction kaon-hyperon through the nonlinear chiral invariant Lagrangians considering kaons,  $\rho$  mesons,  $\sigma$  mesons, hyperons, and corresponding resonances. We calculate the total cross section, angular distributions, polarization, and the phase shifts in the center-of-mass frame to low energy S- and P-wave.

**Summary:**

61

## Polarised Drell-Yan results from COMPASS

**Author:** Celso Franco<sup>1</sup>

<sup>1</sup> *LIP*

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The COMPASS experiment at CERN is one of the leading experiments studying the nucleon spin structure. Until 2012 the Parton Distribution Functions and the Transverse Momentum Dependent Parton Distribution Functions (TMDs) were extensively studied at COMPASS using Semi-Inclusive Deep Inelastic Scattering measurements. In 2015, the Drell-Yan measurements with a negative pion beam interacting with a transversely polarized ammonia target have started and will be continued through 2018. The goal is to access the TMDs of both pions and protons without any prior knowledge about fragmentation functions. Since the Drell-Yan data cover the same kinematic region of the semi-inclusive data, COMPASS has the unique opportunity to test the sign change of the Sivers TMD as predicted by QCD. In this talk the first measurement of spin dependent azimuthal asymmetries in the pion induced Drell-Yan process will be presented. These asymmetries, which are related to the convolution of pion and nucleon TMDs, are extracted from pairs of oppositely charged muons with invariant masses between  $4.3 \text{ GeV}^2$  and  $8.5 \text{ GeV}^2$

**Summary:**

**Tuesday Posters / 63**

## **$J/\psi$ production as a function of event multiplicity in pp collisions at $\sqrt{s} = 13 \text{ TeV}$ using EMCal-triggered events with ALICE at the LHC**

**Author:** Cristiane Jahnke<sup>1</sup>

<sup>1</sup> *Technische Universitaet Muenchen (DE)*

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The study of the  $J/\psi$  production in pp collisions provides important information on perturbative and non-perturbative quantum chromodynamics. The production of the heavy-quark pair can be described perturbatively while its hadronisation into quarkonium state is a non-perturbative process. These processes are not fully understood and additional experimental data are necessary to further constrain the theoretical production models. Additionally, using high multiplicity pp events, we can study how charmonium production depends on the event activity. These measurements are used to investigate the possible influence of multiple partonic interactions to the  $J/\psi$  production and the interplay between soft and hard processes. In this work we report studies of  $J/\psi$  production as a function of event multiplicity in pp collisions at  $\sqrt{s} = 13 \text{ TeV}$  at mid-rapidity with ALICE. The  $J/\psi$  are reconstructed via their dielectron decay channel in events where at least one of the decay electrons was triggered on by the Electromagnetic Calorimeter (EMCal). The availability of a high- $p_T$  electron trigger enhances the sampled luminosity significantly relative to the available minimum-bias triggered data set and extends the  $p_T$  reach for the  $J/\psi$  measurement. Using these data, the  $J/\psi$  measurement is performed in the transverse momentum interval  $8 < p_T < 40 \text{ GeV}/c$ .

**Summary:**

**Monday Posters / 64**

## **Enhanced strange hadron production in high-multiplicity pp collisions with ALICE at the LHC**

**Authors:** Rafael Derradi De Souza<sup>1</sup>; ALICE Collaboration<sup>None</sup>

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Since long the measurement of strange and multi-strange hadron production rates has demonstrated to be a key measurement in the investigation of the properties of nuclear matter created in high energy collisions. In particular, the observation of strangeness enhancement in collisions of large systems, such as Pb-Pb, is historically considered as a signature of the formation of a QGP phase in such collisions. Recently, a relative increase of strange hadron production rates with respect to those of non-strange particles was also observed in high multiplicity pp and p-Pb collisions by the ALICE experiment. In this work, we present results of strange and multi-strange hadron measurements as a function of the charged particle multiplicity in pp collisions at 7 and 13 TeV. The dependence with the collision energy and comparisons with theoretical predictions based on QCD inspired model are discussed. Moreover, performance studies with a large sample of high-multiplicity triggered events in pp collisions at 13 TeV are also presented. This last data sample extends the reach in multiplicity currently available in the minimum bias sample, allowing for a better comparison with results from p-Pb and peripheral Pb-Pb collisions.

**Summary:**

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## Short-distance RG-analysis of X(3872) radiative decays

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In this work we present a theoretical approach to deal with radiative decays of meson molecules. This is a promising framework to understand mesons that lie near the production threshold of  $D$  and  $B$  mesons, and don't fit in the traditional quarkonia predictions. We apply this approach specifically to the meson  $X(3872)$ : considering it a  $DD^*$  molecule, we deal with its radiative decays  $X \rightarrow J/\psi$  and  $X \rightarrow \psi(2S)$ . Contrary to previous claims, we demonstrate that the molecular model is compatible with the experimental radiative decay data. We use effective field theory techniques and the so called power-divergence subtraction (PDS) scheme. Based on the popular dimensional regularization and minimal subtraction scheme, PDS is designed to handle non-perturbative phenomena such as bound states and resonances. We find that short and long-distance physics are equally important in these decays. Our results may be used as guide to build models for the short-distance structure of the  $X(3872)$ .

**Summary:**

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## Pasta phases within the QMC model

**Author:** Guilherme Grams<sup>1</sup>

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The search for the existence of pasta phases in the low density regions of nuclear and neutron star matter is performed within the context of the quark-meson coupling (QMC) model, which incorporates quark degrees of freedom. Fixed proton fractions are considered, as well as nuclear matter in beta equilibrium at zero temperature. We discuss the recent attempts to better understand the surface energy in the coexistence phases regime and we present results that show the existence of the pasta phases subject to some choices of the surface energy coefficient. We also analyse the influence of the nuclear pasta on some neutron star properties.

**Summary:**

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## **Diffractive Production of Quarkonium in p-A Collisions at LHC**

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In the present work, we investigated the exclusive diffractive production of charmonium in proton-nucleus collisions at the Large Hadron Collider (LHC) energies. Such exclusive production reactions possess a cleaner experimental signal than inclusive production once it is characterized by low multiplicity of particles between final produced state and the incident protons of collider beam. The considered theoretical framework was the perturbative model of Quantum Chromodynamics (QCD) for the Pomeron exchange. In particular, we have used the resolved Pomeron model which depends on the Pomeron flux and Pomeron parton distribution functions. The main goal is to provide predictions for the single diffractive cross section for the J/Psi meson production at the energies of 5.02 TeV and 8.8 TeV. We have shown that a measurement is feasible as the order of magnitude is 400 microbarns even absorption corrections. Furthermore, we analyze the ratio of the diffractive to inclusive cross section which allows theoretical uncertainties to be canceled, mostly those associated to approximations performed in inclusive case.

**Summary:**

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## **Integral representation and Minkowski space bound state problems**

**Authors:** Jaume Carbonell<sup>1</sup>; Tobias Frederico<sup>2</sup>; Vladimir Karmanov<sup>3</sup>

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The bound state Bethe-Salpeter amplitude described by a Nakanishi two-dimensional integral representation has a smooth weight function  $g$ , which carries the detailed dynamical information. The Light-front wave function can be derived and is given by a one-dimensional, integral representation with the same weight function  $g$ . By using the generalized Stieltjes transform,  $g$  can be written in terms of the Light-Front wave function in the complex plane of its arguments. Also a new integral equation for  $g$  is derived for a bound state case. We found a prescription for obtaining the kernel  $N$  starting with the kernel  $K$  of the Bethe-Salpeter equation, and the method is valid for any kernel given by an irreducible Feynman amplitude. We briefly discuss a possible application in hadronic physics, where from the Light-front wave function one obtains the Nakanishi weight function and the associated Bethe-Salpeter amplitude.

**Summary:**

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## Isospin matter and pion stars

**Authors:** Bastian Brandt<sup>1</sup>; Eduardo Fraga<sup>2</sup>; Gergely Endrodi<sup>1</sup>; Juergen Schaffner-Bielich<sup>1</sup>; Mauricio Hippert Teixeira<sup>2</sup>; Sebastian Schmalzbauer<sup>1</sup>

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We explore the condensation of charged pions in the presence of a large isospin chemical potential, in the absence of baryons, within the Linear Sigma Model. A mean-field expansion is used to calculate the thermodynamics and the spectrum of excitations of the pion-condensed medium. The pion condensate is shown to explicitly break the  $U(1)_{T_3}$  vector isospin symmetry associated with electromagnetic gauge invariance, making it a superconductor.

Results are successfully compared to lattice calculations and used to find the equation of state of isospin matter, made electrically neutral by the addition of leptons. From the obtained equation of state, we calculate the mass-radius relation of a new class of compact stars: pion stars, which are found to have masses of up to  $\sim 230 M_{\odot}$ , with radii of  $\sim 10^2 - 10^5$  km.

**Summary:**

We study the condensation of pions under a large isospin chemical potential, in the absence of baryons. As an application, we calculate the mass-radius relation of pion stars, a new class of compact stars.

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## Investigating the exclusive vector meson photoproduction in nuclear collisions at Run 2 LHC energies

**Authors:** Bruno Moreira<sup>1</sup>; Fernando Navarra<sup>2</sup>; Gláuber dos Santos<sup>1</sup>; Magno Machado<sup>3</sup>; Victor Gonçalves<sup>1</sup>

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The advent of the high-energy colliders has motivated the study of the hadron structure at high energies. In such scenario, a hadron becomes a dense system and the nonlinear effects inherent to the QCD dynamics may become visible. Recent studies show that vector meson exclusive photoproduction has the potential to probe the QCD dynamics at high energies. In this work we present an analysis of exclusive vector meson photoproduction in nuclear collisions at Run 2 LHC energies using the color dipole formalism. The rapidity distributions are estimated considering the more recent phenomenological models for the dipole-proton scattering amplitude, which are based on the color glass condensate formalism and are able to describe the inclusive and exclusive ep HERA data. The current theoretical uncertainty in the color dipole predictions is estimated and a comparison with the experimental results is performed.

**Summary:**

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## Heavy quark production in photon-hadron interactions at high energies

**Authors:** Celso Sena<sup>1</sup>; Gláuber dos Santos<sup>1</sup>; Victor Gonçalves<sup>2</sup>

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The photon-induced interactions, as those present in the deep inelastic scattering (DIS) process and in ultraperipheral hadronic collisions, can be used to improve our understanding of the strong interactions in the high energy regime. In particular, the photon-induced interactions where one of the incident hadrons fragments and only one rapidity gap is present in the final state, usually denoted inclusive processes. In this work we present a study of the inclusive heavy quark photoproduction in ep and eA collisions using the color dipole formalism. The structure functions and the total cross sections for the charm and bottom production are estimated using the more recent phenomenological models for the dipole scattering amplitude available in the literature. Moreover, a comparison with the experimental results from ep HERA collider is performed.

**Summary:**

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## Geometrical scaling description for the exclusive production of vector mesons and DVCS

**Authors:** Felipe Gregoletto Ben<sup>1</sup>; Magno Machado<sup>2</sup>; Werner Sauter<sup>3</sup>

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In this work, we investigate the exclusive production of particles in scattering processes in the so-called saturation region. Within this scheme the phenomenon of geometric scaling takes place: cross sections are functions only of a dimensionless combination of the relevant kinematic variables, which happens both in inclusive and diffractive cases, as in the production of vector mesons. In particular, the scaling variable is given in general by  $\tau = Q^2/Q_s^2$ , where  $Q^2$  is the photon virtuality

and  $Q_s$  represents the saturation scale, which drives the energy dependence and the corresponding nuclear effects.

Based on the scaling property, we are able to derive a universal expression for the cross sections for the exclusive vector meson production and deeply virtual Compton scattering (DVCS) in both photon-proton and photon-nucleus interactions. This phenomenological result describes all available data from DESY-HERA for  $\rho$ ,  $\phi$  and  $J/\psi$  production and DVCS measurements. A discussion is also carried out on the size of nuclear shadowing corrections on photon-nucleus interaction.

This work has been published in the following paper <https://journals.aps.org/prd/abstract/10.1103/PhysRevD.96.054015>

**Summary:**

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## Exploring the Thermodynamics of Confining Models

**Authors:** Apóllo Silva<sup>1</sup>; Bruno Mintz<sup>None</sup>

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Establishing a description for confinement is not something simple. In order to try to understand a little about this phenomenon, we will explore the thermodynamics of models that try to describe it in terms of propagators with violation of positivity. In this work, “confinement” is always understood in the sense of positivity violation of the propagator of the elementary fields. For simplicity, we will define a model for scalar fields with a momentum dependent and nonlocal mass term. The (euclidian) Lagrangian for such a toy model is given by

$$\begin{equation} \mathcal{L}_E = \frac{1}{2} \int d^4x \left[ \phi(x) \left( -\partial^2 + m^2 + \frac{\Lambda^4}{-\partial^2 + M^2} \right) \phi(x) \right]; . \end{equation}$$

A Lagrangian written in this way is analogous to the refined Gribov-Zwanziger (RGZ) Lagrangian and has a similar propagator to the gluon propagator in the lattice. One of our objectives is to verify the thermodynamic properties of this Lagrangian in order to analyze possible inconsistencies. For this we use the functional formalism of Quantum Field Theory at finite temperature, from which we obtain the partition function and, consequently, the thermodynamic variables such as pressure, energy density, entropy density, etc. Then, we obtain the two-point function at finite temperature of the scalar field  $\phi$ , in order to study whether or not there is a restoration of positivity (hence, deconfinement, in our language). Finally, we obtain the first order perturbative correction for the partition function and for thermodynamic variables considering an auto-interaction potential of type  $\phi^4$ .

**Summary:**

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## $\eta_c$ photoproduction at LHC energies

**Authors:** Victor Gonçalves<sup>1</sup>; Bruno Moreira<sup>1</sup>

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In this contribution, we study the inclusive and diffractive  $\eta_c$  photoproduction in  $pp$  and  $pPb$  ultra-peripheral collisions (UPC's) at the LHC Run II energies. In a hadron-hadron UPC, it is well known that the hadrons can act as sources of almost real photons allowing the study of photon-photon and photon-hadron interactions. Our goal is the study of the  $\eta_c$  production in photon-gluon and the photon-Pomeron subprocesses using the nonrelativistic QCD formalism (NRQCD). In this formalism, the photon-hadron process can be factorized in terms of the short distances coefficients for the photon-gluon subprocess (perturbatively calculated) and long distances matrix elements, related to the formation of the quarkonium at the final state, which are extracted from global analysis of the quarkonium data. As the photoproduction of  $\eta_c$  is a purely color –octet contribution, this process is a probe of the color –octet mechanism. In our analysis, we show our predictions for the rapidity and  $p_T$  distributions and total cross sections for the  $\eta_c$  photoproduction. A comparison with the predictions for the  $\eta_c$  production in photon-photon and exclusive photon-hadron interactions is presented.

**Summary:**

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## Towards a Dalitz Plot Analysis of the decay $D^+ \rightarrow \pi^- \pi^+ \pi^+$ in LHCb experiment

**Authors:** Carla Gobel Burlamaqui De Mello<sup>1</sup>; Fernanda Goncalves Abrantes<sup>2</sup>; Valdir Salustino Guimaraes<sup>1</sup>; Sandra Amato<sup>3</sup>; Erica Polycarpo Macedo<sup>3</sup>; Alberto Correa Dos Reis<sup>4</sup>; Juan Baptista<sup>5</sup>

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In general, three-body decays can be described as quasi-two-body decays where intermediate resonances decay into two particles, and then observing a the final state constituted of three particles. To study these processes it is necessary to perform an amplitude analysis to the corresponding Dalitz Plot (the two-dimensional representation of the decay phase space). It is common to use the so-called Isobar Model, in which each resonance is modelled as a relativistic Breit-Wigner function and, together with proper angular distributions and form factors, the total amplitude is written as a coherent sum of the individual resonance amplitudes. However, dealing with broad scalar states - which appear in  $\pi \pi$  S-wave —the Isobar Model turns out to be inadequate and other approaches, as a model-independent partial wave analysis, are interesting alternatives. The treatment of the  $\pi \pi$  scalar amplitude is currently an open problem.

In this work, we show the current status towards the full amplitude analysis of the decay  $D^+ \rightarrow \pi^- \pi^+ \pi^+$  using run I data from the LHCb experiment.

**Summary:**

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## Lepton-rich cold QCD matter

**Authors:** José Jiménez<sup>1</sup>; Eduardo Fraga<sup>1</sup>

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We investigate proton-neutron star matter using the state-of-the-art perturbative equation of state for cold and dense QCD in the presence of a fixed lepton fraction in which both electrons and neutrinos are included. Besides computing the modifications in the equation of state due to the presence of trapped neutrinos, we show that stable strange quark matter has a more restricted parameter space.

**Summary:****Tuesday Posters / 78**

## An introductory study to white dwarfs

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White dwarfs are compact objects that stand against gravitational collapse by their internal pressure of degenerate matter. In this work we aimed to perform an introductory study on these stars, using two equations of state: (I) an ideal Fermi gas and (II) the one by Baym Pethick and Sutherland (BPS). In addition, we analyzed these two state equations in two scenarios, the Newtonian and the one from General Relativity, which allowed us to analyze the effects of curved space-time. We also studied a rotating white dwarf, finding a metric for this case. With these two cases, with rotation and static well determined, we introduced the concepts of instability by the turning point criterion and dynamic instability criterion. Finally, with the RNS program, we performed the numerical resolution of the BPS equation of state with ( $J = \text{constant}$  and  $J = 0$  respectively) rotation in order to analyze the behavior of the turning point criterion in these two cases. All the numerical resolution of the equations of a non-rotating white dwarf were made using FORTRAN programs written by the author and all the results found were compatible with those of the literature.

**Summary:****Monday Posters / 79**

## Exclusive vector meson photoproduction with proton dissociation in photon-hadron interactions at the LHC

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At forward rapidities and high energies we expect to probe non-linear effects of the Quantum Chromodynamics (QCD). One of the most promising observables to constrain the QCD dynamics at this

regime is the exclusive vector meson photoproduction (EVMP). We study the EVMP in association with a leading baryon (product of the proton dissociation) in photon-hadron interactions that take place in  $pp$  and  $pPb$  collisions at large impact parameters. We present the rapidity distributions for  $\rho$  and  $J/\psi$  photoproduction in association with a leading baryon (neutron and delta states) at LHC run 2 energies. Our results show that the  $V + \Delta$  cross section is almost 30 % of the  $V + n$  one. Our results also show that a future experimental analysis of these processes is, in principle, feasible and can be useful to study the leading particle production.

**Summary:**

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## Investigating the graviton production in future electron-positron colliders

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The production of gravitons via two-photon fusion and ZZ fusion processes are considered using the scale of the gravitational interactions around a few TeV. We focus on the expected energies of the proposed electron-positron colliders with a center-of-mass energy at the TeV scale. The number of events is predicted, and the background from the Standard Model is analyzed. The dependence on the effective Planck scale and on the number of extra dimensions is investigated.

**Summary:**

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## Diffraction double quarkonium production at the LHC

**Authors:** Cristiano Brenner Mariotto<sup>1</sup>; Victor Gonçalves<sup>2</sup>; Rafael Palota da Silva<sup>3</sup>

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In this paper we study the double quarkonium production in single and double diffractive processes considering the Resolved Pomeron model. Based on the nonrelativistic QCD (NRQCD) factorization formalism for the quarkonium production mechanism we estimate the rapidity and transverse momentum dependence of the cross section for the  $J/\psi J/\psi$  and  $\Upsilon\Upsilon$  production in diffractive processes at LHC energies. The contributions of the color-singlet and color-octet channels are estimated and predictions for the total cross sections in the kinematical regions of the LHC experiments are also presented. Our results demonstrate that the contribution of diffractive processes is not negligible and that its study can be useful to test the Resolved Pomeron model.

**Summary:**

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**Double quarkonium production in  $pp$  collisions at the LHC****Authors:** Cristiano Brenner Mariotto<sup>1</sup>; Rafael Palota da Silva<sup>2</sup>; Victor Gonçalves<sup>3</sup><sup>1</sup> *Universidade Federal do Rio Grande*<sup>2</sup> *UFPel*<sup>3</sup> *Universidade Federal de Pelotas***Corresponding Author:** cristianomariotto@furg.br

In this contribution we investigate the inclusive double quarkonium production in  $pp$  collisions at the Run 2 LHC energies. The cross sections are estimated using the Non-Relativistic QCD (NRQCD) factorization formalism, taking into account the color singlet and color octet contributions. We present predictions for the total cross sections for the  $J/\Psi J/\Psi$  and  $\Upsilon\Upsilon$  production, as well as for the rapidity and transverse momentum distributions. Our results indicate that these distributions are dominated by the color singlet contribution, with the color octet one being important only at large  $p_T$ . Finally, we compare our results with the predictions for the double quarkonium production by the double parton scattering mechanism.

**Summary:**

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**Supersymmetry Breaking at Finite Temperature in a Susy Harmonic Oscillator with Interaction.****Authors:** Célio Marques<sup>1</sup>; Gilmar de Souza Dias<sup>2</sup>; Helder Sanchez Chavez<sup>3</sup>; Faqir Khanna<sup>4</sup><sup>1</sup> *Instituto Federal de Ciencia e Tecnologia do Espirito Santo*<sup>2</sup> *IFES*<sup>3</sup> *UCL*<sup>4</sup> *University of Alberta***Corresponding Author:** celiofisica@gmail.com

The supersymmetry breaking of a supersymmetric harmonic oscillator with polynomial interaction is analyzed. Some thermal effects are studied following TFD formalism. The restored supersymmetry results in nonvanishing energy at finite temperatures due the additivity of the thermal effects, while at  $T = 0$  the energy is zero.

**Summary:**

The supersymmetry breaking of a supersymmetric harmonic oscillator with polynomial interaction is analyzed

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**No gapless 2SC color superconducting phase for two flavor quark matter at high density****Authors:** Ricardo L. Sonogo Farias<sup>1</sup>; Dyana Duarte<sup>2</sup>; Rudnei de Oliveira Ramos<sup>3</sup>

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The properties of color superconducting cold dense quark matter under compact star conditions are investigated using an SU(2) Nambu Jona-Lasinio (NJL) model in which the divergences are treated using “medium separation scheme” (MSS) as regularization scheme. We compare our results with the usual treatment of the divergent integrals (3D cutoff) that is referred to as the “traditional regularization scheme” (TRS). Our results show that a way of conciliating results for the behavior of the diquark condensates obtained with NJL models and recent lattice results, that show that the diquark condensate always increase with the density. These discrepancies between NJL-type models and the lattice, when we increase the density, might be closely connected on how the UV momentum integrals are treated in these models. These same results also show that one can eliminate this discrepancy by a proper separation of medium effects from the integrand of the divergent integrals that require regularization. All resulting divergent integrals are the same as those that appear in the vacuum, i.e., at  $T = 0$  and  $\mu = 0$ . By this proper separation of medium effects from the divergent vacuum integrals, we have obtained results suppressing the so-called gapless 2SC phase (g-2SC) and favoring the conventional 2SC phase at high density. These changes in the phase diagram of the cold dense quark matter are related that the ultraviolet cutoff  $\Lambda$ , used with a TRS, effectively cuts important degrees of freedom near the Fermi surface leading to an incorrect result for the diquark condensate as a function of the density.

**Summary:****Tuesday Posters / 85**

## Symmetry deviations in the pasta nuclear structures

**Authors:** Sergio Rocha<sup>1</sup>; Sidney Avancini<sup>2</sup><sup>1</sup> Instituto Federal de Santa Catarina<sup>2</sup> Departamento de Física. Universidade Federal de Santa Catarina**Corresponding Author:** sergio.rocha@ifsc.edu.br

In this work we calculate some exotic nuclear phase properties of the neutron-proton-electron matter known as “nuclear pasta” in the context of the Walecka model at zero temperature. We extend the usual spherical Thomas-Fermi Approximation by including non-spherical terms in the density and energy expansions in order to properly describe geometry deviations in the complex structures commonly found in the nuclear pasta, for instance, droplet, rod and slab. Numerical solutions to this problem are not a simple task due to the loss of spherical symmetry in the fields description. However, our preliminary results suggest the possibility for new low-energy structures comprising prolate-oblate deviations of spherical symmetry.

**Summary:****Monday Posters / 88**

## Leading Pomeron Contributions and the TOTEM Data at 13 TeV

**Author:** Mateus Broilo<sup>1</sup>**Co-authors:** Emerson Luna <sup>1</sup>; Márcio Menon <sup>2</sup>

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The recent data by the TOTEM Collaboration on  $\sigma_{tot}$  and  $\rho$  at 13 TeV, have shown agreement with a leading Odderon contribution at the highest energies, as demonstrated in the very recent analysis by Martynov and Nicolescu (MN). In order to investigate the same dataset by means of Pomeron dominance, we introduce a general class of forward scattering amplitude, with leading contributions even under crossing, associated with simple, double and triple poles in the complex angular momentum plane. For the lower energy region, we consider the usual non-degenerated Regge trajectories, with even and odd symmetry. The analytic connection between  $\sigma_{tot}$  and  $\rho$  is obtained by means of dispersion relations and we carry out fits to  $pp$  and  $\bar{p}p$  data in the interval  $\sqrt{s} = 5 \text{ GeV} - 13 \text{ TeV}$ ; following MN we consider only the TOTEM data at the LHC energy region. From the fits, we conclude that the general analytic model, as well as some particular cases representing standard parameterizations, are not able to describe satisfactorily the  $\sigma_{tot}$  and  $\rho$  data at 13 TeV.

**Summary:****Monday Posters / 89**

## Effects of mesonic interactions in Neutron Stars core

**Author:** Leonardo Moreira<sup>1</sup>**Co-author:** Marcelo Chiapparini<sup>1</sup><sup>1</sup> UERJ**Corresponding Author:** leomoreira96@outlook.com

The following work studies the effects of the interactions originated from scalars and vectors mesons exchanges in the interior of Neutron Stars. We analyze the differences that appears on masses and radii between stars sustained against gravitational collapse exclusively by the degeneracy pressure of matter and stars that have also the presence of interactions mediated by mesons. In the second case it was used the linear Walecka model in the mean field approximation in order to describe the scalar and vector fields. The macroscopic characteristics of the families of stars were generated by the numerical integration of TOV equations, using computational codes written by the author.

**Summary:****Tuesday Posters / 91**

## Magnetized neutral mesons at finite temperature

**Authors:** William Rafael Tavares<sup>1</sup>; Sidney Avancini<sup>2</sup>; Ricardo Farias<sup>3</sup>; Norberto N. Scoccola<sup>4</sup><sup>1</sup> Universidade Federal de Santa Catarina<sup>2</sup> Departamento de Física. Universidade Federal de Santa Catarina<sup>3</sup> UFSM<sup>4</sup> 1.Department of Theoretical Physics, Comisión Nacional de Energía Atómica; 2.Department of Theoretical Physics, Comisión Nacional de Energía Atómica, CONICET; 3.Universidad Favaloro;**Corresponding Author:** william.tavares@posgrad.ufsc.br

We study the two flavor Nambu–Jona-Lasinio model within the Mean Field Approximation and RPA framework to evaluate the pole masses of the  $\sigma$  and  $\pi^0$  mesons in the presence of a constant magnetic field at finite temperatures.

First, we emphasize the importance of the regularization method used in this work. For this aim, we explicitly employ the Magnetic Field Independent Regularization(MFIR) and as we show, this prescription does not present any non-physical oscillation in quark condensates or depends of extra parameters in comparison with other methods of regularization most used in the literature. Also, this choice generates results which agree well with those produced by lattice simulations for the quark condensate.

We present also an alternative representation of the zeta function which is more convenient to evaluate numerically the summation in the Landau Levels in our equations. As a prediction of our calculations, we can see that the Mott dissociation temperature rises as the magnetic field increases and a abrupt jump of the meson masses to the the resonant masses at  $T = T_{Mott}$ .

Our method also proves to be useful in evaluations of quantities such as the equation of state of magnetized quark matter with mesonic contributions, work that is in progress.

**Summary:**

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## **Charged pion masses under strong magnetic fields in the NJL model**

**Authors:** Daniel Gomez Dumm<sup>1</sup>; Máximo Coppola<sup>2</sup>; Norberto Scoccola<sup>3</sup>

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The behavior of charged pion masses in the presence of a static uniform magnetic field is studied in the framework of the two-flavor NJL model, using a magnetic field-independent regularization scheme. Analytical calculations are carried out employing the Ritus eigenfunction method, which allows us to properly take into account the presence of Schwinger phases in the quark propagators. Numerical results are obtained for definite model parameters, comparing the predictions of the model with present lattice QCD results.

**Summary:**

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## **Study of the covariant Wigner function applied to the linear sigma model**

**Authors:** Sidney Avancini<sup>1</sup>; Joana Carolina Sodré<sup>2</sup>; Jeferson de Lima Tomazelli<sup>2</sup>

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In this work we study the Wigner-Weyl formalism adequate for a theory with nucleons interacting through scalar and pseudoscalar fields, and for this we use the linear sigma model. Our goal is to understand the phenomena observed in experiments at laboratories such as the LHC or BNL, where a new state of matter is reached, the quark-gluon plasma. So we need to study chiral phase transitions, and the understanding of transport phenomena is crucial to this. Such experiments aim a better understanding of the fundamental structure of matter, from its formation in the primordial universe to its behavior in the most varied regimes.

An important application of effective models is the study of the chiral phase transitions in QCD under finite temperature and density conditions. Due to its simplicity compared to other models, the linear sigma model is a good candidate to this application. Another advantage is the fact that the model is renormalizable, unlike other models such as the Nambu–Jona-Lasinio or the nonlinear sigma model. However, since these phase transitions are out of equilibrium, we need a theory that can deal with dissipative phenomena. Then, we need a way to quantize the phase space. For this, we use the Wigner function, which is a quasi-probability distribution function. Since we are dealing with a relativistic model, we must adapt it to the formalism, and therefore we study the covariant Wigner function. We use the covariant Wigner function in the classical and semiclassical approximation in order to find a transport equation analogous to the Vlasov equation for the linear sigma model. Our formalism can be extended aiming the calculation of transport properties (viscosity, thermal conductivity) which are important to simulate heavy-ion collisions.

**Summary:**

**Tuesday Posters / 94**

## Phenomenological Analysis of the process DPS

**Author:** Edgar Paitan<sup>None</sup>

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Our understanding about the matter and its interactions is being tested in proton-proton collisions at the Large Hadron Collider (LHC) in a range of energies. Differently from previous colliders, where the cross sections can be estimated assuming that the dominant interaction occurs between one parton of the projectile and one parton of the target, named Single Parton Scattering processes (SPS), in the LHC the contribution of double parton scattering (DPS) processes becomes no negligible due to the high parton luminosity in the initial state of the collision. Such in this opportunity we will present some of the results obtained so far from a phenomenological analysis using the simplified form of the cross section process DPS, where in the initial state they involve gluons, next we will discuss in which work regime is valid and its possible explanations and contributions of phenomenological analysis.

**Summary:**

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## Magnetized color superconducting quark matter under compact star conditions: Phase structure within the SU(2)<sub>f</sub> NJL model

**Authors:** Máximo Coppola<sup>1</sup>; Pablo Guillermo Allen<sup>2</sup>; Gabriela Grunfeld<sup>None</sup>; Norberto Scoccola<sup>3</sup>

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The properties of magnetized color superconducting cold dense quark matter under compact star conditions are investigated using an SU(2) Nambu Jona-Lasinio (NJL)-type model in which the divergences are treated using a magnetic field independent regularization scheme in order to avoid unphysical oscillations. We study the phase diagram for several model parametrizations. The features of each phase are analyzed through the behavior of the chiral and superconducting condensates together with the different particle densities for increasing chemical potential or magnetic field. While confirming previous results derived for the zero magnetic field or isospin symmetric matter case, we show how the phases are modified in the presence of  $\beta$ -equilibrium as well as color and electric charge neutrality conditions.

**Summary:**

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## **A study on the solutions of GLR-MQ non-linear evolution equations**

**Authors:** Gilvana Coelho Penedo<sup>1</sup>; Werner Sauter<sup>2</sup>

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In the high energy regime, the proton structure consists of a very large number of parton that interact with each other according to the theory of strong interactions, Quantum Chromodynamics (QCD). Through QCD, the number of partons in the proton is described by equations of parton evolution that depend on kinematic variables. These equations can be linear, the DGLAP equations, and nonlinear, the equations GLR-MQ. We have studied some analytical solutions of the equations of parton evolution. In order to generate the preliminary results, we used an ansatz for the solution of the parton distributions functions (PDFs). As future work, we will use the Laplace transform method to solve the non-linear equations.

**Summary:**

**Tuesday Posters / 98**

## **The infrared dynamics of the three-gluon vertex**

**Authors:** Antonio Mauricio Soares Narciso Ferreira<sup>1</sup>; Arlene Cristina Aguilar<sup>2</sup>

<sup>1</sup> *University of Campinas*

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The infrared behavior of the three gluon vertex is one of the most prominent subjects of study in current non perturbative QCD, playing a central role in dynamical gluon mass generation through the Schwinger mechanism and being an essential ingredient in the Bethe-Salpeter equation which governs glueballs. However, the analysis of this vertex through Schwinger-Dyson equations (SDEs) is difficult, due to its rich tensor structure and the complexity of the SDE that it satisfies. Instead, in this preliminary study we aim to determine the non-transverse part of the three gluon vertex by solving the Slavnov-Taylor identity (STI) that relates it to the ghost-gluon scattering kernel. The later is computed by solving a truncated SDE that is much simpler than that of the three gluon vertex. When the ghost-gluon scattering kernel is then used as input for the STI of the three gluon

vertex, we obtain for its non transverse form factors results that are in qualitative agreement with those found in lattice simulations and, in particular, display a zero-crossing, a feature that has been widely discussed in recent literature.

**Summary:**

**Monday Posters / 100**

## Parton distribution functions and absorptive corrections

**Author:** Mateus Pelicer<sup>1</sup>

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The Parton Distribution Function measure the probability to find a parton inside a hadron, but these functions are of non-perturbative origin and, therefore, cannot be calculated from first principles in perturbative Quantum Chromodynamics. In this work we review how the parton distribution functions are determined, specifically the HERAPDF2.0, which is determined from deep inelastic scattering data only. Then we investigate how absorptive corrections can be implemented in order to improve the fit of the gluon distribution at low  $x$  and low  $Q^2$ , where it currently becomes negative from NLO on.

**Summary:**

**Monday Posters / 101**

## Double Parton Scattering

**Author:** Daniel Souza Lima<sup>1</sup>

<sup>1</sup> UFSC

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Double parton scattering (DPS) is a mechanism in which two partons from each proton initiate a scattering process. The cross section formula is described by a partonic distribution function (PDF), a double parton distribution (DPD) and scattering cross sections relative to more fundamental hard processes, i.e., the formula can be written in such a way that is possible to describe different distance scales, similarly to the case of one parton scattering (SPS). A pertinent problem is the transition cases between the DPS, initiated by partons far from each other, from those initiated by correlated partons that are from a common origin. Currently, there is already a way to tackle this problem by preserving DPS meaning and its field formulation definition, and this work, meanwhile it pursues this theoretical framework aiming for its betterment, reviews open questions and details on DPS Physics.

**Summary:**

**Monday Posters / 102**

## BFKL equation with discrete poles in diffractive observables

**Authors:** Cesar Eduardo Krumreich<sup>1</sup>; Werner Sauter<sup>2</sup>

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In the present day, the theoretical description of the behavior of the cross section in the regime of high energies is still the focus of questioning. A proposal that is still valid, is that the slight growth of the cross section is associated with the exchange of an object with the quantum numbers of the vacuum, called Pomeron. Phenomenologically, via Regge's theory, it was possible to construct a value for its intercept. In QCD we find by means of perturbative calculations that the Pomeron is described through interactions between gluons in the form of a ladder. The evolution of the gluons in this ladder is represented by the BFKL equation. Its solution through a fixed coupling constant returns us as a result a cut in the complex plane of angular momentum. However, when it is solved with the running coupling constant, the cut is replaced by a sequence of poles. It is also possible to find, in more recent approaches, that the sum of the cut plus the sequence of poles, also appear as solution. The purpose of this paper is to summarize the Pomeron in Regge theory and the ways of solving the BFKL equation with running coupling. A proposed application is the diffractive production of massive vector mesons.

**Summary:**

**Tuesday Posters / 104**

## Three-body nonelastic breakup cross-section for weakly bound nuclei

**Author:** Lucas Souza<sup>1</sup>

**Co-authors:** Emanuel Chimanski<sup>2</sup>; Brett Carlson<sup>2</sup>; Tobias Frederico<sup>2</sup>; Mahir Hussein<sup>1</sup>

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<sup>2</sup> *Instituto Tecnológico de Aeronáutica*

Halo nuclei are composed by a core of strongly bound nucleons surrounded by a halo of weakly bound neutrons or protons. When scattered by a target nucleus, halo nuclei may undergo into a fragmentation process opening different possible exit channels for detection. For example, the surrounding nucleons can either be captured or emitted during the reaction. With more nucleons in the halo the complexity of the possibilities increase and the distinction between bound and unbound states also becomes present. The extension three-body theories to derive an expression for the fragment yield in the reaction  $A(a, b)X$ , where the projectile is  $a = x_1 + x_2 + b$ , was done in Ref.[1]. Based on [1] we treat inclusive non-elastic breakup reactions involving weakly bound projectiles. The inclusive breakup cross section computed as a sum of a generalized four-body form of the elastic breakup cross section plus the inclusive nonelastic breakup cross section that involves the reaction cross section. We consider a three-body projectile and compute the nonelastic breakup cross sections for the two following possible cases: when  $b$  and  $x$  are emitted and  $y$  is absorbed (or  $y$  is emitted and  $x$  is absorbed) and both  $x$  and  $y$  are absorbed with just  $b$  being detected. All distorted waves are represented by eikonal waves and the Sao Paulo potential is used for modeling the optical interaction potential. The three-body incoming wave function is obtained by the renormalized short-range method. We investigate how the structure effects of two-neutron halo appears in the  $^{20}\text{C}$  from the  $^{20}\text{C} + C = ^{18}\text{C} + X$  reaction and also reactions of great experimental interest with heavy target like  $^{20}\text{C} + ^{208}\text{Pb} = ^{18}\text{C} + X$ .

[1] B.V. Carlson, T. Frederico, M.S. Hussein; Phys. Lett. B, 767, (2017) 53.

**Summary:**

## Monday Posters / 105

## On a renormalizable class of gauge fixings for the gauge invariant operator $A_{2\min}$

**Authors:** Duive Maria van Egmond<sup>1None</sup>; Silvio Sorella<sup>None</sup>; Ozorio Holanda<sup>None</sup>; Rodrigo Terin<sup>None</sup>; Marcelo Guimaraes<sup>None</sup>; Marcio Capri<sup>None</sup>; Giovanni Peruzzo<sup>None</sup>; Henrique Toledo<sup>None</sup>

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The dimension two gauge invariant non-local operator  $A_{2\min}$ , obtained through the minimization of  $\int d^4x A^2$  along the gauge orbit, allows to introduce a non-local gauge invariant configuration  $A_\mu$  which can be employed to built up a class of Euclidean massive Yang-Mills models useful to investigate non-perturbative infrared effects of confining theories. A fully local setup for both  $A_{2\min}$  and  $A_\mu$  can be achieved, resulting in a local and BRST invariant action which shares similarities with the Stueckelberg formalism. Though, unlike the case of the Stueckelberg action, the use of  $A_{2\min}$  gives rise to an all orders renormalizable action, a feature which will be illustrated by means of a class of covariant gauge fixings which, as much as 't Hooft's  $R\zeta$ -gauge of spontaneously broken gauge theories, provide a mass for the Stueckelberg field.

**Summary:**

## Monday Posters / 106

## In-medium nucleon axial form factor using a light-front nucleon wave function and a quark-meson coupling model

**Author:** Edson Suisso<sup>1</sup>

<sup>1</sup> INPI

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We study the nucleon axial ( $G_A$ ) form factor in symmetric nuclear matter in a light-front approach using the in-medium inputs calculated by the quark-meson coupling model, where the quarks interact with a flavor independent contact force. We found results comparable to the ones obtained with a confining interaction.

**Summary:**

## Tuesday Posters / 107

## Searching for coherent neutrino-nucleus interaction (CENNS) with Mössbauer Spectroscopy

**Authors:** Sergio Barbosa Duarte<sup>1</sup>; Gilmar Souza Dias<sup>2</sup>; Helder H. C. Sanchez<sup>3</sup>; Célio Marques<sup>4</sup>

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In this work we study the viability of the Mossbauer technique to measure neutrino-nucleus interaction, specifically Coherent Elastic Neutrino Nucleus Scattering. To describe the neutrino-nucleus interaction we propose a simple collective model in which the Mossbauer-nucleus is considered as an inert core with  $A - 1$  nucleons, and valence neutron. The core is slightly deformed in the direction of the transferred momentum by the weak process involving the  $Z_0$  exchange with the core. Independent particles transitions are Pauli-blocked and only collective transitions are permitted to the core. The very small deformation of the core imposes a perturbative change in the effective potential of the valence neutron. The non perturbed neutron s-state, which is spherically symmetric, is split into two energy level with has a narrow separation. Now the valence neutron can explore energy transition between the  $1/2$  and  $3/2$  spin states. We show that the Mossbauer spectroscopy is able to detect accurately this nuclear state change and it can be used as a new observable associated to CENNS.

**Summary:**

In this work we study the viability of the Mossbauer technique to measure neutrino-nucleus interaction, specifically Coherent Elastic Neutrino Nucleus Scattering.

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## Quark-antiquark potentials in nonperturbative models

**Author:** Carlos Mena<sup>1</sup>

**Co-author:** Leticia F. Palhares<sup>1</sup>

<sup>1</sup> UERJ

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We investigate some non-perturbative models for Quantum Chromodynamics (QCD) with the purpose of testing its validity in the perturbative region of nuclear interaction and to explore its behavior in the infrared region. In particular, we focus on the calculations and analysis of the potentials between supermassive quarks and antiquarks, since this observable might reveal the appearance of confinement properties in non-perturbative models through a linear growth at large and intermediate distances. We calculate the potentials associated with the massive Gluon, Gribov-Zwanziger and Gribov-Zwanziger Refined models at tree level for the non-relativistic case. In addition, we have included the flux of the Renormalization Group in the QCD coupling constant, which allowed us to study the energy-scale dependence of the parameters of the potentials. Our results indicate that, in the tree-level approximation, all potentials we have obtained can reproduce the perturbative result at high energies and some of them bring significant non-perturbative corrections.

**Summary:**

**Tuesday Posters / 109**

## Description of pp forward elastic scattering at 7 and 8 TeV

**Author:** Anderson Kendi Kohara<sup>1</sup>

**Co-authors:** Erasmo Ferreira<sup>2</sup>; Murilo Santana Rangel<sup>3</sup>; Takeshi Kodama<sup>2</sup>

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We analyse the recent LHC data at 7 and 8 TeV for pp elastic scattering with special attention for the structure of the real part, which is shown to be crucial to describe the differential cross section in the forward region. Our description contains the zero of the real amplitude predicted by André Martin.

**Summary:**

**Tuesday Posters / 110**

## Scale independence in an asymptotically free theory at finite temperatures

**Author:** Gabriel Ferrari<sup>1</sup>

**Co-authors:** Jean-Loic Kneur <sup>2</sup>; Marcus Benghi Pinto ; Rudnei de Oliveira Ramos <sup>3</sup>

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A recently developed variational resummation technique, incorporating renormalization group properties consistently, has been shown to solve the scale dependence problem that plagues the evaluation of thermodynamical quantities, e.g., within the framework of approximations such as in the hard-thermal-loop resummed perturbation theory. This method is used in the present work to evaluate thermodynamical quantities within the two-dimensional nonlinear sigma model, which, apart from providing a technically simpler testing ground, shares some common features with Yang-Mills theories, like asymptotic freedom, trace anomaly and the nonperturbative generation of a mass gap. The present application confirms that nonperturbative results can be readily generated solely by considering the lowest-order (quasiparticle) contribution to the thermodynamic effective potential, when this quantity is required to be renormalization group invariant. We also show that when the next-to-leading correction from the method is accounted for, the results indicate convergence, apart from optimally preserving, within the approximations here considered, the sought-after scale invariance.

**Summary:**

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## Dynamics of inhomogeneous chiral condensates

**Author:** Gastao Krein<sup>1</sup>

<sup>1</sup> *Instituto de Física Teórica, UNESP*

**Corresponding Author:** gkrein@ift.unesp.br

We present results of a study of the dynamics of the formation of inhomogeneous phases of the chiral transition transition in QCD. The possibility of the formation of a spatially modulated chiral condensate in the final stages of a heavy-ion

collision is investigated assuming a Ginzburg-Landau-Langevin time evolution, using model-motivated free energy functionals. Time scales for the formation of inhomogeneous condensates are contrasted with the expansion rate of the medium, modelled by one-dimensional Bjorken flow.

**Summary:**

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## QCD probes at LHC

**Author:** Gustavo Gil Da Silveira<sup>1</sup>

<sup>1</sup> *Universidade do Estado do Rio de Janeiro (BR)*

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The talk will cover results from all LHC experiments on measurements of particle production in pPb and PbPb, multiplicity dependence of particle production, collectivity studies, elliptic flow, and jet quenching.

**Summary:**

**Tuesday Posters / 115**

## RENORMALIZABILITY OF MASSIVE $N = 1$ SUPER YANG MILLS THEORY IN LANDAU GAUGE

**Authors:** M. A. Capri<sup>None</sup>; D. van Egmond<sup>None</sup>; M. S. Guimaraes<sup>None</sup>; O. Holanda<sup>None</sup>; S. P. Sorella<sup>None</sup>; R. C. Terin<sup>None</sup>; H. C. Toledo<sup>None</sup>

In this work, we study the renormalizability properties of an  $N = 1$  non-abelian gauge theory defined by a multiplet containing a massive vectorial excitation. The model we study is the supersymmetric version of a Stueckelberg-like action, in the sense that the massive gauge field is constructed by means of a compensating scalar field, thus preserving gauge invariance.

We prove that the supersymmetric generalization is renormalizable constructing a set of suitable ward identities. Although the model is probably non-unitary, we will not undertake such investigation in the present work. Supersymmetric generalizations of Stueckelberg-like models was studied since very early but mostly concentrated on the better behaved abelian models, for instance, for a proposal of an abelian Stueckelberg sector in MSSM), with some constructions of non-abelian theories with tensor multiplets and also with composite gauge fields.

**Summary:**

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## Compact stars as a test for modified gravity theories

**Author:** Manuel Malheiro<sup>1</sup>

<sup>1</sup> *ITA*

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We investigate the equilibrium configurations of neutron stars, quark stars and white dwarfs in a modified gravity theory, namely,  $f(R, T)$  gravity, for which  $R$  and  $T$  stand for the Ricci scalar and trace of the energy-momentum tensor, respectively. Considering the functional form  $f(R, T) = R + 2\lambda T$ , with  $\lambda$  being a constant, we obtain the hydrostatic equilibrium equation for the theory. Some physical properties of compact stars, such as: mass, radius, pressure and energy density, as well as their dependence on the parameter  $\lambda$  are derived.

**Summary:**

**Monday Posters / 117**

## Temperature effects on nuclear pseudospin symmetry in the Dirac-Hartree-Bogoliubov formalism

**Authors:** MANUEL MALHEIRO<sup>1</sup>; Ronai Lisboa<sup>2</sup>; Pedro Alberto<sup>3</sup>; Carlson Brett<sup>4</sup>

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We present finite temperature Dirac-Hartree-Bogoliubov (FTDHB) calculations for the tin isotope chain to study the dependence of pseudospin on the nuclear temperature. In the FTDHB calculation, the density dependence of the self-consistent relativistic mean fields, the pairing, and the vapor phase that takes into account the unbound nucleon states are considered self-consistently. The mean field potentials obtained in the FTDHB calculations are fit by Woods-Saxon (WS) potentials to examine how the WS parameters are related to the energy splitting of the pseudospin pairs as the temperature increases. We find that the nuclear potential surface diffuseness is the main driver for the pseudospin splittings and that it increases as the temperature grows. We conclude that pseudospin symmetry is better realized when the nuclear temperature increases. The results confirm the findings of previous works using RMF theory at zero temperature, namely that the correlation between the pseudospin splitting and the parameters of the Woods-Saxon potentials implies that pseudospin symmetry is a dynamical symmetry in nuclei. We show that the dynamical nature of the pseudospin symmetry remains when the temperature is considered in a realistic calculation of the tin isotopes, such as that of the Dirac-Hartree-Bogoliubov formalism.

**Summary:**

**Tuesday Posters / 119**

## Nuclear processes in Astrophysics: Recent progress

**Authors:** Vincenzo Liccardo<sup>1</sup>; Manuel Malheiro<sup>1</sup>; Mahir Hussein<sup>2</sup>; Tobias Frederico<sup>1</sup>

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The origin of the elements has been one of the most fascinating questions scientists have tried to give an answer to in the last 7 decades. The formation of light elements in the primordial universe and heavier elements, both in the intergalactic environment and in the astrophysical sources, occurs through nuclear reactions. We can say that nuclear processes are responsible for the production of energy and synthesis of the elements in the various astrophysical sites. Thus, nuclear reactions have a determining role in the existence and evolution of several astrophysical environments, from the Sun to the spectacular explosions of supernovae. Nuclear astrophysics is responsible for trying to bring answers to the most basic and important questions of our own existence and our future. There are still many issues that are unresolved such as, how stars and our galaxy have formed and how they evolve, how and where are the heaviest elements made, what is the abundance of nuclei in the universe and what is the nucleosynthesis output of the various production processes, why the amount of lithium-7 observed is less than predicted. In this paper we review our current understanding of the different astrophysical nuclear processes leading to the formation of chemical elements and particular attention is paid to the formation of heavy elements occurring during explosive nucleosynthesis in astrophysics catastrophic events. Thanks to the recent multi-messenger observation of a binary neutron star merger, which also confirmed production of heavy elements, explosive events such as short Gamma-ray bursts and the following Kilonovae are now strongly supported as nucleosynthesis sites.

**Summary:**

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## **Renormalizability of pure $\mathcal{N} = 1$ Super Yang-Mills in the Wess-Zumino gauge in the presence of the local composite operators $A^2$ and $\bar{\lambda}\lambda$**

**Authors:** Rodrigo Carmo Terin<sup>None</sup>; Marcio Capri<sup>1</sup>; Silvio Sorella<sup>2</sup>; Henrique Toledo<sup>1</sup>

<sup>1</sup> *Universidade do Estado do Rio de Janeiro*

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The  $\mathcal{N} = 1$  Super Yang-Mills theory in the presence of the local composite operator  $A^2$  is analyzed in the Wess-Zumino gauge by employing the Landau gauge fixing condition. Due to the supersymmetric structure of the theory, two more composite operators,  $A_\mu \gamma_\mu \lambda$  and  $\bar{\lambda}\lambda$ , related to the susy variations of  $A^2$

are also introduced. A BRST invariant action containing all these operators is obtained. An all order proof of the multiplicative renormalizability of the resulting theory is then provided by means of the algebraic renormalization setup. Though, due to the non-linear realization of the supersymmetry in the Wess-Zumino gauge, the renormalization factor of the gauge field turns out to be different from that of the gluino.

**Summary:**

**Monday Posters / 122**

## **$J/\psi$ interactions in a hadron gas**

**Author:** Fernando Navarra<sup>1</sup>

<sup>1</sup> *Universidade de São Paulo*

In heavy ion collisions after the quark-gluon plasma there is a hadronic gas phase. Using effective Lagrangians we study the interactions of charmed mesons which lead to  $J/\psi$  production and absorption in this gas. We update and extend previous calculations introducing strange meson interactions and also including the interactions mediated by the recently measured exotic charmonium resonances  $Z(3900)$  and  $Z(4025)$ . These resonances open new reaction channels for the  $J/\psi$ , which could potentially lead to changes in its multiplicity. We compute the  $J/\psi$  production cross section in processes such as  $D_{(s)}^{(*)} + \bar{D}^{(*)} \rightarrow J/\psi + (\pi, \rho, K, K^*)$  and also the  $J/\psi$  absorption cross section in the corresponding inverse processes. Using the obtained cross sections as input to solve the rate equation, we conclude that the interactions in the hadron gas slightly reduce the  $J/\psi$  abundance.

**Summary:**

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## High Precision Statistical Landau Gauge Lattice Gluon Propagator Computation vs. the Gribov-Zwanziger approach

**Author:** Orlando Oliveira<sup>1</sup>

<sup>1</sup> *University of Coimbra*

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The compatibility of the results from the Gribov-Zwanziger tree level prediction and lattice simulations, using large statistical ensembles, for the Landau gauge gluon propagator are investigated, thereby complementing earlier work using small-scale statistics. Our results show that the data is well described by the tree level estimate only up to momenta  $p \ll 1$  GeV while clearly favoring the so-called Refined Gribov-Zwanziger scenario, implying particular relations between certain possible  $d=2$  condensates. We also provide a global fit of the lattice data which interpolates between the above scenario at low momenta and the usual continuum one-loop renormalization improved perturbation theory after introducing an infrared log-regularizing term.

**Summary:**

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## Charmed mesons at finite temperature and chemical potential

**Author:** Fernando Serna<sup>1</sup>

<sup>1</sup> *IFT-UNESP*

**Corresponding Author:** fernandoserna@ift.unesp.br

We compute the masses of the pseudoscalar mesons  $\pi^+$ ,  $K^0$  and  $D^+$  at finite temperature and baryon chemical potential. The computations are based on a symmetry-preserving Dyson-Schwinger equation treatment of a vector-vector four quark contact interaction. The results found for the temperature dependence of the meson masses are in qualitative agreement with lattice QCD data and QCD sum rules calculations. The chemical potential dependence of the masses provide a novel prediction of the present computation.

**Summary:**

**Monday Posters / 125****Probing the Efimov discrete scaling in atom-molecule collision****Author:** Mahdi ahmadian shalchi<sup>1</sup><sup>1</sup> *Instituto de Física Teórica, Universidade Estadual Paulista, 01140-070, Sao Paulo, SP, Brazil***Corresponding Author:** mashalchi@gmail.com

The discrete Efimov scaling behavior, well-known in the low-energy spectrum of three-body bound systems for large scattering lengths (unitary limit), is identified in the energy dependence of atom-molecule elastic cross-section in mass imbalanced systems. That happens in the collision of a heavy atom with mass  $m_H$  with a weakly-bound dimer formed by the heavy atom and a lighter one with mass  $m_L \ll m_H$ . Approaching the heavy-light unitary limit the s-wave elastic cross-section  $\sigma$  will present a sequence of zeros/minima at collision energies following closely the Efimov geometrical law. Our results, obtained with Faddeev calculations and supplemented by a Born-Oppenheimer analysis, open a new perspective to detect the discrete scaling behavior from low-energy scattering data, which is timely in view of the ongoing experiments with ultra-cold binary mixtures having strong mass asymmetries, such as Lithium and Caesium or Lithium and Ytterbium.

**Summary:****Monday Posters / 126****Fractal structure of Hadrons and multiparticle production****Author:** Airton Deppman<sup>1</sup><sup>1</sup> *University of São Paulo***Corresponding Author:** deppman@if.usp.br

In 1979, Feynman and Veneziano had already proposed that multiparticle production can have a fractal structure, what could explain the complexity of the multiparticle processes in high energy collisions. In the next decades, multiparticle fractality was observed through the intermittence that appears in many distributions measured in different laboratories. Almost two decades before that, however, Hagedorn, Frautisch and Chew had already proposed that hadron structure presents a feature present in all fractals, namely, the self-similarity. From 2000 up to now, data from high energy collisions have evidenced that energy and momentum distributions present a long tail and deviates from the exponential behaviour expected from Hagedorn's theory. More recently, it has been shown that a system with fractal structure must be described by Tsallis statistics, where the long tail is a natural result of power-law distributions obtained. In the present work, the fractal structure of hadrons is investigated. Fractal dimensions are calculated and compared with the results from intermittence analysis, systematic analyses of multiparticle production are presented, and other aspects of hadron fractality are investigated. Some possible consequences of this fractal structure in our understanding of non-perturbative QCD are explored.

**Summary:****Monday Posters / 127****Baryon mass spectrum and electromagnetic form factors****Author:** Bruno El-Bennich<sup>1</sup>

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We present a survey of electromagnetic form factors and mass spectra of light baryons obtained within a Poincaré covariant Faddeev equation framework, the ingredients of which are constrained by calculations in continuum QCD.

**Summary:**