Non-Perturbative QFT in Euclidean and Minkowski

Report of Contributions

https://indico.cern.ch/e/772852

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

Analytic structure of scattering amplitudes

Thursday, 12 September 2019 14:20 (50 minutes)

We calculate the onshell $2 \longrightarrow 2$ scattering amplitude in a scalar model to exemplify the use of contour deformations when solving Lorentz-invariant integral equations. The integrals produce branch cuts in the complex plane of the integrand which prohibit a naive Euclidean integration path. By employing contour deformations, we can also access the kinematical regions associated with the scattering amplitude in Minkowski space. We show that in principle a homogeneous Bethe-Salpeter equation together with analytic continuation methods is sufficient to determine the resonance pole locations on the second Riemann sheet as long as they are well above the threshold. However, this scalar model does not produce resonance poles but instead virtual states on the real axis of the second sheet, which poses difficulties for analytic continuation methods. To address this, we calculate the scattering amplitude on the second sheet directly and use the two-body unitarity relation which follows from the scattering equation.

Primary author: EICHMANN, Gernot (University of Lisbon)

Presenter: EICHMANN, Gernot (University of Lisbon)

Session Classification: Bound states of confined 'constituents'

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

Distributions of Quarks and Gluons in the Pion and Kaon

Thursday, 12 September 2019 15:30 (50 minutes)

The pion and kaon occupy a special place in QCD as they are bound-states of a dressed-quark and a dressed-antiquark, but would also be massless in the chiral-limit because of dynamical chiral symmetry breaking (DCSB) in QCD. The structure of these Nambu-Goldstone bosons is therefore intimately tied to key questions in QCD, such as, the origin of hadron masses and color confinement. This talk will present recent results on the partonic structure of the pion and kaon obtained using the Dyson-Schwinger equations. Particular focus will be given to the properties of the pion and kaon as expressed by aspects of their light-front wave functions, and the connection of these properties to DCSB, examples include, parton distribution amplitudes and functions, form factors, TMDs and GPDs. Opportunities to measure aspects of this partonic structure at facilities such as Jefferson Lab and a future electron-ion collider will also be briefly discussed.

Primary author: CLOET, Ian C.

Presenter: CLOET, Ian C.

Session Classification: Bound states of confined 'constituents'

Contribution ID: **3** Type: **not specified**

Complex poles and gluon confinement by a screened expansion

Tuesday, 10 September 2019 09:50 (50 minutes)

A purely analytical approach to non-perturbative QCD is discussed.
The exact, gauge-fixed, Faddeev-Popov Lagrangian of Yang-Mills theory is studied by the screened massive expansion which emerges from a mere change of the expansion point of ordinary perturbation theory. The gluon propagator has gauge-invariant complex conjugated poles which might give a direct dynamical proof of gluon confinement. Their genuine nature is discussed. Actually, because of BRST symmetry, the analytic properties and the poles are shown to play a central role in the optimization of the expansion, which becomes a very predictive and ab initio tool. While in excellent agreement with the lattice data in the Euclidean space, the expansion provides valuable information in sectors which
are not easily explored on the lattice, like Minkowski space and a generic covariant gauge. Moreover, even in the Euclidean space, the method gives a lattice-independent estimate of the running coupling in the continuum limit.

Primary author: SIRINGO, Fabio

Presenter: SIRINGO, Fabio

Session Classification: Confinement

Contribution ID: **4** Type: **not specified**

The Complex Gluon, Ghost and Higgs

Wednesday, 11 September 2019 14:20 (50 minutes)

We discuss how to extract from lattice data information about the (unphysical as gauge variant) spectral representation of gluons and ghosts using a regularized inversion strategy, compatible with the standard Källen-Lehmann spectral integral, whilst allowing generalizations thereof, namely with non-positive density and/or complex conjugate poles.

We also discuss how to introduce gauge invariant spectral functions for gauge Higgs systems and what the differences are with the standard correlation functions at the level of perturbation theory.

As an extra, we introduce a gauge independent topological momentum space index that is sensitive to the analytic structure of the propagators and which we speculate to be able to detect phase transitions.

Primary author: DUDAL, David

Presenter: DUDAL, David

Session Classification: Propagators and Vertices

Contribution ID: **5** Type: **not specified**

Microscopic hadronic quark physics for existing and near-term quantum computer devices

Tuesday, 10 September 2019 15:30 (50 minutes)

Given any effective Hamiltonian possessing the mechanism of spontaneous chiral symmetry it can be mapped to an equivalent problem of several interacting spins, by means of a Bravyi-Kitaev transformation. Jordan-Wigner transformations are also discussed.

The resulting Hamiltonian is on a suitable form to be implemented on a digital quantum computer, where spins are mapped into qubits. We propose a systematic method to determine the mass spectrum of quark-antiquark bound states, and compute it to its simplest form . Some exploratory runs have been made using the IBM quantum computer.

Primary authors: Prof. RIBEIRO, José Emílio; Dr LEITÃO, Sofia; Dr CRUZ, Diogo; Dr OMAR, Yasser; Prof. SEIXAS, João

Presenter: Prof. RIBEIRO, José Emílio

Session Classification: Confinement

Contribution ID: **6** Type: **not specified**

The generalised spectral structure of QFT correlators

Tuesday, 10 September 2019 11:00 (50 minutes)

Local formulations of QFT imply that gauge theory correlators can potentially contain generalised infrared poles. In this talk I will outline the theoretical significance of these components, and report on recent lattice fit results for the gluon propagator.

Primary author: LOWDON, Peter

Presenter: LOWDON, Peter

Session Classification: Confinement

Contribution ID: **7** Type: **not specified**

Relativistic Quantum Theories

Tuesday, 10 September 2019 13:30 (50 minutes)

The inability to distinguish inertial coordinate systems by measuring quantum observables implies that equivalent states in different inertial coordinate systems are related by a unitary representation of the Poincar\'e group on the Hilbert space of the quantum theory. These representations can be decomposed into a direct integral of irreducible representations. This decomposition is relevant for both interacting and non-interacting theories. Poincar\'e covariant, Lorentz covariant and Euclidean covariant treatments of irreducible representations are distinguished by different representations of the Hilbert space. The different Hilbert space representations are in terms of square integrable functions of the eigenvalues of commuting observables, representations with Lorentz covariant kernels (Wightman functions) and representations with reflection-positive Euclidean covariant kernels. The relation between these representations is developed by starting with the representations in terms of square integrable functions of the eigenvalues of commuting observables. The treatment of the dynamics in each representation is discussed.

Primary author: POLYZOU, Wayne (University of Iowa)

Presenter: POLYZOU, Wayne (University of Iowa)

Session Classification: Confinement

Contribution ID: **8** Type: **not specified**

Bethe-Salpeter equation with spin dof

Thursday, 12 September 2019 09:50 (50 minutes)

A survey of the challenges in solving the ladder Bethe-Salpeter equation with spin dof, within an approach able to be played directly in Minokowski space, is presented. The interesting features of the light-front distributions for both two-fermion and fermion-scalar bound systems are discussed in view of possible correlations with the underlying dynamical interaction.

Primary author: SALME', Giovanni (INFN - National Institute for Nuclear Physics)

Presenter: SALME', Giovanni (INFN - National Institute for Nuclear Physics)

Session Classification: Bound states of confined 'constituents'

Contribution ID: **11** Type: **not specified**

Baryon Transition Form factors: from the spacelike to the timelike region

Thursday, 12 September 2019 09:00 (50 minutes)

Wait to be defined by the speaker.

Primary author: PEÑA, Teresa

Presenter: PEÑA, Teresa

Session Classification: Bound states of confined 'constituents'

Contribution ID: **12** Type: **not specified**

Nakanishi representation for propagators

Wednesday, 11 September 2019 09:00 (50 minutes)

The definition and the way to extract Nakanishi representation for propagators and triple vertices in Gauge Theories will be presented during the talk. How they can be usefull for calculation of meson electromagnetic form factors in Minkowski space will be ilustrated in cases of the VHP and the pion TFF.

Primary author: SAULI, Vladimir

Presenter: SAULI, Vladimir

Session Classification: Propagators and Vertices

Contribution ID: **13** Type: **Posters**

Extracting topological information from momentum space propagators

Wednesday, 11 September 2019 16:40 (50 minutes)

A new topological invariant quantity, sensitive to the analytic structure of both fermionic and bosonic propagators, is proposed. A generalization compatible with the presence of complex poles is introduced and applied to the classification of propagators typically emerging from non-perturbative considerations. We present partial evidence that this topological number can be used to detect deconfinement.

Primary author: PAIS, Pablo

Presenter: PAIS, Pablo

Session Classification: Posters

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

Positivity violation in the quark propagator in Minkowski space

Tuesday, 10 September 2019 14:20 (50 minutes)

I discuss results of a recent study on the analytic structure of the quark propagator in Minkowski space. The analytic structure of the quark propagator in Minkowski space is more complex than in Euclidean space due to the possible existence of poles and branch cuts at timelike momenta. Here I discuss a computational method based on the spectral representation of the propagator. The method allows one to handle in exact manner poles and branch cuts in momentum integrals. I will present explicit calculations in a schematic model for the quark-gluon scattering kernel. In particular, I will show that one can obtain positive violation in the propagator's spectral functions that are not necessarily related to the presence of complex-mass poles, a feature that is relevant for interpretation of quark confinement in terms of changes in the analytical structure of propagators.

Primary author: Prof. KREIN, Gastao (Instituto de Fisica Teorica, UNESP)

Presenter: Prof. KREIN, Gastao (Instituto de Fisica Teorica, UNESP)

Session Classification: Confinement

Contribution ID: **15** Type: **not specified**

Spectral information from T>0 lattice QCD and in-medium quarkonium

Thursday, 12 September 2019 13:30 (50 minutes)

The extraction of spectral functions from Euclidean correlator data, simulated non-perturbatively at finite temperature, using first principles lattice QCD is a central challenge of modern high energy nuclear physics. In this talk I will first discuss different theoretical approaches, currently deployed to attack this problem, before showcasing recent progress and outstanding challenges in the context of in-medium heavy quarkonium physics.

Primary author: Dr ROTHKOPF, Alexander (University of Stavanger)

Presenter: Dr ROTHKOPF, Alexander (University of Stavanger)

Session Classification: Bound states of confined 'constituents'

Contribution ID: **16** Type: **not specified**

Spectral functions from the Functional Renormalization Group

Wednesday, 11 September 2019 09:50 (50 minutes)

We review some general aspects of calculations in Minkowski space-time with Functional Methods with a focus on the Functional Renormalization Group.
In particular the implications of having an momentum dependent regulator present are discussed and results for a scalar theory are presented.
Insights from calculations are used to construct improved methods for spectral reconstructions, focusing on the gluon spectral function in Yang-Mills.
Lastly, the calculation of observable, which only require elementary correlation functions in Minkowski space-time is addressed, in particular transport coefficients in Yang-Mills.

Primary author: WINK, Nicolas

Presenter: WINK, Nicolas

Session Classification: Propagators and Vertices

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

Propagators and vertices from lattice QCD

Wednesday, 11 September 2019 11:00 (50 minutes)

I will present an overview of results for gluon, ghost and quark propagators and veretices from lattice QCD, and discuss what this may tell us about their analytic structure.

Primary author: SKULLERUD, Jon-Ivar (National University of Ireland Maynooth)

Presenter: SKULLERUD, Jon-Ivar (National University of Ireland Maynooth)

Session Classification: Propagators and Vertices

Contribution ID: **18** Type: **not specified**

Continuum Limit of Gluon and Ghost Propagators in Minimal Landau Gauge

Wednesday, 11 September 2019 13:30 (50 minutes)

We study the continuum limit of SU(2) Landau-gauge gluon and ghost propagators, obtained from numerical simulations performed on lattice volumes of up to 192^4, in the scaling region.

Presenters: CUCCHIERI, Attilio; MENDES, Tereza

Session Classification: Propagators and Vertices

Contribution ID: **19** Type: **Posters**

Pion calculation observables with the Minkowski space pion model

Wednesday, 11 September 2019 16:40 (50 minutes)

The pion structure in Minkowski space is described in terms of an analytic model of the Bethe–Salpeter amplitude combined with Euclidean Lattice QCD results.
The model is physically motivated to take into account the running quark mass, which is fitted to Lattice QCD data. In the present work, we extend the an previus work, with the present model utilized to calculated the pion observables, in order to test the parameters dependence and the consequences for the pion observables, and, see the limits of the model presented in terms of the initial parameters. The model is build in order to fit quark propagator in the space-like region, from the lattice calculations with the Landau gauge, that choice preserve the Lorentz invariance of the QCD. The Lattice calculation utilized here, have two degenerate light quarks, u and d, and, also the heavy s quark. The pion pseudoscalar vertex is associated to the quark mass function, as dictated by dynamical chiral symmetry breaking requirements in the limit of vanishing current quark mass. The quark propagator is analyzed in terms of a spectral representation, and it shows a violation of the positivity constraints. The pion Bethe–Salpeter amplitude is also built in terms of a integral representation. The pion space-like electromagnetic form factor is calculated with a quark electromagnetic current, which satisfies the Ward–Takahashi identity to ensure current conservation. The results for the form factor and weak decay constant are found to be consistent with the experimental data.

Primary authors: Dr DE MELO, João Pacheco ([1]˜Laboratório de Física Teórica e Computacional - LFTC - Universidade Cruzeiro do Sul/Universidade Cidade de São Paulo,SP., Brazil); Dr MELLO, Clayton (Universidade Federal do Amapa Amapa, Brazil); Ms MOITA , Rômulo (Instituto Tecnológico de Aeronáutica, São José dos Campos,SP., Brazil); FREDERICO, Tobias (Instituto Tecnologico de Aeronautica)

Presenter: Dr DE MELO, João Pacheco ([1]˜Laboratório de Física Teórica e Computacional - LFTC - Universidade Cruzeiro do Sul/Universidade Cidade de São Paulo,SP., Brazil)

Session Classification: Posters

Contribution ID: **20** Type: **Posters**

Lattice computation of the Landau gauge quark propagator at finite temperature

Wednesday, 11 September 2019 16:40 (50 minutes)

We report on the computation of the quark propagator at finite temperature in the Landau gauge using quenched gauge configurations. The propagator form factors are computed for various temperatures, above and below the gluon deconfinement temperature T_c, and for all the Matsubara frequencies. Significant differences are found between the form factores below and above T_c, which suggest a strong connection between gluon dynamics, the mechanism for chiral symmetry breaking and the deconfinement mechanism. For temperatures above T_c and for low momenta, our results support also a description of quarks as free quasi-particles. We also report preliminary results concerning the behaviour of the quark propagator in different Z_3 sectors of the $SU(3)$ gauge group.

Primary authors: OLIVEIRA, Orlando (University of Coimbra); SILVA, Paulo (Center for Physics, University of Coimbra)

Presenter: SILVA, Paulo (Center for Physics, University of Coimbra)

Session Classification: Posters

Contribution ID: **21** Type: **Posters**

Heavy Quarkonium in Basis Light-front Quantization Approach

Heavy quarkonium has been solved as a relativistic bound state using Basis Light-Front Quantization (BLFQ), a non-perturbative Hamiltonian approach. We aim to extend the formalism from the valence Fock sector $|q\bar{q}>$ to higher Fock space by including the $|q\bar{q}q\bar{q}>$ sector, in hopes of bringing new aspects into the QCD bound states.

Primary authors: VARY, James (Iowa State University); LI, Meijian (Iowa State University); MARIS, Pieter (Iowa State University)

Presenter: LI, Meijian (Iowa State University)

Contribution ID: **22** Type: **not specified**

Pion GPD from light-front wave functions and DGLAP evolution

Thursday, 12 September 2019 11:00 (50 minutes)

We shall report on the model building of the pion GPD, within the DGLAP kinematic region, through the overlap of light-front wave functions. The wave functions can be modelled on the basis of the so-called Nakanishi representation and brought to make contact with realistic solutions of the Bethe-Salpeter equation. Then, we will capitalise on a new type of process-independent QCD charge to evolve effectively the GPD from a hadronic scale up to larger momentum scales, relevant for a comparison with experimental data.

Primary author: Prof. RODRIGUEZ QUINTERO, José (Universidad de Huelva)

Presenter: Prof. RODRIGUEZ QUINTERO, José (Universidad de Huelva)

Session Classification: Bound states of confined 'constituents'

Contribution ID: **23** Type: **Posters**

Solutions of DSE in Minkowski space via Nakanishi Integral Representation

Wednesday, 11 September 2019 16:40 (50 minutes)

An important tool to deal with the formulation in Minkowski space is the Integral Representation (IR) proposed by Nakanishi.
In this work, we use the IR to obtain a solution of the Dyson-Schwinger equation directly in Minkowski space, and compare with a solution in a rotated axis from the Euclidean axis, what we call "Un-Wick rotation". To this end we must find the relation between the fermion propagator self energy and the spectral densities, together with the DSE in the rainbow-approximation.
We solve the DSE in the rainbow ladder approximation for massive gauge boson, written for the spectral densities in arbitrary gauges with undressed gauge-boson-fermion vertex in the Minkowski space by using the Nakanishi Integral Representation.

Primary authors: Dr DUARTE, D (Instituto Tecnologico de Aeronautica); Dr SHAOYANG, J (Iowa State University); Dr YDREFORS, E (Instituto Tecnologico de Aeronautica); DE PAULA, Wayne (Instituto Tecnologico de Aeronautica); FREDERICO, Tobias (Instituto Tecnologico de Aeronautica); MARIS, Pieter (Iowa State University)

Presenter: DE PAULA, Wayne (Instituto Tecnologico de Aeronautica)

Session Classification: Posters

Contribution ID: **24** Type: **Posters**

Nontrivial analytic structure of fermion propagators: Truncation Artefact or Confinement Signal?

Wednesday, 11 September 2019 16:40 (50 minutes)

Dyson-Schwinger studies of the fermion propagator are typically performed in Euclidean metric, providing information on the nonperturbative behavior of the fermion propagator at spacelike momenta. It has been known for more than 40 years that an analytic continuation to the entire complex momentum plane can, and often does, reveal 'mass-like' singularities at complex-conjugate momenta, even in QED. The existence of complex singularities instead of the a mass-pole at timelike momenta would certainly imply that the fermion field is confined; however, it would also have profound consequences for the (naive) Wick rotation. I discuss different numerical methods to investigate the analytic structure of fermion propagators and apply them to both QED and QCD. It turns out that the obtained analytic structure depends not only on the coupling strength, but also on details of e.g. the regularization scheme and the truncation of the DSEs.

Primary author: MARIS, Pieter (Iowa State University)

Presenter: MARIS, Pieter (Iowa State University)

Session Classification: Posters

Contribution ID: **25** Type: **Posters**

From propagators to resonances in QCD

Wednesday, 11 September 2019 16:50 (20 minutes)

We show results for propagators and vertices in Yang-Mills theory and QCD obtained from the 3PI effective action. Their use in calculating bound-states and resonances requires access to complex momenta, necessitating special care. We perform appropriate deformations of the integration contour to avoid cuts and poles and present corresponding results for bound states as well as first results for resonances using a simpler truncation of the functional equations.

Primary authors: Dr HUBER, Markus (Giessen University); WILLIAMS, Richard (University of Giessen)

Co-author: Prof. FISCHER, Christian (JLU Gießen)

Presenters: Dr HUBER, Markus (Giessen University); WILLIAMS, Richard (University of Giessen)

Session Classification: Posters

Contribution ID: **26** Type: **Posters**

Coordinate-Space time order perturbation theory

Wednesday, 11 September 2019 16:30 (20 minutes)

Presenter: SALAS-BERNÁRDEZ, Alexandre

Session Classification: Posters

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

Welcome

Presenter: OLIVEIRA, Orlando

Contribution ID: **29** Type: **not specified**

Nonperturbative propagators in the complex momentum plane

Presenter: MARIS, Pieter (Iowa State University)

Contribution ID: **30** Type: **not specified**

Welcome

Tuesday, 10 September 2019 09:10 (10 minutes)

Presenter: OLIVEIRA, Orlando

Contribution ID: **31** Type: **not specified**

Nonperturbative propagators in the complex momentum plane

Presenter: MARIS, Pieter

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

Nonperturbative propagators in the complex momentum plane

Presenter: MARIS, Pieter

Contribution ID: **33** Type: **not specified**

Nonperturbative propagators in the complex momentum plane

Tuesday, 10 September 2019 09:20 (30 minutes)

Presenter: MARIS, Pieter

Contribution ID: **34** Type: **not specified**

Conference Dinner

Wednesday, 11 September 2019 19:30 (1h 30m)