Asia-Pacific Symposium for Lattice Field Theory (APLAT 2020)

Report of Contributions

https://conference-indico.kek.jp/e/113

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

Thermal transition in QCD with Nf=2+1 flavours of Wilson quark

Tuesday, 4 August 2020 14:00 (20 minutes)

The thermal transition in QCD has been studied in detail using the staggered-quark formulation. Here we report on progress using Nf=2+1 flavours of Wilson fermions, employing anisotropic, fixed-scale lattice simulations. Observables are compared for two values of the pion mass, focusing on chiral properties: the chiral condensate and its susceptibility, quark number susceptibilities, and the onset of parity doubling in the light and strange baryonic sector. For the pseudo-critical temperature obtained from the chiral condensate, we combine our results with those from twisted-mass fermions and extrapolate to the physical point - without a continuum extrapolation -, yielding T_pc=159(6) MeV.

Primary author: AARTS, Gert (Swansea University)

Co-authors: ALLTON, Chris; GLESAAEN, Jonas; HANDS, Simon; JAEGER, Benjamin; KIM, Seyong; LOMBARDO, Maria-Paola; NIKOLAEV, Aleksandr; RYAN, Sinead; SKULLERUD, Jon-Ivar; WU, Liang-Kai

Presenter: AARTS, Gert (Swansea University)

Session Classification: QCD at nonzero Temperature and Density

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

Bringing scattering data to the finite volume of lattice QCD

Tuesday, 4 August 2020 15:00 (20 minutes)

Hamiltonian effective field theory (HEFT) is an approach which allows for the extraction of hadron finite-volume energy spectra from scattering observables such as phase shifts and inelasticities. As an alternative to Luscher's method, HEFT easily generalises to systems with multiple coupled channels and multiple bare states. HEFT also allows for the extraction of eigenvectors from the Hamiltonian, providing new insight into the composition of finite-volume eigenstates and their dependence on the lattice volume. In this presentation we'll explore renormalisation in HEFT using pion-nucleon scattering data in the Delta resonance channel. By examining the composition of the Delta resonance and its dependence on the regulator parameter, connections with alternative renormalisation schemes are made.

Primary author: ABELL (*), Curtis (University of Adelaide)

Co-authors: LEINWEBER, Derek B.; THOMAS, Anthony W.

Presenter: ABELL (*), Curtis (University of Adelaide)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

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

Fermion-Higgs composite state mass in a SU(2) Wilson-Yukawa model

Tuesday, 4 August 2020 16:20 (20 minutes)

A correct non perturbative treatment of gauge theories requires physical particles to be described by gauge invariant operators. It is then appropriate to use composite operators made of elementary gauge dependant fields as physical observables.

Primary author: AFFERRANTE (*), Vincenzo (University of Graz)

Co-authors: MAAS, Axel; TOREK, Pascal

Presenter: AFFERRANTE (*), Vincenzo (University of Graz)

Session Classification: Physics Beyond the Standard Model

Track Classification: Applications beyond QCD

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

Study of the rho resonance using the HAL QCD method

Tuesday, 4 August 2020 15:20 (20 minutes)

In this talk, we show the recent status of the rho resonance study in the HAL QCD method.
We investigate the I=1 two-pion potential at $m_\pi \approx 411$ MeV by using a new calculation strategy, namely the combination of three techniques: the one-end trick, the sequential propagator, and covariant approximation averaging (CAA).
Thanks to the new strategy, we determine the non-local I=1 two-pion potential at the next-leading-order of the derivative expansion for the first time and obtain the pole of the S-matrix corresponding to the rho resonance.
As regards the resonance parameters, our resonance mass is consistent with the previous study using the finite-volume method, but slightly larger decay width and coupling are obtained. We discuss possible origins of this difference.

Primary author: AKAHOSHI (*), Yutaro (Yukawa Institute for Theoretical Physics, Kyoto University)

Co-authors: HAL QCD COLLABORATION; AOKI, Sinya

Presenter: AKAHOSHI (*), Yutaro (Yukawa Institute for Theoretical Physics, Kyoto University)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

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

Tensor renormalization group approach to four-dimensional complex \phiˆ4 theory at finite density

Friday, 7 August 2020 15:20 (20 minutes)

Tensor network is an attractive approach to field theory with
negative sign problem. The complex \phiˆ4 theory at finite density is a test bed for numerical algorithms to verify their effectiveness.
The model shows a characteristic feature called the Silver Blaze phenomenon associated with the sign problem in the large volume limit at low temperature. We analyze the four-dimensional model employing the anisotropic tensor renormalization group algorithm. We find a clear signal of the Silver Blaze phenomenon on a large volume of V=1024ˆ4, which implies that the tensor network approach is effective even for four-dimensional field theory beyond two dimensions.

Primary author: AKIYAMA (*), Shinichiro (University of Tsukuba)

Co-authors: KADOH, Daisuke; KURAMASHI, Yoshinobu; YAMASHITA, Takumi; YOSHIMURA, Yusuke

Presenter: AKIYAMA (*), Shinichiro (University of Tsukuba)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

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

Extending Bridge++ Lattice Simulation Code to Vector Processors

Tuesday, 4 August 2020 15:00 (20 minutes)

We report our recent extension of Bridge++, a general-purpose code set for numerical simulations of lattice gauge theories, to the latest vector processor, NEC SX-Aurora TSUBASA. The Bridge++ project aims at developing a readable, extensible, and portable workbench with sufficiently high performance. Based on the code set we investigate fast algorithms for parallel numerical calculations, and code optimization techniques. While the major target of the code set has been cluster systems with scalar processors, we are now extending it to various architectures such as GPUs and processors with wide SIMD registers. In this talk, we introduce our framework for accommodating these platforms, and present the optimization for the vector processor.

Primary author: AOYAMA, Tatsumi (KEK)

Co-authors: BRIDGE++ PROJECT; KANAMORI, I.; MATSUFURU, H.; NAMEKAWA, Y.

Presenter: AOYAMA, Tatsumi (KEK)

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

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

Complex Langevin analysis of the spontaneous breaking of 10D rotational symmetry in the Euclidean IKKT matrix model

Wednesday, 5 August 2020 14:00 (20 minutes)

The IKKT matrix model is a promising candidate for a nonperturbative formulation of superstring theory, in which spacetime is conjectured to emerge dynamically from the microscopic matrix degrees of freedom in the large-N limit. Indeed in the Lorentzian version, Monte Carlo studies suggested the emergence of (3+1)-dimensional expanding space-time. Here we study the Euclidean version instead, and investigate an alternative scenario for dynamical compactification of extra dimensions via the spontaneous symmetry breaking (SSB) of 10D rotational symmetry. We perform numerical simulations based on the complex Langevin method (CLM) in order to avoid a severe sign problem. Furthermore, in order to avoid the singular-drift problem in the CLM, we deform the model and determine the SSB pattern as we vary the deformation parameter. From these results, we conclude that the original model has an SO(3) symmetric vacuum, which is consistent with previous results obtained by the Gaussian expansion method (GEM). We also apply the GEM to the deformed matrix model and find consistency with the results obtained by the CLM.

Primary author: AZUMA, Takehiro (Setsunan University)

Co-authors: ANAGNOSTOPOULOS, Konstantinos N.; ITO, Yuta; NISHIMURA, Jun; OKUBO, Toshiyuki; PAPADOUDIS, Stratos Kovalkov

Presenter: AZUMA, Takehiro (Setsunan University)

Session Classification: Physics Beyond the Standard Model

Track Classification: Physics Beyond the Standard Model

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

Machine Learning and Histogram Reweighting: Detecting and Studying Phase Transitions

Wednesday, 5 August 2020 17:00 (20 minutes)

We present a synergistic approach between machine learning and histogram reweighting to discover and study phase transitions in physical systems. We treat the output of a neural network, designed for phase classification, as an observable in a statistical system enabling its extrapolation over continuous ranges in parameter space using histogram reweighting. The approach, which leads to quantitative results and overcomes the need to understand the studied system in detail, is applied to the two-dimensional Ising model by training a convolutional neural network to separate its symmetric and broken-symmetry phases. We further demonstrate that the Ising-trained neural network is sufficient to predict the phase transition in q-state Potts models and the ϕ^4 scalar field theory under a change of order, universality class or the presence of continuous or discrete degrees of freedom. Finally, we present calculations of critical exponents and the critical coupling for the Ising model and the ϕ^4 scalar field theory using a finite size scaling analysis on quantities derived entirely from the neural network implementation and their histogram-reweighted extrapolations.

Primary author: BACHTIS (*), Dimitrios (Swansea University)

Co-authors: AARTS, Gert; LUCINI, Biagio

Presenter: BACHTIS (*), Dimitrios (Swansea University)

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

Contribution ID: **9** Type: **not specified**

P-wave form factors from the inclusive semileptonic $B\ rightarrow X_c\ell\nu$ decays

Tuesday, 4 August 2020 17:20 (20 minutes)

We report our estimation for the Isgur-Wise form factors for the inclusive semileptonic $B \to X_c\ell\nu$ on 2+1-flavor lattice QCD.
The M\"obius domain-wall fermion action is used for light, strange, charm and bottom quarks. The structure function receives contributions from various exclusive modes, including the dominant S-wave states $D_s^{(*)}$ as well as the P-wave states D_s^{**}. In this work, we identify and separate these contributions in the lattice data, from
which we put some constraints on the $B_s \to D_s^{**}\ell\nu$ form factors. Our work takes into account the structure functions for the cases of zero-recoil and non-zero recoil.

Primary author: BAILAS (*), Gabriela (KEK)

Co-authors: HASHIMOTO, S.; KANEKO, T.

Presenter: BAILAS (*), Gabriela (KEK)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **10** Type: **not specified**

Nucleon electromagnetic form factors at large momenta using the Feynman-Hellmann theorem

Wednesday, 5 August 2020 16:20 (20 minutes)

The hadronic form factors at large momentum transfers often suffer from substantial excited state contributions and poor signal-to-noise ratios. Using the Feynman-Hellmann theorem allows for calculations of the hadronic form factors which only rely on two-point functions this allows access to higher momenta while still controlling the excited state contributions. We will present results from our study of the electromagnetic form factors of the nucleons up to approximately \(9 \textrm{ GeV}ˆ2\). The calculations are performed using \(N_{f} = 2+1\) flavour, \(\mathcal{O}(a)\)-improved Wilson fermions on lattices with spacing \(a=0.074 \textrm{ fm}\) and three different pion masses of \(466 \textrm{ MeV}\), \(360 \textrm{ MeV}\) and \(310 \textrm{ MeV}\).

Primary author: BATELAAN (*), Mischa (University of Adelaide)

Co-authors: ZANOTTI, James; YOUNG, Ross

Presenter: BATELAAN (*), Mischa (University of Adelaide)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

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

Parton Distribution Functions from pseudo-distributions

Friday, 7 August 2020 14:40 (20 minutes)

We present a detailed study of the nucleon unpolarized parton distribution function (PDF) using the approach of parton pseudo-distribution functions. We use this method to extract PDFs from the lattice results obtained using simulations with the
light quark mass fixed to its physical value. Then, the physical Ioffe time distributions are obtained from the nucleon matrix elements extracted from lattice simulations through a matching procedure. We reconstruct the PDF using different approaches. Using a direct Fourier transform of Ioffe-time data poses an inverse problem, due to the ill-defined inverse equation. We use two advanced reconstruction techniques to tackle this problem: the Backus-Gilbert method and fitting data to a suitable function as implied by global fitting in phenomenology. We fit the real and imaginary parts of Ioffe-time data to the cosine and sine Fourier transform of $x^a(1-x)^b$ type function, respectively. We find good agreement with PDFs from global fits and it is further improved by quantifying several systematic effects.

Primary author: BHAT (*), Manjunath (Adam Mickiewicz University)

Co-authors: CICHY, Krzysztof; CONSTANTINOU , Martha; SCAPELLATO, Aurora

Presenter: BHAT (*), Manjunath (Adam Mickiewicz University)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

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

Visualisations of the non-trivial QCD vacuum

Friday, 7 August 2020 16:00 (20 minutes)

Despite the success of quantum chromodynamics (QCD) in describing the strong nuclear force, a clear picture of how this theory gives rise to the distinctive properties of confinement and dynamical chiral symmetry breaking at low energy is yet to be found. One of the more promising models used to explain these phenomena in recent times is known as the centre vortex model. In this work we explore the properties of the gluon propagator in the context of this model, adding to the already substantial body of evidence supporting the importance of centre vortices in QCD. We also present novel visualisation techniques that have been devised to allow for detailed hands-on exploration of the centre-vortex structure of the QCD vacuum. These techniques provide new insight into the behaviour of centre vortices in low-energy lattice QCD.

Primary author: BIDDLE (*), James (Centre for the Subatomic Structure of matter, Department of Physics, The University of Adelaide)

Co-authors: Prof. LEINWEBER, Derek; Dr KAMLEH, Waseem

Presenter: BIDDLE (*), James (Centre for the Subatomic Structure of matter, Department of Physics, The University of Adelaide)

Session Classification: Vacuum Structure and Confinement

Track Classification: Vacuum Structure and Confinement

Contribution ID: **13** Type: **not specified**

Magnetic Polarisability with the background Field Method

Thursday, 6 August 2020 16:00 (20 minutes)

The magnetic polarisability is a fundamental property of hadrons, which provides insight into their structure in the low-energy regime. The pion magnetic polarisability is calculated using lattice QCD in the presence of background magnetic fields. The results presented are facilitated by the introduction of a new magnetic-field dependent quark-propagator eigenmode projector and the use of the background-field corrected clover fermion action. The magnetic polarisabilities are calculated in a relativistic formalism, and the excellent signal-to-noise property of pion correlation functions facilitates precise values.

Primary author: BIGNELL (*), Ryan (University of Adelaide)

Co-authors: LEINWEBER, Derek; KAMLEH, Waseem

Presenter: BIGNELL (*), Ryan (University of Adelaide)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

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

Alternative derivation of relativistic three-particle quantization condition

Tuesday, 4 August 2020 14:20 (20 minutes)

We present a simplified derivation of the relativistic three-particle quantization condition for identical, spinless particles. The simplification is afforded by using time-ordered perturbation theory (TOPT) and a three-particle quasilocal K matrix that is not fully symmetrized to organize the relevant diagrams in an intuitive manner, ultimately leading to a new form of the quantization condition. This form can then be related algebraically to both the standard quantization condition, which uses a fully symmetric three-particle K matrix, and the quantization condition based on extending unitary representations of the three-particle amplitude to finite volume. It should also allow a more straightforward generalization of the quantization condition to nondegenerate particles, and perhaps also to more than three particles.

Primary author: BLANTON (*), Tyler (University of Washington)

Co-author: SHARPE, Stephen R.

Presenter: BLANTON (*), Tyler (University of Washington)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

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

Determination of the charm quark mass from Nf = 2+1 QCD with Wilson fermions

Thursday, 6 August 2020 14:00 (20 minutes)

We have recently performed a determination of the charm quark mass on Nf = 2+1 CLS ensembles of non-perturbatively improved Wilson fermions. I will present the preliminary results of this analysis for the renormalization-group invariant charm quark mass and the ratio m_c/m_s on these ensembles. The extrapolation to the chiral and continuum limits is performed using 5 lattice spacings ranging roughly from 0.09 down to 0.04 fm and pion masses from 420 MeV to 130 MeV. The spatial extent of the ensembles is generally at least 4 / M_\pi. In my talk, I will discuss the various analysis strategies we considered, including the fitting procedure, corrections for the correlations in the data, and the chiral-continuum extrapolation.

Primary author: BOUMA (*), Sjoerd (University of Regensburg)

Presenter: BOUMA (*), Sjoerd (University of Regensburg)

Session Classification: Standard Model Parameters and Renormalisation

Track Classification: Standard Model Parameters and Renormalisation

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

Multigrid methods for Chiral Fermions

Tuesday, 4 August 2020 14:20 (20 minutes)

We compare two of different methods for coarsening domain wall fermions and discuss progress towards a multigrid method for DWF with the ability to set up and solve during gauge configuration generation.

Primary author: BOYLE, Peter (Brookhaven National Laboratory)

Co-author: YAMAGUCHI, Azusa

Presenter: BOYLE, Peter (Brookhaven National Laboratory)

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

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

Lattice study of rotating gluodynamics

Thursday, 6 August 2020 15:20 (20 minutes)

In this report we present the results of lattice study of how rotation influences confinement/deconfinement transition in SU(3) gluodynamics. To conduct this study we pass to the reference frame which rotates with the system under consideration. In this reference frame rotation is accounted for by the external gravitational field. We calculate the Polyakov loop, its susceptibility
and determine the critical temperature of the confinement/deconfinement transition for various angular velocities. We find that rotation leads to rise of the critical temperature.

Primary author: BRAGUTA, Victor (JINR)

Co-authors: KOTOV, A.Yu.; KUZNEDELEV, D.D.; ROENKO, A.

Presenter: BRAGUTA, Victor (JINR)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

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

Simplical Lattice Field Theory on de Sitter and anti de Sitter Manifolds

Friday, 7 August 2020 16:00 (20 minutes)

The generalization of Lattice Field Theory targeting in curved Riemann manifolds referred to as Quantum Finite Elements (QFE) requires geometrical tools.
A brief outline for the construction of a Simplicial Complex and
its Delaunay dual, the construction Finite Element of lattice action based on
the elegant Discrete Exterior Calculus (DEC) is given. The focus in on spheres and hyperbolic manifolds suited to radial quantization of conformal field theory and
the AdS/CFT correspondence respectively. The formalism aims to construct simlicial
actons for scalar, Dirac and non-Abelian fields.

Primary author: BROWER, Richard (Boston University)

Presenter: BROWER, Richard (Boston University)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **19** Type: **not specified**

Maiani-Testa meets the inverse problem

Thursday, 6 August 2020 16:20 (20 minutes)

In their seminal publication of 1990, Maiani and Testa showed that Euclidean correlators are contaminated by off-shell contributions, limiting a direct extraction of amplitudes away from threshold. In this presentation, we revisit and extend this work, and explore the connection with recent developments on the inverse problem in Lattice QCD.

Primary author: BRUNO, Mattia (CERN)

Co-author: HANSEN, Maxwell T.

Presenter: BRUNO, Mattia (CERN)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **20** Type: **not specified**

Finite volume effects and meson scattering in the 2-flavour Schwinger model

Friday, 7 August 2020 14:00 (20 minutes)

We investigate the two-flavour Schwinger model in the canonical formulation with fixed fermion number.
We use Wilson fermions on the lattice and present a formalism which describes the Dirac operator with dimensionally reduced canonical operators.
These reduced operators allow the direct examination of different meson sectors and the determination of the energy spectrum in
each of the sectors. Using Lüscher's finite-volume mass-shift formula we discuss the 1-meson mass as well as the effective 3-meson coupling.
From the 2-meson energies we determine the scattering phase shifts and compare the 3-meson energies in the finite volume to various
predictions based on scattering theory.

Primary author: BÜHLMANN (*), Patrick (University of Bern)

Co-author: WENGER, Urs

Presenter: BÜHLMANN (*), Patrick (University of Bern)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **21** Type: **not specified**

Pseudoscalar-Photon Transition Form Factors from Twisted Mass Lattice QCD

Friday, 7 August 2020 17:20 (20 minutes)

We report on our computation of the pseudoscalar-photon transition form factors from twisted mass lattice QCD for three pseudoscalar states, i.e. the neutral pion and the eta and eta' mesons, to determine the corresponding light pseudoscalar pole contributions in the dispersive analysis of hadronic light by light scattering in the muon g-2.
The neutral pion transition form factor is computed directly at the physical point.
While the eta and eta' transition form factors are more numerically challenging than the one for the neutral pion, we present first results for the eta and eta' 3-point amplitude and explore methods for extracting the transition form factors.

Primary author: BURRI (*), Sebastian (University of Bern)

Presenter: BURRI (*), Sebastian (University of Bern)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

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

Determination of α_s in $N_f = 3$ QCD from current-current correlation functions in position space

Thursday, 6 August 2020 14:20 (20 minutes)

In this talk, we present a lattice determination of the coupling constant α_s in $N_f = 3$ QCD for renormalization scales $\mu \in (1, 2)$ GeV.
The computation has been performed on ensembles generated by the Coordinated Lattice Simulations (CLS) consortium, with tree-level Symanzik-improved gauge action and Wilson O(a)-improved fermions. Our approach is based on the study of current-current correlation functions in position space and allows to determine α_s (or alternatively the Λ parameter) with a competitive precision.

Primary author: CALÌ (*), Salvatore (Jagiellonian University)

Co-authors: CICHY, Krzysztof; KORCYL, Piotr; SIMETH, Jakob

Presenter: CALÌ (*), Salvatore (Jagiellonian University)

Session Classification: Standard Model Parameters and Renormalisation

Track Classification: Standard Model Parameters and Renormalisation

Contribution ID: **23** Type: **not specified**

Compton amplitude via the Feynman-Hellman theorem

Friday, 7 August 2020 16:20 (20 minutes)

In this talk, we highlight our group's recent developments on computing the Compton amplitude in a lattice approach. We briefly discuss how to access the Compton amplitude directly via the second-order Feynman-Hellmann theorem. As an application, we compute the nucleon Compton tensor across a range of photon momenta at an unphysical quark mass. This enables us to study the Q^2 dependence of the low moments of the nucleon structure functions in a lattice calculation for the first time. We discuss possible further applications of this approach.

Primary author: CAN (*), K. Utku (University of Adelaide)

Co-authors: HANNAFORD-GUNN, A.; HORSLEY, R.; NAKAMURA, Y.; PERLT, H.; RAKOW, P. E. L.; SCHIERHOLZ, G.; SOMFLETH, K. Y.; STÜBEN, H.; YOUNG, R. D.; ZANOTTI, J. M.; (CSSM/UKQCD/QCDSF COLLABORATIONS)

Presenter: CAN (*), K. Utku (University of Adelaide)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **24** Type: **not specified**

From QCD string breaking to quarkonium spectrum

Thursday, 6 August 2020 16:20 (20 minutes)

Signal-to-noise problem and excited states contamination, inter alia, make studies of the QCD string breaking phenomenon a challenging task in lattice QCD. The static quark potentials produced for these studies can be combined with the Born Oppenheimer approximation to give an important insight into I=0 quarkonium resonances. Precise determination of various lattice potentials are also needed for better understanding of the bound states and hybrid mesons recently observed at LHC and other experiments. In this talk, we present preliminary results on the Wilson loop correlators and compare smeared and unsmeared static potentials for two flavour QCD with improved Wilson fermions. The systematic errors are reduced by solving the generalised eigenvalue problem.

Primary author: CATILLO (*), Marco (Ludwig Maximilian University of Munich)

Co-authors: MARINKOVIC, Marina; BICUDO, Pedro; CARDOSO, Nuno

Presenter: CATILLO (*), Marco (Ludwig Maximilian University of Munich)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **25** Type: **not specified**

D to K semileptonic decay from n_f = 2 + 1 + 1 lattice QCD with physical light quarks

Wednesday, 5 August 2020 16:20 (20 minutes)

We present our (HPQCD) latest lattice QCD calculation of the scalar and the vector form factors for the D ⟶ Klν semi-leptonic decay over a full range of qˆ2 including qˆ2 = 0. This calculation has been performed on the N_f=2+1+1 MILC HISQ ensembles with the physical and heavier than physical light quark masses.This calculation allows us to precisely determine the central CKM matrix element, V_{cs} in the Standard Model, by comparing the lattice QCD results for the form factors and the experimental decay rate.

Primary author: CHAKRABORTY (*), Bipasha (University of Cambridge)

Co-authors: DAVIES, C. T. H.; PARROTT, W.; KOPONEN, J.; LEPAGE, G. P.; [HPQCD]

Presenter: CHAKRABORTY (*), Bipasha (University of Cambridge)

Session Classification: Weak Decays and Matrix Elements

Track Classification: Weak Decays and Matrix Elements

Contribution ID: **26** Type: **not specified**

Hadronic light-by-light contribution to $(g-2)_\mu$ near the SU(3)-flavor-symmetric point

Wednesday, 5 August 2020 14:20 (20 minutes)

Understanding the tension between the Standard Model prediction and the experimental results on the anomalous magnetic moment of the muon (a_\mu) has been an active research field over the past two decades. The theoretical uncertainty mainly comes from the hadronic contributions, among which the hadronic light-by-light scattering (a_μ^{hlbl}) process plays an important role. We investigate this contribution on the lattice with a position-space approach. In our setup, we treat separately the QED part in the continuum and infinite volume and the QCD part on the lattice, which helps to avoid finite-size effects due to the photon in finite-volume. However, noticeable finite-size effects due to long-distance physics still persist in our approach. In our recent work [arXiv:2006.16224], we have performed computations of a_μ^{hlbl} on the lattice with $N_f = 3$ ensembles having degenerate light and strange quark masses. Our results have satisfactory statistical errors and allow us to concentrate on our strategy to control the finite-size effects using the pion-exchange contribution. The extension of our setup to include non flavor-symmetric ensembles does not require much effort, thanks to the pre-computed single-propagator trace in position space shared among other Mainz projects. Our work in progress toward the physical point will be briefly reported, with focus on the Wick-contraction topologies that vanish at the flavor-symmetric point.

Primary author: CHAO (*), En-Hung (Johannes Gutenberg-Universität Mainz)

Co-authors: GÉRARDIN, Antoine; GREEN, Jeremy; HUDSPITH, Renwick J.; MEYER, Harvey B.; OTTNAD, Konstantin

Presenter: CHAO (*), En-Hung (Johannes Gutenberg-Universität Mainz)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **27** Type: **not specified**

Conformal magnetic effect in scalar QED

Friday, 7 August 2020 14:00 (20 minutes)

Quantum polarization effects associated with the conformal anomaly in a static magnetic field background may generate a transverse electric current in the vacuum of massless particles (either bosons or fermions). The current may be produced either in an unbounded curved spacetime or in flat spacetime in a physically bounded system. In both cases, the magnitude of the electric current is proportional to the beta-function associated with the renormalization of electric charge. We investigate the electric current density induced by the magnetic field in the vicinity of a Dirichlet boundary in lattice scalar QED. We show that the electric current, generated by this "conformal magnetic effect at the edge" (CMEE), is well described by the conformal anomaly in the symmetry–unbroken phase. In the symmetry–broken phase, the anomalous current becomes the usual Meissner current generated by the superconducting condensate.

Primary author: CHERNODUB, Maxim (Institut Denis Poisson, CNRS)

Co-authors: GOY, V. A.; MOLOCHKOV, A. V.

Presenter: CHERNODUB, Maxim (Institut Denis Poisson, CNRS)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

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

*** CANCELLED*** Extending Lattice H2 to AdS3

Wednesday, 5 August 2020 14:40 (20 minutes)

In a recent work, we describe and quantify a method for setting up a lattice for quantum field theory in AdS2 based on the triangle group, which enables maximally symmetric tilings of hyperbolic space. Here we extend this lattice setup to the AdS3 cylinder via Hamiltonian methods, enabling us to study dynamical systems. We verify basic properties of this discretized Euclidean AdS3 space with the continuum, such as propagators and the four-point function. For the latter, using a "conformal center of mass frame" we are able to make the kinematic variables of the configuration conformal, providing a convenient framework for further study.

Primary author: COGBURN (*), Cameron (Boston University)

Co-authors: BROWER, Richard C.; COGBURN, Cameron V.

Presenter: COGBURN (*), Cameron (Boston University)

Session Classification: Physics Beyond the Standard Model

Track Classification: Applications beyond QCD

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

Investigation of a b̄b̄ud tetraquark resonance with I(Jˆ P) = 0(1⁻) using lattice QCD static potentials

We explore the existence of tetraquark resonances with lattice QCD potentials computed for a static b̄b̄ pair in the presence of two light quarks ud. We use the Born-Oppenheimer approximation and an extension of the emergent wave method, where effects of the heavy quark spins are included via the mass difference of the B and the B* meson. Focus is given on a resonance with isospin I = 0 and relative angular momentum L=1 of the heavy quarks b̄b̄.

Primary author: ZIMERMMANE-SANTOS, André C. (Goethe University of Frankfurt)

Co-authors: HOFFMANN, Jakob; WAGNER, Marc

Presenter: ZIMERMMANE-SANTOS, André C. (Goethe University of Frankfurt)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

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

Scattering of Goldstone bosons in SU(2) with Nf=2 fundamental fermions

Tuesday, 4 August 2020 16:40 (20 minutes)

We present the first lattice calculation of the scattering amplitude of Goldstone bosons in the singlet channel relevant to test the viability of a composite Higgs scenario beyond the Standard Model. In such a framework, the scattering of the underlying Goldstone bosons controls the properties of the Higgs boson. The Higgs boson properties are constrained by the Standard Model and experimentally measured by the CERN experiments and therefore provide stringent tests of models of new physics.
In this work we focus on a SU(2) gauge theory with 2 flavours of Dirac fermions in the fundamental representation, a minimal UV completion of a composite Higgs model. We calculate the scattering amplitude near threshold of two of two Goldstone bosons in the singlet channel. The first principle prediction sheds light on the viability of the model.

Primary author: DRACH, Vincent (University of Plymouth)

Co-authors: FRITZSCH, Patrick; LÒPEZ, Fernando Romero; RAGO, Antonio

Presenter: DRACH, Vincent (University of Plymouth)

Session Classification: Physics Beyond the Standard Model

Track Classification: Physics Beyond the Standard Model

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

Two-current Correlations and the Pion Valence Quark Distribution from Lattice QCD

Friday, 7 August 2020 16:40 (20 minutes)

An understanding of the partonic structure of hadrons is an essential ingredient in making precise predictions and measurements of hadronic cross-sections and various Standard, and Beyond Standard, Model parameters. Several encouraging proposals have been developed in the past decade that relate lattice calculable quantities with PDFs via frameworks akin to QCD factorization. We report results of one such LQCD formalism, wherein the pion valence quark distribution is extracted through a short-distance collinear factorization of space-like separated vector and axial-vector current correlations. A simultaneous fit of such matrix elements computed on four distinct gauge ensembles, including systematic lattice corrections, yields a physical Ioffe-time distribution (ITD). The pion valence PDF extracted from this ITD is found to be consistent with experiment across the entire Bjorken-x region, and offers tantalizing clues to its large-x behavior. We further demonstrate the recently derived one-loop matching coefficient that is central to this work has a well-controlled behavior in Ioffe-time.

Primary author: EGERER (*), Colin (William & Mary)

Co-authors: HADSTRUC COLLABORATION; SUFIAN, R.S.; KARPIE, J.; EDWARDS, R.; JOO, B.; MA, Y.-Q.; ORGINOS, K.; QIU, J.-W.; RICHARDS, D.

Presenter: EGERER (*), Colin (William & Mary)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

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

$B_{(s)} - \bar{B}_{(s)}$ mixing on domain-wall lattices

Wednesday, 5 August 2020 15:00 (20 minutes)

We are presenting our ongoing Lattice QCD study on $B-\bar{B}$ mixing. Comparing a variety of different methods, we are extracting bag parameters B_{B_s} and B_{B_d} on several RBC/UKQCD and JLQCD ensembles with 2+1 dynamical-flavour domain wall fermions, including physical-pion-mass ensembles. We are simulating a range of heavy quark masses on each ensemble from below the charm quark mass towards (but still below) the bottom quark mass. The plan for this study is to perform a full continuum limit allowing us to get an independent determination of the CKM matrix elements $|V_{ts}|$ and $|Vtd|$, which will help to test whether the CKM matrix is indeed unitary.

Primary author: ERBEN (*), Felix (University of Edinburgh)

Co-author: TSANG, Justus Tobias

Presenter: ERBEN (*), Felix (University of Edinburgh)

Session Classification: Weak Decays and Matrix Elements

Track Classification: Weak Decays and Matrix Elements

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

Lattice QCD calculation of the pion charge radius using a model-independent method

Wednesday, 5 August 2020 15:00 (20 minutes)

We use a method to calculate the hadron's charge radius without model-dependent momentum extrapolations. The method does not require the additional quark propagator inversions on the twisted boundary conditions or the computation of the momentum derivatives of quark propagators and thus is easy to implement. We apply this method to the calculation of pion charge radius ⟨r^2⟩. For comparison, we also determine ⟨r^2⟩ with the traditional approach of computing the slope of the form factors. The new method produces results consistent with those from the traditional method and with statistical errors 1.5-1.9 times smaller. For the four gauge ensembles at the physical pion masses, the statistical errors of ⟨r^2⟩ range from 2.1% to 4.6% by using ☒50 configurations. For the ensemble at m_π≈340 MeV, the statistical uncertainty is even reduced to a sub-percent level.

Primary author: FU (*), Yang (Peking University)

Co-authors: FENG, Xu; JIN, Lu-Chang

Presenter: FU (*), Yang (Peking University)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

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

What is chiral susceptibility probing?

Tuesday, 4 August 2020 17:20 (20 minutes)

The chiral susceptibility, or the first derivative of the chiral condensate, is used as a probe for QCD phase transition. It is well-known that the chiral condensate is an order parameter of SU(2)_L x SU(2)_R symmetry breaking. However, the condensate also breaks the axial U(1) symmetry, which is usually not paid attention as it is already broken by anomaly. In this talk, we would like to show a surprising numerical result by JLQCD collaboration that the chiral susceptibility is dominated by the axial U(1) anomaly at high temperature. Namely, the chiral susceptibility is probing the temperature dependence of anomaly, rather than that of SU(2)_L x SU(2)_R.

Primary author: FUKAYA, Hidenori (Osaka University)

Co-authors: JLQCD COLLABORATION; AOKI, S.; AOKI, Y.; HASHIMOTO, S.; KANEKO, T.; ROHRHOFER, C.; SUZUKI, K.

Presenter: FUKAYA, Hidenori (Osaka University)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **35** Type: **not specified**

Sign problem and the tempered Lefschetz thimble method

Wednesday, 5 August 2020 16:00 (20 minutes)

Tempered Lefschetz thimble method (TLTM) [Fukuma-Umeda(1703.00861)] is an algorithm towards solving the numerical sign problem. There, the integration region is deformed into the complex space following the antiholomorphic gradient flow equation, and the system is parallel-tempered using the flow time as a tempering parameter so as to solve both sign and ergodicity problems simultaneously. In this talk, I explain the basics of the algorithm, and discuss its application to various models, including the Thirring model, the Hubbard model away from half filling, and the theta vacuum with finite theta. An application to a chiral matrix model (a toy model of finite density QCD) will be discussed by Nobuyuki Matsumoto in his talk.

Primary author: FUKUMA, Masafumi (Kyoto University)

Co-authors: MATSUMOTO, Nobuyuki; UMEDA, Naoya

Presenter: FUKUMA, Masafumi (Kyoto University)

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

Contribution ID: **36** Type: **not specified**

Valance parton distribution of pion from lattice QCD

Friday, 7 August 2020 15:00 (20 minutes)

We present a high-statistics lattice QCD determination of the valence parton distribution function (PDF) of pion, with a mass of 300 MeV, using two very fine lattice spacings of a = 0.06 fm and 0.04 fm. Our analysis use both RI-MOM and ratio-based schemes to renormalize the equal-time bi-local quark-bilinear matrix elements of pions boosted up to 2.4 GeV momenta. We reconstruct the x-dependent PDF, as well as infer the first few even moments of the PDF using the 1-loop perturbative LaMET framework. This talk is based on arXiv: 2007.06590.

Primary author: GAO (*), Xiang (Tsinghua University&BNL)

Presenter: GAO (*), Xiang (Tsinghua University&BNL)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **37** Type: **not specified**

Radial Lattice Quantization of 3D ϕ^4 Field Theory

Thursday, 6 August 2020 14:00 (20 minutes)

We present numerical results for 3d ϕ^4 field theory on the $R \times S^2$ manifold in radial quantization using the quantum extension of the finite element method (QFE). The Monte Carlo study supports the QFE ansatz that once counterterms cancel effects from geometric defects in the UV, one reaches the nonperturbative conformal fixed point of the 3d Ising CFT. We demonstrate that including the Ricci curvature term for an improved lattice action drastically accelerates the approach to the continuum limit, opening the way for high precision calculation of scaling dimensions, OPE couplings, and the central charge.

Primary author: GASBARRO (*), Andrew (University of Bern)

Co-authors: BROWER, Richard; FLEMING, George

Presenter: GASBARRO (*), Andrew (University of Bern)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **38** Type: **not specified**

Grand Canonical Distribution from LQCD for experiment data analysis

Tuesday, 4 August 2020 15:00 (20 minutes)

We propose new way of heavy ion collisions experiment data analysis. We analyze physical parameters of fireball created in RHIC experiment based on Grand Canonical Distribution and different Lattice QCD data available at the moment. Our results on chemical potential are in agreement with previous model estimations and do not depend on Lattice setup. At same time, we found possible T(V) states of fireball and estimated the most probable temperature and volume of fireball as function of collision energy.

Primary author: GOY, Vladimir (Far Eastern Federal University)

Co-authors: BORNYAKOV, V.; BOYDA, D.; MOLOCHKOV, A.; NAKAMURA, A.

Presenter: GOY, Vladimir (Far Eastern Federal University)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **39** Type: **not specified**

Preliminary Lattice Calculation of the Pion Light-Cone Distribution Amplitude via the Operator Product Expansion

Friday, 7 August 2020 14:20 (20 minutes)

The moments of the pion light-cone distribution amplitude (LCDA) can be extracted by comparison with the operator product expansion of the pion hadronic tensor with an artificially heavy intermediate quark. We perform a preliminary lattice calculation of this hadronic tensor in the quenched approximation at multiple lattice spacings and use it to extract the continuum limit of the second moment of the pion LCDA. Our results are in agreement with other lattice calculations of the second moment, illustrating the potential of this method.

Primary author: GREBE (*), Anthony (Massachusetts Institute of Technology)

Co-authors: HOPE COLLABORATION; DETMOLD , William; KANAMORI, Issaku; LIN, C-J. David; MONDAL, Santanu; PERRY, Robert; ZHAO, Yong

Presenter: GREBE (*), Anthony (Massachusetts Institute of Technology)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **40** Type: **not specified**

Charmed baryon spectroscopy from lattice QCD near the physical point

Thursday, 6 August 2020 16:40 (20 minutes)

The low-lying spectrum of charmed baryons is calculated in lattice QCD on the $32^3 \times 64$, $N_f = 2+1$ PACS-CS gauge configurations at the almost physical pion mass of 156 MeV/c^2. By employing a set of interpolating operators with different Dirac structures and quark-field smearings for the variational analysis, we extract the ground and first few excited states of the spin-1/2 and spin-3/2, singly-, doubly-, and triply-charmed baryons.

Primary author: GUBLER, Philipp (JAEA)

Co-author: TRJQCD COLLABORATION

Presenter: GUBLER, Philipp (JAEA)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **41** Type: **not specified**

Alternatives to Kogut-Susskind formulation for quantum computation

Thursday, 6 August 2020 14:20 (20 minutes)

When the realizations of QFT on quantum computer are discussed, the Kogut-Susskind formulation of lattice Hamiltonian is a popular option. We provide alternative formulations and discuss the pros and cons.

Primary author: HANADA, Masanori (Surrey)

Co-authors: BUSER, Alex; GHARIBYAN, Hrant; HONDA, Masazumi; LIU, Junyu

Presenter: HANADA, Masanori (Surrey)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **42** Type: **not specified**

$B_c \to J/\psi$ Semileptonic Form Factors and $R(J/\psi)$ Using the Heavy-HISQ Method

Wednesday, 5 August 2020 17:00 (20 minutes)

We present the results of HPQCD's recent calculation of the $B_c \to J/\psi$ semileptonic form factors and $R(J/\psi)$ for the first time from lattice QCD using the heavy-HISQ method. We also extend these results to angular observables which we compute in the standard model and in several new physics scenarios.

Primary author: HARRISON (*), Judd (University of Glasgow)

Co-authors: HPQCD; DAVIES, Christine; LYTLE, Andrew

Presenter: HARRISON (*), Judd (University of Glasgow)

Session Classification: Weak Decays and Matrix Elements

Track Classification: Weak Decays and Matrix Elements

Contribution ID: **43** Type: **not specified**

The effects of fermions in the complex Langevin simulation of the Lorentzian type IIB matrix model

Wednesday, 5 August 2020 14:20 (20 minutes)

The type IIB matrix model was proposed as a nonperturbative formulation of superstring theory. In particular, interesting results such as the emergence of (3+1)D exponentially expanding space-time have been obtained from the Lorentzian version of the model. Recently the complex Langevin simulation of the bosonic model has been performed to avoid the previously used approximation in overcoming the sign problem. In this talk, we include the effects of fermions in this simulation to discuss their impact on the (3+1)D space-time structure.

Primary author: HATAKEYAMA (*), Kohta (KEK)

Co-authors: ANAGNOSTOPOULOS, Konstantinos N.; AZUMA, Takehiro; HIRASAWA, Mitsuaki; ITO, Yuta; NISHIMURA, Jun; PAPADOUDIS, Stratos Kovalkov; TSUCHIYA, Asato

Presenter: HATAKEYAMA (*), Kohta (KEK)

Session Classification: Physics Beyond the Standard Model

Track Classification: Physics Beyond the Standard Model

Contribution ID: **44** Type: **not specified**

Low-lying charmonium properties from lattice QCD + quenched QED

Thursday, 6 August 2020 17:00 (20 minutes)

The properties of low-lying charmonium mesons offer points of high precision comparison between lattice QCD and experiment, if discretisation effects set by the charm quark mass can be controlled. Using $n_f = 2 + 1 + 1$ configurations with the HISQ action, developed by the HPQCD collaboration to have very small discretisation errors, we achieve precision at or below the 1% level for a range of quantities. These include the hyperfine splitting, the J/ψ vector (and tensor) decay constants and the charm connected hadronic vacuum polarisation contribution to the anomalous magnetic moment of the muon. For the last of these we are able to obtain a result with a 0.3% uncertainty. At this level of precision it is necessary to understand leading electromagnetic effects which we do through the inclusion of quenched QED. One such effect that must be accounted for is the electromagnetic effect on the tuning of the charm mass in our calculations. The meson mass shift from QED may be separated into contributions from the quark self energy and the physical contribution from the Coulomb potential. We extract the Coulomb potential contribution and compare with expectations from potential models.

Primary author: HATTON (*), Daniel (University of Glasgow)

Co-authors: HPQCD COLLABORATION; DAVIES, Christine; KOPONEN, Jonna; LEPAGE, G. Peter; LYTLE, Andrew

Presenter: HATTON (*), Daniel (University of Glasgow)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **45** Type: **not specified**

Semileptonic $B \to \pi\ell\nu$ decays

Wednesday, 5 August 2020 17:40 (20 minutes)

The desire for additional determinations of the CKM matrix element V_{ub} and a long-standing 2-3σ discrepancy between results from inclusive $B \to X_u$ and exclusive $B \to \pi$ processes motivate the study of $B \to \pi$ semileptonic form factors on the lattice. The status of our preliminary $B \to \pi\ell\nu$ results will be discussed by highlighting updates to our analysis. The analysis is carried out on a subset of the RBC/UKQCD 2+1f Iwasaki gauge action ensembles, with b quarks simulated using the Columbia formulation of the relativistic heavy quark action, and the light valence-quarks simulated with domain wall fermions. The final results of this project will provide updates to the 2015 RBC/UKQCD $B \to \pi\ell\nu$ result.

Primary author: HILL (*), Ryan (University of Southampton)

Co-authors: FLYNN, Jonathan; JUETTNER, Andreas; SONI, Amarjit; TSANG, Justus Tobias; WITZEL, Oliver

Presenter: HILL (*), Ryan (University of Southampton)

Session Classification: Weak Decays and Matrix Elements

Track Classification: Weak Decays and Matrix Elements

Contribution ID: **46** Type: **not specified**

The dual Meissner effect due to the violation of non-Abelian Bianchi identity

Thursday, 6 August 2020 17:20 (20 minutes)

Quark confinement is still an unsolved problem. The dual Meissner effect is one of the ideas of this mechanism. In this picture, it is considered that the color flux tube between quarks is caused by the condensation of monopole in the QCD vacuum. However, how to define monopole in QCD is a difficult problem. Recently, it was shown the violation of non-Abelian Bianchi identity is equal to Abelian-like monopole currents. In this talk, we show numerical results of the dual Meissner effect due to these monopole currents.

Primary author: HIRAGUCHI (*), Atsuki (Kochi University)

Co-authors: ISHIGURO, Katsuya; SUZUKI, Tsuneo

Presenter: HIRAGUCHI (*), Atsuki (Kochi University)

Session Classification: Vacuum Structure and Confinement

Track Classification: Vacuum Structure and Confinement

Contribution ID: **47** Type: **not specified**

Space-time structure in the Lorentzian type IIB matrix model in the large-N limit

Wednesday, 5 August 2020 15:00 (20 minutes)

The Lorentzian type IIB matrix model is a promising candidate for a non-perturbative formulation of superstring theory. In the previous work, Monte Carlo calculations provided interesting results indicating the spontaneous breaking of SO(9) to SO(3) and the emergence of (3+1)-dimensional space-time. There, an approximation was used to avoid the sign problem, however. In this talk, we report our results obtained by using the complex Langevin method to overcome the sign problem instead of using the approximation. In particular, we discuss the space-time structure in the large-N limit based on our results obtained for large matrix size.

Primary author: HIRASAWA (*), Mitsuaki (SOKENDAI)

Co-authors: ANAGNOSTOPOULOS, Konstantinos N.; AZUMA, Takehiro; HATAKEYAMA, Kohta; ITO, Yuta; NISHIMURA, Jun; PAPADOUDIS, Stratos Kovalkov; TSUCHIYA, Asato

Presenter: HIRASAWA (*), Mitsuaki (SOKENDAI)

Session Classification: Physics Beyond the Standard Model

Track Classification: Physics Beyond the Standard Model

Contribution ID: **48** Type: **not specified**

Digital Quantum Simulation of the Schwinger Model with Theta Term via Adiabatic State Preparation

Thursday, 6 August 2020 14:40 (20 minutes)

We perform a digital quantum simulation of the Schwinger model with the theta term, which is practically inaccessible by standard lattice Monte Carlo simulations. We construct the true vacuum state of a lattice Schwinger model using adiabatic state preparation which, in turn, allows us to compute an expectation value of the fermion mass operator with respect to the vacuum. Upon taking a continuum limit we find that our result in massless case agrees with the known exact result. In massive case, we find an agreement with mass perturbation theory in small mass regime and deviations in large mass regime. We estimate computational costs required to take a reasonable continuum limit.

Primary author: HONDA, Masazumi (Yukawa Institute for Theoretical Physics)

Co-authors: CHAKRABORTY, Bipasha; KIKUCHI, Yuta; IZUBUCHI, Taku; TOMIYA, Akio

Presenter: HONDA, Masazumi (Yukawa Institute for Theoretical Physics)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **49** Type: **not specified**

Renormalisation of quark and gluon operators using Feynman-Hellmann

Thursday, 6 August 2020 14:40 (20 minutes)

The decomposition of energy and momentum in the hadron in terms of quark and gluon constituents is of fundamental importance to hadron structure, and with the ongoing development of the future Electron-Ion Collider, there is tremendous interest in imaging the transverse distributions of these constituents. This program will be strengthened by complimentary studies in Lattice QCD, where a renormalisation of the lattice operators is necessary to connect the calculated distributions to the corresponding phenomenological quantities reported in a familiar renormalisation scheme, such as MS-bar. In such a renormalisation scheme, the quark and gluon operators mix under renormalisation. In literature it has been common to obtain the off-diagonal renormalisation factors through perturbation theory. However, for consistency, a fully non-perturbative renormalisation scheme that computes all components of the renormalisation matrix is desired. We will demonstrate an RI-MOM renormalisation scheme that includes mixed quark and gluon amputated vertex functions, to directly compute the mixing renormalisation factors. The method utilised exploits Feynman-Hellmann techniques to overcome troublesome statistical noise associated with singlet operators. The current demonstration is performed in the quenched approximation, with a straightforward generalisation to the dynamical case to be considered in near-future work.

Primary author: HOWSON (*), Tomas (University of Adelaide)

Co-authors: CSSM-QCDSF-UKQCD COLLABORATIONS; HORSLEY, R.; KAMLEH, W.; NAKAMURA, Y.; PERLT, H.; RAKOW, P. E. L.; SCHIERHOLZ, G.; STÜBEN, H.; YOUNG, R. D.; ZANOTTI, J. M.

Presenter: HOWSON (*), Tomas (University of Adelaide)

Session Classification: Standard Model Parameters and Renormalisation

Track Classification: Standard Model Parameters and Renormalisation

Contribution ID: **50** Type: **not specified**

Abelian and monopole dominance without gauge fixing in pure SU(3) gauge theory

Thursday, 6 August 2020 17:00 (20 minutes)

Understanding the color confinement mechanism is not yet solved in QCD. The dual Meissner effect is one of the most promising pictures as the color confinement mechanism. Recently the dual Meissner picture due to violation of the non-Abelian Bianchi identities was proposed. In this talk, we show numerical results based on that picture in pure SU(3) gauge theory, especially almost perfect Abelian dominance and monopole dominance for the static q-qbar potential without gauge fixing.

Primary author: ISHIGURO, Katsuya (Kochi University)

Co-authors: HIRAGUCHI, Atsuki; SUZUKI, Tsuneo

Presenter: ISHIGURO, Katsuya (Kochi University)

Session Classification: Vacuum Structure and Confinement

Track Classification: Vacuum Structure and Confinement

Contribution ID: **51** Type: **not specified**

QCD sum rule from lattice correlators

Thursday, 6 August 2020 15:00 (20 minutes)

We propose a method to compute a spectral sum appearing in the QCD sum rule from lattice correlators.
This spectral sum corresponds to the Borel transform of the vacuum polarization, which widely appears in the phenomenological study.
We discuss how to compute it from two-point correlation functions on the lattice.
We measure it for three lattice spacing and confirm that the method gives results consistent with operator product expansion.

Primary author: ISHIKAWA (*), Tsutomu (KEK, SOKENDAI)

Co-authors: JLQCD COLLABORATION; HASHIMOTO, S.

Presenter: ISHIKAWA (*), Tsutomu (KEK, SOKENDAI)

Session Classification: Standard Model Parameters and Renormalisation

Track Classification: Standard Model Parameters and Renormalisation

Contribution ID: **52** Type: **not specified**

Sparse modeling approach to obtaining the shear viscosity from smeared correlation functions

Thursday, 6 August 2020 15:00 (20 minutes)

We propose the sparse modeling method to estimate the spectral function from the smeared correlation functions. We give a description of how to obtain the shear viscosity from the correlation function of the renormalized energy-momentum tensor (EMT) measured by the gradient flow method ($C(t,\tau)$) for the quenched QCD at finite temperature. The measurement of the renormalized EMT in the gradient flow method reduces a statistical uncertainty thanks to its property of the smearing. However, the smearing breaks the sum rule of the spectral function and the oversmeared data in the correlation function may have to be eliminated from the analyzing process of physical observables. In this work, we demonstrate that the sparse modeling analysis in the intermediate-representation basis (IR basis), which connects between the Matsubara frequency data and real frequency data. It works well even using very limited data of $C(t,\tau)$ only in the fiducial window of the gradient flow. We utilize the ADMM algorithm which is useful to solve the LASSO problem under some constraints. We show that the obtained spectral function reproduces the input smeared correlation function at finite flow-time. Several systematic and statistical errors and the flow-time dependence are also discussed.
This talk is based on
https://arxiv.org/abs/2004.02426

Primary author: ITOU, Etsuko (Keio university)

Co-author: NAGAI, Yuki

Presenter: ITOU, Etsuko (Keio university)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **53** Type: **not specified**

Connecting Matrix Elements to Multi-Hadron Form-Factors

Thursday, 6 August 2020 16:40 (20 minutes)

We review developments in calculating multi-hadron form-factors and transition processes via lattice QCD. Our primary tools are finite-volume scaling relations, which non-perturbatively map spectra and matrix elements to their corresponding infinite-volume amplitudes. We focus on two hadron processes probed by an external current, and provide various checks on the finite-volume formalism in the limiting cases of perturbative interactions and systems forming a bound state. Additionally, we study model-independent properties of their corresponding infinite-volume amplitudes, allowing us to rigorously define form-factors of resonating systems and amplitudes useful for BSM physics.

Primary author: JACKURA (*), Andrew (Old Dominion University and Jefferson Lab)

Co-authors: BRICENO, Raul; HANSEN, Maxwell; SHERMAN, Keegan; ORTEGA-GAMA, Felipe

Presenter: JACKURA (*), Andrew (Old Dominion University and Jefferson Lab)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **54** Type: **not specified**

Bayesian Model Averaging

Wednesday, 5 August 2020 16:40 (20 minutes)

Statistical modeling plays a key role in lattice field theory calculations. Examples including extracting masses from correlation functions or taking the chiral-continuum limit of a matrix element. We discuss the method of model averaging, a way to account for uncertainty due to model variations, from the perspective of Bayesian statistics. Statistical formulas are derived for model-averaged expectation values and for estimating the required model probability weights. In addition, we reframe the common problem of data subset selection (e.g. choice of minimum time separation for fitting a two-point correlation function) as a model selection problem and study model averaging as a universal alternative to hand tuning of fit ranges.

Primary author: JAY (*), William (Fermilab)

Co-author: NEIL, Ethan

Presenter: JAY (*), William (Fermilab)

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

Contribution ID: **55** Type: **not specified**

Chiral symmetry and taste symmetry on the eigenvalue spectrum of staggered Dirac operators

Tuesday, 4 August 2020 15:00 (20 minutes)

Chirality of HYP-smeared staggered quarks and its matrix elements on Dirac eigenspace are studied. We introduce a new chirality operator and a new shift operator, and show that chiral Ward identities relate them. Leakage is defined as matrix elements between two eigenstates of the staggered Dirac operator, which represents the transition matrix from one eigenstate to the other. Numerical evidence of Ward identities on leakage patterns for the chirality and shift operators is presented. We also show that approximate conservation of taste symmetry appears as a characteristic of leakage patterns of the chirality, which allows us to distinguish would-be zero modes from non-zero modes. The amount of the unphysical leakages indicates the size of the taste symmetry breaking.

Primary author: JEONG (*), Hwancheol (Seoul National University)

Co-authors: SWME COLLABORATION; JUNG, Chulwoo; JWA, Seungyeob; KIM, Jangho; KIM, Jeehun; KIM, Nam Soo; KIM, Sunghee; LEE, Sunkyu; LEE, Weonjong; LEE, Youngjo; PAK, Jeonghwan

Presenter: JEONG (*), Hwancheol (Seoul National University)

Session Classification: Chiral Symmetry

Track Classification: Chiral Symmetry

Contribution ID: **56** Type: **not specified**

Implementation of neighboring communication in QWS

Tuesday, 4 August 2020 16:20 (20 minutes)

As parallel systems become massive, the neighboring communication in lattice QCD becomes more and more important.
In this talk, I will focus on the implementation of neighboring communication in QCD Wide SIMD library (QWS) for the supercomputer Fugaku.
We adopt the double buffering algorithm and implement it on top of a wrapper library to call the uTofu API, which is a low level interface for the TofuD interconnect.
The wrapper part is independent from the other part of QWS and can be used from the other applications. As an example, we use it in solving 2-dimensional Poisson equation.

Primary author: KANAMORI, Issaku (RIKEN)

Presenter: KANAMORI, Issaku (RIKEN)

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

Contribution ID: **57** Type: **not specified**

B->D(*)\ell\nu form factors from relativistic lattice QCD

Wednesday, 5 August 2020 16:40 (20 minutes)

We report on our calculation of the B->D(*)\ell\nu form factors in 2+1 flavor relativistic lattice QCD. Our simulations are carried out by employing the M\""obius domain-wall quark action at lattice cut-offs a^{-1} \sim 2.4, 3.6 and 4.5 GeV with the bottom quark masses up to 0.7 a^{-1}. We discuss the extrapolation of the form factors to the continuum limit and physical quark masses.

Primary author: KANEKO, Takashi (KEK)

Co-authors: JLQCD COLLABORATION; AOKI, Y.; BAILAS, G.; COLQUHOUN, B.; FUKAYA, H.; HASHIMOTO, S.; KOPONEN, J.

Presenter: KANEKO, Takashi (KEK)

Session Classification: Weak Decays and Matrix Elements

Track Classification: Weak Decays and Matrix Elements

Contribution ID: **58** Type: **not specified**

Nucleon and Pion Ioffe time pseudo-distributions

Friday, 7 August 2020 17:00 (20 minutes)

The light-cone definition of Parton Distribution Functions (PDFs) does not allow for a direct ab initio determination employing methods of Lattice QCD simulations that naturally take place in Euclidean spacetime. In this presentation we focus on pseudo-PDFs where the starting point is the equal time hadronic matrix element with the quark and anti-quark fields separated by a finite distance. We focus on Ioffe-time distributions, which are functions of the Ioffe-time ν, and can be understood as the Fourier transforms of parton distribution functions with respect to the momentum fraction variable x. We present lattice results for the case of the nucleon and the pion, we discuss several lattice systematics and we also perform a comparison with the pertinent phenomenological determinations

Primary author: KARPIE (*), Joseph (Columbia University)

Co-authors: EDWARDS, Robert; EGERER, Colin; ORGINOS, Kostas; RADYUSHKIN, Anatoly; RICHARDS, David; ROTHKOPF, Alexander; SUFIAN, Raza; ZAFEIROPOULOS, Savvas

Presenter: KARPIE (*), Joseph (Columbia University)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **59** Type: **not specified**

Double-winding Wilson loops towards flux tube interaction in SU(N) lattice gauge theory

Friday, 7 August 2020 16:20 (20 minutes)

We study “”shifted”” double-winding Wilson loop average in SU(N) lattice Yang-Mills theory by using both strong coupling expansions and numerical simulations.
We evaluate its average by changing the distance of a transverse direction.
From this result, we discuss how interactions between the two color flux tubes change, when the distance R is varied.

Primary author: KATO, Seikou (Oyama National College of Technology)

Co-authors: SHIBATA (KEK), Akihiro; KONDO (CHIBA UNIV.), Kei-Ichi

Presenter: KATO, Seikou (Oyama National College of Technology)

Session Classification: Vacuum Structure and Confinement

Track Classification: Vacuum Structure and Confinement

Contribution ID: **60** Type: **not specified**

Quantum Links for U(1) Gauge Theory on Qubits and Reduction to Z2 Gauge Theory and Toric Code

Wednesday, 5 August 2020 17:20 (20 minutes)

The quantum link Hamiltonian was introduced two decades ago as an alternative to Wilson's Euclidean lattice QCD with gauge fields represented by bi-linearfermion/anti-fermion operators, and later generalized as D-theory. Recasting as a Hamiltonian in Minkowski space for real time evolution, D-theory leads naturally to quantum algorithms. We investigate the simplest toy model of U(1) compact QED on triangular 2+1D lattice and construct gauge invariant kernels via the Suzuki-Trotter expansions which are realized as a quantum circuit capable of being tested on the Noisy Intermediate Scale Quantum (NISQ) devices. We demonstrate the performance of our algorithm on the existing hardware called IBM-Q with error mitigation. Furthermore, we also explore the similarity of our model to the Z2 gauge theory. Since its simplest example without dynamics, so-called toric code, can be leveraged as the quantum error correcting code, we may find a clue to an efficient scalable error correction/detection algorithm specifically for our model based on the relation between U(1) and Z2.

Primary author: KAWAI (*), Hiroki (Boston University)

Co-authors: BROWER, Richard C.; BERENSTEIN, David; COGBURN, Cameron V.

Presenter: KAWAI (*), Hiroki (Boston University)

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

Contribution ID: **61** Type: **not specified**

Anisotropic pressure induced by finite-size effects at nonzero temperature in SU(3) Yang-Mills theory

Tuesday, 4 August 2020 16:40 (20 minutes)

We study the pressure anisotropy in anisotropic finite-size systems in SU(3) Yang-Mills theory at nonzero temperature. Lattice simulations are performed on lattices with anisotropic spatial volumes with periodic boundary conditions. The energy-momentum tensor defined through the gradient flow is used for the analysis of the stress tensor on the lattice. We find that a clear finite-size effect in the pressure anisotropy is observed only at a significantly shorter spatial extent compared with the free scalar theory, even when accounting for a rather large mass in the latter.

Primary author: KITAZAWA, Masakiyo (Osaka University)

Co-authors: MOGLIACCI, Sylvain; KOLBÉ, Isobel; HOROWITZ, W.A.

Presenter: KITAZAWA, Masakiyo (Osaka University)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **62** Type: **not specified**

QCD Equation of State in External Magnetic Field and at Finite Baryon Density

Tuesday, 4 August 2020 17:00 (20 minutes)

In this report we present our first results on lattice study of QCD equation of state in external magnetic field and at finite baryon density. The simulations are performed with $N_f = 2 + 1$ rooted staggered quarks at physical quark masses. Finite baryon density is implemented through the lattice simulations at imaginary chemical potential. The results for the equation of state are expanded in imaginary chemical potential up to $O(\mu_B^6)$ and analytically continued to the real domain. A significant influence of the magnetic field on QCD equation of state is observed.

Primary author: KOLOMOYETS, Natalia (JINR)

Co-authors: ASTRAKHANTSEV (ZURICH U.), Nikita; BRAGUTA (JINR), Victor; KOTOV (JINR), Andrey; NIKOLAEV (SWANSEA U.), Alexander

Presenter: KOLOMOYETS, Natalia (JINR)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **63** Type: **not specified**

Using Xilinx Alveo accelerators for Lattice QCD

Tuesday, 4 August 2020 16:40 (20 minutes)

Lattice QCD is one of the major scientific work-loads on supercomputer installations. Most of the computer time is spent in an iterative solver of a large, sparse set of linear equations. One of the simplest examples of such an iterative solver is the conjugate gradient algorithm. In this talk, we present an optimized implementation of this algorithm in the context of Lattice QCD for Xilinx Alveo U280 accelerator cards. We compare its performance with that obtained on a CPU architecture and highlight the advantages of an FPGA-based implementation.

Primary author: KORCYL, Piotr (Jagiellonian University)

Co-authors: KORCYL, Grzegorz; CALI, Salvatore

Presenter: KORCYL, Piotr (Jagiellonian University)

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

Contribution ID: **64** Type: **not specified**

Sigma-Lambda state mixing from lattice QCD+QED

Thursday, 6 August 2020 17:20 (20 minutes)

Mixing in the Σ^0–Λ^0 system is a direct consequence of broken isospin symmetry and is a measure of both isospin-symmetry breaking as well as general SU(3)-flavour symmetry breaking. In this talk we present a novel scheme for calculating the extent of the physical Σ^0–Λ^0 mixing using simulations in lattice QCD+QED and discuss some of its features and initial results.

Primary author: KORDOV (*), Zeno (The University of Adelaide)

Co-author: CSSM/QCDSF/UKQCD

Presenter: KORDOV (*), Zeno (The University of Adelaide)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **65** Type: **not specified**

Complex Langevin Simulations of Low-dimensional Supersymmetric Quantum Field Theories

Tuesday, 4 August 2020 17:00 (20 minutes)

Using complex Langevin dynamics, we probe the possibility of dynamical breaking of supersymmetry in a class of low-dimensional N=2 supersymmetric quantum field theories with complex potentials. We conclude that complex Langevin dynamics can reliably predict the nonperturbative breaking of supersymmetry in cases where Monte Carlo methods are unreliable.

Primary author: KUMAR (*), Arpith (IISER Mohali)

Co-author: JOSEPH, Anosh

Presenter: KUMAR (*), Arpith (IISER Mohali)

Session Classification: Physics Beyond the Standard Model

Track Classification: Physics Beyond the Standard Model

Contribution ID: **66** Type: **not specified**

Chiral phase transition temperature in (2+1)-flavor QCD

Tuesday, 4 August 2020 14:20 (20 minutes)

We present a lattice QCD based determination of the chiral phase transition temperature in QCD with two massless (up and down) and one strange quark having its physical mass. We propose and calculate two novel estimators for the chiral transition temperature for several values of the light quark masses, corresponding to Goldstone pion masses in the range between (approximately) 58 MeV and (approximately) 163 MeV. The chiral phase transition temperature is determined by extrapolating to vanishing pion mass using universal scaling analysis. After thermodynamic, continuum and chiral extrapolations we find the chiral phase transition temperature $T_c^0 = 132^{+3}_{-6}$MeV.

Primary author: LAHIRI, Anirban (Bielefeld University)

Co-authors: DING, H.-T.; HEGDE, P.; KACZMAREK, O.; KARSCH, F.; LI, S.-T.; MUKHERJEE, Swagato; OHNO, H.; PETRECZKY, P.; SCHMIDT, C.; STEINBRECHER, P.

Presenter: LAHIRI, Anirban (Bielefeld University)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **67** Type: **not specified**

Gluon Field Digitization for Quantum Computers

Thursday, 6 August 2020 15:00 (20 minutes)

The efficient digitization required for the quantum simulations of QCD can be obtained by approximating continuous SU(3) gluon fields by discrete subgroups. In this talk, we discuss on-going efforts to develop this program of digitization: deriving improved discrete group lattice actions, classical simulations for quantifying systematic errors, and implementable circuits for digital quantum computers.

Primary author: LAMM (*), Henry (Fermilab)

Co-author: NUQS COLLABORATION

Presenter: LAMM (*), Henry (Fermilab)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **68** Type: **not specified**

Progress in the lattice studies of Sp(4) gauge theory with antisymmetric fermions

Tuesday, 4 August 2020 17:20 (20 minutes)

We report the progress in the lattice studies of Sp(4) gauge theory coupled to fermions in the antisymmetric representation. Such a theory containing three Dirac flavors has a direct relevance to the phenomenological model building for certain types of composite Higgs and top partial compositeness. We formulate the lattice action with the standard plaquette and the Wilson-Dirac fermions. Our primary interests are in the mass spectra and the decay constants of (flavored) spin-0 and spin-1 mesons. In the quenched setup we measure these quantities at several values of the lattice spacing and valence fermion mass, and extrapolate the results to the continuum and the massless limits. Towards the dynamical calculations we also present some preliminary results by focusing on the finite volume effects and the mass dependence at finite lattice spacing.

Primary author: LEE, Jong-Wan (Pusan National University)

Co-authors: BENNETT, Ed; HONG, Deog Ki; LIN, C.-J. David; LUCINI, Biagio; PIAI, Maurizio; VADACCHINO, Davide

Presenter: LEE, Jong-Wan (Pusan National University)

Session Classification: Physics Beyond the Standard Model

Track Classification: Physics Beyond the Standard Model

Contribution ID: **69** Type: **not specified**

Machine learning study on the Dirac eigenvalue spectrum of staggered quarks

Tuesday, 4 August 2020 15:20 (20 minutes)

We study chirality of staggered quarks on the Dirac eigenvalue spectrum using machine learning technique. As a result of theoretical research, we expect a characteristic pattern, we call leakage pattern, in the matrix elements of the chirality operator sandwiched between two eigenstates of staggered Dirac operator. Machine learning analysis gives 98.7(34)% accuracy per a single normal gauge configuration for classifying non-zero mode quartets in Dirac eigenvalue spectrum. It confirms that the leakage pattern is universal on normal gauge configurations. We choose the multi-layer perceptron (MLP) method which is one of the deep learning models. It happens to give the best performance in our study. The model's prediction is compared with other models', such as XGboost. Numerical study is done using HYP staggered quarks on the 20^4 lattice in quenched QCD.

Primary author: LEE (*), Sunkyu (Seoul National University)

Co-authors: JEONG, Hwancheol; JUNG, Chulwoo; JWA, Seungyeob; KIM, Jangho; KIM, Jeehun; KIM, Nam Soo; KIM, Sunghee; LEE, Weonjong; LEE, Youngjo; PAK, Jeonghwan

Presenter: LEE (*), Sunkyu (Seoul National University)

Session Classification: Chiral Symmetry

Track Classification: Chiral Symmetry

Contribution ID: **70** Type: **not specified**

The Pion Vector Form Factor from Lattice QCD at the physical point

Friday, 7 August 2020 15:20 (20 minutes)

We present a Lattice QCD investigation of the pion electromagnetic form factor based on gauge configurations generated by Extended Twisted Mass Collaboration with N_f = 2+1+1 dynamical quark flavors. The calculation is carried out at two different lattice spacing values directly at the physical point. Employing Wilson clover twisted mass fermions at maximal twist guarantees O(a) improved results. We present a preliminary continuum extrapolation of the form factor and compare to the experiment. In addition, we provide an estimate of the pion charge radius.

Primary author: LEE (*), Youngik (University of Bonn)

Co-authors: ETM COLLABORATION; KOSTRZEWA, B.; PETSCHLIES, M.; URBACH, C.; WENGER, U.

Presenter: LEE (*), Youngik (University of Bonn)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **71** Type: **not specified**

Fluctuations of conserved charges in a background magnetic field

Tuesday, 4 August 2020 16:20 (20 minutes)

We will present results on the second order fluctuations of net baryon number, electric charge and strangeness as well as correlations among these conserved charges in (2+1)-flavor lattice QCD in the presence of a background magnetic field.
Simulations are performed using the tree level improved gauge action and the highly improved staggered quark
(HISQ) action with a fixed scale approach (a=0.117 fm). The light quark mass is set to be 1/10 of the physical strange quark mass and the corresponding pion mass is about 220 MeV at vanishing magnetic field. At zero temperature the simulations are performed on $32^3 \times 96$ lattices while at nonzero temperature on $32^3 \times N_\tau$ lattices having six values of N_τ varying from 16 to 6 corresponding to temperature ranging from 105 MeV to 280 MeV. The magnetic field strength eB is simulated with about 15 different values up to 3.5 GeV^2 at each temperature. Chiral condensates and disconnected susceptibilities as a function of eB are also discussed.

Primary author: LI (*), Sheng-Tai (Chinese Academy of Sciences (CAS) - Institute of Modern Physics (IMP) & Central China Normal University)

Co-authors: DING (CENTRAL CHINA NORMAL UNIVERSITY) , Heng-Tong; WANG (CENTRAL CHINA NORMAL UNIVERSITY), Xiao-Dan; ZHANG (CENTRAL CHINA NORMAL UNIVERSITY), Yu; TOMIYA (RIKEN BNL RESEARCH CENTER, BROOKHAVEN NATIONAL LABORATORY), Akio

Presenter: LI (*), Sheng-Tai (Chinese Academy of Sciences (CAS) - Institute of Modern Physics (IMP) & Central China Normal University)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **72** Type: **not specified**

Parton distribution functions of $\triangle^+$ on the lattice

Friday, 7 August 2020 17:40 (20 minutes)

We perform a first calculation for the unpolarized parton distribution function of the Δ^+ baryon using lattice QCD simulations within the framework of Large Momentum Effective Theory. Two ensembles of $N_f = 2+1+1$ twisted mass fermions are utilized with a pion mass of 270 MeV and 360 MeV, respectively. The baryon, which is treated as a stable single-particle state, is boosted with momentum P_3 with values $\{0.42, 0.83, 1.25\}$ GeV, and we utilize momentum smearing to improve the signal. The unpolarized parton distribution function of Δ^+ is obtained using a non-perturbative renormalization and a one-loop formula for the matching, with encouraging precision. In particular, we compute the $\overline{d}(x) - \overline{u}(x)$ asymmetry and compare it with the same quantity in the nucleon, in a first attempt towards resolving the physical mechanism responsible for generating such asymmetry.

Primary author: LI (*), Yuan (Peking University)

Co-authors: CHAI, Yahui; XIA, Shicheng; ALEXANDROU, Constantia; CICHY, Krzysztof; CONSTANTINOU, Martha; FENG, Xu; HADJIYIANNAKOU, Kyriakos; JANSEN, Karl; KOUTSOU, Giannis; LIU, Chuan; SCAPELLATO, Aurora; STEFFENS, Fernanda

Presenter: LI (*), Yuan (Peking University)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **73** Type: **not specified**

Staggering Nucleon Matrix Elements

Wednesday, 5 August 2020 17:00 (20 minutes)

We will present the first calculation of the nucleon vector and axial-vector charges with a single 2+1+1 flavors Highly Improved Staggered Quarks (HISQ) ensemble generated by the MILC collaboration and a matching valence action. We will focus on the theoretical foundation of staggered baryons and outline the methods to calculate physical observables with staggered valence quarks.

Primary author: LIN (*), Yin (Fermilab/University of Chicago)

Co-authors: FERMILAB LATTICE AND MILC COLLABORATIONS; GOTTLIEB, Steven; HUGHES, Ciaran; KRONFELD, Andreas; MEYER, Aaron; SIMONE, James; STRELCHENKO, Alexei

Presenter: LIN (*), Yin (Fermilab/University of Chicago)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **74** Type: **not specified**

Charmed meson decay constants from 2+1-flavor lattice QCD

Thursday, 6 August 2020 16:00 (20 minutes)

On a lattice with 2+1-flavor dynamical domain-wall fermions at the physical pion mass, we calculate the decay constants of the charmed and light vector mesons including D/D*, Ds/Ds*, phi and K. *The lattice size is 48^396*, which corresponds to a spatial extension of ~5.5 fm with the lattice spacing a~0.114 fm. For the valence quarks we use overlap fermions at several mass points close to their physical values. The results are then interpolated/extrapolated to the physical point.

Primary author: LIU, Zhaofeng (Institute of High Energy Physics, Beijing)

Co-authors: CHEN, Ying; CHIU, Wei-Feng; GONG, Ming; LIU, Zhaofeng; MA, Yunheng

Presenter: LIU, Zhaofeng (Institute of High Energy Physics, Beijing)

Session Classification: Weak Decays and Matrix Elements

Track Classification: Weak Decays and Matrix Elements

Contribution ID: **75** Type: **not specified**

First QCD+QED simulations with C* boundary conditions

Wednesday, 5 August 2020 15:20 (20 minutes)

For the first time the openQ*D code was used to generate fully dynamical Nf=1+2+1 QCD+QED configurations with C* boundary conditions and degenerate down and strange quarks at an unphysical value of the electromagnetic coupling alpha˜0.04. In this talk, technical details about the generation, will be presented. In particular the stability of the algorithm, diagnostic observables and neutral and charged meson masses will be discussed. Furthermore the chosen tuning strategy will be shortly presented.

Primary author: LÜCKE (*), Jens (Humboldt University Berlin)

Co-authors: RC*; BUSSONE, Andrea; CAMPOS, Isabel; DALE, Madeleine; FRITZSCH, Patrick; HANSEN, Martin; MARINKOVIC, Marina Krstic; PATELLA, Agostino; TANTALO, Nazario

Presenter: LÜCKE (*), Jens (Humboldt University Berlin)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **76** Type: **not specified**

First-principles calculation of electroweak box diagrams from lattice QCD

Wednesday, 5 August 2020 14:00 (20 minutes)

We present the first realistic lattice QCD calculation of the γW-box diagrams relevant for beta decays. The nonperturbative low-momentum integral of the γW loop is calculated using a lattice QCD simulation, complemented by the perturbative QCD result at high momenta. Using the pion semileptonic decay as an example, we demonstrate the feasibility of the method. By using domain wall fermions at the physical pion mass with multiple lattice spacings and volumes, we obtain the axial γW-box correction to the semileptonic pion decay, □γWVA|π=2.830(11)stat(26)sys×10−3, with the total uncertainty controlled at the level of ~1%. This study sheds light on the first-principles computation of the γW-box correction to the neutron decay, which plays a decisive role in the determination of |Vud|.

Primary author: MA (*), Pengxiang (Peking University)

Co-authors: FENG, Xu; GORCHTEIN, Mikhail; JIN, Lu-Chang; SENG, Chien-Yeah

Presenter: MA (*), Pengxiang (Peking University)

Session Classification: Weak Decays and Matrix Elements

Track Classification: Weak Decays and Matrix Elements

Contribution ID: **77** Type: **not specified**

Shear viscosity of classical Yang-Mills field with use of scaling invariance

Thursday, 6 August 2020 14:40 (20 minutes)

We report on our recent results of the shear viscosity η of the classical Yang-Mills (CYM) field on a lattice by using the Green-Kubo formula, where the shear viscosity is calculated from the time-correlation function of the energy-momentum tensor in equilibrium. The point of our investigation consists in utilization of the inherent scale invariance of CYM, and thereby the possible lattice-spacing dependence of the numerical results was circumvented. Thus the dependence of the shear viscosity $\eta(g,T)$ on the coupling g and temperature T is represented by a scaling function $f_\eta(g^2T)$ as $\eta(g,T) = Tf_\eta(g^2T)$ due to the scaling-invariant property of the CYM. The explicit functional form of $f_\eta(g^2T)$ is successfully determined from the calculated shear viscosity: It turns out that $\eta(g,T)$ of the CYM field is proportional to $1/g^{1.10-1.88}$ at weak coupling, which has a weaker dependence
on g than that in the leading-order perturbation theory but consistent with that of the “”anomalous viscosity”” $\eta \propto 1/g^{1.5}$ under the strong disordered field.
The obtained shear viscosity is also found to be roughly consistent with that estimated through the analysis of the anisotropy of the pressure of the CYM dynamics in the expanding geometry with recourse to a hydrodynamic equation.

Primary author: MATSUDA (*), Hidefumi (Kyoto University)

Co-authors: KUNIHIRO, Teiji; M\"{U}LLER, Berndt; OHNISHI, Akira; TAKAHASHI, Toru T.

Presenter: MATSUDA (*), Hidefumi (Kyoto University)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **78** Type: **not specified**

A physicist-friendly reformulation of the mod-two Atiyah-Patodi-Singer index

Friday, 7 August 2020 16:20 (20 minutes)

Gauge anomaly in 4-dimensions can be viewed as a current inflow into an extra-dimension, where the total phase of the fermion partition function is given in a gauge invariant way by the Atiyah-Patodi-Singer(APS) eta-invariant of a 5-dimensional Dirac operator. However, this formalism requires a non-local boundary condition, which makes the physical roles of edge/bulk modes unclear and the causality of the total theory doubtful. In this talk, we consider a special case where the Dirac operator is in a real representation and its eta invariant becomes the mod-two type APS index. We propose a physicist-friendly reformulation of the mod-two index using domain-wall fermion formalism, which naturally describes how the global anomaly is canceled between edge and bulk.

Primary author: MATSUKI (*), Yoshiyuki (Osaka University)

Co-authors: FUKAYA, Hidenori; FURUTA, Mikio; MATSUO, Shinichiroh; ONOGI, Tetsuya; YAMAGUCHI, Satoshi; YAMASHITA, Mayuko

Presenter: MATSUKI (*), Yoshiyuki (Osaka University)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **79** Type: **not specified**

Complex Langevin analysis of four-dimensional SU(2) gauge theory with a theta term

Wednesday, 5 August 2020 14:40 (20 minutes)

The Monte Carlo simulation of the gauge theory with a theta term is difficult due to the sign problem. We use the complex Langevin method to overcome the problem. In our previous work on two-dimensional U(1) gauge theory with a theta term, we were able to reproduce the exact solution by introducing a puncture on the torus. We also proved that the effect of the puncture disappears in the infinite volume limit as long as $|\theta|<\pi$. In this study, we extend this method to four-dimensional SU(2) gauge theory. Recently the analytic study of 't Hooft anomaly matching condition predicted two possible phase structures around $\theta=\pi$ for this theory. We discuss the possibility of investigating the phase structure by the complex Langevin simulation.

Primary author: MATSUMOTO (*), Akira (SOKENDAI, KEK)

Co-authors: HATAKEYAMA, Kohta; HIRASAWA, Mitsuaki; HONDA, Masazumi; ITO, Yuta; NISHIMURA, Jun; YOSPRAKOB, Atis

Presenter: MATSUMOTO (*), Akira (SOKENDAI, KEK)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **80** Type: **not specified**

Application of the tempered Lefschetz thimble method to a chiral random matrix model

Wednesday, 5 August 2020 16:20 (20 minutes)

Monte Carlo simulations of finite density QCD is plagued by the sign problem. The tempered Lefschetz thimble method (TLTM) [Fukuma-Umeda(1703.00861)] is a promising algorithm towards solving the sign problem, where the integration region is deformed into the complex space and the system is parallel-tempered with the flow time so as to solve both sign and ergodicity problems simultaneously. In this talk, we apply the TLTM to a chiral random matrix model, which models finite density QCD in the large N limit. We show that the TLTM correctly reproduces exact results for small N and discuss the scaling of the computational cost as N increases [Fukuma-NM-Umeda(in preparation)]. We also explain how to implement HMC algorithm to the TLTM [Fukuma-NM-Umeda(1912.13303)].

Primary author: MATSUMOTO (*), Nobuyuki (Kyoto University)

Co-authors: FUKUMA, Masafumi; UMEDA, Naoya

Presenter: MATSUMOTO (*), Nobuyuki (Kyoto University)

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

Contribution ID: **81** Type: **not specified**

Three-Photon Decay of J/ψ from Latttice QCD

Thursday, 6 August 2020 16:20 (20 minutes)

The rare decay J/ψ⟶3γ, analog to Ortho-positronium decaying to 3γ in quantum electrodynamics, can provide a high precision test for the non-perturbative quantum chromodynamics. Such a decay process was first observed by CLEO collaboration in 2008 and then by BESIII in 2013. However, the relevant theoretical researches are very limited due to the dominant non-perturbative effects. We propose to use lattice QCD to study this problem. To this end, a new method has been proposed, that only the correlation functions directly related to the physical decay width are computed with all polarizations of the initial and final states summed over, to avoid the complicated decomposition for the matrix element. Using this new method, we present the first lattice result for this rare decay. Such a new method has also been applied for the decay ηc⟶2γ, and we obtain a lattice result that is consistent with the experimental one within two standard deviations for the first time. In the work of three-photon decay, we also put forward a scheme to analyze the Dalitz plot of the corresponding process based on the lattice data which can provide direct information for the relevant experiments.

Primary author: MENG (*), Yu (Peking University)

Co-authors: LIU (PEKING UNIVERSITY), Chuan; ZHANG (PEKING UNIVERSITY), Ke-Long

Presenter: MENG (*), Yu (Peking University)

Session Classification: Weak Decays and Matrix Elements

Track Classification: Weak Decays and Matrix Elements

Contribution ID: **82** Type: **not specified**

Noise-robust Implementation of Gauss's law for quantum computers

Thursday, 6 August 2020 15:20 (20 minutes)

We discuss continuous symmetries identities using the tensor formulation of lattice spin and gauge models. We show that the symmetries are encoded in the selection rules of the tensor. This allows truncations that preserve the symmetries exactly. We present the tensorial expression of the transfer matrix for Abelian gauge theories and explain how gauge fixing and Gauss's law relate.
We propose redefinitions of the electric quantum numbers such that Gauss's law is always satisfied even when the time evolution is implemented on NISQ devices. We discuss ways to minimize the number of degrees of freedom.
We briefly discuss practical implementations for a Z2 gauge theory.
This follows arXiv:2003.10986 (Phys. Rev. D in press) and Phys. Rev. D 100, 014506

Primary author: MEURICE, Yannick (University of iowa)

Co-author: QULAT

Presenter: MEURICE, Yannick (University of iowa)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **83** Type: **not specified**

Lattice QCD on QPACE 4

Tuesday, 4 August 2020 15:20 (20 minutes)

QPACE 4 is the latest member of the QCD PArallel Compute Engine (QPACE) series, which was deployed in Regensburg in June 2020. It features 64 Fujitsu A64FX model FX700 CPUs interconnected by InfiniBand EDR. The A64FX is the first CPU supporting the Arm Scalable Vector Extension (SVE). In this contribution we discuss the implementation of SVE in the Grid Lattice QCD framework and show Grid benchmarks on QPACE 4.

Primary author: MEYER, Nils (University of Regensburg)

Co-authors: GEORG, Peter; PLEITER, Dirk; SOLBRIG, Stefan; WETTIG, Tilo

Presenter: MEYER, Nils (University of Regensburg)

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

Contribution ID: **84** Type: **not specified**

Vacuum Restructuring in Finite Geometries: Nonperturbative Casimir Effects in Lattice Gauge Theories

Wednesday, 5 August 2020 15:20 (20 minutes)

The Casimir effect is a quantum phenomenon rooted in the fact that vacuum fluctuations of quantum fields are affected by physical objects and boundaries. As the energy spectrum of vacuum fluctuations depends on distances between (and geometries of) physical bodies, the quantum vacuum exerts a small but experimentally detectable force on neutral objects. Usually, the associated Casimir energy is calculated for free or weakly coupled quantum fields. Recent studies of the Casimir effect in non-perturbative regimes within lattice gauge field theory are reviewed in the present talk. We discuss vacuum restructuring in finite geometries: the influence of the Casimir boundaries on the chiral and deconfining phase transitions and the mass-scales.

Primary author: MOLOCHKOV, Alexander (Pacific Quantum Center, Far Eastern Federal University)

Co-authors: CHERNODUB, Maxim; GOY, Vladimir; TANASHKIN, Alexey

Presenter: MOLOCHKOV, Alexander (Pacific Quantum Center, Far Eastern Federal University)

Session Classification: Physics Beyond the Standard Model

Track Classification: Applications beyond QCD

Contribution ID: **85** Type: **not specified**

Resurgence structure on compactified spacetime with twisted boundary condition

Friday, 7 August 2020 16:40 (20 minutes)

Recently, in the context of the resurgence program, it was conjectured that the perturbative ambiguity caused by the IR renormalon is canceled against the semi-classical object called bion. This conjecture requires the circle compactification with the Z_N twisted boundary condition, in which the bion solution is found. Contrary to this conjecture, we find that there is no IR renormalon in circle-compactified theories. We then argue that the bion cancels the perturbative ambiguity caused by the proliferation of Feynman diagrams, which are significantly affected by the compactification. These observations are helpful in giving a unified understanding on the resurgence structure.

Primary author: MORIKAWA (*), Okuto (Kyushu University)

Presenter: MORIKAWA (*), Okuto (Kyushu University)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **86** Type: **not specified**

Bottomonium resonances from lattice QCD static-static-light-light potentials

Tuesday, 4 August 2020 16:20 (20 minutes)

We study I = 0 quarkonium resonances decaying into pairs of heavy-light mesons using static-static-light-light potentials from lattice QCD. To this end, we solve a coupled channel Schrödinger equation with one confined quarkonium channel and two channels with a heavy-light meson pair to compute phase shifts and t-matrix poles for the lightest decay channel. Finally, we discuss our results in the context of corresponding experimental results.

Primary author: MUELLER (*), Lasse (Goethe University Frankfurt)

Co-authors: BICUDO, Pedro; CARDOSO, Nuno; MUELLER, Lasse; WAGNER, Marc

Presenter: MUELLER (*), Lasse (Goethe University Frankfurt)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **87** Type: **not specified**

Studies on meson-baryon interactions in the HAL QCD method with all-to-all propagators

Tuesday, 4 August 2020 16:40 (20 minutes)

We investigate meson-baryon interactions in the HAL QCD method with all-to-all propagators using the stochastic estimations. We mainly report the analysis of the S-wave kaon-nucleon interactions at $m_\pi \approx 570$ MeV. Since there are no quark-antiquark creation/annihilation processes in this system, all-to-all propagators merely play a role in increasing statistics. In addition, we present the preliminary results for the P-wave pion-nucleon interaction in the $I = 3/2$ channel using the Δ source operator on a small volume at $m_\pi \approx 870$ MeV, which has a bound state corresponding to the $\Delta(1232)$ state.

Primary author: MURAKAMI (*), Kotaro (Yukawa Institute for Theoretical Physics, Kyoto University)

Co-authors: HAL QCD COLLABORATION; AKAHOSHI, Yutaro; AOKI, Sinya

Presenter: MURAKAMI (*), Kotaro (Yukawa Institute for Theoretical Physics, Kyoto University)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **88** Type: **not specified**

Supercomputer Fugaku and QCD Wide SIMD Library (QWS) on Fugaku

Tuesday, 4 August 2020 16:00 (20 minutes)

The supercomputer Fugaku is a new supercomputer in Kobe, Japan, co-developed by RIKEN with Fujitsu, and the top system of the latest June 2020 TOP500 supercomputers. I will introduce the supercomputer Fugaku and a Lattcie QCD simulation library, QCD Wide SIMD library (QWS) for Fugaku. I will also present some tuning methods for Fugaku, QWS performance on Fugaku, and tentative benchmark results on full system of Fugaku.

Primary author: NAKAMURA, Yoshifumi (RIKEN)

Presenter: NAKAMURA, Yoshifumi (RIKEN)

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

Contribution ID: **89** Type: **not specified**

Casimir energy for the domain-wall fermion

Friday, 7 August 2020 14:20 (20 minutes)

We investigate Casimir energy for free fermions on the lattice.
The Casimir energy of fermion fields can be defined with the lattice regularization.
The continuum extrapolation of our results reproduces the Casimir energy known in continuum theory.
We also show the lattice effect for the Casimir energy.
The lattice effect is important as an artifact that should be well-understood in order to perform reliable lattice simulations with a small volume in particle physics.
On the other hand, the lattice effects can appear in materials such as topological insulators in condensed matter physics, and it can be detected in experiments.
We discuss a typical behavior near the phase-transition of the domain-wall fermion.

Primary author: NAKAYAMA (*), Katsumasa (DESY)

Co-authors: ISHIKAWA, Tsutomu; SUZUKI, Kei

Presenter: NAKAYAMA (*), Katsumasa (DESY)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **90** Type: **not specified**

A better conditioned Domain Wall Operator

Tuesday, 4 August 2020 14:00 (20 minutes)

A variation of the Domain Wall operator with an additional parameter α will be introduced. The conditioning of the new Domain Wall operator depends on α, whereas the corresponding 4D propagator does not. The new and the conventional Domain Wall operator agree for α = 1. By tuning α, speed ups of the linear system solvers of around 20% could be achieved.

Primary author: NEFF, Hartmut

Presenter: NEFF, Hartmut

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

Contribution ID: **91** Type: **not specified**

Target space defects and anisotropic gauge theories

Friday, 7 August 2020 14:40 (20 minutes)

We study the defects that can be defined within the framework of lattice gauge theories, in the presence of anisotropic couplings and try to identify their target space avatars. These are relevant for describing topological insulators.

Primary author: NICOLIS, Stam (Institut Denis Poisson (CNRS UMR7013))

Presenter: NICOLIS, Stam (Institut Denis Poisson (CNRS UMR7013))

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **92** Type: **not specified**

QCD at nonzero temperature and density

Friday, 7 August 2020 17:40 (20 minutes)

Replica evolution of classical field is proposed as an approximate simulator of real-time quantum field dynamics at finite temperatures. We consider N classical field configurations $(\phi_{tx}, \pi_{tx}(\tau = 0, 1, \cdots N-1)$, dubbed as replicas, which interact with each other via the τ-derivative terms and evolve with the classical equation of motion. The τ-derivative terms in the Hamiltonian, $\xi^2 \sum_x (\phi_{x+\hat{\tau}} - \phi_x)^2/2$, correspond to the kinetic part of the Euclidean action in the imaginary time formalism of the finite temperature quantum field theory by regarding the replica index τ as the imaginary time index.Thus the replica evolution is technically the same as the molecular dynamics part of the hybrid Monte-Carlo sampling. The partition function of replicas at temperature ξ is proven to be proportional to that in quantum field theory at temperature $T = \xi/N$. At the same time, the time dependence of the replica-index average of field variables is described by the classical equation of motion when the fluctuations are small. We examine the statistical and dynamical properties of the ϕ^4 theory in the 4+1 spacetime dimensions. We note that the Rayleigh-Jeans divergence in the classical field can be removed in replica evolution with $N \geq 2$ by including the mass counterterm. We also find that the thermal mass obtained from the unequal time correlation function at zero momentum grows as a function of the coupling as in the perturbative estimate in the small coupling region. Hence the replica evolution, the classical field theory with improved quantum statistical property, would be a candidate to represent the real-time evolution of quantum field.

Primary author: OHNISHI, Akira (Yukawa Institute for Theoretical Physics, Kyoto University)

Co-authors: MATSUDA, Hidefumi; KUNIHIRO, Teiji; TAKAHASHI, Toru T.

Presenter: OHNISHI, Akira (Yukawa Institute for Theoretical Physics, Kyoto University)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **93** Type: **not specified**

Nucleon structure from 2+1-flavor domain-wall fermions lattice QCD

Wednesday, 5 August 2020 17:20 (20 minutes)

Current status of LHP+RBC joint nucleon structure calculations using RBC+UKQCD 2+1-flavor domain-wall fermions lattice-QCD ensembles is summarized.

Primary author: OHTA, Shigemi (IPNS, KEK)

Co-author: LHP, RBC, UKQCD

Presenter: OHTA, Shigemi (IPNS, KEK)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **94** Type: **not specified**

Lattice QCD propagators, Padé Approximants and Analytic structure

Thursday, 6 August 2020 17:40 (20 minutes)

An analysis of the lattice Landau gauge gluon and ghost propagators for pure Yang-Mills is performed using Padé approximants to compute their analytical structure. The gluon propagator is described by a pair of complex conjugate poles and a branch cut along the negative side of the Euclidean momenta. The ghost propagator revels a simple pole at zero momenta and the method identifies a branch cut that does not start at the origin. We discuss the implications of our finds and compare them to the published literature.

Primary author: OLIVEIRA, Orlando (University of Coimbra, Portugal)

Co-authors: FALCÃO, Alexandre; SILVA, Paulo J.

Presenter: OLIVEIRA, Orlando (University of Coimbra, Portugal)

Session Classification: Vacuum Structure and Confinement

Track Classification: Vacuum Structure and Confinement

Contribution ID: **95** Type: **not specified**

Baryons in the Gross-Neveu model in 1+1 dimensions at finite number of flavors

Friday, 7 August 2020 17:20 (20 minutes)

In a recent work we investigated the existence of inhomogeneous chiral phases (i.e., a phase where the chiral condensate has a spatial dependence) in the 1+1-dimensional Gross-Neveu model at finite number of fermion flavors. In the present work we continue this investigation by studying the formation of baryons, their spatial distribution and their relation to the inhomogeneous chiral condensate.

Primary author: PANNULLO (*), Laurin (Goethe University Frankfurt)

Co-authors: LENZ, Julian; WAGNER, Marc; WELLEGEHAUSEN, Björn; WIPF, Andreas

Presenter: PANNULLO (*), Laurin (Goethe University Frankfurt)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **96** Type: **not specified**

Heavy to strange semileptonic decays

Wednesday, 5 August 2020 17:20 (20 minutes)

"D ⟶ Klν and B ⟶ Kl + l – are important heavy to strange semileptonic decay processes, giving us direct comparison with experiment, and access to CKM
matrix elements and potential new physics. We can calculate form factors for
both of these processes in lattice QCD and connect them together by determining heavy to strange form factors for heavy quark masses ranging from c to b. We can also explore the connection to form factors with different light quark masses. Using the HISQ action on N f = 2 + 1 + 1, we demonstrate how D ⟶ K calculations can be extended up towards the b by a study of heavy-strange to η_s form factors, including tests of the dependence on heavy quark mass, comparing to HQET expectations. We also give preliminary D ⟶ K and B ⟶ K results, for the latter including results for the tensor form factor with an accurately renormalised tensor current."

Primary author: PARROTT, William (University of Glasgow)

Co-author: HPQCD

Presenter: PARROTT, William (University of Glasgow)

Session Classification: Weak Decays and Matrix Elements

Track Classification: Weak Decays and Matrix Elements

Contribution ID: **97** Type: **not specified**

Finite-volume effects in HVP contribution to muon g-2

Wednesday, 5 August 2020 14:40 (20 minutes)

The leading finite-volume corrections to the HVP contribution to the muonic (g-2) are related to the forward Compton amplitude of the pion in a completely model-independent fashion. The developed formalism is able to capture a few leading contributions, up to errors of order exp(-wML) where w˜1.93 and M is the pion mass. By using models and chiPT for the forward Compton tensor, the finite-volume corrections are estimated for typical interesting volumes.

Primary author: PATELLA, Agostino (Humboldt-Universität zu Berlin)

Co-author: HANSEN, Maxwell T.

Presenter: PATELLA, Agostino (Humboldt-Universität zu Berlin)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **98** Type: **not specified**

Gluon gravitational form factors for hadrons of different spins

Wednesday, 5 August 2020 17:40 (20 minutes)

We extract structure functions corresponding to the first moment of the gluon GPDs from the matrix elements of the gluon energy momentum tensor on a clover ensemble with m_{\pi} = 450 MeV. We present the various GFFs for states of different spins with a focus on the D-terms. We then compare extracted physical quantities like the pressure and shear forces between the different hadrons.

Primary author: PEFKOU (*), Dimitra (MIT)

Co-authors: HACKETT, Dan; SHANAHAN, Phiala

Presenter: PEFKOU (*), Dimitra (MIT)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **99** Type: **not specified**

Strategy of the Heavy quark Operator Product Expansion applied to the Pion's Light Cone Distribution Amplitude

Friday, 7 August 2020 14:00 (20 minutes)

The Heavy quark Operator Product Expansion (HOPE) method allows one to extract information about light-cone matrix elements via local, instant form matrix elements. When applied to the calculation of the pion's light cone distribution amplitude, it allows (in principle) the full x dependence of the distribution amplitude to be determined. In practice, finite statistics and finite momenta mean that only a finite number of moments may be extracted. In this talk, I explain the HOPE method, and show how boosting the hadronic state leads to enhanced sensitivity to the moments. I also discuss some kinematical tricks which enable us to extract information about the second moment at much low momenta than would be naively expected.

Primary author: PERRY (*), Robert (National Chiao Tung University)

Co-authors: LIN, David; GREBE, Anthony; DETMOLD, Will; ZHAO, Yong; KANAMORI, Issaku; MONDAL, Santanu

Presenter: PERRY (*), Robert (National Chiao Tung University)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **100** Type: **not specified**

Finite temperature study of a 4+6 flavor mass-split system

Tuesday, 4 August 2020 14:20 (20 minutes)

Near-conformal systems are favored candidates to describe composite Higgs or composite dark matter particles. Their finite temperature phase structure may provide new insights into the dynamics. It is particularly important to determine the order of the phase transition. Many-flavor near-conformal systems might exhibit a first-order phase transition with a possibly large latent heat. This could have important phenomenological implications, e.g. the existence of primordial gravitational waves. In our study, we focus on a mass-split system with four light and six heavy flavors.

Starting with the phase structure of the mass-degenerate system, we continue to explore the mass-split system for different ratios of light flavor over heavy flavor masses.

Primary author: PETERSON (*), Curtis (University of Colorado at Boulder)

Co-authors: WITZEL, Oliver; HASENFRATZ, Anna

Presenter: PETERSON (*), Curtis (University of Colorado at Boulder)

Session Classification: Physics Beyond the Standard Model

Track Classification: Physics Beyond the Standard Model

Contribution ID: **101** Type: **not specified**

Investigation of Doubly Heavy Tetraquark Systems using Lattice QCD

Friday, 7 August 2020 14:20 (20 minutes)

We search for possibly existent bound states in the heavy-light tetraquark channels with quark content $\bar{b}\bar{b}ud$, $\bar{b}\bar{b}us$ and $\bar{b}\bar{c}ud$ using lattice NRQCD for the heavy quarks. We use different gauge link ensembles with $N_f = 2 + 1$ flavours of domain-wall fermions and consider a basis of local and non-local interpolators. Besides extracting the energy spectrum from the correlation matrix, we perform additionally a Lüscher analysis to extrapolate our results to infinite volume.

Primary author: PFLAUMER (*), Martin (Goethe University Frankfurt)

Co-authors: LESKOVEC, Luka; MEINEL, Stefan; WAGNER, Marc

Presenter: PFLAUMER (*), Martin (Goethe University Frankfurt)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **102** Type: **not specified**

Reaching high momenta using Distillation.

Friday, 7 August 2020 16:00 (20 minutes)

The need to reach high hadron momentum is key to calculations of Parton Distribution Functions and other measures of hadron structure within lattice QCD. Meanwhile, the distillation framework provides a valuable means both of more fully sampling the lattice, and of controlling the contribution of excited states. In this talk, we extend the distillation framework through the implementation of the so-called momentum-smearing method, and show that it allows a major improvement in the determination of the energies of the nucleon in motion. We then apply the method to the extraction of the Nucleon Charges between nucleons at non-zero momentum.

Primary author: RICHARDS, David (Jefferson Lab)

Co-authors: HADSTRUCT COLLABORATION.; EDWARDS, Robert; EGERER, Colin; ORGINOS, Kostas

Presenter: RICHARDS, David (Jefferson Lab)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **103** Type: **not specified**

Hybrid static potentials at small quark-antiquark separations

Friday, 7 August 2020 14:40 (20 minutes)

We compute hybrid static potentials in SU(2) lattice gauge theory using a multilevel algorithm and three different small lattice spacings. The resulting static potentials, which are valid for quark-antiquark separations as small as 0.05 fm, are important e.g. when computing masses of heavy hybrid mesons in the Born-Oppenheimer approximation. We also discuss and exclude possible systematic errors from topological freezing, the finite lattice volume and glueball decays.

Primary author: RIEHL (*), Carolin (Goethe University Frankfurt)

Co-author: WAGNER, Marc

Presenter: RIEHL (*), Carolin (Goethe University Frankfurt)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **104** Type: **not specified**

Dark matter and gravitational waves

Tuesday, 4 August 2020 14:40 (20 minutes)

With non-perturbative lattice calculations we investigate the finite-temperature confinement transition of a composite dark matter model. We focus on the regime in which this early-universe transition is first order and would generate a stochastic background of gravitational waves. Future searches for stochastic gravitational waves will provide a new way to discover or constrain composite dark matter, in addition to direct-detection and collider experiments. As a first step to enabling this phenomenology, we determine how heavy the dark fermions need to be in order to produce a first-order stealth dark matter confinement transition.

Primary author: RINALDI, Enrico (RIKEN)

Co-authors: SCHAICH, D.; BROWER, R. C.; CUSHMAN, K.; FLEMING, G. T.; GASBARRO, A.; HASENFRATZ, A.; JIN, X. Y.; KRIBS, G. D.; NEIL, E. T.; OSBORN, J. C.; REBBI, C.; VRANAS, P.; WITZEL, O.

Presenter: RINALDI, Enrico (RIKEN)

Session Classification: Physics Beyond the Standard Model

Track Classification: Physics Beyond the Standard Model

Contribution ID: **105** Type: **not specified**

A non-perturbative renormalization scheme with the gradient flow

Thursday, 6 August 2020 15:20 (20 minutes)

The range of energy scales normally accessible by large-volume lattice computations is typically fairly limited
$(1/asimeq1 - 4$ GeV) and potentially insufficient to reproduce high-energy perturbative results.
In order to match lattice results with more phenomenologically amenable schemes, such as the $\bar{M}S$ scheme, we must evolve the non-perturbative results to higher energies where matching with perturbation theory is possible.
We thereupon present a method to determine both the renormalization constants and anomalous dimensions for local operators by studying ratios and double ratios of correlation functions both in continuum perturbation theory and on the lattice. In particular, we employ the Yang-Mills (Wilson) gradient flow to parametrize the renormalization scale.
This has two major benefits. On the lattice, the introduction of the flow time fixes the energy scale, which permits a continuum limit free from power divergences in the lattice spacing due to operator mixing.
Further, while the gradient flow slightly complicates perturbation theory, it has been shown that all gauge fields in the bulk are intrinsically renormalized.
Focusing on massless fermion bilinears, we study correlation functions at positive flow time at leading and next-to-leading order in perturbation theory with $\bar{M}S$ subtraction. Through renormalization group equations, it is possible to match these correlators to lattice data at the hadronic scale,
with the goal of identifying an energy regime within which both agree.

Primary author: RIZIK (*), Matthew (National Superconducting Cyclotron Laboratory, Michigan State University)

Co-authors: HASENFRATZ, Anna; MONAHAN, Christopher; SHINDLER, Andrea; WITZEL, Oliver

Presenter: RIZIK (*), Matthew (National Superconducting Cyclotron Laboratory, Michigan State University)

Session Classification: Standard Model Parameters and Renormalisation

Track Classification: Standard Model Parameters and Renormalisation

Contribution ID: **106** Type: **not specified**

A new perspective to hadronic excitations above Tc

Tuesday, 4 August 2020 16:00 (20 minutes)

Hadronic matter is known to change its behaviour during a crossover at finite temperature. One part of this crossover is the chiral transition, whose properties are well studied. The other part involves the fate of hadronic bound states and single quarks, the transition of which is less clear. We study two-flavor QCD for temperatures starting from 190 MeV and quark masses down to lighter-than-physical quarks using chirally symmetric domain-wall fermions. Adopting a novel approach to fit lattice data we get new results for screening masses, which allow for a more detailed comparison to perturbative calculations. The lattice data favors a cut instead of a single pole for the propagation of hadronic excitations above Tc. Key features of previous studies, including chiral spin and SU(4) symmetry, are reproduced.

Primary author: ROHRHOFER (*), Christian (Osaka University)

Co-authors: AOKI, Y.; COSSU, G.; FUKAYA, H.; HASHIMOTO, S.; SUZUKI, K.

Presenter: ROHRHOFER (*), Christian (Osaka University)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **107** Type: **not specified**

Exploring the ’t Hooft limit of meson observables

Wednesday, 5 August 2020 15:20 (20 minutes)

The ‘t Hooft limit of QCD, also referred to as large Nc limit, constitutes a simplification of the theory that preserves most of its non-perturbative properties, including confinement and spontaneous chiral symmetry breaking. It also leads to some definite predictions such as a non-existing Delta I=1/2 rule in the K-> pi pi isospin decay amplitudes. Many phenomenological approaches to hadron physics employ approximations inspired by this limit, even for quantities such as the former, where the large Nc prediction is off. In this talk, I will present our recent lattice results for some relevant observables for light meson physics, such as meson mases and decay constants, nonleptonic kaon decay amplitudes, and scattering amplitudes.

Primary author: ROMERO-LOPEZ (*), Fernando (University of Valencia)

Co-authors: DONINI, Andrea; HERNANDEZ, Pilar; PENA, Carlos

Presenter: ROMERO-LOPEZ (*), Fernando (University of Valencia)

Session Classification: Weak Decays and Matrix Elements

Track Classification: Weak Decays and Matrix Elements

Contribution ID: **108** Type: **not specified**

Gamma model - bosonization and gauge theory interpretation

Friday, 7 August 2020 17:20 (20 minutes)

This talk is about a bosonization procedure based on Clifford algebra-valued degrees of freedom, valid for spaces of any dimension. Its interpretation in terms of lattice Z_2 gauge theory will be presented. Brief comparison with other bosonization proposals will be given.

Primary author: RUBA (*), Blazej (Jagiellonian University in Cracow)

Co-authors: BOCHNIAK, Arkadiusz; WOSIEK, Jacek; WYRZYKOWSKI, Adam

Presenter: RUBA (*), Blazej (Jagiellonian University in Cracow)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **109** Type: **not specified**

Energy-like observables for the chiral phase transition of 2+1 flavor QCD

Tuesday, 4 August 2020 15:20 (20 minutes)

The chiral symmetry restoration of QCD, with two light flavours in the chiral limit, is expected to be a phase transition belonging to the universality class of 3d O(N) models. The imprint of the criticality should be observed in the thermodynamic observables if we move close enough to the chiral limit. We discuss results of conserved charge fluctuations and Polyakov loop, which we propose to behave as energy-like observables with respect to the chiral phase transition, towards the chiral limit. Calculations have been performed on 2+1 flavour HISQ ensembles with pion masses starting from 160 MeV down to 55 MeV.

Primary author: SARKAR (*), Mugdha (Bielefeld University)

Co-authors: CLARKE, David; KACZMAREK, Olaf; KARSCH, Frithjof; LAHIRI, Anirban; SCHMIDT, Christian

Presenter: SARKAR (*), Mugdha (Bielefeld University)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **110** Type: **not specified**

Lattice calculation of GPDs and twist-3 PDFs of the proton

Wednesday, 5 August 2020 16:40 (20 minutes)

In this talk we present the first lattice QCD calculation of unpolarized and helicity generalized parton distributions (GPDs) for the proton. We use the quasi-distribution approach, which relies on computations of correlation functions that, for sufficiently fast moving hadrons, can be matched to light-cone distributions using perturbation theory. The calculations are performed on an ensemble of $N_f = 2 + 1 + 1$ maximally twisted mass fermions with a clover improvement, at pion mass $m_\pi = 270$ MeV and lattice spacing $a = 0.093$ fm. The proton is boosted up to 1.67 GeV to check momentum convergence. We are able to extract the x-dependence of GPDs, that is mostly unknown so far, with controlled statistical uncertainties. We also present other directions we explore, such as the extraction of the twist-3 parton distribution function $g_T(x)$ and the test of the Wandura-Wilczek approximation.

Primary author: SCAPELLATO (*), Aurora (Adam Mickiewicz University)

Co-authors: ALEXANDROU, Constantia; BHATTACHARYA, Shohini; CICHY, Krzysztof; CONSTANTINOU, Martha; HADJIYIANNAKOU, Kyriakos; JANSEN, Karl; METZ, Andreas; STEFFENS, Fernanda

Presenter: SCAPELLATO (*), Aurora (Adam Mickiewicz University)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **111** Type: **not specified**

Relativistic N particle energy shifts in finite volume

Thursday, 6 August 2020 17:00 (20 minutes)

Using a non-relativistic EFT, we derive a general relativistic expression for the energy shift in finite volume. This includes the N-particle ground state, and the first two- and three-particle excited states. In addition, we probe the N particle energy shift formula in complex phiˆ4 theory. We investigate different fit models, that include relativistic effects, exponentially suppressed corrections and perturbation-theory inspired ansätze. We discuss the challenges to reliably obtain the three-body scattering amplitude.

Primary author: SCHLAGE (*), Nikolas (University Bonn)

Co-authors: ROMERO-LOPEZ, Fernando; RUSETSKY, Akaki; SCHLAGE, Nikolas; URBACH, Carsten

Presenter: SCHLAGE (*), Nikolas (University Bonn)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **112** Type: **not specified**

Equivalence of three-particle quantization conditions

Tuesday, 4 August 2020 14:40 (20 minutes)

We show that a recently derived alternative form of the relativistic three-particle quantization condition for identical particles can be rewritten in terms of the R matrix introduced to give a unitary representation of the infinite-volume three-particle scattering amplitude. Combined with earlier work, this shows the equivalence of the relativistic effective field theory approach of Refs. [1, 2] and the "finite-volume unitarity"approach of Refs. [3, 32]. It also provides a generalization of the latter approach to arbitrary angular momentum of two-particle subsystems.

Primary author: SHARPE, Stephen (University of Washington)

Co-author: BLANTON, Tyler D.

Presenter: SHARPE, Stephen (University of Washington)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **113** Type: **not specified**

The lattice Yang-Mills theory with a gauge-invariant gluon mass in view of the gauge-invariant BEH mechanism towards confinement

Friday, 7 August 2020 16:40 (20 minutes)

At the last lattice conference, we have proposed to investigate the massive Yang-Mills model, namely, Yang-Mills theory with a gauge-invariant gluon mass term, in order to clarify the mechanism of quark confinement in the Yang-Mills theory with massgap. The gluon mass term simulates the dynamically generated mass to be extracted in the low-energy effective theory of the Yang-Mills theory and plays the role of a new probe to study the phase structure and confinement mechanism.
In this talk, we first review the massive Yang-Mills model, whose gauge-invariant gluon mass term is deduced from a specific gauge-scalar model with a single radially-fixed scalar field under a suitable constraint called the reduction condition, and why such a gauge-scalar model is constructed without breaking the gauge symmetry through the gauge-independent description of the Brout-Englert-Higgs mechanism which does not rely on the spontaneous breaking of gauge symmetry. Then, we discuss how the numerical simulations for the proposed massive Yang-Mills theory can be performed by taking into account he reduction condition in the complementary gauge-scalar model on a lattice.

Primary author: SHIBATA, Akihiro (Computing Research Center, KEK)

Co-authors: KONDO, Kei-Ichi; MATSUDO, Ryutaro; NISHINO, Shogo

Presenter: SHIBATA, Akihiro (Computing Research Center, KEK)

Session Classification: Vacuum Structure and Confinement

Track Classification: Vacuum Structure and Confinement

Contribution ID: **114** Type: **not specified**

Field Selection Algorithm for Correlation Functions

Tuesday, 4 August 2020 17:00 (20 minutes)

The most computational cost in typical lattice QCD simulation is doing the invertion to obtain the propagator. While it is a huge waste to free the propagators in RAM after the contraction. This work explores a field selection algorithm for the correlation functions. The field selection algorithm constructs the correlation function by selecting point on the lattice. It is found that almost the same precision can be obtained at three point function and two point function with about 1/100 point of full lattice. The field selection algorithm has a huge advantage to save the propagators on disk and also to accelerate the complex contraction.

Primary author: SHICHENG (*), Xia (Peking University)

Co-authors: LI, Yuan; FENG, Xu

Presenter: SHICHENG (*), Xia (Peking University)

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

Contribution ID: **115** Type: **not specified**

Heavy quark diffusion coefficient from lattice QCD

Thursday, 6 August 2020 14:00 (20 minutes)

We show the heavy quark diffusion coefficient calculated on the lattice. The coefficient is obtained from the color-electric correlators via Kubo formula. The correlators are measured at $1.5T_c$ on different large isotropic lattices in the quenched approximation under gradient flow. After continuum extrapolation we also extrapolate the continuum correlators back to zero flow time. The extrapolated correlators are then fitted using theoretically motivated model spectral functions. By taking the slope of the spectral function at vanishing frequency we obtain the heavy quark diffusion coefficient. In this talk we will also compare our results with those from other lattice studies.

Primary author: SHU (*), Hai-Tao (Bielefeld University)

Co-authors: ALTENKORT, Luis; ELLER, Alexander M.; KACZMAREK, Olaf; MAZUR, Lukas; MOORE, Guy D.

Presenter: SHU (*), Hai-Tao (Bielefeld University)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **116** Type: **not specified**

The Role of Boundary Conditions in Quantum Computations of Scattering Observables

Thursday, 6 August 2020 16:00 (20 minutes)

Quantum computing may offer the opportunity to simulate strongly-interacting field theories, such as quantum chromodynamics, with physical time evolution. This would give access to Minkowski signature correlators, in contrast to the Euclidean calculations routinely performed at present. However, as with present-day calculations, quantum computation strategies still require the restriction to a finite system size, including a finite, usually periodic, spatial volume. In this work, we investigate the consequences of this in the extraction of hadronic and Compton-like scattering amplitudes. Using the framework presented in Phys. Rev. D101 014509 (2020), we quantify the volume effects for various 1 + 1D Minkowski-signature quantities and show that these can be a significant source of systematic uncertainty, even for volumes that are very large by the standards of presentday Euclidean calculations. We then present an improvement strategy, based in the fact that the finite volume has a reduced symmetry. This implies that kinematic points, which yield the same Lorentz invariants, may still be physically distinct in the finite-volume system. As we demonstrate, both numerically and analytically, averaging over such sets can significantly suppress the unwanted volume distortions and improve the extraction of the physical scattering amplitudes.

Primary author: STURZU (*), Alexandru (New College of Florida)

Co-authors: BRICENO, Raul; GUERRERO, Juan; HANSEN, Maxwell

Presenter: STURZU (*), Alexandru (New College of Florida)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **117** Type: **not specified**

Nuclear force from lattice QCD with LapH smearing

Friday, 7 August 2020 15:00 (20 minutes)

Recent studies by HAL QCD collaboration have been successful in calculating hadron interactions from the first principles of QCD. In this talk, we apply the Laplacian Heaviside (LapH) smearing for the two nucleon source operator to enhance overlap with the low-energy elastic states and calculate the s-wave nuclear force. Our potential with the LapH smeared source has similar structure and comparable statistical errors to that with the standard wall source operator. This will be an important step towards future extension to the P-wave nuclear forces.

Primary author: SUGIURA (*), Takuya (RIKEN iTHEMS)

Co-authors: HAL QCD COLLABORATION; AOYAMA, Tatsumi; DOI, Takumi

Presenter: SUGIURA (*), Takuya (RIKEN iTHEMS)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **118** Type: **not specified**

Violation of non-Abelian Bianchi identity and color confinement in QCD

Thursday, 6 August 2020 16:40 (20 minutes)

A new scheme for color confinement in QCD due to violation of non-Abelian Bianchi identity (VNABI) is proposed and numerical results in pure SU2 and SU3 QCD supporting the scheme are shown.

Primary author: SUZUKI, Tsuneo (Research Center for Nuclear Physics, Osaka University)

Co-authors: HIRAGUCHI, Atsuki; ISHIGURO, Katsuya

Presenter: SUZUKI, Tsuneo (Research Center for Nuclear Physics, Osaka University)

Session Classification: Vacuum Structure and Confinement

Track Classification: Vacuum Structure and Confinement

Contribution ID: **119** Type: **not specified**

Thermal field theory with pure states

Thursday, 6 August 2020 17:20 (20 minutes)

Recently, many studies of quantum field theory with quantum computers have reported. Quantum calculation can only treat unitary evolution, so thermal physics is one of difficulty of it because one needs to produce mixed states within allowed operations. Towards resolving the problem, we attempt to investigate thermal physics with thermal pure quantum(TPQ) state formalism. TPQ state formalism enables us to calculate the thermal average without mixed states. In the talk, we report progress on the application of TPQ state formalism to quantum field theory.

Primary author: TOMIYA (*), Akio (Riken/BNL)

Co-authors: IZUBUCHI, Taku; KIKUCHI, Yuta; NAGAI, Yuki; RENDÓN, Gumaro

Presenter: TOMIYA (*), Akio (Riken/BNL)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **120** Type: **not specified**

Semileptonic $B_s \to K$ and $B_s \to D_s$ decays

Wednesday, 5 August 2020 16:00 (20 minutes)

We present our results for the semileptonic formfactors of exclusive $B_s \to K\ell\nu$ and $B_s \to D_s\ell\nu$ decays. The calculation is based on RBC/UKQCD's set of 2+1 dynamical flavour gauge field ensembles spanning three lattice spacings. We use domain wall fermions for the valence up/down, strange and charm quarks whilst the bottom quark is simulated using the relativistic heavy quark action. After presenting the extrapolation to zero lattice spacing and physical quark masses we show our complete error budget and kinematic extrapolations over the entire q^2 range.
Using our results we predict ratios which serve as tests of lepton flavour universality. These form factors can be combined with experimental data (where available) to extract the CKM matrix elements V_{ub} and V_{cb}, complimentary to extractions from $B \to \pi\ell\nu$ and $B \to D\ell\nu$.

Primary author: TSANG (*), J Tobias (University of Southern Denmark, CP3)

Co-authors: RBC/UKQCD COLLABORATIONS; FLYNN, Jonathan; HILL, Ryan; JÜTTNER, Andreas; SONI, Amarjit; WITZEL, Oliver

Presenter: TSANG (*), J Tobias (University of Southern Denmark, CP3)

Session Classification: Weak Decays and Matrix Elements

Track Classification: Weak Decays and Matrix Elements

Contribution ID: **121** Type: **not specified**

Nucleon structure at physical point in 2 + 1 flavor lattice QCD

Wednesday, 5 August 2020 16:00 (20 minutes)

We will present the current status of nucleon structure studies with physical light quarks (m_pi = 135 MeV) in a large spatial extent of about 10 fm. Our calculations are carried out with the PACS10 gauge configurations generated by the PACS Collaboration with the stout-smeared O(a) improved Wilson fermions and Iwasaki gauge action at beta=1.82 corresponding to the lattice spacing of 0.084 fm. In this talk, we mainly focus on the quark momentum and helicity fractions, which are regarded as bench marks on lattice calculations of parton distribution functions. In addition, we will also present the preliminary result of the axial charge with another PACS10 ensemble generated at the finer lattice spacing, so as to estimate the systematic uncertainties due to the lattice discretization error.

Primary author: TSUJI (*), Ryutaro (Tohoku University)

Co-authors: PACS COLLABORATION; AOKI, Yasumichi; ISHIKAWA, Ken-Ichi; KURAMASHI, Yoshinobu; SHINTANI, Eigo; SASAKI, Shoichi; YAMAZAKI, Takeshi

Presenter: TSUJI (*), Ryutaro (Tohoku University)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **122** Type: **not specified**

Long-distance contribution to neutrinoless double beta decays in pion sector

Wednesday, 5 August 2020 14:20 (20 minutes)

Neutrinoless double beta decay, if detected, would prove that neutrinos are Majorana fermions and provide the direct evidence for lepton number violation. If such decay would exist in nature, then $\pi^-\pi^- \to ee$ and $\pi^- \to \pi^+ee$ (or equivalently $\pi^-e^+ \to \pi^+e^-$) are the two simplest processes accessible via first-principle lattice QCD calculations. In this work, we calculate the long-distance contributions to the $\pi^- \to \pi^+ee$ transition amplitude using four ensembles at the physical pion mass with various volumes and lattice spacings. We adopt the infinite-volume reconstruction method to control the finite-volume effects arising from the (almost) massless neutrino. Providing the lattice QCD inputs for chiral perturbation theory, we obtain the low energy constant $g_{\pi\pi\nu}(m_\rho) = -10.89(28)_{\rm stat}(74)_{\rm sys}$, which is close to $g_{\pi\pi\nu}(m_\rho) = -11.96(31)_{\rm stat}$ determined from the crossed channel $\pi^-\pi^- \to ee$ decay.

Primary author: TUO (*), Xin-yu (Peking university)

Co-authors: FENG, Xu; JIN, Lu-chang

Presenter: TUO (*), Xin-yu (Peking university)

Session Classification: Weak Decays and Matrix Elements

Track Classification: Weak Decays and Matrix Elements

Contribution ID: **123** Type: **not specified**

On the ratio between scalar and tensor glueball masses in Yang-Mills theories

Friday, 7 August 2020 15:00 (20 minutes)

We suggest that in Yang-Mills theories the ratio R of the mass of the tensor glueball over the mass of the scalar glueball is a universal quantity that depends only on the dimensionality of the space. To support this conjecture, we compute numerically R for Sp(2N) gauge theories for N = 1, 2, 3, 4 in d=4 Euclidean dimensions on a lattice and we analyse our results together with previous lattice studies of other Yang-Mills theories, in both d=4 and d=3. We then compare our findings to various analytic models in which R can be computed explicitly in the large N limit.. Finally, we show that a constant R might emerge in a context in which scale invariance is broken, giving rise to a light dilaton state that can be interpreted as the lowest-lying scalar glueball. Our results provide further insights towards our understanding of confinement in QCD

Primary author: VADACCHINO (*), Davide (Trinity College Dublin)

Co-authors: BENNETT, Ed; HOLLIGAN, Jack; HONG, Deog Ki; LEE, Jong-Wan; LIN, C.-J. David; LUCINI, Biagio; PIAI, Maurizio

Presenter: VADACCHINO (*), Davide (Trinity College Dublin)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **124** Type: **not specified**

Chiral symmetry and the Roper resonance

Tuesday, 4 August 2020 16:00 (20 minutes)

The origin of the low-lying nature of the Roper resonance has been the subject of significant interest for many years, including several investigations using lattice QCD. It has been claimed that chiral symmetry plays an important role in our understanding of this resonance. We present results from our systematic examination of the potential role of chiral symmetry in the low-lying nucleon spectrum through the direct comparison of the clover and overlap fermion actions. After a brief summary of the background motivation, we specify the computational details of the study and outline our comparison methodologies. We do not find any strong evidence supporting the claim that chiral symmetry plays a significant role in understanding the Roper resonance on the lattice.

Primary author: VIRGILI (*), Adam (University of Adelaide)

Co-authors: KAMLEH, Waseem; LEINWEBER, Derek

Presenter: VIRGILI (*), Adam (University of Adelaide)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **125** Type: **not specified**

Quark composition and color structure of heavy-heavy mesons and tetraquarks

Tuesday, 4 August 2020 17:00 (20 minutes)

We explore the quark composition of bottomonium bound states and resonances with I = 0 and L = 0 using lattice QCD static potentials from a previous study of string breaking and the Born-Oppenheimer approximation. We also compare the relative importance of meson-meson and diquark-antidiquark creation operators for the lattice QCD static potential relevant for b-bar b-bar u d tetraquarks with I = 0.

Primary author: WAGNER, Marc (Goethe University Frankfurt)

Co-authors: BICUDO, Pedro; CARDOSO, Nuno; PETERS, Antje; VELTEN, Sebastian

Presenter: WAGNER, Marc (Goethe University Frankfurt)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **126** Type: **not specified**

Gell-Mann-Oakes-Renner relation in external magnetic fields at zero temperature

Thursday, 6 August 2020 14:20 (20 minutes)

We present results of chiral condensates, masses and decay constants of neutral pseudo scalar mesons in (2+1)-flavor QCD in the presence of external magnetic fields at zero temperature. We discuss the validity of Gell-Mann-Oakes-Renner relation in a wide region of magnetic field strength eB up to around 3.5 GeV^2. The simulations were performed on $32^3 \times 96$ lattices using the Highly Improved Staggered Quarks (HISQ) action with a single lattice cutoff a=0.117 fm and $m_\pi \approx 220$ MeV. Sixteen values of eB along the z direction up to around 3.5 GeV^2 have been applied in the simulation.

Primary author: WANG (*), Xiao-Dan (Central China Normal University)

Co-authors: DING, H.-T.; LI, S.-T.; TOMIYA, A.; WANG, X.-D.; ZHANG, Y.

Presenter: WANG (*), Xiao-Dan (Central China Normal University)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **127** Type: **not specified**

The applications of quantum computing techniques to lattice gauge theory and quantum noise mitigation

Wednesday, 5 August 2020 17:40 (20 minutes)

Due to the existence of sign problem in the Lattice QCD simulation with finite chemical potential, the traditional Monte-Carlo simulations on classical supercomputers are confronted with significant difficulties on achieving high precision. On the other hand, with the fast development of quantum computers, it might be possible to provide the ultimate solution to sign problem in the future. However, constrained by the nature of NISQ quantum hardware in the current days, quantum noise is one of the main barriers which prevent the realistic applications of quantum computers. Here I will introduce an optimization algorithm, which is run on current quantum devices and has been applied to a 1+1 dimension lattice gauge theory. I will also talk about a method to mitigate the quantum noise in an efficient way, which has been tested on IBM-Q quantum hardwares.

Primary author: WANG (*), Xiaoyang (Peking University)

Co-authors: FUNCKE, Lena; HARTUNG, Tobias; JANSEN, Karl; KU¨HN, Stefan; STORNATI, Paolo

Presenter: WANG (*), Xiaoyang (Peking University)

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

Contribution ID: **128** Type: **not specified**

Partial deconfinement for some bosonic matrix models

Wednesday, 5 August 2020 15:20 (20 minutes)

We provide evidence for partial deconfinement by using lattice Monte Carlo simulations of some bosonic matrix models.
Partial deconfinement is the phenomenon that coexists the confined and deconfined phases in the system, in particular of several large-N gauge theories, at finite temperature.
By appropriately fixing the gauge, we observe that only submatrices deconfine in the analysis of the gauged-Gaussian matrix model and the Yang-Mills matrix model.
We also discuss the applications to QCD.

Primary author: WATANABE (*), Hiromasa (University of Tsukuba)

Co-authors: BERGNER, G.; BODENDORFER, N.; FUNAI, S. Shiba; HANADA, M.; KNAGGS, M.; RINALDI, E.; SCHAFER, A.; VRANAS, P.

Presenter: WATANABE (*), Hiromasa (University of Tsukuba)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **129** Type: **not specified**

QED+QCD Corrections to the Anomalous Magnetic Moment of the Muon

Wednesday, 5 August 2020 14:00 (20 minutes)

There exists a long standing discrepancy of around 3.5 sigma between experimental measurements and standard model calculations of the magnetic moment of the muon. Current experiments aim to reduce the experimental uncertainty by a factor of 4, and Standard Model calculations must also be improved by a similar order. The largest uncertainty in the Standard Model calculation comes from the QCD contribution, in particular the leading order hadronic vacuum polarisation (HVP). To calculate the HVP contribution, we use lattice gauge theories which allows us to study QCD at low energies. In order to better understand this quantity, we investigate the effect of QED corrections to the leading order HVP term by including QED in our lattice calculations, and investigate flavour breaking effects. This is done using fully dynamical QCD+QED gauge configurations generated by the QCDSF collaboration and a novel method of quark turning.

Primary author: WESTIN (*), Alex (University of Adelaide)

Presenter: WESTIN (*), Alex (University of Adelaide)

Session Classification: Hadron Structure

Track Classification: Hadron Structure

Contribution ID: **130** Type: **not specified**

Neutral B and B_s mixing matrix elements using NRQCD and the MILC HISQ ensembles

Wednesday, 5 August 2020 14:40 (20 minutes)

In this talk I will briefly review our recent lattice calculations for matrix elements contributing to the mass and width differences of neutral B mesons [arXiv:1907.01025, arXiv:1910.00970]. The calculations were done using the MILC ensembles generated with 4-flavours of sea quarks utilizing the highly improved staggered quark action. An improved nonrelativistic quark action was used for the bottom quark. Consequences of these calculations include determinations of the CKM matrix elements $|V_{td}|$ and $|V_{ts}|$, predictions for the rare branching fractions $B_{d,s} \to \mu^+\mu^-$, and an improved Standard Model determinations for $\Delta\Gamma_s$.

Primary author: WINGATE, Matthew (University of Cambridge)

Co-authors: HPQCD COLLABORATION; DAVIES, C. T. H.; DOWDALL, R. J.; HARRISON, J. G. I. H.; HORGAN, R. R.; LEPAGE, G. P.; MONAHAN, C. J.; SHIGEMITSU, J.; WINGATE, M.

Presenter: WINGATE, Matthew (University of Cambridge)

Session Classification: Weak Decays and Matrix Elements

Track Classification: Weak Decays and Matrix Elements

Contribution ID: **131** Type: **not specified**

Inhomogeneous phases in the 2+1-dimensional Gross-Neveu model in the limit of infinite fermion flavors

Wednesday, 5 August 2020 15:00 (20 minutes)

We explore the phase diagram of the 2+1-dimensional Gross-Neveu model in the limit of infinite flavors, which shares certain properties with QCD, and the existence of an inhomogeneous phase using lattice field theory. Numerical results are presented, which include the phase boundaries in the μ-T plane as well as the structure of the chiral condensate in the inhomogeneous phase.

Primary author: WINSTEL (*), Marc (Goethe University, Frankfurt am Main)

Co-authors: BUBALLA, Michael; KURTH, Lennart

Presenter: WINSTEL (*), Marc (Goethe University, Frankfurt am Main)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **132** Type: **not specified**

Near-conformal dynamics in a chirally broken system

Tuesday, 4 August 2020 14:00 (20 minutes)

Composite Higgs models must exhibit very different dynamics from quantum chromodynamics (QCD) regardless whether they describe the Higgs boson as a dilaton-like state or a pseudo-Nambu-Goldstone boson. Large separation of scales and large anomalous dimensions are frequently desired by phenomenological models. Mass-split systems are well-suited for composite Higgs models because they are governed by a conformal fixed point in the ultraviolet but are chirally broken in the infrared. In this work we use lattice field theory calculations with domain wall fermions to investigate a system with four light and six heavy flavors. We demonstrate how a nearby conformal fixed point affects the properties of the four light flavors that exhibit chiral symmetry breaking in the infrared. Specifically we describe hyperscaling of dimensionful physical quantities and determine the corresponding anomalous mass dimension. We obtain y_m=1+gammaˆ*= 1.47(5) suggesting that N_f=10 lies inside the conformal window. Comparing the low energy spectrum to predictions of dilaton chiral perturbation theory, we observe excellent agreement which supports the expectation that the 4+6 mass-split system exhibits near-conformal dynamics with a relatively light 0ˆ++ isosinglet scalar.

Primary author: WITZEL, Oliver (University of Colorado Boulder)

Co-author: LATTICE STRONG DYNAMICS COLLABORATION

Presenter: WITZEL, Oliver (University of Colorado Boulder)

Session Classification: Physics Beyond the Standard Model

Track Classification: Physics Beyond the Standard Model

Contribution ID: **133** Type: **not specified**

Domain Wall and Overlap Fermions in 2+1D

Tuesday, 4 August 2020 16:00 (20 minutes)

Layered systems such as graphene have become an important area of investigation. Within the broader programme of investigating critical phenomena in such systems, we look at different mass configurations for domain wall fermions and overlap fermions in 2+1D. The equivalence between formulations is reviewed, and formulations for the condensate and susceptibility are given. Locality of fermion operators is required for the recovery of U(2) symmetry and is demonstrated with numerical experiments. Further aspects are also considered.

Primary author: WORTHY (*), Jude (Swansea University)

Co-author: Prof. HANDS, Simon

Presenter: WORTHY (*), Jude (Swansea University)

Session Classification: Physics Beyond the Standard Model

Track Classification: Applications beyond QCD

Contribution ID: **134** Type: **not specified**

Constraints of kinematic bosonization in two and higher dimensions

Friday, 7 August 2020 17:00 (20 minutes)

Contrary to the common wisdom, local bosonizations of fermionic systems exist in higher dimensions. Interestingly, resulting bosonic variables must satisfy local constraints of a gauge type. They effectively replace long distance exchange interactions. In this work we study in detail the properties of such a system which was proposed a long time ago. In particular, dependence of the constraints on lattice geometry and fermion multiplicity is further elaborated and is now classified for all two dimensional, rectangular lattices with arbitrary sizes. For few small systems the constraints are solved analytically and the complete spectra of reduced spin hamiltonias are shown to agree with the original fermionic ones. The equivalence is also extended to fermions in an external Wegner Z2 field. It is also illustrated by an explicit calculation for a particular configuration of Wegner variables.

Primary author: WOSIEK, Jacek (Jagiellonian University)

Co-authors: BOCHNIAK, Arkadiusz; RUBA, Blazej; WYRZYKOWSKI, Adam

Presenter: WOSIEK, Jacek (Jagiellonian University)

Session Classification: Theoretical Developments

Track Classification: Theoretical Developments

Contribution ID: **135** Type: **not specified**

Multiple right-hand-side implementation for DDαAMG

Tuesday, 4 August 2020 14:40 (20 minutes)

We present a multiple right-hand side (rhs) implementation of the Adaptive Aggregation-based Domain Decomposition Multigrid method (DDαAMG) using twisted mass fermions.
Our implementation extends the strong scaling region of DDαAMG and simplifies vectorization, which would otherwise require using vector extensions. This multiple rhs implementation is thus better suited to take advantage of current and emerging HPC trends, which involve increasing core counts per node and more diverse CPU architectures, such as ARM, Intel Xeon, and AMD Epyc.
In this talk, we will describe our implementation strategy and show preliminary scaling results. Moreover, we will show preliminary results obtained using Block Krylov solvers as complementary preconditioners within DDαAMG, as provided by the Fast Accurate Block Linear krylOv Solver (Fabulous) library.

Primary author: YAMAMOTO (*), Shuhei (The Cyprus Institute)

Co-authors: BACCHIO, Simone; FINKENRATH, Jacob

Presenter: YAMAMOTO (*), Shuhei (The Cyprus Institute)

Session Classification: Algorithms, machines, and code development

Track Classification: Algorithms, machines, and code development

Contribution ID: **136** Type: **not specified**

Glueball dark matter in SU(N) lattice gauge theory

Friday, 7 August 2020 15:20 (20 minutes)

The glueballs in the SU(N) Yang-Mills theory are theoretically the most natural among composite dark matter scenarios.
In this work, we evaluate the interglueball potential in SU(N) lattice gauge theories using the HALQCD method and derive the glueball dark matter scattering cross section, and then constrain the scale parameter of the gauge theory from the observational data.

Primary author: YAMANAKA, Nodoka (University of Massachusetts Amherst)

Co-authors: NAKAMURA, Atsushi; WAKAYAMA, Masayuki

Presenter: YAMANAKA, Nodoka (University of Massachusetts Amherst)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **137** Type: **not specified**

Complex Langevin analysis of 2D U(1) gauge theory on a torus with a θ term

Wednesday, 5 August 2020 14:20 (20 minutes)

Monte Carlo simulation of gauge theories with a theta term is known to be extremely difficult due to the sign problem. We consider the complex Langevin method (CLM), which is one of the approaches to overcome this problem. As a first step, we apply the method to 2D U(1) gauge theory with a theta term, which can be solved analytically. We find that naive implementation of the method fails because of the topological nature of the theta term. In order to circumvent this problem, we introduce a puncture on the torus. We find that the CLM works and reproduces the exact results for the punctured model even at large theta. We also prove that the punctured model is equivalent to the infinite volume limit of the original model inside the fundamental domain of theta.

Primary author: YOSPRAKOB (*), Atis (SOKENDAI)

Co-authors: HIRASAWA, M.; MATSUMOTO, A.; NISHIMURA, J.

Presenter: YOSPRAKOB (*), Atis (SOKENDAI)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **138** Type: **not specified**

Dirac eigenvalue spectrum and its relation to U(1)A symmetry breaking in high temperature Nf = 2 + 1 QCD

Tuesday, 4 August 2020 14:40 (20 minutes)

We will present results on the Dirac eigenvalue spectrum as well as its relation to the axial U(1) and SU(2)xSU(2) symmetries at a high temperature in (2+1)-flavor QCD. The simulations are carried out using the highly improved staggered quarks (HISQ) action on Nτ = 8, 12 and 16 lattices with the aspect ratio Nσ /Nτ in a range of [4,9] and 4-5 pion masses ranging from 160 MeV to 55 MeV at a single temperature of ~ 200 MeV.

Primary author: ZHANG (*), Yu (Central China Normal University)

Co-authors: DING, H.-T.; LI, S.-T.; MUKHERJEE, Swagato; TOMIYA, A.; WANG, X.-D.

Presenter: ZHANG (*), Yu (Central China Normal University)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **139** Type: **not specified**

Simulation of complexified U(1) lattice gauge theory

Wednesday, 5 August 2020 14:00 (20 minutes)

We present an update on our previous studies [1] of pure U(1) lattice gauge theory with a sign problem due to a complex coupling \beta. To that end a novel simulation method is employed:
Configuration space is rewritten as a union of linear submanifolds in complexified space. These submanifolds are the tangent spaces of the Lefschetz thimble decomposition. Therefore the sign problem is drastically reduced.
Tangent spaces are infinite spaces, so we specify boundaries for them, such that homotopy to real field space is in the end ensured.
The Monte Carlo simulation is set up on the tangent space corresponding to the global minimum of the action.
The other spaces are taken into account by linear mappings to them, so we can monitor their respective contributions one by one. The relative weights are computed via reweighting.
We discuss simulation results including the scaling of the sign problem with the number of tangent spaces. In particular, promising results are obtained for the beta_I / beta_R > 1 region which is relevant in the context of quantum real-time simulations.
[1] J. M. Pawlowski, M. Scherzer, C. Schmidt, F. P. G. Ziegler, F. Ziesché, „Simulating gauge theories on Lefschetz thimbles“, , 37th International Symposium on Lattice Field Theory, arXiv:2001.09767 [hep-lat]

Primary author: ZIEGLER (*), Felix (University of Southern Denmark (SDU))

Co-authors: PAWLOWSKI, Jan M.; SCHERZER, Manuel; SCHMIDT, Christian; ZIESCHÉ, Felix

Presenter: ZIEGLER (*), Felix (University of Southern Denmark (SDU))

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **140** Type: **not specified**

Finite-volume scattering formalism for all three-pion isospin channels

Tuesday, 4 August 2020 14:00 (20 minutes)

I summarize recent work (arXiv:2003.10974) providing a generalization of finite-volume scattering formalism for non-identical pions in isosymmetric QCD. The result allows one to use discrete finite-volume energies, determined using lattice QCD, to constrain scattering amplitudes for all possible values of two- and three-pion isospin. As an example, I present a toy implementation for I($\pi\pi\pi$) = 0, focusing on the quantum numbers of the ω and h1 resonances.

Primary author: HANSEN, Maxwell (CERN)

Presenter: HANSEN, Maxwell (CERN)

Session Classification: Hadron Spectroscopy and Interactions

Track Classification: Hadron Spectroscopy and Interactions

Contribution ID: **141** Type: **not specified**

Towards color superconductivity on the lattice — perturbative predictions and the complex Langevin method

Friday, 7 August 2020 17:00 (20 minutes)

The phase structure of QCD at finite density is expected to be revealed by the complex Langevin method (CLM), which is a promising approach to overcome the sign problem. In particular, we discuss the possibility of investigating the color superconductivity (CSC) on the lattice by the CLM. Towards that end, we predict the parameter region in which CSC occurs in lattice perturbation theory based on the gap equation. Our perturbative calculations are justified by considering a small spatial volume due to the asymptotic freedom. Most notably, we can predict the explicit form of the Cooper pairs without imposing any ansatz.

Primary author: YOKOTA (*), Takeru (The University of Tokyo)

Co-authors: ASANO, Yuhma; ITO, Yuta; MATSUFURU, Hideo; NAMEKAWA, Yusuke; NISHIMURA, Jun; TSUCHIYA, Asato; TSUTSUI, Shoichiro

Presenter: YOKOTA (*), Takeru (The University of Tokyo)

Session Classification: QCD at nonzero Temperature and Density

Track Classification: QCD at nonzero Temperature and Density

Contribution ID: **142** Type: **not specified**

Welcome and instructions

Tuesday, 4 August 2020 13:50 (10 minutes)