Lattice 2008 Parallel and Poster Presentations

Alphabetical by presenter

1. **Stochastic quantization at nonzero chemical potential**

   Presenter: Gert Aarts — Swansea University

   Time: Tuesday, 2:30 **Room:** Chesapeake A

   Section: Nonzero Temperature and density

   Co-authors: Ion-Olimpiu Stamatescu

   Abstract:

   The method of stochastic quantization and complex Langevin dynamics is applied to lattice QCD at finite chemical potential. We discuss U(1) and SU(3) one link models and study the phase of the determinant in detail. Even in the region where the sign problem is severe, we find excellent agreement between the Langevin results and exact expressions available here. We present first results for QCD at finite chemical potential using the hopping expansion.

2. **Seed methods for linear equations in lattice QCD problems with multiple right-hand sides**

   Presenter: Abdou Abdel-Rehim — Baylor University

   Poster Session: A **Section:** Algorithms and Machines

   Co-authors: Ronald B. Morgan, Walter Wilcox

   Abstract:

   The $M^\dagger M$ formulation of lattice QCD linear equations problem gives a Hermitian positive definite systems of linear equations with multiple right-hand sides. The seed conjugate gradient method solves one right-hand side with the conjugate gradient method and simultaneously projects for the other right-hand sides over the Krylov subspace thus developed. Then the next system is solved and used to seed the remaining ones. Rounding error in the conjugate gradient method limits how much the seeding can improve convergence. We propose three changes to the seed conjugate gradient method: only the first right-hand side is used for seeding, this system is solved past convergence, and the roundoff error is controlled with some reorthogonalization. Results are actually better with only one seeding, even in the case of related right-hand sides. Controlling rounding error gives the potential for large reduction in the number of iterations needed for the second and subsequent right-hand side, and examples will be given showing an order of magnitude improvement.

3. **A fitting procedure for the determination of hadron excited states applied to the Nucleon**

   Presenter: Constantia Alexandrou — University of Cyprus

   Time: Tuesday, 3:10 **Room:** Auditorium

   Section: Hadron Spectroscopy

   Co-authors: C. N. Papanicolas and E. Stiliaris

   Abstract:

   We present a novel method of analysis suitable for extracting excited states. We demonstrate the applicability of the method by reanalyzing the η_c correlator. We then extract the mass of the positive and negative parity excited states of the nucleon using two dynamical twisted mass fermions at four quark masses.

4. **The background field method on the lattice**

Presenter: Andrei Alexandru — The George Washongton University

Time: Monday, 5:20 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: Frank X. Lee

Abstract:

Hadron properties are modified in the presence of a static electromagnetic field. The most important effects are parameterized by the dipole moment and the polarizability. These parameters can be determined by measuring linear and quadratic responses in the mass shift of hadrons placed in a weak field. In this talk I will discuss some issues surrounding how to introduce such a field on the Euclidean lattice, using both analytical and numerical means.

5. **Matching the bare and $\overline{\text{MS}}$ charm quark masses using weak coupling simulations**

Presenter: Ian Allison — TRIUMF

Time: Thursday, 9:30 **Room:** Chesapeake C

Section: Standard Model Parameters and Renormalization

Co-authors: HPQCD collaboration

Abstract:

Quark masses are a fundamental ingredient to the simulation of QCD on the lattice. Recent advances in the formulation of relativistic quarks have allowed the reliable calculation of states containing charm quarks with significantly reduced discretization errors. The Highly Improved Staggered Quark (HISQ) action has already been used to calculate the charm quark mass. Here we combine traditional lattice perturbation theory with Monte Carlo simulations in the weak coupling regime to calculate the ratio m_c/m_s. The use of the same action for the charm and strange quarks allows us to take advantage of a significant cancellation of systematic errors in this quantity.

6. **Energy dependence of nucleon-nucleon potentials**

Presenter: Sinya Aoki — University of Tsukuba

Time: Wednesday, 2:50 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: J. Balog, T. Hatsuda, N. Ishii, K. Murano, H. Nemura, P. Weisz

Abstract:

Recently, through the Bethe-Salpeter(BS) wave function in lattice QCD, we have calculated a nucleon-nucleon(NN) potential, which qualitatively agrees with phenomenological NN potentials. Since the BS wave function depends on the energy of the eigenstate, it is important to know how the potential defined in this way depends on the energy. We investigate this problem theoretically using solvable models in 2-dimensional quantum field theories as well as numerically in quenched lattice QCD. We also propose a method to construct the energy independent potential from energy dependent ones.

7. **Quark mass renormalization with non-exceptional momenta**

Presenter: Yasumichi Aoki — RIKEN BNL Research Center

Time: Wednesday, 3:50 **Room:** Chesapeake C

Section: Standard Model Parameters and Renormalization

Co-authors: RBC and UKQCD collaborations

Abstract:

Renormalization conditions imposed on quark bilinear vertex functions in the conventional RI-MOM scheme use exceptional momenta configurations. With practical values for the lattice cutoff, these vertex functions are contaminated with unwanted low energy physics (pion pole, zero modes, etc), which is a large source of systematic error. These effects can be reduced by using non-exceptional momenta. We discuss the quark mass renormalization with non-exceptional momenta using 2+1 flavor domain wall fermions and present the results of a perturbative, one-loop calculation which allows such a non-exceptional momenta RI-MOM renormalization to be converted to the $\overline{\mathrm{MS}}$ scheme.

8. **Baryonic Spectral Functions above the Deconfinement Phase Transition**

Presenter: Masayuki Asakawa — Osaka University

Time: Friday, 5:00 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors:

Abstract:

We present the first result of the baryonic spectral functions at several temperatures above the deconfinement phase transition. The analysis was carried out with the maximum entropy method. We shall discuss the existence of non-trivial structures in the spectral functions and their relation to the diquark and baryonic correlations in the deconfinement phase.

9. **Spectrum of closed k-strings in D=2+1**

Presenter: Andreas Athenodorou — University of Oxford

Time: Friday, 2:30 **Room:** Tidewater B

Section: Vacuum Structure and Confinement

Co-authors:

Abstract:

We calculate the excitation spectrum of closed k-strings in 2+1 dimensional SU(N) gauge theories for N=4, 5 and k=2. Our results demonstrate that the spectrum of the k=2 string falls into sectors that belong to the antisymmetric and symmetric representations, showing that k-strings know not only about the centre of the group but also about the full group. We also observe that the lightest states in each irreducible representation are consistent with what one would expect from an effective string theory that belongs to the same bosonic universality class (Nambu-Goto) as the fundamental string. We see that the corrections compared to the free string theory are of O(1), in striking contrast to what we observe for the fundamental string.

10. **Finite Volume Study of the Delta Magnetic Moments Using Dynamical Clover Fermions**

Presenter: Christopher Aubin — College of William and Mary

Time: Monday, 5:40 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: Kostas Orginos

Abstract:

We calculate the magnetic dipole moment of the Delta baryon using a background magnetic field on 2+1-flavors of clover fermions on anisotropic lattices. We focus on the finite volume effects that can be significant in background field studies, and thus we use two different spatial volumes in addition to several quark masses.

11. **Strange quark content of the nucleon**

Presenter: Ronald Babich — Boston University

Time: Thursday, 10:40 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: Richard Brower, Michael Clark, George Fleming, James Osborn, Claudio Rebbi

Abstract:

We discuss the calculation of disconnected diagrams needed for determining the strange quark content of the nucleon on the lattice. We present results for the strange scalar form factor and the related parameter f_{Ts}, which enters into the cross section for the scattering of dark matter off nuclei in supersymmetric extensions of the standard model. In addition, we present results for the strange contribution to the nucleon's axial and electromagnetic form factors. The calculations were performed with two dynamical flavors of Wilson fermions on a $24^3 \times 64$ anisotropic lattice with $a_s \approx 3a_t \approx 0.11$ fm and $M_\pi \approx 400$ MeV.

12. **Scaling behavior and sea quark dependency of pion spectrum**

Presenter: Taegil Bae — Seoul National University

Time: Tuesday, 5:20 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: David Adams, Taegil Bae, Chulwoo Jung, Hyung-Jin Kim, Jongjeong Kim, Kwangwoo Kim, Weonjong Lee, Stephen Sharpe and Boram Yoon

Abstract:

We present results of pion multiplet spectrum calculated using a mixed action (valence quarks are HYP staggered fermions and sea quarks are asqtad staggered fermions). We compare the results between the MILC coarse lattices ($a = 0.12$ fm) and MILC fine lattices ($a = 0.09$ fm). We also investigate the sea quark mass dependency of the pion spectrum. We also review the procedure to determine lattice spacings in various different methods.

13. **Hunting for the strangeness content of the nucleon**

Presenter: Gunnar Bali — University of Regensburg

Time: Thursday, 11:00 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: Sara Collins, Andreas Schaefer

Abstract:

We calculate Δs and related observables, employing variance-reduced all-to-all propagator methods.

14. **Nucleon axial coupling constant with $N_F = 2$ twisted mass fermions and other 3 point functions**

Presenter: Remi Baron — CEA Saclay

Time: Thursday, 11:20 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: V. Drach, P. Harraud, Z. Liu, V. Morenas, J. Carbonell, M. Brinet, R. Baron, P. Guichon, O. Pene, C. Alexandrou, T. Korzec, G. Koutsou, C. Urbach, D. Renner

Abstract:

We present results for the nucleon axial coupling constant using two flavors of light dynamical twisted mass fermions. Calculations are performed for pion masses from 500 MeV down to 300 MeV at a

lattice spacing of 0.086 fm. At the lightest mass, we perform calculations with physical sizes of 2.1 and 2.7 fm to check for finite size effects. Cutoff effects are studied using a coarser lattice spacing of 0.1 fm. Preliminary results for nucleon parton distributions will also be presented.

15. **Electromagnetic splittings of hadrons from improved Staggered quarks in full QCD**

Presenter: Subhasish Basak — Indiana University

Time: Thursday, 10:40 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: Steven Gottlieb

Abstract:

We present our initial study of the electromagnetic splittings of charged and neutral mesons and baryons using MILC lattices. Hadron masses are calculated on MILC N_f=2+1 QCD ensembles at lattice spacing 0.15fm and two different volumes, together with quenched non-compact U(1) configurations. Quark propagators relevant for the hadron masses are obtained using order a^2 Symanzik improved action at six different quark masses ranging 1 - 0.1 times strange quark mass. Chiral and continuum extrapolations are performed using partially quenched chiral perturbation theory incorporating electromagnetic corrections.

16. **Color singlet and adjoint free energy at finite temperature**

Presenter: Alexei Bazavov — University of Arizona

Poster Session: A **Section:** Nonzero Temperature and density

Co-authors: Peter Petrezcky, Alexander Velytsky

Abstract:

We study correlation functions of static quark-antiquark pairs in SU(2) gauge theory at finite temperature. By measuring Polyakov loop correlators and temporal Wilson loops with APE smearing of spatial links we are able to give consistent definitions of the singlet and adjoint free energies at short distances, where the notion of these free energies is meaningful. APE smearing procedure allows to achieve a high degree of overlap in the singlet channel and to reconstruct the adjoint part from the color averaged and singlet free energy.

17. **HISQ action in dynamical simulations**

Presenter: Alexei Bazavov — University of Arizona

Time: Tuesday, 5:00 **Room:** Chesapeake B

Section: Algorithms and Machines

Co-authors: C. Bernard, C. DeTar, W. Freeman, S. Gottlieb, U.M. Heller, J.E. Hetrick, J. Laiho, L. Levkova, J. Osborn, R. Sugar, D. Toussaint

Abstract:

We report on recent progress in employing the Highly Improved Staggered Quarks (HISQ) action introduced by the HPQCD/UKQCD collaboration in simulations with dynamical fermions. The HISQ action is an order a^2 Symanzik-improved action with further suppressed taste symmetry violations. The improvement in taste symmetry is achieved by introducing Fat7 smearing of the original gauge links and reunitarization (projection to an element of U(3) or SU(3)) followed by Asq-type smearing. Major challenges for calculating the fermion force are related to the reunitarization step. We present a preliminary study of the HISQ action on two 2+1+1 flavor ensembles with the lattice spacing roughly equivalent to the MILC Asqtad a=0.125 and 0.09 fm ensembles.

18. **Minkowskian Dynamics of a Polyakov Loop Model under a Heating Quench**

Presenter: Bernd Berg — Florida State University

Time: Wednesday, 3:50 **Room:** Tidewater B

Section: Nonzero Temperature and density

Co-authors: Alexei Bazavov, Adrian Dumitru

Abstract:

We determine the time evolution of fluctuations of the Polyakov loop after a quench into the deconfined phase of SU(3) gauge theory for for a simple classical relativistic Lagrangian. Structure factors indicate spinodal decomposition followed by relaxation. The time to reach the structure factor peaks diverges like $\sim 1/k^2$ in the long-wavelength limit due to formation of competing Z(3) domains. For realistic temperatures we find that even modes with k on the order of T experience delayed thermalization. Relaxation times of very long wavelength modes are on the order of the size of the system; thus, the dynamics of competing domains should accompany the hydrodynamic description of the deconfined vacuum.

19. **Generalizations of the Ginsparg-Wilson relation and a remnant of supersymmetry on the lattice**

Presenter: Georg Bergner — FSU Jena

Time: Monday, 2:30 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors: Falk Bruckmann and Jan M. Pawlowski

Abstract:

In the same way as the well known Ginsparg-Wilson relation a lattice symmetry relation for field theories with a general linear symmetry is introduced. The new relation encodes the remnant of the original symmetry on the lattice and guides the construction of invariant lattice actions. We apply this approach to lattice supersymmetry. In this case an additional constraint has to be satisfied because of the appearance of a derivative operator in the symmetry transformations. Due to this constraint the non-local SLAC derivative operator appears in the relation. In spite of this non-local form we show how local solutions for a quadratic action can be found. Because of its general form the relation also applies for non-quadratic interacting theories. We show that in this case the solution of the relation leads in general to non-polynomial actions and investigate the conditions for a reduction to a polynomial solution.

20. **Exotic static 3-body potentials**

Presenter: Pedro Bicudo — IST, Lisboa

Time: Wednesday, 2:30 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: Marco Cardoso, Orlando Oliveira

Abstract:

We study the quark-antiquark-gluon techniques in SU(3) lattice QCD, for different geometries, namely angles of 0, 45, 60, 90, 120, 135 and 180 degrees, between the quark-gluon and the antiquark-gluon segments. We calculate the form of the static potential and discuss whether, or not, two-body interactions exist between the three different bodies. We also study the existence of repulsion between the strings. We also mention the interactions between three gluon systems.

21. **Pion Scattering in Wilson Chiral Perturbation Theory**

Presenter: Benedikt Biedermann — Humboldt University Berlin

Poster Session: B **Section:** Chiral Symmetry

Co-authors: Sinya Aoki, Oliver Bär

Abstract:

We compute the $\pi\pi$ scattering amplitude in Wilson Chiral Perturbation Theory for two flavors. The lattice spacing effects due to the explicit chiral symmetry breaking are kept through $O(a^2)$, and we consider the regime where the quark mass m is of order $a^2\Lambda_{\rm QCD}^3$. Analytic expressions for the scattering lengths in different isospin channels are given. As a result of the $O(a^2)$ terms the scattering lengths do not vanish in the chiral limit. Moreover, additional chiral logarithms proportional to $a^2 \ln M_\pi^2$ are present in the one-loop results. These contributions can obscure the continuum chiral logarithms and the determination of some low-energy constants from numerical lattice simulations.

22. **Chiral condensate and topological susceptibility in the 2-flavour Schwinger model**

Presenter: Wolfgang Bietenholz — DESY Zeuthen

Poster Session: A **Section:** Chiral Symmetry

Co-authors: I. Hip, S. Shcheredin, J. Volkholz

Abstract:

We present numerical results for the 2-flavour Schwinger model with dynamical overlap hypercube fermions. We measure the densities of the microscopic Dirac spectrum in distinct topological sectors and discuss the link to the chiral condensate Σ in the light of Random Matrix Theory. We also measure Σ directly and confront its mass and volume dependence with analytic predictions. In this context we discuss the evaluation of the topological susceptibility from measurements in fixed sectors by various techniques.

23. **Hadron structure in terms of OPE with non-perturbative Wilson coefficients**

Presenter: Wolfgang Bietenholz — DESY Zeuthen

Poster Session: B **Section:** Hadron Structure

Co-authors: QCDSF

Abstract:

Lattice calculations can contribute significantly to the understanding of Deep Inelastic Scattering data by evaluating moments of the nucleon structure functions. To this end we study the product of electromagnetic currents between quark states. Operator Product Expansion decomposes it into matrix elements of local operators (depending on the quark momenta) and Wilson coefficients (as functions of the larger photon momenta). For consistency we evaluate for the first time also a set of Wilson coefficients non-perturbatively, based on propagators for numerous momentum sources, on a $16^3 \times 32$ lattice with overlap quarks. Results for the leading Wilson coefficients are extracted by means of a Singular Value Decomposition.

24. **Comparing iterative methods to compute the overlap Dirac operator at nonzero chemical potential**

Presenter: Jacques Bloch — University of Regensburg

Time: Monday, 5:40 **Room:** Chesapeake C

Section: Algorithms and Machines

Co-authors: Tobias Breu, Tilo Wettig

Abstract:

The overlap Dirac operator at nonzero quark chemical potential involves the computation of the sign function of a non-Hermitian matrix. In this talk we present iterative Krylov subspace approximations, which allow for an efficient computation of the operator, even on large lattices. We compare the accuracy and efficiency of two alternative methods based on the Arnoldi and on the two-sided Lanczos method. Moreover, to overcome a drop in efficiency when the argument of the sign function has eigenvalues close to the imaginary axis, a small number of critical eigenvectors are added to the Krylov subspace, and a deflation scheme in this augmented subspace is proposed.

25. **The light baryon spectrum calculated with 2+1 flavors of domain wall fermions**

Presenter: Thomas Blum — University of Connecticut/RIKEN BNL Research Center

Time: Monday, 6:00 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: RBC/UKQCD Collaboration

Abstract:

We compute the light baryon spectrum using 2+1 flavors of domain wall fermions and the Iwasaki gauge action. Calculations are carried out for two values of the gauge coupling, 2.13 and 2.25, on lattices with size $24^3 \times 64$ and $32^3 \times 64$. The size of the extra dimension of the domain wall fermions is $L_s = 16$, and the light-to-strange quark mass ratio ranges down to about 0.11. We discuss the masses of the octet and decuplet baryons, describe fits that are used to extrapolate to the physical mass values, and study effects of non-zero lattice spacing.

26. **On the phase diagram of the Higgs $SU(2)$ model**

Presenter: Claudio Bonati — Pisa University and INFN

Time: Monday, 5:00 **Room:** Tidewater B

Section: Vacuum Structure and Confinement

Co-authors: G. Cossu, A. D'Alessandro, M. D'Elia, A. Di Giacomo

Abstract:

We study the phase diagram at zero temperature of the Higgs $SU(2)$ model with $\lambda = \infty$ (fixed Higgs length); this model is usually believed to have two different phases at high gauge coupling β separated by a line of first order transitions but not distinuguished by any typical symmetry associated with a local order parameter, as first proved by Fradkin and Shenker. We show that in regions of the parameter space where is usually supposed to be a first order phase transition is in fact only present a smooth crossover in all the local observables analized (plaquettes, gauge-Higgs coupling, Z_2 monopole density); a first analysis of the results obtained using the magnetic monopole operator is presented.

27. **Minimally Doubled Fermion Revival**

Presenter: Artan Borici — University of Tirana

Time: Monday, 2:50 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors:

Abstract:

In this talk we will present recent developments in reducing the number of fermion doublers on the lattice.

28. **A Variational Study of the Nucleon Wavefunction**

Presenter: Jonathan Bratt — MIT

Time: Wednesday, 3:10 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: J. W. Negele

Abstract:

The structure of the nucleon is studied variationally on the lattice by maximizing the overlap between a trial function and the nucleon with respect to variational parameters in the the interpolating field. Variational parameters include the RMS radius of smeared quark sources, the degree of gauge field smearing, and the positions of smeared quark sources. Exploratory calculations were performed with quenched Wilson fermions at a pion mass of 900 MeV.

29. **Breakdown of large-N reduction in the quenched Eguchi-Kawai model**

Presenter: Barak Bringoltz — University of Washington

Time: Monday, 6:00 **Room:** Tidewater A

Section: Applications beyond QCD

Co-authors: Stephen R. Sharpe

Abstract:

We study the validity of the large-N equivalence between four-dimensional SU(N) lattice gauge theory and its momentum quenched version–the Quenched Eguchi-Kawai (QEK) model. We find that the assumptions needed for the proofs of equivalence do not automatically follow from the quenching prescription. We use weak-coupling arguments to show that large-N equivalence is in fact likely to break down in the QEK model, and that this is due to dynamically generated correlations between different Euclidean components of the gauge fields. We then use Monte-Carlo simulations at intermediate couplings with $20 \leq N \leq 200$ to provide strong evidence for the presence of these correlations and for the consequent breakdown of reduction. This evidence includes a large discrepancy between the transition coupling of the "bulk" transition in lattice gauge theories and the coupling at which the QEK model goes through a strongly first-order transition. To accurately measure this discrepancy we adapt the recently introduced Wang-Landau algorithm to gauge theories.

30. **Parton Distribution Amplitudes with Non-Perturbative Renormalisation**

Presenter: Dirk Broemmel — University of Southampton

Time: Friday, 3:10 **Room:** Auditorium

Section: Hadron Structure

Co-authors: for the UKQCD and RBC collaborations

Abstract:

We present results for the first two moments of the light-cone distribution amplitudes of the π and K pseudoscalar mesons and of the $\rho\, K^*$ and ϕ vector mesons. The calculations are performed on the UKQCD/RBC collaborations' ensembles generated with the Iwasaki gauge action and with 2+1 flavours of domain wall fermions. Particular emphasis is given to the non-perturbative renormalisation using the Rome-Southampton method where we discuss the benefits of the momentum source approach.

31. **Möbius Algorithm for Domain Wall and GapDW Fermions**

Presenter: Richard C. Brower — Phyics Department, Boston University

Time: Tuesday, 5:20 **Room:** Chesapeake B

Section: Algorithms and Machines

Co-authors: Kostas Orginos and Pavlos Vranas

Abstract:

The Möbius domain wall action is a generalization of Shamir's action, which gives exactly the same overlap fermion as the separation (L_s) between the domain walls is taken to infinity. The precise map between the domain wall and effective overlap kernels and the Ward-Takahashi identities for the axial and vector currents is defined at finite quark mass including finite Ls chiral violations. The performance advantages of the algorithm are presented for a small ensemble of lattices. In particular, it is shown that at the larger lattice spacings relevant to current dynamical simulations Möbius fermions work well together with GapDWF reducing L_s by more than a factor of two.

32. **Dual quark condensate and dressed Polyakov loops**

Presenter: Falk Bruckmann — U Regensburg

Time: Thursday, 11:40 **Room:** Chesapeake C

Section: Vacuum Structure and Confinement

Co-authors: Erek Bilgici, Christof Gattringer, Christian Hagen

Abstract:

We construct a new order parameter for finite temperature QCD by considering the quark condensate for U(1)-valued temporal boundary conditions for the fermions. Fourier transformation with respect to the boundary condition defines the dual condensate. This quantity corresponds to an equivalence class of Polyakov loops, thereby being an order parameter for the center symmetry. We explore the duality relation between the quark condensate and these dressed Polyakov loops numerically, using quenched lattice QCD configurations below and above the QCD phase transition. It is demonstrated that the Dirac spectrum responds differently to changing the boundary condition, in a manner that reproduces the expected Polyakov loop pattern. We find the dressed Polyakov loops to be dominated by the lowest Dirac modes, in contrast to thin Polyakov loops investigated earlier.

33. **Search for Chiral Fermion Actions on Non-Orthogonal Lattices**

Presenter: Michael Buchoff — University of Maryland, College Park

Time: Monday, 5:00 **Room:** Chesapeake B

Section: Chiral Symmetry

Co-authors: Paulo Bedaque, Brian Tiburzi, and Andre Walker-Loud

Abstract:

The graphene inspired lattices recently proposed by Creutz and Borici have sparked interest in the use of non-orthogonal lattices in lattice QCD. These lattices have the desired chiral symmetry and have the minimal doubling required by the Nielsen-Ninomiya no-go theorem. However, due to the lack of discrete symmetries, radiative corrections in the gauged lattice theory will lead to the generation of unwanted relevant and marginal operators. In this talk, the viability of these graphene inspired lattices, as well as other non-orthogonal lattices, will be discussed.

34. **Stochastic All-to-All Propagators for Baryon Correlators**

Presenter: John Bulava — Carnegie Mellon University

Time: Thursday, 9:10 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: Robert Edwards, Colin Morningstar

Abstract:

The effectiveness of various dilution schemes in the evaluation of baryonic two-point functions is compared. The error of a representative set of observables as a function of the number of Dirac matrix inversions is used as a basis for comparison. To achieve an equivalent reduction in error, we demonstrate that an increase in the number of dilution projectors on a single noise source usually requires fewer inversions than the use of multiple noise sources. This exploratory study was performed on 100 quenched gauge configurations and will be applied to the calculation of low-lying hadron spectra.

35. **Update on doubly heavy meson spectroscopy**

Presenter: Tommy Burch — University of Utah

Poster Session: B **Section:** Hadron Spectroscopy

Co-authors: MILC and Fermilab Collaborations

Abstract:

We present an update on the heavy meson mass spectrum resulting from clover-Wilson heavy quarks and antiquarks on $N_f = 2 + 1$ improved staggered configurations. Emphasis is placed on using ratios of correlators to resolve spin splittings, in particular those of P-wave charmonium states (χ_{cJ} and h_c).

36. **Modeling Pions on the Lattice: A Poor Man's QCD**

Presenter: DJ Cecile — Duke University

Time: Monday, 6:20 **Room:** Chesapeake B

Section: Chiral Symmetry

Co-authors:

Abstract:

Current lattice QCD calculations are not able to study pions at realistic masses due to algorithmic difficulties. Instead, lattice studies are confined to unphysically large pion masses, and Chiral Perturbation Theory (ChPT) is used to extrapolate the lattice results to the phenomenological regime. An outstanding problem is to determine the range of quark masses where ChPT is valid and to understand the nonperturbative physics that may cause it to break down. In this talk, I will present a lattice model of pions that we have developed to investigate these problems. This model has the same symmetries as two flavor QCD, and very efficient algorithms can be developed to study it at small quark masses and even in the chiral limit directly. I will discuss this algorithm and present the results of our studies. In particular, I will show how our model is matched with the finite size scaling predictions of ChPT and how our model predicts that the σ-resonance can cause the chiral expansion to break down.

37. **QCD Thermodynamics from Domain Wall Fermions**

Presenter: Michael Cheng — Columbia University

Time: Tuesday, 4:10 **Room:** Chesapeake A

Section: Nonzero Temperature and density

Co-authors: RBC and HotQCD Collaborations

Abstract:

We present our recent studies of the pseudo-critical temperature, T_c, of QCD using domain wall fermions. Domain wall fermions have the advantage that they preserve exact $SU(2)$ chiral symmetry at finite lattice spacing in the limit that $L_s \to \infty$. The RBC Collaboration has performed a set of dynamical calculations at $L_s = 32$ and $N_t = 8$ using the Iwasaki gauge action with two light quarks ($m_l a = 0.003$) and one strange quark ($m_s a = 0.037$). A clear signal for the crossover transition can be seen in the light chiral susceptibility, as well as in the Wilson line. However, at $L_s = 32$, the residual chiral symmetry breaking is not yet fully under control. We also present preliminary results from the HotQCD Collaboration with $N_t = 8$ and $L_s = 96$, where the effects of the residual chiral symmetry breaking are reduced compared to $L_s = 32$.

38. **Recent Developments in Dual Lattice Algorithms**

Presenter: Wade Cherrington — University of Western Ontario

Time: Wednesday, 3:30 **Room:** Chesapeake B

Section: Algorithms and Machines

Co-authors: J. Daniel Christensen

Abstract:

We review recent progress in numerical simulations with dually transformed SU(2) LGT. We present algorithms and results for SU(2) pure Yang Mills in D=3 and D=4, validated against conventional simulations. We show how a local dynamical fermion algorithm can naturally be incorporated into the dual framework, and describe how the dual simulations give access to observables that provide a novel, gauge-invariant perspective on confinement. We conclude with the prospects for this technique and progress on overcoming some of the current challenges we've encountered with this method, specifically critical slowing down and the sign problem.

39. **Topological susceptibilty in 2+1-flavor lattice QCD with overlap fermion**

Presenter: Ting-Wai Chiu — National Taiwan University

Time: Tuesday, 2:30 **Room:** Chesapeake B

Section: Chiral Symmetry

Co-authors: S. Aoki, S. Hashimoto, T.H. Hsieh, H. Matsufuru, J. Noaki, T. Onogi, N. Yamada (JLQCD+TWQCD Collaborations)

Abstract:

We determine the topological susceptibility χ_t in 2+1-flavor QCD simulations with dynamical overlap fermions on a $16^3 \times 48$ lattice at lattice spacing ~ 0.11 fm. Five (up and down) sea quark masses m_q are taken in the range $m_s/6$ to m_s, where m_s is the physical strange quark mass. The χ_t is extracted on a fixed topological sector from a plateau (at large time separation) of 2- and 4-point time-correlation functions of the flavor-singlet pseudoscalar meson (η'), which arises from the finite size effect due to fixed topology.

40. **Calculating the light by light contribution to the muon anomalous magnetic moment using lattice QED**

Presenter: Saumitra Chowdhury — University of Connecticut

Time: Friday, 5:40 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors: Thomas Blum, Masashi Hayakawa, Taku Izubuchi, Norikazu Yamada, Takeshi Yamazaki

Abstract:

We report on an attempt to calculate the light by light contribution to the muon anomalous magnetic moment in QED, using lattice techniques, as a first but significant step toward computing the analogous hadronic contribution. We use domain wall fermions on quenched non-compact QED configurations. The method is discussed in detail, and preliminary results are presented. A signal is not obtained with the limited statistics obtained so far. We discuss prospects for improving the statistics to obtain a non-zero result.

41. **Chiral perturbation theory, $K \to \pi\pi$ decays and 2+1 flavor domain wall QCD**

Presenter: Norman Christ — Columbia Univeristy

Time: Monday, 3:30 **Room:** Tidewater B

Section: Weak Decays and Matrix Elements

Co-authors: Shu Li (RBC and UKQCD Collaborations)

Abstract:

We present a calculation of the low energy constants describing the real and imaginary parts of the $K \to \pi\pi$ decay amplitudes A_0 and A_2. Leading and next leading order chiral perturbation theory is used and its applicability assessed. A combination of statistical and systematic errors limits the precision of the results. The apparent limitations of chiral perturbation theory raise doubts about the accuracy of a possible extrapolation to physical $K \to \pi\pi$ kinematics.

42. **The removal of critical slowing down**

Presenter: Michael Clark — Boston University

Time: Tuesday, 5:40 **Room:** Chesapeake B

Section: Algorithms and Machines

Co-authors: J. Brannick, R. C. Brower, T. A. Manteuffel, S. F. McCormick, J. Osborn, C. Rebbi

Abstract:

We present results from our adaptive multigrid algorithm applied to the Wilson-Dirac operator in 4 dimensions. The key behind the success of the algorithm is an adaptive projection onto the coarse grids that preserves the near null space of the operator. The resulting algorithm has weak dependence on the gauge coupling and exhibits extremely mild critical slowing down in the chiral limit.

43. **Light-Meson Two-Photon Decays in Full QCD**

Presenter: Saul Cohen — Jefferson Lab

Time: Thursday, 9:50 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: Huey-Wen Lin, Jozef Dudek, Robert Edwards

Abstract:

I present a study of two-photon decays of light mesons, focusing on the neutral pion decay. This important process highlights the effects of the axial anomaly in QCD but has been little studied on the lattice. By applying the Lehmann- Symanzik-Zimmermann (LSZ) reduction formula, we reconstruct the electromagnetic matrix elements from three-point vector- vector Green functions calculated on 2+1-flavor isotropic clover lattices.

44. $O(a^2)$ **corrections to the fermion propagator and fermion bilinears**

Presenter: Martha Constantinou — University of Cyprus

Time: Monday, 2:50 **Room:** Tidewater A

Section: Standard Model Parameters and Renormalization

Co-authors:

Abstract:

We present the corrections to the fermion propagator, to SECOND ORDER in the lattice spacing a, in 1-loop perturbation theory. The fermions are described by the clover action and for the gluons we use a 3-parameter family of Symanzik improved actions. Our calculation has been carried out in a general covariant gauge. The results are provided as a polynomial of the clover parameter $c_{\rm SW}$, and are tabulated for 10 popular sets of the Symanzik coefficients (Plaquette, Tree-level Symanzik, Iwasaki, TILW and DBW2 action).

We also study the $O(a^2)$ corrections to matrix elements of fermion bilinear operators that have the form $\bar{\Psi}\Gamma\Psi$, where Γ denotes all possible distinct products of Dirac matrices. The terms of $O(a^2)$ can be used to specify the required modifications of the fermion operators in order to achieve $O(a^2)$ improvement.

Our results are applicable also to the case of twisted mass fermions.

45. **Proton lifetime bounds from chirally symmetric lattice QCD**

Presenter: Paul Cooney — RBC-UKQCD collaboration

Time: Friday, 3:10 **Room:** Tidewater A

Section: Weak Decays and Matrix Elements

Co-authors:

Abstract:

We present results for the matrix elements relevant for proton decay in Grand Unified Theories (GUTs). The calculation is performed at a fixed lattice spacing $a^{-1} = 1.73(3)$ GeV using 2+1 flavors of domain wall fermions on lattices of size $16^3 \times 32$ and $24^3 \times 64$ with a fifth dimension of length 16. We use the indirect method which relies on an effective field theory description of proton decay, where we need to estimate the low energy constants, α and β. We relate these low energy constants to the proton decay matrix elements using leading order chiral perturbation theory. These can then be combined with experimental bounds on the proton lifetime to bound parameters of individual GUTs.

46. **A test of first order scaling in $N_f = 2$ QCD: a progress report**

Presenter: Guido Cossu — Dipartimento di Fisica and INFN, Pisa

Time: Friday, 2:30 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: C. Bonati, M. D'Elia, A. Di Giacomo, C. Pica

Abstract:

We present the status of our analysis on the order of the finite temperature transition in QCD with two flavors of degenerate fermions. Our new simulations on large lattices support the hypothesis of the first order nature of the transition, showing a two state signal. We will discuss the implications and the next steps in our analysis.

47. **Local chiral fermions**

Presenter: Michael Creutz — Brookhaven National Lab

Poster Session: B **Section:** Chiral Symmetry

Abstract:

Borici's construction of minimally doubled chiral fermions builds on a linear combination of two unitarily related naive fermion actions. Being strictly local, extremely efficient numerical implementation should be possible. The resulting system is symmetric under the subgroup of the hypercubic group that preserves a major hypercube diagonal. The symmetry includes both parity even and odd transformations, but allows for an anisotropy to appear at finite lattice spacing.

48. **Solutions to the Ginsparg-Wilson equation**

Presenter: Nigel Cundy — University of Regensburg

Time: Monday, 5:40 **Room:** Chesapeake B

Section: Chiral Symmetry

Co-authors:

Abstract:

I construct a general form for Ginsparg-Wilson Dirac operators, of which the overlap operator and the solutions previously found by Kerler and Fujikawa are specific examples. I demonstrate analytically and numerically that both the Dirac operators and the Ginsparg-Wilson equation. I discuss the relationship between overlap type chiral fermions and fixed point fermions.

49. **Charm physics with HISQ quarks**

Presenter: Christine Davies — University of Glasgow

Time: Wednesday, 2:50 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: HPQCD collaboration

Abstract:

I will give an update on our charm and light physics results using the Highly Improved Staggered Quark action for the valence quarks on MILC configurations. This includes an analysis of heavyonium and heavy-light hyperfine splittings and a discussion of the associated systematic errors. These calculations act as a further test of our recent very accurate D and D_s decay constant results using HISQ quarks.

50. **The curvature of the critical surface $(m_{ud}, m_s)^{crit}(\mu)$, on finer and bigger lattices**

Presenter: Philippe de Forcrand — ETH Zurich and CERN

Time: Friday, 3:50 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: Owe Philipsen

Abstract:

At zero chemical potential μ, the order of the temperature-driven transition depends on the quark masses $m_{u,d}$ and m_s. Along a line in the $(m_{u,d}, m_s)$ plane, this transition is second order. When the chemical potential is turned on, this critical line spans a surface, whose curvature at $\mu = 0$ can be determined without any sign or overlap problem. Our past measurements on $N_t = 4$ lattices suggest that the region of quark masses for which the transition is first order *shrinks* when μ is turned on, which makes a QCD chiral critical point at small μ/T unlikely. We present our first $N_t = 6, N_f = 3$ results, as well as $N_t = 4, N_f = 2 + 1$ results obtained on the computing Grid.

51. **On Scale Determination in Lattice QCD with Dynamical Quarks**

Presenter: Asit K De — Saha Institute, Kolkata

Time: Monday, 2:30 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: A. Harindranath, Jyotirmoy Maiti

Abstract:

Dependence of a/r_c (inverse Sommer parameter in units of lattice spacing a) on am_q (quark mass in lattice units) has been observed in all lattice QCD simulations with sea quarks including the ones with improved actions. How much of this dependence is a scaling violation has remained an intriguing question. Our approach has been to investigate the issue with an action with known lattice artifacts, i.e., the standard Wilson quark and gauge action with $\beta = 5.6$ and 2 degenerate flavors of sea quarks on $16^3 \times 32$ lattices. In order to study in detail the sea quark mass dependence, measurements are carried out at eight values of the PCAC quark mass values am_q from about 0.07 to below 0.015. Though scaling violations may indeed be present for relatively large am_q, a consistent scenario at sufficiently small am_q seems to emerge in the mass-independent scheme where for a fixed β, $1/r_0$ and $\sqrt{\sigma}$ have linear dependence on m_q as physical effects similar to the quark mass dependence of the rho mass. We present evidence for this scenario and accordingly extract the lattice scale ($a = 0.08041(12)(77)$ fm, $a^{-1} = 2.454(4)(23)$ GeV) by chiral extrapolation to the physical point.

52. **Exploring the phase diagram of sextet QCD**

Presenter: Thomas DeGrand — University of Colorado

Time: Friday, 2:50 **Room:** Chesapeake C

Section: Applications beyond QCD

Co-authors: Yigal Shamir, Ben Svetitsky

Abstract:

As a follow up to the previous talk about the beta function of the theory of N_c=3 gluons and N_f=2 symmetric representation (clover) fermions, I'll describe our explorations of the beta-kappa plane, away from the massless limit. Our simulations are mostly done on lattices of length$L = 8$ and 12. The $N_t = 8$ confinement-deconfinement transition is separated from the crossover line for chiral restoration and both occur at pi to rho mass ratios near unity. The behavior of the theory at small quark mass has us puzzled (so far).

53. **Spectrum of 4d N=1 SYM on the lattice with light dynamical gluinos**

Presenter: Kamel Demmouche — Institute fuer Theoretische Physik, University of Muenster

Poster Session: A **Section:** Applications beyond QCD

Co-authors: F. Farchioni, A. Ferling, I. Montvay and G. Muenster

Abstract:

We perform Monte Carlo investigations of the 4d N=1 supersymmetric Yang-Mills (SYM) theory on the lattice with dynamical gluinos in the adjoint representation of the SU(2) gauge group. The motivation is the determination of the mass spectrum of the low-lying bound states of the theory. To this aim, we use the lattice regularisation to investigate the non-perturbative properties of the theory. These bound states are expected to form two supermultiplets consisting of gluinoballs, glueballs and gluino-glueballs. We adopt the Wilson discretization of the action, which explicitly breaks SUSY and chirality at finite lattice spacing. At gauge coupling $\beta = 2.3$, we analyzed $16^3 \cdot 32$ lattices at three values of the gluino mass ($\kappa = 0.1955, 0.196, 0.1965$). The critical gluino mass, where the restoration of chiral symmetry and the superymmetry is expected in the continiuum limit, is estimated to be $\kappa_{cr} \simeq 0.1969$. The two-step multi-bosonic (TSMB) Monte Carlo algorithm is used for the dynamical gluinos. Some features of a novel Polynomial-Hybrid-Monte-Carlo (PHMC) implimentation are also discussed.

54. **Multi-meson States in Lattice QCD**

Presenter: William Detmold — University of Washington

Time: Tuesday, 2:30 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: NPLQCD collaboration

Abstract:

The ground-state energies of systems containing up to twelve π^+'s or K^+'s are computed in dynamical, mixed-action lattice QCD. Clean signals are seen for each ground state, allowing for a precise extraction of both the two body scattering lengths and three-body interaction from a correlated analysis of systems containing different numbers of mesons. The pion (kaon) results allow investigation of the density dependence of the isospin (strangeness) chemical potential for these systems which is found to agree well with the theoretical expectations of leading order chiral perturbation theory. The isospin chemical potential is found to receive a substantial contribution from the $\pi^+\pi^+\pi^+$-interaction at the lighter pion masses studied.

55. **The physics of eight flavours**

Presenter: Albert Deuzeman — University of Groningen

Time: Tuesday, 6:20 **Room:** Chesapeake C

Section: Applications beyond QCD

Co-authors: Maria Paola Lombardo, Elisabetta Pallante

Abstract:

When the flavour content of QCD is increased sufficiently, the theory develops a non-trivial infra red fixed point. Thus, for a number of flavours above a certain critical value, but not yet so high that asymptotic freedom is lost, QCD becomes a conformal field theory. The location of the lower limit of this conformal window has not yet been unequivocally determined. Using an improved lattice action, and exploiting modern algorithms allowing for larger lattices and lower quark masses, we have shown that the theory of QCD with eight flavours has a strong coupling phase in which chiral symmetry is broken. We present proof that the accompanying transition is thermal in nature and as a consequence, the conformal window of QCD can only start afterwards, corroborating recent analytical studies at the expense of older results.

56. **GPU computing for 2-d spin systems: CUDA vs OpenGL**

Presenter: Francesco Di Renzo — University of Parma and INFN

Time: Monday, 5:00 **Room:** Chesapeake C

Section: Algorithms and Machines

Co-authors: V.Anselmi, G. Conti

Abstract:

In recent years the more and more powerful GPU's available on the PC market have attracted attention as a cost effective solution for parallel (SIMD) computing. CUDA is a solid evidence of the attention that the major companies are devoting to the field. CUDA is a hardware and software architecture developed by Nvidia for computing on the GPU. It qualifies as a friendly alternative to the approach to GPU computing that has been pioneered in the OpenGL enviroment. We discuss the application of both the CUDA and the OpenGL approach to the simulation of 2-d spin systems (XY model).

57. **Strangeness in the nucleon from lattice QCD**

Presenter: Takumi Doi — University of Kentucky

Time: Thursday, 11:40 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: Mridupawan Deka, Shao-Jing Dong, Terrence Draper, Keh-Fei Liu, Devdatta Mankame, Nilmani Mathur, Thomas Streuer

Abstract:

We study various nucleon matrix elements involving strangeness contribution, such as $\langle x \rangle_s$, $\langle x^2 \rangle_s$ and strangeness contribution to the nucleon spin. We make a comprehensive study using both the quenched lattice calculation with Wilson fermion and full QCD lattice calculation with N_f=2+1 clover fermion.

58. **The Charmed Strange Mesons from Lattice OCD with Overlap Fermion**

Presenter: Shao-Jing Dong — Department of physics and Astronomy, University of Kentucky

Time: Wednesday, 2:30 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: Keh Fei Liu

Abstract:

The charmed-strange meson spectrum are calculated on a quenched lattice. The charm and strange quark propagators are calculated on the same lattice with the same overlap fermion action. We present results on the scalar and axial meson masses and discuss their relevance to recently discovered D(s0)*(2317) and D(s1)*(2460).

59. **Partially quenched study of strange baryon with $N_f = 2$ twisted mass fermions**

Presenter: Vincent Drach — LPSC

Time: Thursday, 8:50 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: J. Carbonell, M. Brinet, R. Baron, P.Guichon, O. Pene, C. Alexandrou, T. Korzec, G. Koutsou, C. Urbach, E. Pallante , S. Reker

Abstract:

We present results on the mass of the baryon Octet and Decuplet using two flavors of light dynamical twisted mass fermions. The strange quark mass is fixed to its physical value from the kaon sector in a partially quenched set up. Calculations are performed for light quark masses corresponding to pion mass in the range 300-500 MeV and lattice sizes of 2.2 fm and 3 fm. We check for cut-off effects by evaluating the baryon masses at three different lattice spacings.Results from the baryonic sector allow for an independent determination of the strange quark mass. This study allow us to check hierarchy of masses, isospin symmetry and low energy theorem in this sector for all pion masses. Different extrapolations to the physical point are studied.

60. **Light scalar mesons in 2+1 flavor full QCD**

Presenter: Terrence Draper — University of Kentucky

Poster Session: A **Section:** Hadron Spectroscopy

Co-authors: Takumi Doi, Keh-Fei Liu, Devdatta Mankame, Nilmani Mathur,

Abstract:

We study the a_0 and K_0^* light scalar mesons in 2+1 flavor full QCD. Particular attention is paid to fitting excited states, with an eye toward determining whether scattering states are revealed. An ulimate goal will be to see how dynamical quarks affect the picture outlined with an earlier quenched study using overlap fermions, namely, that it is the $a_0(1450)$, not the $a_0(980)$, which is the lowest $q\bar{q}$ scalar iso-vector state.

We use the 2+1 flavor full QCD configurations (with renormalization-group improved gauge action and non-perturbatively O(a)-improved clover quark action) provided by CP-PACS+JLQCD. The lattice size is $16^3 \times 32$ with lattice spacing ~ 0.12 fm. We use valence quark masses which match the sea quark masses, with pion masses in the range $\sim 600 - 800$ MeV.

We use the Sequential Empirical Bayes Method, a constrained-curve fitting algorithm, to fit the ground and some excited states of the local-local correlation functions. This is feasible by using very high statistics; for each of the 800 configurations, we use 32 different delta-function sources (requiring 32 different valence quark matrix inversions) well separated in space and time.

61. **f_K/f_π in full QCD**

Presenter: Stephan Durr — NIC, FZJ/DESY

Time: Monday, 4:10 **Room:** Tidewater B

Section: Weak Decays and Matrix Elements

Co-authors: entire Budapest-Marseille-Wuppertal collaboration

Abstract:

We determine the ratio f_K/f_π in QCD with $N_f = 2 + 1$ dynamical flavors, based on a series of lattice calculations with three different couplings, large volumes and a simulated pion mass reaching down to about 190 MeV. Following Marciano's suggestion, the result is used to give an updated value of the CKM matrix element $|V_{\rm us}|$.

62. **Three Flavor Anisotropic Clover Fermions**

Presenter: Robert Edwards — Jefferson Lab

Time: Monday, 2:50 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: Balint Joo, Huey-Wen Lin

Abstract:

We present results for the parameter tuning of three flavors of anisotropic clover fermions. Properties of the algorithm performance are also described. The subsequent gauge generation of these lattices is part of a larger program to determine the highly excited state hadron spectrum of QCD.

63. **Investigation of the η'-η_c-mixing with improved stochastic estimators**

Presenter: Christian Ehmann — Universität Regensburg

Poster Session: B **Section:** Hadron Spectroscopy

Co-authors: Gunnar Bali

Abstract:

A reliable lattice calculation of charmonium S-wave fine splittings is still a very challenging spectroscopy problem. The situation is complicated by the flavour-singlet nature of charmonia. Possible effects from $c\bar{c}$ annihilation diagrams have been studied previously, with inconclusive results. Here we extend the investigation to also include mixing effects with other pseudoscalar flavour singlet states, in particular with the η' meson, in unprecedented accuracy.

We employ improved stochastic all-to-all propagator techniques (including new methods) to calculate the diagrams that appear within the mixing matrix. The runs are initially performed on $N_f = 2$ $16^3 \times 32$ configurations with the non-perturbatively improved Clover-Wilson action, both for valence and sea quarks.

64. **Numerical simulation of N=1 supersymmetric Yang-Mills theory**

Presenter: Michael Endres — Columbia University

Time: Monday, 5:00 **Room:** Tidewater A

Section: Applications beyond QCD

Co-authors:

Abstract:

We present results from a lattice study of SU(2) color, N=1 supersymmetric Yang-Mills theory using domain wall fermions. Supersymmetry in this particular lattice formulation is expected to emerge accidentally in the continuum and chiral limits, without any fine tuning of operators. Preliminary results for the static quark potential, chiral condensate and spectrum–a potential indicator of supersymmetry restoration–will be presented and discussed.

65. **The curvature of the QCD phase transition line**

Presenter: Gergely Endrodi — Eotvos University, Budapest

Time: Friday, 2:50 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: Zoltan Fodor, Sandor Katz, Kalman Szabo

Abstract:

We determine the curvature of the phase transition line in the mu-T plane through an analysis of various observables, including the Polyakov loop, the quark number susceptibilities and the susceptibility of the chiral condensate. The second derivative of these quantities with respect to mu was calculated. The mesurements were carried out on N_t =4,6,8 and 10 lattices generated with a Symanzik improved gauge and stout-link improved 2+1 flavour staggered fermion action using physical quark masses.

66. **Topological susceptibility in the SU(3) random vortex world-surface model**

Presenter: Michael Engelhardt — New Mexico State University

Time: Monday, 5:20 **Room:** Tidewater B

Section: Vacuum Structure and Confinement

Co-authors:

Abstract:

The topological charge is constructed for SU(3) center vortex world-surfaces composed of elementary squares on a hypercubic lattice. In distinction to the SU(2) case investigated previously, it is necessary to devise a proper treatment of the color structure at vortex branchings, which arise in the SU(3) case, but not for SU(2). The construction is used to evaluate the topological susceptibility in the random vortex world-surface model of infrared Yang-Mills dynamics. Results for the topological susceptibility are reported as a function of temperature, including both the confined as well as the deconfined phase.

67. **Lattice QCD determination of patterns of excited baryon masses**

Presenter: Eric Engelson — University of Maryland

Time: Tuesday, 2:50 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: J. Bulava, R. G. Edwards, G. T. Fleming, B. Joo, K. J. Juge, A. Lichtl, H.-W. Lin, N. Mathur, C. Morningstar, D. G. Richards and S. J. Wallace

Abstract:

he low-lying spectrum of masses for I=1/2 baryon states is calculated on anisotropic, $N_f = 2$ lattices using the variational method. Patterns of low-lying baryon masses distributed over the irreducible representations of the double-covered octahedral group are obtained. Matrices of correlation functions are calculated based on irreducible baryon operators that incorporate smearing of the quark and gluon fields. This work uses similar methods for $N_f = 2$ QCD as have been used in quenched QCD to determine the patterns of low-lying baryon masses.

68. **A determination of the B_s^0 and B_d^0 mixing matrix elements using 2+1 lattice QCD**

Presenter: Richard Evans — University of Illinois at Urbana-Champaign

Time: Friday, 4:10 **Room:** Tidewater A

Section: Weak Decays and Matrix Elements

Co-authors: Aida X. El-Khadra, Elvira Gamiz

Abstract:

We report our results for the matrix elements relevant for the analysis of $B^0 - \bar{B}^0$ mixing using the Asqtad (light quark) and Fermilab (heavy quark) actions. We performed the calculation on MILC ensembles at three different lattice spacings, and use staggered chiral perturbation theory to perform the extrapolations to the physical light quark masses as well as to the continuum. After discussing our systematic error analysis we present results for $f_{B_q}^2 m_{B_q}^2 B_{B_q}$, B_{B_q}, as well as for the ratios $\xi^2 = f_{B_s}^2 B_{B_s}/f_{B_d}^2 B_{B_d}$, B_{B_s}/B_{B_d}.

69. **Hadron spectrum of QCD with one quark flavor**

Presenter: Federico Farchioni — University of Muenster, Germany

Time: Thursday, 11:00 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: I. Montvay, G. Muenster, E.E. Scholz, T. Sudmann, J. Wuilloud

Abstract:

The latest results of an ongoing project for the lattice simulation of QCD with a single quark flavor are presented. The Symanzik tree-level-improved Wilson action is adopted in the gauge sector and the (unimproved) Wilson action for the fermion. Results from new simulations with one step of Stout smearing ($\rho = 0.15$) in the fermion action are discussed. The one-flavor theory is simulated by a polynomial hybrid Monte Carlo algorithm (PHMC) at $\beta = 4.0$ corresponding to $a = 0.13\,\mathrm{fm}$, on $16^3 \cdot 32$ and $24^3 \cdot 48$ lattices; the box-size is $L \simeq 2\,\mathrm{fm}$ and $L \simeq 3\,\mathrm{fm}$, respectively. Previous results were obtained on coarser $12^3 \cdot 32$ lattices at $\beta = 3.8$ corresponding to $a = 0.19\,\mathrm{fm}$. At the lightest simulated quark mass the (partially quenched) pion mass is $\simeq 300$ MeV. New methods for the computation of the fermion determinant sign to be included in the gauge averages, relying on the analysis of the complex Wilson-Dirac spectrum, are investigated. The masses of the lightest bound states are computed, including the pseudoscalar η and the scalar σ meson, the scalar glueball 0^{++} and the Δ^{++} baryon. Results are discussed in view of relics of SUSY in the mass spectrum expected from a large N_c orientifold equivalence with the $\mathcal{N}$=1 Super-Yang-Mills theory.

70. **The Eightfold Way and Confinement from Dynamical First Principles in Strongly Coupled Lattice QCD**

Presenter: Paulo A. Faria da Veiga — ICMC, University of Sao Paulo, Sao Carlos (Brazil)

Time: Friday, 5:20 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors: Michael O'Carroll and A. Francisco Neto

Abstract:

Using the functional integral formalism in an imaginary time formulation of lattice QCD, with three quark flavors and strong coupling, we obtain the 1-particle spectrum exactly and validate the Gell-Mann and Ne'eman's Eightfold Way using the QCD dynamics. A decoupling of temporal hyperplane method unveils the hadron excitations needed to define fundamental 2-point correlations. Using spectral representations for the energy-momentum operators and a Feynman-Kac formula, we relate isolated singularities of the 2-point functions with the 1-particle spectrum. An exact determination of these singularities allows us to obtain the particle dispersion curves and convergent expansions for the hadron masses to all orders in the hopping parameter and the gauge coupling. We obtain a mass splitting between the baryon flavor octet and decuplet, and between the flavor pseudo-scalar and vector mesons as well. We do not see a splitting between the meson spin singlet and octet. A correlation subtraction method allows us to show the hadron spectrum is the only energy-momentum spectrum up to near the 2-meson threshold. This proves confinement up to near this energy threshold. The exact determination of the 1-particle spectrum is a necessary step to go up in the spectrum and look for bound states. Our spectral methods allow us to do this task.

71. **Tuning improved anisotropic actions in lattice perturbation theory**

Presenter: Justin Foley — Carnegie Mellon University

Time: Monday, 2:30 **Room:** Tidewater A

Section: Standard Model Parameters and Renormalization

Co-authors: Colin Morningstar

Abstract:

We discuss the tuning of the anisotropic clover action and Symanzik-improved gauge action in lattice perturbation theory. The fermion action is constructed from stout-smeared spatial links, which complicates the calculation considerably. In addition, the full quark-mass dependence of the action parameters is included in this study. We present results for the fermion and gauge aspect ratios and tadpole coefficients for varying bare aspect ratios, quark masses, and smearing parameters. We consider the optimal choice for the smearing parameters given the perturbative data. Finally, we present a progress report on the calculation of the O(a) improvement coefficients in the quark action.

72. **Non-perturbative quark mass dependence in the heavy-light sector of two-flavour QCD**

Presenter: Patrick Fritzsch — University of Muenster, Institute for Theoretical Physics

Time: Thursday, 9:50 **Room:** Chesapeake C

Section: Standard Model Parameters and Renormalization

Co-authors: Jochen Heitger, Rainer Sommer

Abstract:

We determine the non-perturbative heavy quark mass dependence of heavy-light meson observables in the continuum limit of finite-volume two-flavour lattice QCD. These observables, which are derived from heavy-light Schroedinger functional correlation functions and computed over a range of renormalization group invariant heavy quark masses from about 1.5 to 9 GeV, allow for a quantitative comparison with the predictions of HQET and are of practical relevance for solving renormalization problems in HQET non-perturbatively by a matching to QCD in finite volume.

73. **Revisiting strong coupling QCD at finite baryon density and temperature**

Presenter: Michael Fromm — ETH Zürich

Time: Wednesday, 2:30 **Room:** Tidewater B

Section: Nonzero Temperature and density

Co-authors: Philippe de Forcrand

Abstract:

We employ the idea of reformulating the strong coupling QCD partition function with one species of staggered fermions in terms of polymers (MDP approach). In this representation and parameter region ($\beta_{\mathrm{Gauge}} = 0$) the sign problem was shown to be milder. Using now standard algorithmic techniques we address questions of physical interest such as the mass spectrum for the lightest hadrons (for finite staggered quark mass and in the chiral limit) or the nature of the chiral phase transition for varying quark mass.

74. **Characteristics of the Dirac eigenvalue distribution in dense two-color QCD**

Presenter: Kenji Fukushima — Yukawa Institute for Theoretical Physics

Time: Thursday, 8:50 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors:

Abstract:

We exposit the eigenvalue distribution of the lattice Dirac operator in two-color QCD. We explicitly calculate the eigenvalues in the presence of finite quark chemical potential μ for a given random gauge configuration on the finite-volume lattice assuming the strong coupling limit. We evaluate the chiral and diquark condensates through the spectral density and clarify the characteristic spectral change corresponding to the phase transition. We exhibit the numerical results implemented by the starggered fermion formalism and confirm that our results agree quite well with the mean-field estimate quantitatively. We then exploit our method in the case of the Wilson fermion formalism with two flavors. We finally elaborate the possibility of the Aoki (parity-flavor broken) phase and conclude from the point of view of the spectral density that the artificial pion condensation is absent in strong-coupling two-color QCD.

75. **Overlap solution for Weyl fermions**

Presenter: Christof Gattringer — University of Graz

Time: Wednesday, 4:10 **Room:** Tidewater A

Section: Chiral Symmetry

Co-authors: Markus Pak

Abstract:

We present an overlap solution for Weyl fermions on the lattice. The construction solves two Ginsparg-Wilson type of equations that were obtained by Hasenfratz and von Allmen through a particular block spin transformation. Our solution implements Weyl fermions on the lattice without artefacts.

76. **Exact Chiral Fermions and Finite Density on Lattice**

Presenter: Rajiv Gavai — Tata Institute, Mumbai

Time: Tuesday, 2:50 **Room:** Chesapeake A

Section: Nonzero Temperature and density

Co-authors: Debasish Banerjee and Sayantan Sharma

Abstract:

Any μ^2-divergence is shown analytically to be absent for a class of actions for Overlap and Domain Wall fermions with nonzero chemical potential. All such actions are, however, shown to violate the chiral invariance. While the parameter M of these actions can be shown to be irrelevant in the continuum limit, as expected, it is shown numerically that the continuum limit can be reached with relatively coarser lattices for $1.5 \leq M \leq 1.6$.

77. **Higgs mass bounds from a chirally invariant lattice Higgs-Yukawa model with overlap fermions**

Presenter: Philipp Gerhold — Humboldt-University Berlin, Germany

Time: Friday, 4:10 **Room:** Chesapeake C

Section: Applications beyond QCD

Co-authors: Karl Jansen, Jim Kallarackal

Abstract:

Higgs mass bounds are available from perturbative calculations in the Higgs-Fermion-Sector of the Standard Model. It is, however, a disputed question whether the arguments used in these perturbative calculations are indeed valid. Furthermore, lattice calculations performed in the past aiming at the determination of Higgs mass bounds from Higgs-Yukawa models were blocked by the lack of chiral symmetry at that time.

To overcome these shortcomings we consider a chirally invariant lattice Higgs-Yukawa model based on the Neuberger overlap operator, reproducing the Higgs-fermion coupling structure of the Standard Model. Here, we present results from our PHMC-simulations, allowing to determine upper and lower Higgs mass bounds from this model. In particular we give results on the cutoff dependence of the Higgs mass bounds.

78. **Domain Wall Fermion Lattice Super Yang-Mills**

Presenter: Joel Giedt — Rensselaer Polytechnic Institute

Time: Monday, 5:20 **Room:** Tidewater A

Section: Applications beyond QCD

Co-authors: Richard Brower, Simon Catterall, George T. Fleming, Pavlos Vranas

Abstract:

We discuss the status of gluino condensation and other results using RPI's BlueGene/L cluster, part of the CCNI supercomputing complex. This Domain Wall Fermion computation will give, for the first time, continuum extrapolations of important quantities such as the condensate and string tension.

79. **Confining string beyond the free approximation: the case of random percolation**

Presenter: Pietro Giudice — Universita' di Torino and INFN sez. di Torino

Time: Friday, 2:50 **Room:** Tidewater B

Section: Vacuum Structure and Confinement

Co-authors: Ferdinando Gliozzi, Stefano Lottini

Abstract:

The random percolation model can be view as the dual of a well defined confining gauge theory; because it is simple to simulate this theory, having no dynamics at all, it is possible to study the properties of the flux tube with a very high precision and we show it is possible to describe it by the effective string picture. Our results are lattice regularization independent, therefore they are well defined also in the continuum limit, and for the first time, in a gauge theory, it was possible to determine the next-to-leading quantum corrections throughout the computation of the T^6 coefficient of the Taylor expansion of $\sigma(T)$. Furthermore, this coefficient results to be constrained to the universal ratio $T_c/\sqrt{\sigma}$.

80. **QCD equation of state at non-zero chemical potential**

Presenter: Steven Gottlieb — Indiana University

Time: Monday, 2:50 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: S. Basak, A. Bazavov, C. Bernard, C. DeTar, W. Freeman, U.M. Heller, J.E. Hetrick, J. Laiho, L. Levkova, J. Osborn, R. Sugar, D. Toussaint

Abstract:

We present our new results for the QCD equation of state at nonzero chemical potential at $N_t = 6$ and compare them with $N_t = 4$. We use the Taylor expansion method with terms up to sixth order and 2+1 flavors of asqtad quarks.

81. **Improving B physics simulations**

Presenter: Eric Gregory — University of Glasgow

Poster Session: A **Section:** Hadron Spectroscopy

Co-authors: HPQCD Collaboration

Abstract:

We give improved results for B meson masses using NRQCD b quarks and HISQ light quarks for a range of lattice spacings and sea quark masses enabling controlled extrapolation to the physical point.

82. **Vector meson form factors**

Presenter: Martin Guertler — TU Munich

Time: Thursday, 9:30 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: QCDSF

Abstract:

Electromagnetic form factors play an important role in our understanding of the hadron structure. In this contribution, we present results for the charge, magnetic and quadrupole form factors of the rho, based on QCDSF configurations with two dynamical non-perturbatively improved flavors of Wilson fermions. We extract the charge radius, magnetic moment and quadrupole moment of the rho from an extrapolation to zero momentum transfer. The results are compared to the nucleon and pion counterparts on the same configurations, and to the results by other collaborations.

83. **The EOS from simulations on BlueGene L Supercomputer at LLNL and NYBlue**

Presenter: Rajan Gupta — Los Alamos National Lab

Time: Monday, 2:30 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: Ron Soltz and HotQCD Collaboration

Abstract:

This talk will present an update on results from the high statistics data from simulations of 2+1 flavor p4 ($N_T = 8$) and Asqtad ($N_T = 6, 8$) improved staggered fermion actions using the exact RHMC algorithm. These results are from ongoing calculations being done by the HotQCD collaboration on the BlueGene L supercomputers at LLNL and the NYBlue at BNL and represent over 100M node-hours. We will present results for the equation of state (EOS) and discuss the behavior of a variety of other observables including the Polyakov Loop, chiral and quark number susceptibility across the crossover. A case will be made that results for the EOS have reached a level of precision that they should be used in the phenomenological analysis of Relativistic Heavy Ion collisions.

84. **Finite chemical potential in $N_t = 6$ QCD**

Presenter: Sourendu Gupta — TIFR, Mumbai

Time: Tuesday, 3:50 **Room:** Chesapeake A

Section: Nonzero Temperature and density

Co-authors: R. V. Gavai

Abstract:

We examine the Taylor expansion of the baryon number susceptibility in a series in the baryon chemical potential in lattice simulations with two flavours of light dynamical staggered quarks at lattice cutoff $a = 1/6T$. From the radius of convergence of the series at various temeperatures, we bound the location of the QCD critical point to be $T^E/T_c \approx 0.94$ and $\mu_B^E/T < 1.8$. We also extrapolate various susceptibilities and linkages to finite chemical potential.

85. **Nucleon structure with partially twisted boundary conditions**

Presenter: Philipp Haegler — TU Munich

Time: Monday, 2:30 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: QCDSF/UKQCD collaboration

Abstract:

The analysis of many fundamental hadron structure observables like, e.g., charge radii, magnetic moments, and angular momentum contributions to the nucleon spin requires small but non-zero values of the momentum transfer squared, $t = q^2$. For the volumes and couplings of current lattice simulations, the lowest non-vanishing momentum components are typically $\sim$0.3 GeV and larger, thus making in general model dependent extrapolations to $t = 0$ necessary. Using the concept of partially twisted boundary conditions introduced a couple of years ago by Sachrajda and Villadoro and independently by Bedaque and Chen, we present first preliminary lattice results for the structure of the nucleon at very small values of the momentum transfer. The calculations are based on configurations generated in the framework of the QCDSF/UKQCD collaboration, with two flavours of non-perturbatively $O(a)$-improved Wilson Fermions and Wilson gluons.

86. **Heavy-light hadrons and their excitations**

Presenter: Christian Hagen — University of Regensburg

Poster Session: A **Section:** Hadron Spectroscopy

Co-authors: Tommy Burch, Christian B. Lang, Markus Limmer, Andreas Schäfer

Abstract:

We study the excitations of hadrons containing a single heavy quark. We present meson and baryon mass splittings and ratios of meson decay constants resulting from quenched and dynamical two-flavor configurations. Light quarks are simulated using the chirally-improved (CI) lattice Dirac operator. The heavy quark is approximated by a static propagator, appropriate for the b quark on our lattices ($1/a \sim 1-2$ GeV). We also include some preliminary calculations of the heavy-quark kinetic corrections to the states.

87. **Quark Propagators at the confinement and deconfinement phases**

Presenter: Masatoshi Hamada — Kyushu University

Time: Friday, 5:20 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: Hiroaki Kouno, Atsushi Nakamura, Takuya Saito, Masanobu Yahiro

Abstract:

We calculated quark propagators using quenched lattice QCD at finite temperature and studied what are different features both in the confinement and the deconfinment phases. In particular, our calculations focus quark propagators near the T_c that is the temperature of the confinement-deconfinemt phase transition defined by Polyakov loop expectation values.

88. **Maximum entropy analysis of lattice QCD correlation functions**

Presenter: Tom Harsono — George Washington University

Poster Session: B **Section:** Hadron Spectroscopy

Co-authors: Frank X. Lee

Abstract:

The application of the Maximum Entropy Method (MEM) to the analysis of lattice QCD data is discussed. We obtain information on the mass spectrum of excited states of hadrons by extracting spectral functions from correlation functions. Tests, results, and limitations of the MEM algorithm are presented. The data sets are on $20^3 \times 32$ lattices covering over 10 meson states and 20 baryon states, with each state as a function of 26 quark masses.

89. **Chiral Dynamics from valence overlap fermions in quenched QCD**

Presenter: Masayasu Hasegawa — Institute for Theoretical Physics, Kanazawa University

Time: Tuesday, 2:50 **Room:** Chesapeake B

Section: Chiral Symmetry

Co-authors: Ernst-Michael Ilgenfritz, Katsuya Ishiguro, Taku Izubuchi, Yoshiaki Koma, Yoshifumi Nakamura, Gerrit Schierholz, Tsuneo Suzuki, Volker Weinberg

Abstract:

We perform simulations keeping the Chiral symmetry by using valence overlap fermions. First we define a scalar field, a pseudoscalar field and the form of the effective Lagrangian. Then we adopt the Schwinger-Dyson equation to fix the couplings of the Lagrangian. By using these couplings, we estimate the pion mass.

90. **Epsilon regime calculations with reweighted clover fermions**

Presenter: Anna Hasenfratz — University of Colorado, Boulder

Time: Wednesday, 2:30 **Room:** Tidewater A

Section: Chiral Symmetry

Co-authors: R. Hoffmann, S. Schaefer

Abstract:

We perform fully dynamical simulations at small quark masses by reweighting in the quark mass, calculating the weight factors stochastically. This approach avoids some of the technical difficulties associated with direct simulations. We find that the weight factors fluctuate only moderately on nHYP smeared dynamical Wilson-clover ensembles, and we could successfully reweight 16^4, $(1.85\text{fm})^4$ volume configurations from $m_q \sim 20$ MeV to $m_q \sim 5$ MeV, and 24^4, $(2.77\text{fm})^4$ configurations from $m_q \sim 8$ MeV to $m_q \sim 3$ MeV quark masses, reaching the epsilon-regime. Using the pseudo-scalar and axial vector correlators we predict the low energy constants Σ and F and study their volume and mass dependence.

91. **Quark Number Susceptibilities with Domain-Wall Fermions**

Presenter: Prasad Hegde — Stony Brook University

Poster Session: A **Section:** Nonzero Temperature and density

Co-authors: Frithjof Karsch, Edwin Laermann, Stanislav Scheredin

Abstract:

Quark Number Susceptibilities have assumed significance as signals for deconfinement in QCD with light quarks. In simulations with staggered fermions, strange and light quark number susceptibility are observed to change rapidly from a small value to a large one. This implies that the carriers of baryon number as well as strangeness change from being heavy (baryons) below T_c, to light (quarks) above it.

Due to the explicit flavor symmetry breaking in calculations with staggered fermions at finite values of the cut-off the light hadron spectrum is distorted which may, in particular, influence thermodynamic calculations in the low temperature hadronic phase of QCD. Quark number susceptibilities are expected to be sensitive to such cut-off effects and the use of chiral fermions will help to understand the systematic effects that can arise in thermodynamic calculations at low temperature.

We have recently discussed cut-off effects at non-vanishing chemical potential in thermodynamic calculations that utilize different fermion formulations [1], including domain wall fermions. These considerations also apply to the calculation of quark number susceptibilities, which are second derivatives of the partition function with respect to light and strange quark chemical potentials. We discuss here the general structure of cut-off effects that arise in calculations at non-zero chemical potential and present first results from our calculation of quark number susceptibilities with domain wall fermions.

Reference:

[1] P. Hegde, F. Karsch, E. Laermann and S. Shcheredin, Lattice cut-off effects and their reduction in studies of QCD thermodynamics at non-zero temperature and chemical potential, arXiv:0801.4883 [hep-lat].

92. **Center vortex influence on the Dirac spectrum**

Presenter: Urs Heller — Physical Review D, American Physical Society

Poster Session: B **Section:** Vacuum Structure and Confinement

Co-authors: R. Höllwieser, M. Faber, J. Greensite, U.M. Heller and Š. Olejník

Abstract:

We study the influence of center vortices on the low-lying eigenmodes of the Dirac operator, in both the overlap and asqtad formulations. In particular we suggest a solution to a puzzle raised some years ago by Gattnar et al. [Nucl. Phys. B 716, 105 (2005)], who noted the absence of low-lying Dirac eigenmodes required for chiral symmetry breaking in center-projected configurations. We show that the low-lying modes are present in the staggered (asqtad) formulation, but not for overlap, and we argue that this is due to the absence of a field-independent chiral symmetry on the very rough center-projected configurations for overlap and "chirally improved' fermions. We also confirm and extend the results of Kovalenko et al. [Phys. Lett. B 648, 383 (2007)]: we find strong correlations between center vortex locations, and the scalar density of low-lying Dirac eigenmodes and find that both asqtad and overlap eigenmodes have their largest concentrations in point-like regions, expected from center vortex considerations, rather than on submanifolds of higher dimensionality.

93. **Spectrum of SU(2) gauge theory with two fermions in the adjoint representation**

Presenter: Ari Hietanen — University of Helsinki

Time: Friday, 3:30 **Room:** Chesapeake C

Section: Applications beyond QCD

Co-authors: Jarno Rantaharju, Kari Rummukainen, Kimmo Tuominen

Abstract:

We present the preliminary results of lattice simulations of SU(2) gauge theory with two Wilson fermions in the adjoint representation. Our first goal is to measure the spectrum of the theory, and then extend the computation to the coupling constant using the Schrödinger functional scheme. The main purpose of the study is to find out if the theory has an infrared fixed point, and hence could be a possible candidate for a technicolor theory

94. **The hadron spectrum in full QCD: Analysis details and final result**

Presenter: Christian Hoelbling — Universitaet Wuppertal

Time: Monday, 3:50 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: S. Durr, Z. Fodor, S. Katz, S. Krieg, T. Kurth, L. Lellouch, T. Lippert, K. Szabo, G. Vulvert

Abstract:

I will present details of the analysis of the light hadron spectrum (vector mesons, octet and decuplet baryons) in N_f=2+1 QCD. I will discuss specifics of the chiral, continuum and infinite volume extrapolations and describe our approach towards establishing reliable systematic errors, including a treatment of resonant states.

95. **Probing technicolor theories with staggered fermions**

Presenter: Kieran Holland — University of the Pacific

Time: Friday, 3:50 **Room:** Chesapeake C

Section: Applications beyond QCD

Co-authors: Zoltan Fodor, Julius Kuti, Daniel Nogradi, Chris Schroeder

Abstract:

One exciting possibility of new physics beyond the Standard Model is that the fundamental Higgs sector is replaced by a strongly-interacting gauge theory, known as technicolor. Deciding which new models have certain desirable properties is mostly determined via perturbation theory. I will discuss simulations with staggered fermions to test which candidate models are phenomenologically viable.

96. **A way to get infinite volume results on small lattices**

Presenter: Alan Horowitz — IUP

Time: Thursday, 8:50 **Room:** Tidewater A

Section: Theoretical Developments

Co-authors:

Abstract:

A general methodology is presented by which critical exponents and couplings can be calculated on lattices comprised of order 4^d sites, in any dimension d. It is essentially a generalization of the Bethe-Peierls approximation, supplemented by a constraint that enforces long-distance scaling. The method is illustrated using the 2-d Ising model, where good results are found for the exponents, and the critical coupling is less than 2% from the exact value. At this point I see no obstacles in the extension to gauge models, where hopefully good approximations to infinite volume mass spectra can be extracted.

97. **Clover improvement for stout-smeared 2+1 flavour SLiNC fermions: non-perturbative results**

Presenter: Roger Horsley — University of Edinburgh

Time: Friday, 2:50 **Room:** Auditorium

Section: Hadron Structure

Co-authors: for QCDSF/UKQCD Collaborations

Abstract:

An action is discussed which has a single iteration stout smearing or mild fat link for the hopping terms together with thin links for the clover term. (This is in an attempt to keep the fermion matrix from becoming too extended and also makes practicable lowest order perturbation theory.) Together with the (tree level) Symanzik improved gluon action this constitutes the **S** tout **Li** nk **N** on-perturbative **C** lover or SLiNC action. To cancel $O(a)$ terms the clover coefficient, c_{sw} has to be tuned. In this talk we present a non-perturbative determination of c_{sw} using the Schrödinger Functional and as a by-product the critical hopping parameter, κ_c. While for the thin link clover term we expect little change in c_{sw} as compared to previous unsmeared results, and although only a mild smearing the stout links drastically reduce κ_c to be in the neighbourhood of 1/8. Comparisons are made with lowest order perturbation results. We finally discuss to how coarse a lattice spacing this action remains viable.

98. **New Properties of the Fundamental Topological Structure**

Presenter: Ivan Horvath — University of Kentucky

Time: Thursday, 11:20 **Room:** Chesapeake C

Section: Vacuum Structure and Confinement

Co-authors: Andrei Alexandru, Thomas Streuer

Abstract:

We discuss new features of the sign-coherent topological structure of QCD vacuum and some of the associated consequences.

99. **Topological charge and its fluctuations in 2+1-flavor lattice QCD with domain-wall fermions**

Presenter: Tung-Han Hsieh — Research Center for Applied Sciences, Academia Sinica

Poster Session: A **Section:** Chiral Symmetry

Co-authors: Ting-Wai Chiu (for the TWQCD Collaboration)

Abstract:

We present the results of the topological charge and its fluctuations for the gauge configurations generated by RBC+UKQCD Collaborations using 2+1 flavors of domain wall fermions on size $16^3 \times 32$ lattice (L=1.8 fm) with length 16 in the fifth dimension at the lattice spacing of 1/a=1.73(3) GeV. From the spectral flow of the hermitian operator $\gamma_5 D_w(2+D_w)^{-1}$, we obtain the topological charge Q_t of each gauge configuration for the three ensmebles with light sea quark masses $m_q \sim 0.85m_s$, $0.59m_s$ and $0.33m_s$ (where m_s is the physical strange quark mass). From the results of Q_t, we compute the topological susceptibilty $\chi_t = \langle Q_t^2 \rangle$/volume, and the second normalized cumulant $c_4 = -(\langle Q_t^4 \rangle - 3\langle Q_t^2 \rangle^2)$/volume.

100. **Pion Physics at Finite Volume**

Presenter: Jie Hu — Duke University

Time: Wednesday, 2:50 **Room:** Tidewater A

Section: Chiral Symmetry

Co-authors: Fu-Jiun Jiang, Brian C. Tiburzi

Abstract:

The Compton scattering amplitude with zero frequency photon is proportional to the total charge squared in infinite volume, which is fixed by gauge invariance. However in finite volume those charge vertices can be modified. For demonstration we analyze the electromagnetic interaction of pions with zero frequency photon in finite volume with periodic boundary condition to one loop order using chiral perturbation theory. We construct gauge invariant single particle effective theories to explain these results which are useful for lattice QCD.

101. **Renormalized Polyakov loops in various Representations in finite Temperature SU(2) gauge theory**

Presenter: Kay Huebner — BNL

Time: Thursday, 9:10 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: Claudio Pica

Abstract:

We present results for the renormalized Polyakov loop in the fundamental and adjoint representation for the SU(2) gauge theory at finite temperature. We will discuss their scaling behavior near T_c and test Casimir scaling in the deconfinement phase. Moreover, we will compare these results to calculations for the renormalized Polyakov loops in several representations in the SU(3) gauge theory.

102. **Three-quark systems in MA and MC projected QCD**

Presenter: Hideaki Iida — Yukawa Institute for Theoretical Physics, Kyoto Univ.

Time: Monday, 5:40 **Room:** Tidewater B

Section: Vacuum Structure and Confinement

Co-authors: N.Sakumichi and H.Suganuma

Abstract:

In these years, it becomes possible to perform accurate lattice QCD calculations for the three-quark (3Q) potential [1,2,3]. In this study, using SU(3) quenched lattice QCD, we quantitatively investigate the static 3Q potential in Maximally Abelian (MA) and Maximal Center (MC) projected QCD, respectively [4]. We project SU(3) QCD into Abelian gauge theory by MA gauge fixing and MA projection. The obtained Abelian gauge theory has both electric and magnetic monopole currents, and is decomposed into two parts by Hodge decomposition: one is monopole part including only the magnetic monopole current, and the other is photon part including only the electric current. We find that both MA projected QCD and monopole part have almost the same string tension of the 3Q system as that in original SU(3) QCD, while no linear part appears in the 3Q potential in the photon part. We also examine the 3Q potential in the 4-dim. Z3 spin system obtained by MC gauge fixing and MC projection. The string tension in MC projected QCD accurately coincides with that in the monopole part. Thus, we find Abelian Dominance, Monopole Dominance, and Center Dominance for the string tension of the 3Q potential.

[1] T.T.Takahashi, H.Suganuma et al., Phys.Rev.Lett.86 (2001) 18; Phys.Rev.D65 (2002) 114509.

[2] A.Yamamoto, H.Suganuma and H.Iida, Phys.Lett.B664 (2008) 129.

[3] H.Ichie et al., Nucl.Phys.A721 (2003) 899; Phys.Rev.D70 (2004) 054506.

[4] H.Suganuma, A.Yamamoto, N.Sakumichi, T.T.Takahashi, H.Iida, and F.Okiharu, arXiv:0802.3500, Mod.Phys.Lett.A (2008).

103. **The finite-temperature phase structure of lattice QCD with twisted-mass Wilson fermions**

Presenter: Ernst-Michael Ilgenfritz — Institute for Physics, Humboldt University Berlin

Time: Friday, 3:10 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: K. Jansen, M. P. Lombardo, M. Müller-Preussker, M. Petschlies, O. Philipsen, A. Sternbeck, L. Zeidlewicz (TMFT Collaboration)

Abstract:

We discuss the finite-temperature phase structure of two flavors with a twisted-mass Wilson fermion action and with a tree-level Symanzik improved gauge field action for a temporal lattice size $N_\tau = 8$. We find an Aoki phase at small values of β. At larger values of β a rich structure emerges which is consistent with Creutz's conjecture of a cone form of the transition/crossover surface.

104. **The perturbative ghost propagator in Landau gauge from numerical stochastic perturbation theory**

Presenter: Ernst-Michael Ilgenfritz — Institute for Physics, Humboldt University Berlin

Poster Session: A **Section:** Standard Model Parameters and Renormalization

Co-authors: F. Di Renzo, H. Perlt, A. Schiller, C. Torrero

Abstract:

We present one- and two-loop results for the ghost propagator in Landau gauge calculated in numerical stochastic perturbation theory (NSPT). The one-loop results are compared with available standard lattice perturbation theory in the infinite volume limit. We discuss in detail how to perform the different necessary limits in the NSPT approach and discuss a recipe to treat logarithmic terms by introducing "finite lattice logs'. We find agreement with the one-loop result from standard lattice perturbation theory and estimate, from the non-logarithmic part of the ghost propagator in two-loop order, the unknown constant contribution to the ghost self-energy in the RI'-MOM scheme in Landau gauge. That constant vanishes within our numerical accuracy.

105. **Nuclear forces from quenched and N_f=2+1 full lattice QCD using the PACS-CS gauge configurations**

Presenter: Noriyoshi Ishii — Center for Computational Sciences, University of Tsukuba

Time: Wednesday, 3:50 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: Sinya AOKI, Tetsuo HATSUDA for PACS-CS Collaboration

Abstract:

Two of recent progress in lattice QCD approach to nuclear force are reported. (i) Together with the repulsive core, the tensor force plays an important role in the stability of heavy nuclei. It has also an important influence on nuclear structure. However, a large uncertainty is involved in phenomenological determination of the tensor force especially at short distance due to the existence of the centrifugal barrier. We have recently extended our method[1,2] to the calculation of tensor force. After explaining the method, we will present the numerical results from quenched lattice QCD, which includes the quark mass dependence of tensor force. (ii) By using the N_f=2+1 full lattice QCD gauge configurations generated by PACS-CS collaboration, we calculate (effective) central force in $^1S_0$ and $^3S_1$ channels, and tensor force. We will present our results using gauge configurations with (κ_{ud}, κ_s)=(0.13700, 0.13640) and (0.13770, 0.13640), which correspond to m_π of about 720 MeV and 300 MeV, respectively. The results possess strong repulsive core of about 3-4 GeV at short distance surrounded by weak attraction of about 30-40 MeV at medium distance.

References:

[1] N.Ishii, S.Aoki, T.Hatsuda, Phys.Rev.Lett.99,022001(2007).

[2] S.Aoki, T.Hatsuda, N.Ishii, arXiv:0805.2462[hep-ph].

106. **B meson decay constant in static approximation with domain wall fermion and perturbative $O(\alpha_s a)$ matching**

Presenter: Tomomi Ishikawa — RIKEN BNL Research Center

Time: Thursday, 10:40 **Room:** Tidewater A

Section: Weak Decays and Matrix Elements

Co-authors: for the RBC and UKQCD Collaborations

Abstract:

We discuss the perturbative $O(\alpha_s a)$ matching in the static heavy and light quark system. Even in the usage of domain wall light quarks, $O(a)$ improvement of the heavy-light operator is not negligible. We apply the matching to the calculation of f_B on $2+1$ flavor dynamical domain wall configuration.

107. **A new method of calculating the running coupling constant — numerical results**

Presenter: Etsuko Itou — YITP, Kyoto University

Time: Thursday, 9:50 **Room:** Tidewater A

Section: Theoretical Developments

Co-authors: Erek Bilgici, Antonino Flachi, Masafumi Kurachi, C.-J. David Lin, Hideo Matsufuru, Hiroshi Ohki, Tetsuya Onogi, Takeshi Yamazaki

Abstract:

We present our numerical study of the running coupling constant in a new renormalization scheme using the Wilson loop in finite volume in quenched QCD. Simulations are carried out with plaquette gauge action for various lattice sizes and *beta* values. Using techniques to improve the staistical accuracy, we determine the nonperturbative running coupling constant in a wide range of the energy scale. We compare our lattice data of the running couplng constant with renormalization group evolution at one- and two-loop order.

108. **η' meson from two flavor dynamical domain wall fermions**

Presenter: Taku Izubuchi — Kanazawa Univ. / RIKEN-BNL Research Center

Poster Session: B **Section:** Hadron Spectroscopy

Co-authors: Koichi Hashimoto

Abstract:

We explore the spectrum of a flavor singlet pseudoscalar meson, η', in two-flavor ($N_f = 2$) lattice Quantum Chromo Dynamics (QCD). The continuum-like relation between the topology of the QCD vacuum and the $U(1)_A$ anomaly, which prevents the η' meson from being a Nambu-Goldstone boson, is expected to hold in the domain wall fermions (DWF) used as a lattice quark field in this work. Although our simulation is limited to relatively heavy quark masses and the statistical error is not small despite the improvements in the measurements and fitting procedures for meson propagators, we obtained $m'_\eta = 819(127)$ MeV for the $N_f = 2$ QCD, where the error is only statistical. Several sources of systematic errors, which may be significant, are discussed. Results for the other mesons are also reported.

109. **Analysis of the Schroedinger Functional with Chirally Rotated Boundary Conditions**

Presenter: Karl Jansen — DESY, Zeuthen

Poster Session: A **Section:** Theoretical Developments

Co-authors: Jenifer Gonzalez Lopez, Andrea Shindler

Abstract:

The Schroedinger functional provides a valuable tool to perform non-perturbative renormalization on the lattice, and to study scaling violations towards the continuum limit. We study two different types of chirally rotated boundary conditions which have been recently proposed to obtain automatic O(a) improvement. We investigate the spectral properties and the quark propagators which derive from these two proposals in the continuum at tree-level of perturbation theory.

110. **Lattice QCD with Eight Degenerate Quark Flavors**

Presenter: Xiao-Yong Jin — Columbia University

Time: Tuesday, 6:00 **Room:** Chesapeake C

Section: Applications beyond QCD

Co-authors: Xiao-Yong Jin, Robert D. Mawhinney

Abstract:

We report on simulations of QCD with many flavors of degenerate quarks, the DBW2 gauge action and naive staggered fermions, using the rational hybrid Monte Carlo algorithm. We primarily focus on eight degenerate quark flavors where a variety of values of the coupling constant and quark mass have been used in the simulations. The scaling behavior of the hadron spectrum and the string tension of the heavy quark potential is studied, to probe whether the zero temperature, continuum limit of the theory breaks chiral symmetry.

111. **Multi-hadron operators with all-to-all quark propagators**

Presenter: Jimmy Juge — University of the Pacific

Time: Tuesday, 3:30 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: J. Bulava, R. Edwards, E.Engelson, K.J. Juge, C.J. Morningstar, S. Wallace

Abstract:

Hadron spectroscopy on dynamical configurations are faced with the difficulties of dealing with the mixing of single particle states and multi-hadron states (for large spatial volumes and light dynamical quarks masses). It is conceivable that explicit multi-hadron interpolating operators will be necessary for obtaining sufficiently good overlap on to multi-hadron states in order to extract the low-lying excitation spectrum. We explore here the feasibility of using four/five noise diluted all-to-all quark propagators in the construction of explicit two-hadron operators on quenched, anisotropic lattices. Our longer term goal is to use these operators on large anisotropic, dynamical configurations for hadron spectroscopy.

112. **SU(2) and SU(3) chiral perturbation theory analysis of meson and baryon masses in 2+1 flavor lattice QCD**

Presenter: Daisuke Kadoh — University of Tsukuba

Time: Monday, 4:10 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: for the PACS-CS Collaboration

Abstract:

We investigate quark mass dependences of meson and baryon masses obtained from 2+1 flavor dynamical quark simulations performed by the PACS-CS collaboration. With the use of the SU(2) and SU(3) chiral perturbation theory up to NLO, we examine the chiral behavior of the pseudoscalar meson masses and the decay constants in terms of the up-down quark mass ranging from 3 MeV to 24 MeV and two choices of the strange quark mass around the physical value. We discuss convergences of the SU(2) and SU(3) chiral expansions and present the results for the low energy constants. Chiral behavior of the nucleon mass is also discussed based on the SU(2) heavy baryon chiral perturbation theory up to NNLO.

113. **RHMC simulation of two-dimensional N=(2,2) super Yang-Mills with exact supersymmetry**

Presenter: Issaku Kanamori — RIKEN

Time: Monday, 3:10 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors:

Abstract:

We investigate super Yang-Mills model in two dimensions. The target theory is N=(2,2) super Yang-Mills model. We use a lattice model with one exact supersymmetry at finite lattice spacing proposed

by Sugino. The fermion effect is taken into account by the Rational Hybrid Monte Carlo(RHMC) algorithm. Here we present the vacuum energy as the expectation value of supercharge-exact Hamiltonian which can be used as an order parameter of the supersymmetry breaking. We use finite temperature configurations and then take the zero temperature limit.

114. **Equation of state at finite density in two-flavor QCD with improved Wilson quarks**

Presenter: Kazuyuki Kanaya — University of Tsukuba

Poster Session: B **Section:** Nonzero Temperature and density

Co-authors: S. Aoki, S. Ejiri, T. Hatsuda, N. Ishii, Y. Maezawa, N. Ukita, T. Umeda

Abstract:

We study the equation of state in two-flavor QCD at finite temperature and density. Simulations are made with the RG-improved gluon action and the clover-improved Wilson quark action. Along the lines of constant physics for $m_{\rm PS}/m_{\rm V} = 0.65$ and 0.80, we compute the derivatives of the quark determinant with respect to the quark chemical potential (μ_q) up to the fourth order at $\mu_q = 0$. We adopt several improvement technics in the evaluation. We study thermodynamic quantities and quark number susceptibilities at finite μ_q using these derivatives. When a critical end point exists at finite μ_q, it will induce fluctuations in the quark number. We find a large enhancement of the quark number susceptibility at finite μ_q, suggesting the existence of a nearby critical end point. This result is qualitatively in agreement with previous observations using staggered-type quark actions.

115. **Pion vector and scalar form factors with dynamical overlap quarks**

Presenter: Takashi Kaneko — KEK

Time: Thursday, 9:10 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: S.Aoki, T.W.Chiu, H.Fukaya, S.Hashimoto, T.H.Hsieh, H.Matsufuru, J.Noaki, T.Onogi, E.Shintani, N.Yamada (JLQCD and TWQCD collaborations)

Abstract:

We calculate the pion vector and scalar form factors in two-flavor QCD using all-to-all propagators of overlap quarks. Gauge configurations are generated with dynamical overlap quarks on a $16^3 \times 32$ lattice at a lattice spacing of 0.12 fm with sea quark masses down to a sixth of the physical strange quark mass. We discuss the chiral behavior of the form factors in detail by comparing with chiral perturbation theory up to two loops.

116. **Fluctuation of Goldstone modes and the chiral transition in QCD**

Presenter: Frithjof Karsch — Brookhaven National Laboratory

Time: Tuesday, 6:00 **Room:** Chesapeake A

Section: Nonzero Temperature and density

Co-authors: RBC-Bielefeld collaboration

Abstract:

While chiral properties of QCD at zero temperature are described by an effective, 4-dimensional $O(N)$ model, the chiral transition at non-zero temperature is expected to belong to the universality class of 3-dimensional $O(N)$ models. In both cases fluctuations of the Goldstone modes lead to non-analytic corrections to the chiral condensate at non-vanishing values of the quark masses, which in turn lead to divergent chiral susceptibilities in the chiral limit.

We have studied the quark mass dependence of chiral susceptibilities in (2+1)-flavor QCD on lattices with temporal extent $N_t = 4$, 6 and 8. We show that at temperatures below but close to the chiral transition of QCD the chiral susceptibility of light quarks diverges in proportion to the inverse Goldstone pion mass. We discuss implications of this result for studies of the chiral transition in QCD.

117. **Fractionally charged Wilson loops as a probe of theta dependence in CP(N-1) sigma models**

Presenter: Patrick Keith-Hynes —

Time: Thursday, 10:40 **Room:** Chesapeake C

Section: Vacuum Structure and Confinement

Abstract:

Including a Wilson loop with charge $q = \frac{\theta}{2\pi}$ in the path integral of a $U(1)$ gauge theory in two spacetime dimensions is equivalent to including a θ-term in the two-volume enclosed by the loop. We study the θ-dependence of the free energy density $\varepsilon(\theta)$ for the CP^1, CP^5 and CP^9 sigma models by extracting $\varepsilon(\theta)$ from the area law of a fractionally charged Wilson loop. For CP^1, $\varepsilon(\theta)$ is smooth in the region $\theta \approx \pi$ and well-described by a dilute instanton gas approximation throughout the range $0 < \theta < 2\pi$. For CP^5 and CP^9 the energy density exhibits a clear cusp and evidence for discrete degenerate vacua at $\theta = \pi$, as expected from large N arguments. For CP^9 the θ-dependence is in good quantitative agreement with the leading order large N prediction $\varepsilon(\theta) = \frac{1}{2}\chi_t\theta^2$ throughout the range $0 < \theta < \pi$.

118. **Scaling of B_K for 2+1 flavour domain wall fermions from 24^3 and $32^3 \times 64$ lattices**

Presenter: Chris Kelly — RBC and UKQCD collaborations

Time: Monday, 2:50 **Room:** Tidewater B

Section: Weak Decays and Matrix Elements

Co-authors:

Abstract:

We present results from our calculations of B_K on a $2 + 1$ flavour $32^3 \times 64$ domain wall fermion ensemble. We discuss in particular the chiral extrapolation of B_K using NLO partially-quenched chiral fit forms and the non-perturbative renormalisation of this quantity using the Rome-Southampton RI-MOM method. For the latter we use a gauge-fixed momentum source approach in order to gain a lattice volume average over the standard point source approach.

We compare these results to those on our $24^3 \times 64$ ensembles and discuss scaling.

119. **Precision Scale Determination from the Upsilon Spectrum**

Presenter: Iain Kendall — University of Glasgow

Time: Thursday, 8:50 **Room:** Chesapeake C

Section: Standard Model Parameters and Renormalization

Co-authors: HPQCD collaboration

Abstract:

We determine the radial excitation energy (2S-1S splitting) in the Upsilon spectrum using NRQCD b quarks on MILC configurations. We improve the statistical/fitting errors to $\sim$1% using random wall sources and this allows us to give improved determinations of the physical value of the heavy quark potential parameters r_1 and r_0. We discuss control of systematic errors in this calculation and illustrate the impact that the improvement has on, for example, the determination of α_s.

120. **Tuning HMC using Poisson Brackets**

Presenter: Anthony Kennedy — University of Edinburgh

Poster Session: B **Section:** Algorithms and Machines

Co-authors: Mike Clark (Boston University) and Paulo Silva (University of Edinburgh)

Abstract:

We demonstrate how measurement of the average values of the contributions to the Poisson brackets S,S,T and T,S,T allow us to optimize the integrators used for generating gauge field configurations with dynamical domain wall quarks.

121. **A construction of the Glashow-Weinberg-Salam model on the lattice with exact gauge invariance**

Presenter: Yoshio Kikukawa — Institute of Physics, University of Tokyo

Time: Wednesday, 4:10 **Room:** Tidewater A

Section: Chiral Symmetry

Co-authors: Daisuke Kadoh

Abstract:

We present a gauge-invariant and non-perturbative construction of the Glashow-Weinberg-Salam model on the lattice, based on the lattice Dirac operator satisfying the Ginsparg-Wilson relation. Our construction covers all SU(2) topological sectors with vanishing U(1) magnetic flux and would be usable for a description of the baryon number non-conservation. In infinite volume, it provides a gauge-invariant regularization of the electroweak theory to all orders of perturbation theory. First we formulate the reconstruction theorem which asserts that if there exists a set of local currents satisfying cetain properties, it is possible to reconstruct the fermion measure which depends smoothly on the gauge fields and fulfills the fundamental requirements such as locality, gauge-invariance and lattice symmetries. Then we give a closed formula of the local currents required for the reconstruction theorem.

122. **Computation of the string tension in three dimensions using large N reduction**

Presenter: Joe Kiskis — UC Davis

Time: Tuesday, 2:30 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors: Rajamani Narayanan

Abstract:

We numerically compute the string tension in the large N limit of three dimensional Yang-Mills theory using Wilson loops. Space-time Wilson loops are formed using smeared space-like links and unsmeared time-like links. We use partial reduction and both unfolded and folded Wilson loops in the analysis.

123. **Measurement of shear viscosity in lattice gauge theory without Kubo formula**

Presenter: Masakiyo Kitazawa — Osaka University

Time: Tuesday, 5:40 **Room:** Chesapeake A

Section: Nonzero Temperature and density

Co-authors: Masayuki Asakawa, Berndt Muller, Chiho Nonaka

Abstract:

We propose a novel method to measure the shear viscosity on the lattice. The value of shear viscosity is evaluated from the spatial correlation of the energy-momentum tensor. Since our strategy does not use the Kubo formula which extracts the transport coefficients from the spectral functions, we can avoid the inversion problem to determine it. A numerical result of the first application of this method to the pure Yang-Mills theory will be presented.

124. **Nucleon form factors with dynamical twisted mass fermions**

Presenter: Tomasz Korzec — University of Cyprus

Time: Monday, 2:50 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors:

Abstract:

We present results for the electromagnetic Sachs form factors as well as the axial form factors of the proton. The calculation is performed in twisted mass QCD with two degenerate flavors of light, dynamical quarks at pion masses ranging from 300 MeV to 500 MeV.

125. **Gapless Dirac spectrum at high temperature**

Presenter: Tamas Kovacs — University of Pecs

Time: Thursday, 9:30 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors:

Abstract:

Using the overlap Dirac operator I show that, contrary to some expectations, even well above the critical temperature there is not necessarily a gap in the Dirac spectrum in pure SU(2) gauge theory. This happens when the Polyakov loop and the fermion boundary condition combine to give close to periodic boundary condition for the fermions in the time direction. Due to the absence of a spectral gap in this sector, chiral symmetry is spontaneously broken even above T_c. I speculate on the possible reasons of this effect and also discuss some of its consequences for dynamical fermions, the SU(3) case and QCD with some spatial dimensions compactified.

126. **The hadron spectrum in full QCD: Setup and parameter selection**

Presenter: Stefan Krieg — Wuppertal University/Juelich Supercomputing Centre

Time: Monday, 3:30 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: S. Durr, Z. Fodor, C. Hoelbling, S. D. Katz, T. Kurth, L. Lellouch, T. Lippert, K.K. Szabo, G. Vulvert

Abstract:

I will present details of our framework for computing the light hadron spectrum (vector mesons, octet and decuplet baryons) in N_f=2+1 QCD. I will focus on our strategy of choosing light quark masses and setting the lattice spacing and on ensuring and monitoring the stability of our algorithm in the light quark mass regime.

127. **Spectrum and Wave Functions of Excited States in Lattice Gauge Theory**

Presenter: Helmut Kroger — FIAS Universität Frankfurt

Time: Monday, 4:10 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors: A. Hosseinizadeh,

Abstract:

We address an old problem in lattice gauge theory - the computation of the spectrum and wave functions of excited states. We propose the strategy to construct a stochastic basis of Bargmann link states, drawn from a physical probability density distribution. Then we compute transition amplitudes between

stochastic basis states. From a matrix of transition elements we extract wave functions and the energy spectrum. We apply this method to $U(1)_{2+1}$ lattice gauge theory. We test the method by computing the energy spectrum, wavefunctions and thermodynamical functions of the electric Hamiltonian and compare it with analytical results. We find excellent agreement. We observe scaling of energies and wave functions in the variable of time. We also present first results on a small lattice for the full Hamiltonian including the magnetic term.

128. **Non-Standard Physics in Leptonic Decays**

Presenter: Andreas Kronfeld — Fermilab

Time: Friday, 2:50 **Room:** Tidewater A

Section: Weak Decays and Matrix Elements

Co-authors:

Abstract:

Usually we think of leptonic decays of pseudoscalar mesons as good tests of lattice QCD or (when the CKM matrix is not known by other means) a way to determine the the CKM matrix. In this talk we explore how the exchange of new particles could change the standard-model rate. In particular, we focus on new-physics explanations of the discrepancy between measurement and lattice QCD for the D_s meson. We also discuss other processes where such new physics could be observed.

129. **A new method of calculating the running coupling constant — theoretical formulation**

Presenter: Masafumi Kurachi — Yukawa Institute, Kyoto University

Time: Thursday, 9:30 **Room:** Tidewater A

Section: Theoretical Developments

Co-authors: Erek Bilgici, Antonino Flachi, Etsuko Itou, Masafumi Kurachi, C.-J. David Lin, Hideo Matsufuru, Hiroshi Ohki, Tetsuya Onogi, Takeshi Yamazaki

Abstract:

We propose a new method of calculating the running coupling constant of gauge theories on the lattice. We first give the definition of the running coupling in the new scheme using the Wilson loops in finite volume. We also explain how the running of the coupling constant is extracted from the measurement of the volume dependence. The perturbative calculation of the normlization constant to define the scheme is also given at the leading order.

130. **Center-symmetric dimensional reduction of hot Yang-Mills theory**

Presenter: Aleksi Kurkela — University of Helsinki

Time: Friday, 5:40 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: Philippe de Forcrand, Aleksi Vuorinen

Abstract:

It is expected that incorporating the center symmetry in the conventional dimensionally reduced effective theory for high-temperature SU(N) Yang-Mills theory, EQCD, will considerably extend its applicability towards the deconfinement transition. In this talk, I will discuss the construction of such center-symmetric effective theories and present results from their lattice simulations in the case of two colors. The simulations demonstrate that unlike EQCD, the new center symmetric theory undergoes a second order confining phase transition in complete analogy with the full theory. I will also describe the perturbative and non-perturbative matching of the parameters of the effective theory, and outline ways to further improve its description of the physics near the deconfinement transition.

131. **Scaling Study of dynamically smeared Fermions**

Presenter: Thorsten Kurth — University of Wuppertal

Time: Friday, 3:50 **Room:** Auditorium

Section: Algorithms and Machines

Co-authors: S. Durr, Z. Fodor, C. Hoelbling, R. Hoffmann, S. Krieg, T. Kurth, L. Lellouch, T. Lippert, K. Szabo, G. Vulvert

Abstract:

We present a scaling study for tree-level Symanzik improved gauge, and different dynamically smeared fermionic actions (e.g. stout-link and hex-link Wilson). We study the low-lying $N_f = 3$ baryon spectrum and find a large scaling region, which extends up to 0.2 fm.

132. **Recent results on screening masses**

Presenter: Edwin Laermann — Universitaet Bielefeld

Time: Wednesday, 3:10 **Room:** Tidewater B

Section: Nonzero Temperature and density

Co-authors:

Abstract:

At high temperatures spatial correlations of quark-anti quark operators and the so called screening masses extracted from them provide information about hadronic excitations and the restoration of symmetries in the quark-gluon plasma. We will present results from recent simulations with 2+1 flavors of light quarks at lattice spacings corresponding to temporal extents of $N_t = 4$, 6 and 8. These results will be compared with data from large quenched lattices.

133. **Light pseudoscalar masses and decay constants with a mixed action**

Presenter: Jack Laiho — Washington University

Time: Tuesday, 5:40 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: Christopher Aubin and Ruth Van de Water

Abstract:

We present results for the light pseudoscalar decay constants and masses using domain wall fermions on a 2+1 staggered sea (the MILC ensembles). We study how well our data is described by NLO chiral perturbation theory and explore strategies for chiral fits.

134. **A non-perturbative test of the chirally rotated Schrödinger functional**

Presenter: Bjorn Leder — Trinity College Dublin

Time: Wednesday, 3:10 **Room:** Chesapeake C

Section: Standard Model Parameters and Renormalization

Co-authors:

Abstract:

We present numerical simulations of the chirally rotated Schrödinger functional in lattice QCD with Wilson quarks. In the quenched approximation a set of 2- and 3-point functions is measured. A dimension 3 counterterm is tuned by requiring parity to be restored at finite lattice spacing. With this choice our results are compatible with automatic $O(a)$ improvement in the bulk. The remaining $O(a)$ lattice artifacts, originating from boundaries, are investigated. Finally we discuss some details of the implementation of Schrödinger functional type boundary conditions in the framework of the DD-HMC algorithm. Corresponding perturbative computations are presented by Stefan Sint.

135. **Calculating B_K using HYP staggered fermions**

Presenter: Weonjong Lee — Seoul National University

Poster Session: B **Section:** Weak Decays and Matrix Elements

Co-authors: Taegil Bae, David Adams, Chulwoo Jung, Jongjeong Kim, Weonjong Lee and Stephen Sharpe

Abstract:

We report a recent progress in calculating B_K using a mixed action (valence quarks are HYP staggered fermions and sea quarks are asqtad staggered fermions). We have completed the first round analysis of the data sets on the MILC coarse lattices ($a = 0.12$ fm) and on the MILC fine lattices ($a = 0.09$ fm). We also incorporate fitting functions suggested by staggered chiral perturbation theory. The fitting results are compared between the partially quenched chiral perturbation theory and staggered chiral perturbation theory.

136. **Precise Heavy-Quark Masses and Coupling Constants from Lattice QCD**

Presenter: Peter Lepage — Cornell University

Time: Thursday, 9:10 **Room:** Chesapeake C

Section: Standard Model Parameters and Renormalization

Co-authors: HPQCD Collaboration

Abstract:

We use lattice QCD simulations to extract heavy-quark masses from moments of current-current correlators combined with high-order continuum weak-coupling perturbation theory. This analysis gives very precise results (1.5%) for the c-quark mass. Preliminary results will also be presented for b quarks, together with new results for the ms-bar coupling constant at M_Z.

137. **Contributions of the disconnected diagrams in the hyperfine splitting in charmonium in the quenched case**

Presenter: Ludmila Levkova — University of Utah

Time: Friday, 2:50 **Room:** Chesapeake A

Section: Hadron Spectroscopy

Co-authors: Carleton DeTar

Abstract:

In calculations of the hyperfine splitting in charmonium, the contributions of the disconnected diagrams is considered small and is typically ignored. We aim to estimate nonperturbatively the size of the resulting error, which could potentially affect the high precision calculations of the charmonium spectrum. Following our work on the effects of the disconnected diagrams in unquenched QCD presented at Lattice 2007, we study the same problem in the quenched case. On dynamical ensembles the disconnected charmonium propagators contain light modes which complicate the extraction of the signal at large distances. In the quenched case, where there are no such light modes, the interpretation of the signal is simplified. We present results from lattices with $a \approx 0.09$ fm and $a \approx 0.063$ fm.

138. **Finite Density Simulation with the Canonical Ensemble**

Presenter: Anyi Li — Department of Physics and Astronomy, University of Kentucky, Lexington KY 40506, USA

Time: Tuesday, 3:30 **Room:** Chesapeake A

Section: Nonzero Temperature and density

Co-authors: Xiangfei Meng, Andrei Alexandru, Keh-Fei Liu

Abstract:

We present results on the study of the phase structure at finite density and finite temperature with the canonical ensemble approach. These are based on the $6^3 \times 4$ lattice with Wilson fermions. In the chemical potential - density plane, we clearly observe the S-shape structure in the $N_F = 4$ case, indicating a first order phase transition. We do not see such a structure in the $N_f = 2$ case. We will also present preliminary results on the $N_F = 3$ case in the effort of searching for the critical point.

139. **Bottom spectroscopy on dynamical 2+1 flavor domain wall fermion lattices with a relativistic heavy quark action**

Presenter: Min Li — Columbia University

Time: Wednesday, 3:30 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: RBC and UKQCD collaborations

Abstract:

Following the successful application of the relativistic heavy quark(RHQ) action to the charmonium and charm-strange meson spectrum, we study here the bottom system to explore the validity of this method in a regime with larger heavy quark momenta. The spectrum is calculated using the same dynamical 2+1 flavor, $24^3 \times 64$ domain wall fermion lattice configurations generated by the RBC and UKQCD collaborations and used in the earlier charm study. The 3 parameters in the RHQ action are determined by matching to the experimental bottom-strange meson masses and extrapolated to the chiral limit from three different sea quark masses. We predict the bottomonium mass spectrum and compare it with experiment. Theoretical estimation is also carried out to understand the $O(a^2p^2)$ systematic errors found in the numerical study.

140. **Physical matrix elements for $\Delta I = 3/2$ channel $K \to \pi\pi$ decays**

Presenter: Matthew Lightman — Columbia University

Time: Monday, 3:50 **Room:** Tidewater B

Section: Weak Decays and Matrix Elements

Co-authors:

Abstract:

Physical matrix elements are calculated for the $\Delta I = 3/2$ channel $K \to \pi\pi$ decay using the RBC/UKQCD $32^3 \times 64$, $L_s = 16$ lattices, with 2+1 dynamical flavors and domain wall fermions. Partially quenched pions with masses as light as 250 MeV are studied.

141. **Challenges in Hadronic Form Factor Calculations**

Presenter: Huey-Wen Lin — Jefferson Lab

Time: Monday, 3:10 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: Saul Cohen, Robert Edwards, Kostas Orginos, David Richards

Abstract:

Form factor calculations on the lattice have been done for years, primarily with ground states for both initial and final states. In particular, there have not been any radially excited transition form factor calculations. There is also difficulty in getting good signal at large Q^2 transfer momenta where we could give important theoretical input to experiments, such as the JLab 12 GeV program and studies of deformation of the nucleon. In this work, I will present a simple technique to resolve both of these difficulties at the same time and demonstrate results from anisotropic configurations showing

better signal for excited-state quantities. The same trick can also be applied to isotropic lattices for calculating large-Q^2 form factors.

142. **Nucleon Electromagnetic Form Factors With Domain Wall Fermions on an Asqtad Sea**

Presenter: Meifeng Lin — Massachusetts Institute of Technology

Time: Monday, 3:30 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: J. D. Bratt, R. G. Edwards, M. Engelhardt, G. T. Fleming, Ph. Hagler, M. F. Lin, H. Meyer, B. Musch, J. W. Negele, K. Orginos, A. V. Pochinsky, M. Procura, D. B. Renner, D. G. Richards, W. Schroers, S. Syritsyn

Abstract:

We report recent results for the nucleon electromagnetic form factors by the LHPC collaboration. The calculation was performed with domain wall valence quarks on the MILC coarse lattices with a = 0.124 fm, including high-statistics measurements at pion masses of 300 MeV and 350 MeV. Comparison of the lattice results with baryon chiral perturbation theory will be given.

143. **On the Volume Dependence of Spectral Weights for Unstable Particles in Lattice QCD**

Presenter: Chuan Liu — School of Physics, Peking University

Poster Session: A **Section:** Hadron Spectroscopy

Abstract:

Volume dependence of the spectral weight is usually used as the criteria to distinguish single particle state from multi-particle states in lattice QCD calculations. Within a solvable model, the Lee model, we show that this criteria is in principle only valid for a stable particle or a narrow resonance. If the resonance being studied is broad, then the volume dependence of the corresponding spectral weight resembles that of a multi-particle state instead of a single particle state. For an unstable V-particle in the Lee model, this is shown explicitly. We argue that this conclusion should also be qualitatively correct in general theories like QCD.

144. **Roper Resonance from 2+1 Flavor Clover Fermions**

Presenter: Keh-Fei Liu — University of Kentucky

Time: Tuesday, 3:50 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: A. Alexandru, Y. Chen, T. Doi, S.J. Dong, T. Draper, D. Mankame, N. Mathur, X. Meng, T. Streuer

Abstract:

We will report results of Roper and S_{11} resonances in a dynamical fermion calculation with 2+1 flavor Clover fermions. These are obtained from the $16^3 \times 32$ lattices with $a = 0.122$ fm. They will be compared to those from the quenched approximation with different fermion actions in order to explore the underline chiral dynamics and cutoff effects.

145. **Charmed hadron interactions**

Presenter: Liuming Liu — College of William and Mary / JLAB

Poster Session: A **Section:** Hadron Spectroscopy

Co-authors: Huey-Wen Lin, Kostas Orginos, NPLQCD collaboration

Abstract:

We study scattering processes of charmed mesons with light hadrons in full QCD. We use Fermilab formulation for charm quark and domain wall fermions for light quarks on the sea of staggered quarks. Four different light quark masses are used to extrapolate to the physical point. In addition the charmed baryon spectrum is also presented.

146. **Large N phase transitions in the spectrum of products of complex matrices**

Presenter: Robert Lohmayer — University of Regensburg

Time: Tuesday, 2:50 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors: Herbert Neuberger, Tilo Wettig

Abstract:

It is shown that the simplest multiplicative random complex matrix model generalizes the large N phase structure found in the unitary case: A perturbative regime is joined to a nonperturbative regime at a point of nonanalyticity.

147. **The monopole mass in the random percolation gauge theory**

Presenter: Stefano Lottini — Universita' di Torino and INFN Sezione di Torino

Time: Friday, 3:10 **Room:** Tidewater B

Section: Vacuum Structure and Confinement

Co-authors: Pietro Giudice, Ferdinando Gliozzi

Abstract:

We study the behaviour of the monopole at finite temperature in the (2+1)-dimensional lattice gauge theory dual to the percolation model; by exploiting the correspondences to statistical systems, we possess powerful tools to evaluate the monopole mass both above and below the critical temperature with high-precision Monte Carlo simulations.

148. **Orientifold Planar Equivalence: The Chiral Condensate**

Presenter: Biagio Lucini — Swansea University

Time: Monday, 5:40 **Room:** Tidewater A

Section: Applications beyond QCD

Co-authors: Adi Armoni, Agostino Patella, Claudio Pica

Abstract:

The recently introduced orientifold planar equivalence is a promising tool for solving non-perturbative problems in QCD. One of the predictions of orientifold planar equivalence is that the chiral condensates of a theory with N_f flavours of fermions in the symmetric (or antisymmetric) representation and N_f flavours of Majorana fermions in the adjoint representation have the same large-N value for any value of the mass of the (degenerate) fermions. Assuming the invariance of the theory under charge conjugation, we prove this statement on the lattice for staggered quenched condensates in SU(N) Yang-Mills in the large-N limit. Then, we compute numerically those quenched condensates for N up to 8. After separating the even from the odd corrections in 1/N, we are able to show that our data support the equivalence; however, unlike other quenched observables, subleading terms in 1/N are needed for describing the data for the symmetric and antisymmetric representation at N=3. Possible lessons for the unquenched case are discussed.

149. **Three Nucleons in a Box**

Presenter: Thomas Luu — Lawrence Livermore National Laboratory

Time: Thursday, 9:10 **Room:** Tidewater A

Section: Theoretical Developments

Co-authors: William Detmold, Andre Walker-Loud

Abstract:

We present finite-volume effects for three nucleons in a box assuming short-ranged interactions of "natural size". Our analysis employs standard perturbation theory up to order $1/L^5$, where L^3 is the volume of the box. We give results for both ground states and certain excited states of definite cubic symmetry. We comment on implications of these results to future multi-nucleon LQCD calculations and discuss current efforts in non-perturbative calculations of three nucleons in a box.

150. **The decay constants f_{B^+}, f_{B_s}, f_{D^+}, and f_{D_s} from three-flavor lattice QCD**

Presenter: Paul Mackenzie — Fermilab

Time: Thursday, 11:00 **Room:** Tidewater A

Section: Weak Decays and Matrix Elements

Co-authors: J. Bailey, C. Bernard, T. Burch, C. DeTar, M. Di Pierro, A.X. El-Khadra, R.T. Evans, E. Freeland, E. Gamiz, Steve Gottlieb, U.M. Heller, J.E. Hetrick, A.S. Kronfeld, J. Laiho, L. Levkova, P.B. Mackenzie, J.N. Simone, R. Sugar, D. Toussaint, and R. Van de Water (Fermilab Lattice and MILC Collaborations)

Abstract:

We present new results for the leptonic decay constants f_{B^+}, f_{B_s}, f_{D^+}, and f_{D_s} determined in $2+1$ flavor lattice QCD at lattice spacings $a = 0.09$, 0.12 and 0.15 fm. We also determine f_{D_s}/f_D and f_{B_s}/f_B. We use the MILC collaboration gauge configuration ensembles, clover heavy quarks in the Fermilab interpretation and improved staggered light quarks. Decay constants, computed at partially quenched combinations of the valence and sea light quark masses, are used to determine the low-energy parameters of staggered chiral perturbation theory.

151. **Magnetic and electric screening masses from Polyakov-loop correlations**

Presenter: Yu Maezawa — Enyo Radiation Laboratory, RIKEN

Time: Wednesday, 3:30 **Room:** Tidewater B

Section: Nonzero Temperature and density

Co-authors: for WHOT-QCD Collaboration

Abstract:

Magnetic and electric screening masses of the quark-gluon plasma are studied from lattice QCD with two flavors of improved Wilson quarks at temperatures $T/T_{pc} \simeq 1$–4, where T_{pc} is the pseudocritical temperature. Using the Euclidean-time reflection symmetry and the charge conjugation symmetry, we introduce various types of Polyakov-loop correlation under the Coulomb gauge fixing and extract the electric screening mass (m_E) and the magnetic screening mass (m_M), separately. We find the inequality $m_M < m_E < 2m_M$ in the temperature interval we have studied.

152. **The determination of $\alpha_s(M_Z)$ from perturbative analyses of short-distance-sensitive lattice QCD observables revisited**

Presenter: Kim Maltman — Dep. Math and Stats, York University

Time: Monday, 3:10 **Room:** Tidewater A

Section: Standard Model Parameters and Renormalization

Co-authors: Derek Leinweber, Peter Moran, Andre Sternbeck

Abstract:

We revisit the HPQCD/UKQCD determination of $\alpha_s(M_Z)$ via perturbative analyses of short-distance-sensitive lattice observables, identifying two potential systematic complications in the previous work. We perform a modified analysis designed to deal with these complications, focussing on two high-intrinsic-scale observables, $\log(W_{11})$ and $\log(W_{12})$, and one lower-intrinsic-scale observable, $\log(W_{12}/u_0^6)$. The analysis incorporates not only the MILC data employed by HPQCD/UKQCD, but also the newer $a \sim$0.15 fm MILC and $a \sim$0.06 fm USQCD data. Our results for $\alpha_s(M_Z)$[1] have errors very similar to those of HPQCD/UKQCD, but central values 0.1192, 0.1193 and 0.1193 (for $\log(W_{11})$, $\log(W_{12})$ and $\log(W_{12}/u_0^6)$, respectively) which are (i) in better mutual agreement and (ii) ~ 2 sigma higher than the HPQCD/UKQCD results. These results are in extremely good agreement with the result of the recent updated global electroweek fit, the combined HERA jet cross-section determination, and the most recent hadronic tau decay extraction. The main source of the discrepancy between our results and those of HPQCD/UKQCD is clearly identified.

[1] K. Maltman, D. Leinweber, P. Moran and A. Sternbeck, in preparation

153. **2+1 flavor QCD calculation of $\langle X \rangle$, $\langle X^2 \rangle$ and form factors**

Presenter: Devdatta Mankame — U. Kentucky

Time: Monday, 3:50 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: Terrence Draper, Keh-Fei Liu, Thomas Streuer , Takumi Doi

Abstract:

We calculate the connected part of the nucleon three-point function to study form factors and first few moments of the structure functions of the nucleon (The disconnected diagrams are discussed elsewhere). The calculation employs the CP-PACS/JLQCD 2+1 dynamical clover fermions on a $16^3 \times 32$ lattice with lattice spacing a=0.1219. The Sequential source technique (SST) using non-zero and zero momentum point nucleon interpolating field as the secondary source is applied enabling a study of different currents at various momentum transfer.

154. **Cascade baryon spectrum from lattice QCD**

Presenter: Nilmani Mathur — Tata Institute of Fundamental Research

Time: Thursday, 9:30 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: J. Bulava, R. G. Edwards, E. Engelson, G. T. Fleming, B. Joo, K. J. Juge, A. Lichtl, H.-W. Lin, C. Morningstar, D. G. Richards and S. J. Wallace

Abstract:

A comprehensive study of the cascade baryon spectrum using lattice QCD affords the prospect of predicting the masses of states not yet discovered experimentally, and determining the spin and parity of those states for which the quantum numbers are not yet known. The study of the cascades, containing two strange quarks, is particularly attractive for lattice QCD in that the chiral effects are reduced compared to states composed only of u/d quarks, and the states are typically narrow. We report the results for the cascade spectrum obtained by using anisotropic, $N_f = 2$ lattices and compare with calculations using the quenched approximation.

155. **Simulation with 2+1 flavors of dynamical overlap fermions**

Presenter: Hideo Matsufuru — KEK

Poster Session: A **Section:** Chiral Symmetry

Co-authors: JLQCD and TWQCD collaboration: S. Aoki, T.W. Chiu, S. Hashimoto, T.H. Hsieh, T. Kaneko, J. Noaki, K. Ogawa, T. Onogi, E. Shintani, N. Yamada.

Abstract:

We report the status of lattice QCD simulations with 2+1 flavors of dynamical overlap fermions by JLQCD-TWQCD Collaboration. Numerical simulations are performed on a $16^3 \times 48$ lattice at u and d quark masses ranging (1/6 -1) physical strange quark mass, and at two values of strange quark mass around the physical value. We discuss the numerical algorithms and run statistics, as well as some early physics results.

156. **Probing SU(3) Chiral Perturbation Theory fits to 2+1 flavor DWF QCD**

Presenter: Robert Mawhinney — Columbia University

Time: Tuesday, 3:10 **Room:** Chesapeake B

Section: Chiral Symmetry

Co-authors: RBC and UKQCD Collaborations

Abstract:

In a recent publication, we have tried SU(3) NLO chiral perturbation theory (ChPT) fits to pseudoscalar decay constants and masses for 2+1 flavor DWF simulations. Our simulations have a fixed dynamical strange quark mass, which is about 15% above the physical value. While we find SU(3) ChPT fits agree well with our data, for pseudoscalar masses below $\approx$ 400 MeV, the NLO corrections are very large. Here we extend this analysis by, 1) simultaneously fitting $\langle \pi | \bar{s} d | K \rangle$ to its known ChPT form and 2) fitting masses and decay constants to the full NNLO formulae.

157. **Decay constants from twisted mass QCD**

Presenter: Craig McNeile — University of Glasgow

Time: Tuesday, 6:00 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors:

Abstract:

We present results for chiral extrapolations of the mass and decay constants of the rho meson. The data sets used are the $N_f = 2$ unquenched gauge configurations generated with twisted mass fermions by the European Twisted Mass Collaboration. This analysis requires a discussion of the scale, so we report preliminary results on determining the lattice spacing using NRQCD in the Upsilon system. We describe a calculation of three decay constants in charmonium and explain why they are required. Talk presented for the European Twisted Mass Collaboration.

158. **Rare B decays with moving NRQCD and improved staggered quarks**

Presenter: Stefan Meinel — University of Cambridge

Time: Thursday, 11:40 **Room:** Tidewater A

Section: Weak Decays and Matrix Elements

Co-authors: A. Hart, R. R. Horgan, L. Khomskii, E. H. Mueller, M. B. Wingate

Abstract:

We calculate matrix elements relevant for rare B decays using moving-NRQCD for the b quark and improved staggered actions for the light quarks. Moving NRQCD allows us to work directly with the physical b quark mass and go to higher recoil momentum compared to standard NRQCD. In this talk, first results from 2-point and 3-point functions and the operator matching in lattice perturbation theory are shown. Some difficulties and possible ways of improvement are discussed.

159. **Winding number expansion in canonical approach to finite density**

Presenter: Xiangfei Meng — University of Kentucky and Nankai University in China

Time: Tuesday, 3:10 **Room:** Chesapeake A

Section: Nonzero Temperature and density

Co-authors: Anyi Li, Andrei Alexandru, Keh-Fei Liu

Abstract:

Canonical approach has been designed to avoid the overlap problem and alleviate the sign problem in the study of the phase structure of QCD at finite density and finite temperature. The algorithm entails the projection of quark numbers from the determinant via a Fourier transform (FT) of the U(1) phase (imaginary chemical potential). When the quark number is large, this poses a numerical instability in the FT. We propose to use the expansion of the number of winding of quark loops around the time direction to fit the $log(det)$ and perform the FT analytically. This greatly expands the range in quark number which makes the simulation to study phase structures at finite density and finite temperature feasible.

160. **Approximate forms of the density of states in pure gauge theory**

Presenter: Yannick Meurice — University of Iowa

Time: Friday, 5:00 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors: A. Denbleyker, D. Du, Y. Liu and A. Velytsky

Abstract:

We compare MC calculations of the density of states in SU(2) pure gauge theory with weak and strong coupling expansions. Surprisingly, the range of validity of the two approximations overlap significantly. We discuss the implications for the large order behavior of perturbation theory.

161. **Charge fluctuations and correlations at finite baryon density**

Presenter: Chuan Miao — BNL

Poster Session: B **Section:** Nonzero Temperature and density

Co-authors: RBC-Bielefeld Collaboration

Abstract:

Starting from the Taylor expansion coefficients of the pressure in terms of the quark chemical potentials, we study the baryon number, strangeness and electric charge fluctuations and their correlations. At zero chemical potentials, the quadratic fluctuations increase rapdily with temperature through the transition region and quartic flucuations show strong peaks, which indicate the position of the transition temperature. Furthermore, we will also show various charge fluctuations and correlations as functions of temperature and chemical potentials. In simulations, we have used p4-improved staggered quarks on a line of constant physics with almost realistic quark masses for two sets of lattice cut-off $aT = 1/4$ and $1/6$.

162. **Ghost-gluon vertex in the MAG**

Presenter: Antonio Mihara — Universidade Federal do Amazonas

Poster Session: A **Section:** Theoretical Developments

Abstract:

In the continuum regime the running coupling constant of QCD obtained through the ghost-gluon vertex in Maximally Abelian gauge (MAG) depends only on the renormalization factor of the diagonal

gluon propagator, due to cancellation of the other renormalization factors. This fact is a clear manifestation of Abelian dominance. In this work is presented in detail a calculation of ghost-gluon vertices in the tree level, in MAG on the lattice. These vertices can be useful for numerical and/or perturbative studies, for instance, of the QCD running coupling on the lattice.

163. **Explanation for baryon mass puzzle in strong coupling limit of lattice QCD**

Presenter: Kohtaroh Miura — Yukawa Institute for Theoretical Physics, Kyoto University

Time: Tuesday, 3:30 **Room:** Chesapeake B

Section: Chiral Symmetry

Co-authors: Noboru Kawamoto, Akira Ohnishi

Abstract:

The strong coupling limit of lattice QCD (SCL-LQCD) is an analytic and instructive framework to investigate the chiral phase transition in QCD, and should be consistent with the lattice Monte-Carlo (MC) simulations in the strong coupling region. While the "Baryon Mass Puzzle" is raised by MC group: The previous SCL-LQCD studies for the chiral phase transition and/or the baryon mass do not respect the naive expectation "Baryon mass (M_B)=Critical baryon chemical potential(N_c*μ_c)", and MC results for the baryon mass are also different from N_c*μ_c obtained in SCL-LQCD. We precisely investigate the baryon loop effects in SCL-LQCD with one species of staggered fermion at finite density, and derive an explanation for the Baryon Mass Puzzle by analyzing the competition between N_c*μ_c and the effective potential of the chiral broken vacuum. The discrepancy between M_B and N_c*μ_c is found to be originated to the existence of chiral condensates in the vacuum.

164. **Phase diagram evolution by finite coupling effect in color SU(3) strong coupling lattice QCD at finite temperature and density**

Presenter: Kohtaroh Miura — Yukawa Institute for Theoretical Physics, Kyoto University

Poster Session: A **Section:** Nonzero Temperature and density

Co-authors: Noboru Kawamoto, Akira Ohnishi

Abstract:

The strong coupling lattice QCD (SC-LQCD) provides an analytic and instructive framework for studying the chiral phase transitions in QCD. We take account of the next to leading order of the strong coupling expansion, and investigate its effect to the phase diagram in color SU(3) SC-LQCD with one species of staggered fermion at finite temperature and finite density. By the finite coupling effects, the constituent quark mass (m_q) is suppressed and the critical temperature (T_c) rapidly decreases. While the "effective" chemical potential at finite coupling is smaller than the "original" one, and its competition to mq leads to just a small correction to the critical chemical potential (μ_c). As a results, the ratio μ_c/T_c becomes smaller and closer to the expected real world value. In addition, the value of T_c at zero chemical potential is found to be consistent with one obtained in Monte-Carlo simulations.

165. **Magnetic Polarizability of Hadrons from Dynamical Configurations**

Presenter: Scott Moerschbacher — The George Washington University

Time: Monday, 6:20 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: Andrei Alexandru, Frank X. Lee

Abstract:

We present results of calculations of magnetic polarizabilities of hadrons using the dynamical gauge configurations generated by the CP-PACS collaboration. The calculations were performed for three lattice sizes with a constant box size of 2.5 fm, and for seven values of the magnetic field, which were

introduced via the background field method. Particles under consideration come from the baryon octet, the baryon decuplet, and the meson sector.

166. **Spectroscopy with dynamical Chirally Improved quarks**

Presenter: Daniel Mohler — Karl-Franzens-Universitaet Graz

Time: Monday, 5:00 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: Christof Gattringer, C.B. Lang, Markus Limmer, Thilo Maurer, Andreas Schaefer

Abstract:

We review the latest results of the dynamical simulations with Chirally Improved fermions and report on new developments in the determination of excited light-quark meson states using interpolators constructed by applying covariant derivatives on Jacobi-smeared quark sources within the framework of the variational method.

167. **Some early results from QCD codes running on SiCortex machines**

Presenter: John Mucci — SiCortex

Time: Tuesday, 6:00 **Room:** Chesapeake B

Section: Algorithms and Machines

Co-authors:

Abstract:

SiCortex computers represent a new generation of highly integrated systems with multi-core processors, a built-in high performance-low latency network and a low power consumption profile. We have explored some QCD code performance on current SiCortex machines of different sizes. We will present up-to-date information about those results.

168. **Universality of the $N_f = 2$ Running Coupling in the Schrödinger Functional Scheme**

Presenter: Keiko Murano — Tsukuba University

Time: Friday, 5:20 **Room:** Chesapeake A

Section: Standard Model Parameters and Renormalization

Co-authors: S.Aoki Y.Taniguchi S.Takeda for PACS-CS Collaboration

Abstract:

The ALPHA collaboration has calculated the running coupling constant of QCD with $N_f = 2$ dynamical quarks in Schrödinger Functional (SF) scheme, employing the plaquete gauge action and the non-perturbatively $O(a)$ improved clover quark action. The result shows that the beta-function for the $N_f = 2$ case becomes bigger than the one for the $N_f = 0$ case at lower energy than about 300 MeV, contrary to the naive perturvative expectation that the dynamical quark effect weakens the growth of the running coupling toward low energy.

To confirm whether this interesting observation is really a non-perturbative prediction from QCD, we have calculated the same running coupling constant of $N_f = 2$ QCD using the renormalization-group improved Iwasaki gauge action, which is known to be less affected by potentially a dangerous first order phase transition than the plaquette gauge action.

We have evaluated the Step Scaling Function in weak coupling ($\bar{g}^2(L) = 0.9793$) and strong coupling ($\bar{g}^2(L) = 3.334$) regions. After taking the continuum limit, we have indeed observed that our results agree with the previous ones within statistical errors.

169. **Stochastic quantization of a finite temperature lattice field theory in the real time formula**

Presenter: Shin Muroya — Dept. of C.M., Matsumoto University

Time: Thursday, 10:40 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: Masashi Mizutani, and Atsushi Nakamura

Abstract:

Stochastic quantization method is applied numerically to a finite temperature lattice field theory where the time axis is extended to the Niemi-Semenoff-Umezawa type complex contour. In the theory, the finite temperature property is guaranteed by (anti-) periodicity of the time contour in the complex axis, and the complex time contour along the real axis describes the system evolution in real time. Taking correlations along the real time direction, we can directly obtain the relaxation of the system in the real time.

We numerically apply this method to a scalar field on the lattice which is extended to the finite temperature system in the real time formula. Taking field correlation along the real-time axes, we can discuss the relaxation of the system directly. We compare also the relaxation in real time and the damping in the imaginary time.

170. **Transverse Momentum Distributions of Quarks in the Nucleon from Lattice QCD**

Presenter: Bernhard Musch — Theoretische Physik T39, Technische Universität München, James-Franck-Strasse, D-85747 Garching, Germany

Time: Friday, 3:30 **Room:** Auditorium

Section: Hadron Structure

Co-authors: Philipp Hägler (TU München), Andreas Schäfer, Meinulf Göckeler (Univ. Regensburg, Germany), Dru B. Renner (DESY Zeuthen, Germany), John W. Negele (MIT, Cambridge, USA), LHPC collaboration

Abstract:

Transverse momentum dependent parton distribution functions (TMDPDFs) encode information about the intrinsic motion of quarks inside the nucleon. They are important non-perturbative ingredients in our understanding of, e.g., azimuthal asymmetries in semi-inclusive deep inelastic scattering experiments. Here we present a first lattice approach to polarized and unpolarized transverse momentum dependent quark densities, based on MILC gauge configurations and propagators from LHPC. The operators we employ are non-local and consist of spatially separated quark creation and annihilation operators connected by a straight Wilson line. We briefly discuss their renormalization properties and possible discretization errors.

171. **A fitting robot for variational analysis**

Presenter: Alan Ó Cais — University of Adelaide

Time: Friday, 4:10 **Room:** Chesapeake A

Section: Hadron Spectroscopy

Co-authors: Derek Leinweber, Selim Mahbub

Abstract:

We develop a robot algorithm to maximise the number of distinct states reliably extracted from correlator data using the variational analysis method. The robot attempts to remove, as far as possible, the human element from both the choice of parameters for the variational analysis and the fitting of the subsequent orthogonalised data.

172. **Exotic phases of finite temperature SU(N) gauge theories with massive fermions: F, Adj, A/S**

Presenter: Joyce Myers — Washington University in St. Louis

Time: Thursday, 11:00 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: Michael Ogilvie

Abstract:

The phase diagrams at high temperature of SU(N) gauge theories with massive fermions are calculated by numerically minimizing the one-loop effective potential. We consider fermions in the Fundamental (F), Adjoint (Adj), Antisymmetric (A), and Symmetric (S) representations, for N from 3 to 9, with periodic and antiperiodic boundary conditions applied. For one flavour of A/S (Dirac) fermion with periodic boundary conditions the C-breaking phase is favoured perturbatively for all values of the fermion mass. In the case of one flavour of adjoint Majorana fermion, and periodic boundary conditons, the deconfined phase is favoured for any fermion mass. For one or more adjoint Dirac fermion (two or more Majorana fermions) we find partially-confining phases as well as new phases with unusual properties. Our results for SU(3) and SU(4) are consistent with our lattice simulations of a related model.

173. **Heavy baryon mass spectrum from Lattice QCD with 2+1 dynamic sea quark flavors**

Presenter: Heechang Na —

Time: Wednesday, 3:10 **Room:** Auditorium

Section: Hadron Spectroscopy

Abstract:

We investigate the mass differences of charm and bottom heavy baryons, using MILC lattice gauge configurations with 2+1 dynamic sea quark flavors. We extend our previous work to three lattice spacings: fine($a \approx 0.09$), coarse($a \approx 0.12$), and medium-coarse($a \approx 0.15$) lattice. For extrapolations and interpolations, we apply simple linear fits and simultaneous linear fits for the valence quark masses as well as the sea quark masses with various options.

174. **Non-commutative product formulation of exact lattice supersymmetry at large N**

Presenter: Kazuhiro Nagata — Indiana University

Time: Tuesday, 3:10 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors:

Abstract:

Introducing a novel type of non-commutative product in the Dirac-Kahler twisted superspace, we formulate a field theoretically rigid framework of extended supersymmetry on a lattice. The non-commutative product employed in this formulation honestly represents the "mild" non-commutativity which was originally introduced in the work with A. D'Adda, I. Kanamori and N. Kawamoto in order to overcome the lattice Leibniz rule difficulty. As a first example of this treatment, we calculate one-loop (in some cases any loops) quantum corrections for a twisted Wess-Zumino model with N x N hermitian matrix-valued superfields on a two dimensional lattice. The calculations are entirely given in the lattice superfield method. We report that apart from the overall wave function renormalization the planar diagrams strictly protect the mass and the coupling constant from the radiative corrections at non-zero lattice spacing, which implies the realization of exact lattice supersymmetry w.r.t. all the supercharges in the large-N limit.

175. **Finite Density QCD with Wilson Fermions**

Presenter: Atsushi Nakamura — Hiroshima University

Poster Session: B **Section:** Nonzero Temperature and density

Co-authors: M. Hamada, S. Motoki, T. Saito and T. Takaishi

Abstract:

We report numerical study of finite density QCD with Wilson fermions using a new expansion algorithm, and its comparison with the imaginary chemical potential calculation. The fermion determinant is expanded as a series of $(\exp(\pm\mu/T)-1)$, and the calculation of Tr of the inverse matrix is executed by using the noise method with the help of the eigen values and eigen functions.

176. **The electric dipole moment of the nucleon from lattice QCD with imaginary vacuum angle θ**

Presenter: Yoshifumi Nakamura — DESY

Time: Monday, 5:00 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: S. Aoki, T. Doi, K. Hashimoto, R. Horsley, T. Izubuchi, D. Pleiter, P.E.L. Rakow, G. Schierholz, J.M. Zanotti

Abstract:

We present results of feasibility studies to compute theelectric dipole moment of the nucleon from direct simulations atimaginary vacuum angle θ. The use of imaginary θ results in a real action which can be simulated using the standard hybrid Monte Carlo algorithm and avoids re-weighting techniques. This is sufficient, as practically θ is very small so just linearised functions of theta can be considered for which the analytic continuation is trivial. The calculation proceeds via the computation of the form factor F_3. To obtain clearer signal, we use twisted boundary conditions. In this study, we use two dynamical flavors of clover Wilson fermions on $16^3 32$ lattices with $m_\pi/m_\rho \approx 0.8$. We furthermore highlight some features of the QCD vacuum at finite θ and compare θ dependence for topological charge obtained by re-weighting and direct methods.

177. **Charm quark system in 2+1 flavor lattice QCD using the PACS-CS configurations**

Presenter: Yusuke Namekawa — University of Tsukuba

Time: Wednesday, 3:50 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: for PACS-CS Collaboration

Abstract:

We study heavy-heavy and heavy-light charm quark systems with the relativistic heavy quark action in 2+1 flavor lattice QCD. Configurations are generated by the PACS-CS collaboration at the lattice spacing of $a = 0.09$ fm with the spatial extent of $L = 2.9$ fm, employing the O(a)-improved Wilson quark action. We investigate the dynamical up-down quark mass dependence of the charmonium spectrum with focus on the hyperfine splitting. We also present some preliminary results of the charmonium spectrum and the D meson decay constants directly measured on the physical point.

178. **Universal properties of Wilson loop operators in large N QCD**

Presenter: Rajamani Narayanan — Florida International University

Time: Tuesday, 3:30 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors: Herbert Neuberger

Abstract:

The eigenvalue spectrum of the Wilson loop operator in large N Yang-Mills theory undergoes a transition as its area is changed. Universal properties associated with this transition will be explained and numerical results will be presented in support of the universal behavior.

179. **Nucleon Generalized Form Factors with Domain Wall Fermions on an Asqtad Sea**

Presenter: John Negele — MIT

Time: Friday, 5:00 **Room:** Auditorium

Section: Hadron Structure

Co-authors: J. D. Bratt, R. G. Edwards, M. Engelhardt, G. T. Fleming, Ph. Hagler, M. F. Lin, H. Meyer, B. Musch, K. Orginos, A. V. Pochinsky, M. Procura, D. B. Renner, D. G. Richards, W. Schroers, S. Syritsyn

Abstract:

Recent results by the LHPC collaboration are presented for generalized form factors, corresponding to moments of generalized parton distributions, using domain wall valence quarks on an Asqtad sea with lattice spacing $a = 0.124$ fm. New high statistics measurements at pion masses of 300 and 350 MeV are included. Results for the quark orbital angular momentum are discussed and the relevance to contemporary experiments is emphasized.

180. **The Conformal Window in SU(3) Yang-Mills**

Presenter: Ethan Neil — Yale University

Time: Tuesday, 5:20 **Room:** Chesapeake C

Section: Applications beyond QCD

Co-authors: Thomas Appelquist, George T. Fleming

Abstract:

Yang-Mills theory is known to exhibit very different behavior as the number of light fermion flavors N_f is varied. In particular, for sufficiently large N_f the theory changes from confining to conformal behavior in the infrared. We have obtained evidence for SU(3) Yang-Mills, based on the study of the running coupling through the Schrodinger Functional approach, that the transition between these two phases occurs between 8 and 12 flavors. I will present the details of our staggered fermion simulations at $N_f = 8$ and 12, and show some preliminary results from a study in progress at $N_f = 10$ using clover-improved Wilson fermions.

181. **Lambda-nucleon force from lattice QCD**

Presenter: Hidekatsu Nemura — RIKEN

Time: Wednesday, 4:10 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: N. ISHII, S. AOKI, T. HATSUDA for PACS-CS Collaboration

Abstract:

We study Lambda-nucleon force by using lattice QCD. Recently, nucleon-nucleon force has been studied from the Bethe-Salpeter amplitude measured in the lattice QCD.[1,2] This new methodology would be a remarkable success to explore the hyperon-nucleon (YN) and hyperon-hyperon (YY) interactions from QCD, since the present phenomenological YN and YY potentials have still large uncertainty due to the difficulty of the YN and YY scattering experiments. The first-time application for proton-Xi^0 interaction was reported at the LATTICE2007 conference[3], and the latest result can be found in http://arXiv.org/.[4] We will report an attempt to apply this method to study the Lambda-nucleon

force. The numerical calculation is twofold: (i)Full lattice QCD results by using NF=2+1 PACS-CS full QCD gauge configurations with the spatial lattice volume $(2.86\ \mathrm{fm})^3$[5], (ii)quenched lattice QCD results with larger spatial lattice volume $(4.4\ \mathrm{fm})^3$.

[1] N.Ishii, S.Aoki, and T.Hatsuda, Phys.Rev.Lett. 99, 022001 (2007).

[2] S.Aoki, T.Hatsuda, and N.Ishii, arXiv:0805.2462 [hep-ph].

[3] H.Nemura, N.Ishii, S.Aoki, and T.Hatsuda, arXiv:0710.3622[hep-lat].

[4] H.Nemura, N.Ishii, S.Aoki, and T.Hatsuda,arXiv:0806.1094[nucl-th].

[5] Y.Kuramashi for the PACS-CS Collaboration, arXiv:0711.3938[hep-lat].

182. **Large N transition in the 2D $SU(N) \times SU(N)$ nonlinear sigma model**

Presenter: Herbert Neuberger — Rutgers

Time: Tuesday, 3:50 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors: R. Narayanan and E. Vicari

Abstract:

We show by numerical means that a short distance smoothed two point function in the continuum SU(N) x SU(N) principal chiral model in two dimensions has a large N phase phase transition at a distance of the order of the correlation length.

183. **Light meson spectrum with $N_f = 2 + 1$ dynamical overlap fermions**

Presenter: Jun Noaki — KEK

Time: Tuesday, 6:20 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: S.Aoki, T.W.Chiu, S.Hashimoto, T.H.Hsieh, H.Matsufuru, T.Kaneko, T.Onogi, E.Shintani, N. Yamada (JLQCD and TWQCD Collaborations)

Abstract:

We present numerical simulation using overlap fermion action with 2+1 dynamical flavors. We calculate pseudo-scalar masses and decay constants on a $16^3 \times 48 \times (0.11\mathrm{fm})^4$ lattice with five different masses for the ud quark mass in the range of $m_s/6 - m_s$ and two different masses for the strange quark. We extrapolate our lattice results to the chiral limit by fitting the data with various fit functions including the prediction from the two-loop chiral perturbation theory.

184. **Status of the QPACE Project**

Presenter: Andrea Nobile — INFN Trento and ECT*

Poster Session: A **Section:** Algorithms and Machines

Co-authors: H. Baier, H. Boettiger, M. Drochner, N. Eicker, U. Fischer, Z. Fodor, G. Goldrian, S. Heybrock, D. Hierl, T. Huth, B. Krill, J. Lauritsen, T. Lippert, T. Maurer, J. McFadden, N. Meyer, I. Ouda, D. Pleiter, A. Schäfer, H. Schick, F. Schifano, H. Simma, S. Solbrig, T. Streuer, K. -H. Sulanke, R. Tripiccione, T. Wettig, F. Winter

Abstract:

The QPACE (QCD PArallel computing on the CEll) collaboration is developing a massively parallel architecture optimized for lattice QCD simulations. We give an overview of the current hardware status of the project. The main components of a single node are a PowerXCell 8i processor with a peak double-precision performance of 100 GFlop/s (or 200 GFlop/s in single precision) and a custom-designed, FPGA-based network processor. The nodes will be connected in a 3-d torus. We aim for a

bidirectional network bandwidth of 6 GB/s per node and a latency for remote memory copy operations of 1 microsecond, low enough not to impact the performance for the typical data transfer patterns in lattice QCD simulations. A liquid cooling solution is being developed that allows us to pack 256 nodes in a single rack, with an estimated power consumption as low as 1.3 Watts per GFlop/s (double precision). An installation of 2048 nodes is planned for mid 2009. We estimate that lattice QCD code can obtain a sustained performance of over 20% on such a machine.

185. **Nearly conformal electorweak sector with chiral fermions**

Presenter: Daniel Nogradi — University of California, San Diego

Time: Tuesday, 5:40 **Room:** Chesapeake C

Section: Applications beyond QCD

Co-authors: Zoltan Fodor, Kieran Holland, Julius Kuti, Chris Schroeder

Abstract:

SU(3) non-abelian gauge theory with dynamical overlap fermions in the 2-index symmetric (sextet) representation is considered. This model may be a viable model of the electroweak symmetry breaking sector along the lines of the "walking" technicolor paradigm. The number of fermion species is chosen such that the theory is expected to be below the conformal window. I'll discuss how the epsilon-regime and random matrix theory can be used to test whether at any given set of parameters (N_c, N_f, etc) the theory is in the conformal phase or indeed just below it. Preliminary Monte Carlo results will be presented as well.

186. **High Temperature Confinement in SU(N) Gauge Theories**

Presenter: Michael Ogilvie — Washington University

Time: Thursday, 11:20 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: Peter Meisinger

Abstract:

SU(N) gauge theories, extended with adjoint fermions having periodic boundary conditions, are confining at high temperature for sufficiently light fermion mass m. Lattice simulations indicate that this confining region is smoothly connected to the confining region of low-temperature pure SU(N) gauge theory. In the high temperature confining region, the one-loop effective potential for Polyakov loops has a Z(N)-symmetric confining minimum. String tensions associated with Polyakov loops are smooth functions of m/T. In the magnetic sector, the Polyakov loop plays a role similar to a Higgs field, leading to a breaking of SU(N) to $U(1)^{(N-1)}$. This is turn yields an effective theory where magnetic monopoles give rise to string tensions for spatial Wilson loops. These string tensions are calculable semiclassically. There are many analytical predictions for the high-temperature region that can be tested by lattice simulations, but lattice work will be crucial for exploring the crossover from this region to the low-temperature confining behavior of pure gauge theories.

187. **Nucleon sigma term and strange quark content from dynamical overlap simulations**

Presenter: Hiroshi Ohki — Yukawa Institute for Theoretical Physics, Kyoto University

Time: Thursday, 9:50 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: Hidenori Fukaya, Shoji Hashimoto, Matsufuru Hideo, Tetsuya Onogi, Norikazu Yamada

Abstract:

We present a calculation of the nucleon sigma term on the two-flavor QCD configurations with dynamical overlap fermions. We analyse the lattice data for the nucleon mass using the baryon chiral

perturbation theory. Using partially quenched data sets, we extract the connected and disconnected contributions to the nucleon sigma term separately. Chiral symmetry on the lattice much simplifies the detemination of the disconnected contribution. We find it to be much smaller than the previous lattice calculations. This finding gives a great impact on the determination of the strange quark content.

188. **Quarkyonic phase in the strong coupling region of lattice QCD**

Presenter: Akira Ohnishi — Yukawa Institute for Theoretical Physics, Kyoto University

Time: Wednesday, 2:50 **Room:** Tidewater B

Section: Nonzero Temperature and density

Co-authors: K. Miura

Abstract:

We study the phase diagram of quark matter at finite temperature (T) and chemical potential (μ) including finite coupling ($1/g^2$) effects in the strong coupling lattice QCD for color SU(3). We find that there appears a phase at $\mu \sim 1$, where the chiral symmetry is largely restored and the baryon denisty is high, which would corresponds to the quarkyonic phase suggested at large N_c.

189. **Search for the Charmonium Dissociation Temperature with Variational Analysis in Lattice QCD**

Presenter: Hiroshi Ohno — University of Tsukuba

Time: Thursday, 11:40 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: T. Umeda and K. Kanaya for WHOT-QCD Collaboration

Abstract:

Charmonium dissociation temperatures are studied in a quenched anisotropic lattice QCD with standard plaquette gauge action and $O(a)$ improved Wilson fermion action. Simulations are carried out at temperatures in the range $0.88T_C$ to $3.2T_C$. We calculate effective masses and Bethe-Salpeter wave functions for the ground state (1S, 1P) and some excited states (2S, 2P). To distinguish between bound states and scattering states, we apply two methods: First, we compare effective masses for charmonium correlation functions at finite spatial momentum under different spatial boundary conditions. Because the scattering states are sensitive to the boundary conditions, finite volume effects are expected when a charmonium dissociates. Second, we study if the wave functions show a sign of scattering states which will be characterized by a broad wave function. We find no clear evidences of dissociation for the charmonium states up to $2.3T_C$ so far.

190. **Nucleon structure functions from dynamical (2+1)-flavor domain wall fermions**

Presenter: Shigemi Ohta — IPNS/KEK, SOKENDAI, RBRC/BNL

Time: Friday, 5:20 **Room:** Auditorium

Section: Hadron Structure

Co-authors: for RBC and UKQCD Collaborations

Abstract:

We report low moments of nucleon structure functions from the coarse RIKEN-BNL-Columbia (RBC) and UKQCD joint dynamical (2+1)-flavor domain-wall fermions (DWF) ensembles. Fully non-perturbatively renormalized iso-vector quark momentum fraction, $\langle x \rangle_{u-d}$, helicity fraction, $\langle x \rangle_{\Delta u - \Delta d}$, and transversity, $\langle 1 \rangle_{\delta u - \delta d}$, will be included. The lattice cut off is estimated at $a^{-1} = 1.7$ GeV. The lattice volume is as large as 2.7 fm across. The dynamical strange mass is set at slightly heavier than physical, and degenerate up and down mass is varied correpsonding to pion mass of about 0.67, 0.56, 0.42 and 0.33 GeV.

191. **Initial guesses for multi-shift solvers**

Presenter: James Osborn — Argonne National Lab

Time: Monday, 6:00 **Room:** Chesapeake C

Section: Algorithms and Machines

Co-authors:

Abstract:

I will show a method for providing an initial guess to a multi-shift solver. This can also be extended to the case of multiple sources each with a different shift.

192. **Searching for the conformal window**

Presenter: Elisabetta Pallante — University of Groningen

Time: Tuesday, 5:00 **Room:** Chesapeake C

Section: Applications beyond QCD

Co-authors: Albert Deuzeman, Maria Paola Lombardo

Abstract:

We attempt to give an answer to the long standing question of whether QCD-like theories enter a conformal phase before the loss of asymptotic freedom at N_f =16 1/2. A complete picture also includes an understanding of the shape of the chiral phase boundary in the (T, N_f) plane and what may distinguish a quark-gluon plasma phase from a conformal phase. I report on our results at varying Nf (see also the talk by A. Deuzeman for $N_f = 8$) and for the region around $N_f = 12$. I critically discuss our strategy and further developments.

193. **Cluster Algorithm Renormalization Group Method**

Presenter: Guillermo Palma — Universidad de Santiago de Chile

Poster Session: B **Section:** Hadron Spectroscopy

Co-authors: D. Zambrano

Abstract:

In this paper we propose a self consistent method to study critical systems numerically by a combined collective-mode algorithm and Renormalization Group (RG) on the lattice. We used the 2D Ising model on a square lattice to illustrate the method. Starting with a lattice of lattice size $L = 108$ and using the scale factor $b = 3$, three RG steps were performed. We computed the lattice shifted critical temperature and its infinite volume limit, the Onsager's critical temperature, as well as the critical exponents ν and η. The numerical results are very accurate, with errors typically of a few in one thousand. Compared to standard methods of Monte Carlo Renormalization Group, our method is faster by a factor which grows monotonically with the lattice size from 6 for $L = 64$ to 10 for $L = 162$. This allows the possibility to compute critical quantities of other critical models with the present method, by using appropriate cluster algorithms on the fundamental lattice combined with RG on the lattice.

194. **Fluctuations and reweighting of the quark determinant on large lattices**

Presenter: Filippo Palombi — CERN

Time: Wednesday, 3:10 **Room:** Chesapeake B

Section: Algorithms and Machines

Co-authors: Martin Luescher

Abstract:

We propose to stabilize simulations of lattice QCD with very light Wilson quarks by separating the low modes of the Dirac operator from the bulk of the modes. The latter can be simulated using the HMC algorithm, while the determinant of the low modes is included in a reweighting factor. Theoretical arguments and some numerical experiments on a 64×32^3 lattice suggest that the reweighting efficiency achieved with the proposed mode splitting is only weakly dependent on the lattice size.

195. **Geometric effects in lattice QCD thermodynamics**

Presenter: Marco Panero — University of Regensburg

Time: Monday, 4:10 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors:

Abstract:

I present a study of the equation of state in quenched QCD, discussing some systematic effects related to the lattice geometry. In particular, I comment on the modification of the Stefan-Boltzmann law for a gas of free gluons in a finite system, and on its quantitative impact on the numerical results at high temperatures, for the typical parameters of current lattice simulations. Finally, I also extend this analysis to preliminary results obtained from simulations of SU(N) gauge theories with $N > 3$ colors.

196. **Fermions in higher representations. Some results about SU(2) with adjoint fermions**

Presenter: Agostino Patella — Swansea University

Time: Friday, 3:10 **Room:** Chesapeake C

Section: Applications beyond QCD

Co-authors: Luigi Del Debbio (Edinburgh), Claudio Pica (BNL)

Abstract:

The lattice formulation of gauge theories with fermions in two-index representations of the gauge group is discussed. The interest in this class of theories is manifold. Candidates for technicolor theories, the orientifold multicolor generalization of QCD, and the (softly-broken) SYM belong to this class. The implementation of the HMC/RHMC algorithm for simulating the dynamical fermions in arbitrary representations is presented. Working with two flavors of Wilson fermions in the adjoint representation, we start mapping the phase diagram of the SU(2) theory.

197. **Determining bare quark masses for Nf=2+1 dynamical simulations**

Presenter: Michael Peardon — Trinity College Dublin

Time: Monday, 3:10 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: for the Spectrum project

Abstract:

A simple prescription for choosing bare strange and light quark masses in 2+1 flavour dynamical simulations is presented. The method is tested in simulations of dynamical anisotropic 2+1 flavour Sheikholeslami-Wohlert improved fermions. Some first physics results on these ensembles are presented.

198. **Fermionic correlation functions from the staggered Schroedinger functional**

Presenter: Paula Perez Rubio — Trinity College Dublin / Universidad Autnoma de Madrid

Time: Wednesday, 3:30 **Room:** Chesapeake C

Section: Standard Model Parameters and Renormalization

Co-authors: Stefan Sint

Abstract:

Starting from the Schroedinger functional with staggered one-component fermions on a fine lattice of size $(L/a)^3 \times T/a$ we first reconstruct the action in terms of the four-component spinors. Two different set-ups are proposed, corresponding to the coarse lattice having size $(L/2a)^3 \times T'/2a$, with $T' = T \pm a$. The continuum limit is then defined at fixed T'/L. Both cases have previously been investigated in the pure gauge theory. Here we define fermionic correlation functions and study their approach to the continuum limit at tree-level of perturbation theory.

199. **Clover improvement for stout-smeared 2+1 flavour SLiNC fermions: perturbative results**

Presenter: Holger Perlt —

Time: Friday, 2:30 **Room:** Auditorium

Section: Hadron Structure

Abstract:

For the **S** tout **Li** nk **N** on-perturbative **C** lover (SLiNC) action we determine in one-loop lattice perturbation theory the critical hopping parameter κ_c and the clover parameter c_{SW} which is needed for $\mathcal{O}(a)$ improvement. Doing this calculation off-shell we are able to compute for the first time the non gauge invariant quark field improvement coefficient c_{NGI}. Additionally, we present first results for the renormalization factors of the scalar, pseudoscalar, vector and axial vector currents. We discuss the peculiarity of mean field improvement for the SLiNC action. Applied to the clover parameter c_{SW} we find the mean field improved one-loop value to be shifted close to the non-perturbative value.

200. **Critical behavior of the energy and pressure correlation functions in SU(2) gauge theory**

Presenter: Claudio Pica — Brookhaven Lab

Time: Thursday, 9:50 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: F. Karsch and K. Hubner

Abstract:

The critical behavior of zero-momentum correlation functions of the energy-momentum tensor components near the second order finite temperature transition of the (3+1)-dimensional SU(2) gauge theory is studied. While the correlation function of the trace of the energy-momentum tensor is shown to diverge uniformly like the specific heat as the critical temperature is approached, the pressure-pressure correlation function remains finite. Implications relevant for the calculation of transport coefficients, in particular the bulk viscosity, in the vicinity of a second order phase transition are discussed.

201. **Tracking LQCD Workflows**

Presenter: Luciano Piccoli — Fermilab, IIT

Poster Session: B **Section:** Algorithms and Machines

Co-authors: James Kowalkowski, James Simone

Abstract:

The Lattice Quantum Chromo Dynamics (LQCD) applications demand a workflow system capable of tracking output data products, application configuration, such as input physics parameters and run time information. Our experience shows that current scientific workflow systems are capable of carrying out the execution of LQCD workflows on a cluster environment or on the Grid. However they lack functionality to meet essential requirements, such as recording of workflow and application parameters; tracking of execution status of multiple workflows and individual workflow participants; and a centralized data repository from which users can extract any statistics about the system. We

have developed a model for tracking the workflow products and all the configuration data used to produce it. Any execution of a workflow gets fully recorded and the user has quick access to the complete execution history, including location of final and intermediate data products. The model can be integrated to any workflow system. For our prototype we chose openWFEru because of the programming language used (Ruby). Among the benefits provided by the proposed model is the ability to add workflow recovery based on the recorded information to systems that do not provide it.

202. **Writing Efficient QCD Code Made Simpler: qa0**

Presenter: Andrew Pochinsky — MIT

Poster Session: A **Section:** Algorithms and Machines

Abstract:

A new tool for writing platform-independent optimized QCD code, qa0, is described. Performance of a Möbius Domain Wall Fermion inverter written with qa0 on several platforms is presented.

203. **A lattice study of light scalar tetraquarks with isopins 0, 1/2 and 1**

Presenter: Sasa Prelovsek — Jozef Stefan Institute, Ljubljana, Slovenia

Time: Tuesday, 4:10 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors:

Abstract:

We simulate light scalar tetraquarks on the lattice using diquark-antidiquark interpolating fields. We use Chirally Improved quarks and the quenched approximation, which allows us to unambiguously assign the quark content to a state. States with isospins 0, 1/2 and 1 are studied using non-degenerate masses for u/d and s quarks. In each flavor channel we extract the ground and few excited states by using the variational method. The tetraquark and scattering states are distinguished by comparing energies and spectral weights from two different spatial volumes. We find the ground states to be consistent with $\pi\pi, K\pi$ and KK scattering, while the excited states are interpreted in terms of scattering and possible tetraquark states.

204. **The hadronic light-by-light contribution to the anomalous magnetic moment of the muon: a lattice approach**

Presenter: Paul Rakow — University of Liverpool

Time: Monday, 3:50 **Room:** Tidewater A

Section: Standard Model Parameters and Renormalization

Co-authors: QCDSF

Abstract:

The anomalous magnetic moment, $g-2$, of the electron and muon has been measured to great accuracy, (better than one part in 10^9). The muon case is particularly interesting, as it is more sensitive to possible New Physics effects. However to detect signs of New Physics, we also need a very accurate theoretical value. One of the largest theoretical uncertainties in current calculations is the hadronic light-by-light contribution, due to internal photon-photon scattering induced by virtual hadrons.

We report on an ongoing calculation of the photon-photon scattering tensor and $g-2$ using a direct lattice method. We discuss some methods needed to make the direct calculation less expensive than one would naively expect, and show some first results for the photon-photon scattering tensor.

205. **Blasting Through Lattice Calculations using CUDA**

Presenter: Claudio Rebbi — Boston University

Poster Session: B **Section:** Algorithms and Machines

Co-authors: Kipton Barros, Richard Brower, Mike Clark

Abstract:

Modern graphics hardware is well suited to highly parallel numerical tasks and provides significant cost and performance benefits. Graphics hardware vendors are now making available development tools to support high performance computing. NVidia's CUDA platform, in particular, offers direct access to graphics hardware through a programming language similar to C. Using the CUDA platform we have implemented a Dirac-Wilson operator which runs at 62 Gigaflops on the Tesla C870, a video card which is composed of 128 processor cores running at 1.35 Ghz.

206. **Status of ETMC simulations with N_f =2+1+1 twisted mass fermions**

Presenter: Siebren Reker — University of Groningen

Time: Monday, 5:20 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: R. Baron, P. Boucaud, A. Deuzeman, F. Farchioni, V. Gimenez Gomez, G. Herdoiza, K. Jansen, I. Montvay, D. Palao, E. Pallante, O. Pene, C. Urbach, M. Wagner, U. Wenger

Abstract:

I will present the current status of runs performed in the twisted mass formalism, with N_f =2+1+1 dynamical fermions: a degenerate light doublet and a mass split heavy doublet. The procedure for tuning to maximal twist will be described and our current status of the runs. Results for a set of observables obtained on ensembles at maximal twist will be given. The influence of the dynamical strange and charm will be shown by comparing these results with those obtained with the two-flavour action. Finally the impact of stout smearing will be discussed.

207. **Reducing Chiral Symmetry Breaking in Domain Wall Fermions at fixed L_s**

Presenter: Dwight Renfrew — Columbia University

Time: Wednesday, 2:50 **Room:** Chesapeake B

Section: Algorithms and Machines

Co-authors: Thomas Blum, Norman Christ, Robert Mawhiney

Abstract:

Potentially practical calculations using domain wall fermions with realistic quark masses on large volumes with large lattice spacing are prevented by the large explicit chiral symmetry breaking present at strong coupling. The topological dislocations responsible for this chiral symmetery breaking can be suppressed by adding the determinant of a 4-D Wilson fermion operator with appropriate negative mass to the path integral measure. This approach has been implemented in the Columbia Physics System (CPS) and is being tested for a ratio of determinants of dynamical Wilson fermions with chirally twisted imaginary mass components designed to reduce but not eliminate topology change. This talk reports on progress including early testing results.

208. **Hadronic contribution to $g-2$ from twisted mass fermions**

Presenter: Dru Renner — DESY Zeuthen

Time: Thursday, 11:20 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: Xu Feng

Abstract:

We calculate the vacuum polarization tensor for pion masses from 500 MeV to 300 MeV using dynamical twisted mass fermions at a lattice spacing of 0.086 fm. We analyze the form of the polarization tensor on the lattice using the symmetries of twisted QCD. Results for the lowest order hadronic contribution to $g-2$ are presented.

209. **A study of quark-gluon vertices using the lattice Coulomb gauge domain wall fermion**

Presenter: Furui Sadataka — Teikyo Univ.

Time: Thursday, 11:40 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors:

Abstract:

I calculate the quark-gluon vertex of the tensor type $\Gamma(p,q) = g_3(p^2)q_4\vec{q}$ in the limit of $\vec{q} \to \vec{0}$, i.e. $\Gamma(p,q)/q_4|\vec{q}|$ using the gauge configuration of the Domain Wall Fermion (DWF) provided by the RBC-UKQCD collaboration [1].

In [2], I observed that the quark propagator of the Coulomb gauge in the cylinder cut, i.e. the three momentum $\vec{p}$ is directed along the diagonal of the cubic space has small fluctuation and I use this propagator in the evaluation of the operator by applying the non-perturbative renormalization method [3].

The p dependence of the quark-gluon coupling is compared with that of running coupling $\alpha_I(p^2)$ measured by the ghost-gluon vertex in Coulomb gauge [4].

[1] C. Allton et al., Phys. Rev. D76, 014504 (2007)

[2] S. Furui, arXiv:0801.0325

[3] G. Martinelli et al., Nucl. Phys. B445, 81(1995)

[4] S. Furui, arXiv:0805.0680, S. Furui and H. Nakajima, PoS (Lattice2007)301(2007), arXiv:0708.1421

210. **Infrared gluons in the stochastic quantization approach**

Presenter: Takuya Saito — Kochi Univ.

Time: Friday, 3:30 **Room:** Tidewater B

Section: Vacuum Structure and Confinement

Co-authors: Atsushi Nakamura, Yoshiyuki Nakagawa, Hiroshi Toki

Abstract:

We have calculated the gluon propagators in the infrared limit in quenched QCD lattice simulations with the stochastic quantization. We discuss suppression of the infrared gluons in the confinement phase, the volume size effect, gauge-parameter alpha dependence, etc.

211. **No-go theorem of Leibniz rule and supersymmetry on the lattice**

Presenter: Makoto Sakamoto — Department of Physics, Kobe University

Time: Monday, 3:30 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors: Mitsuhiro Kato and Hiroto So

Abstract:

Lack of Leibniz rule on a lattice is an obstacle to realize supersymmetry on a lattice. We study a product rule and a difference operator equipped with the Leibniz rule in a general framework of lattice

field theory, and prove a no-go theorem that it is impossible to construct any difference operator and product rule on a lattice with the properties of (i) translation invariance, (ii) locality and (iii) Leibniz rule. We then propose a way to escape from the no-go theorem by introducing infinite flavor systems, and present lattice supersymmetric models which realize (the lattice version of) the full supersymmetry.

212. **Eigenvalue Distributions of Quark Matrix at Finite Isospin Chemical Potential**

Presenter: Yuji Sasai — Tsuyama National College of Technology

Time: Tuesday, 5:00 **Room:** Chesapeake A

Section: Nonzero Temperature and density

Co-authors: Gernot Akemann, Atsushi Nakamura and Tetsuya Takaishi

Abstract:

The comparison between Lattice QCD and Random Matrix Theory (RMT) provides information of the pion decay constant F_π. We calculated eigen-value distributions of quark matrix on $8^3 \times 4$ lattice by $N_f = 2$ KS fermions. We performed fittings between these lattice data and RMT at coupling $\beta = 5.30$ and iso-vector chemical potential $\mu a = 0.0, 0.004773$, 0.1 and 0.2 (weak non-hermiticity) and then find good agreement. Especially our data indicates that F_π decreases as the iso-vector chimical potential increases.

213. $\pi - \pi$**,** KK **and** BB **Interactions**

Presenter: Martin Savage — University of Washington

Time: Monday, 6:00 **Room:** Chesapeake B

Section: Chiral Symmetry

Co-authors: NPLQCD

Abstract:

NPLQCD have calculated the scattering lengths for $I = 2\pi\pi$ and $I = 1KK$ in mixed-action lattice calculations (domain-wall valence quarks on rooted staggered MILC lattice ensembles) at pion masses down to 290 MeV. With the aid of mixed-action chiral perturbation theory, a precise prediction for the $I = 2\pi\pi$ scattering length is made, and a somewhat less precise prediction of the $I = 1KK$ scattering length is also made.

As warm-up for dynamical calculations, the potentials between two B-mesons have been extracted from a quenched calculation in the heavy-quark limit (a limit in which an energy-independent, source-independent potential can be defined).

I present the results of these calculations.

214. **Extracting rho and Delta resonances from lattice simulations at small quark masses**

Presenter: Gerrit Schierholz — DESY

Time: Friday, 3:50 **Room:** Chesapeake A

Section: Hadron Spectroscopy

Co-authors: QCDSF Collaboration

Abstract:

It is not obvious how to extract masses of resonances from lattice simulations in Euclidean space-time. The problem becomes acute in recent simulations at small pion masses. Using established relations between the scattering matrix in infinite volume and the two-particle spectrum in a periodic box, we compute the masses of rho and Delta and highlight special features of the chiral extrapolation.

215. **The QCD phase diagram and the equation of state at non-zero density from a Taylor expansion of the pressure**

Presenter: Christian Schmidt — Universität Bielefeld

Time: Monday, 3:10 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: RBC-Bielefeld Collaboration

Abstract:

We present results on Taylor expansion coefficients of the pressure in terms of various chemical potentials. Improved staggered fermions are used with two different lattice spacing, $N_t = 4,6$. We discuss approximations of the radius of convergence of such expansions and their consequences for the QCD phase diagram. We also compare results of two different quark masses. Furthermore, we use the Taylor expansion coefficients to calculate lines of constant entropy per baryon number in the QCD phase diagram which are relevant for Heavy Ion Collisions and construct the equation of state along those lines.

216. **Physical results from 2+1 flavor Domain Wall QCD**

Presenter: Enno E. Scholz — Brookhaven National Laboratory

Time: Monday, 5:40 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: for the RBC and UKQCD Collaborations

Abstract:

We will review the recent results obtained by applying SU(2) chiral perturbation theory to the pion and kaon sectors. Here we focus on the meson masses and decay constants and the determination of the light quark masses. The simulations have been performed using the Iwasaki gauge action at two different lattice spacings with the physical spatial volume held approximately fixed at $(2.7)^3$ fm. The Domain Wall fermion formulation was used for the 2+1 dynamical quark flavors: two (mass degenerate) light flavors with masses as light as roughly 1/5 the mass of the physical strange quark mass and one heavier quark flavor at approximately the value of the physical strange quark mass.

217. **Lattice Chirality and Decoupling of Mirror Fermions**

Presenter: Yanwen Shang — University of Toronto

Time: Monday, 5:20 **Room:** Chesapeake B

Section: Chiral Symmetry

Co-authors: Erich Poppitz

Abstract:

With LHC commissioned in just a few month ahead, all sorts of ideas about physics beyond the standard model are being explored intensively. A strong-coupling chiral theory appearing at TeV scale remains a possibility but also a very hard scenario to study. When it comes to strongly coupled theories, lattice regularization is by far the most reliable method. But defining exact chiral gauge theory on the lattice remains a difficult problem on its own. We show that the idea to use additional non-gauge, high-scale mirror-sector dynamics to decouple the mirror fermions without breaking the gauge symmetry might lead to a practically manageable solution. We demonstrate, using the exact lattice chirality, that partition functions of lattice gauge theories with vector like fermion representations can be split into "light" and "mirror" parts, and each contains a chiral representation. Such a splitting is only well defined when both sectors are separately anomaly free. We also prove that, the generating function and therefore the spectrum of an arbitrary chiral gauge theory is a smooth function of the background gauge field, if and only if the anomaly free condition is satisfied. We reached this conclusion by proving

some very general properties of an arbitrary chiral gauge theory on lattice, and the results should be of importance for further studies in this field.

218. **Cell processor implementation of a MILC lattice QCD application**

Presenter: Guochun Shi — NCSA, UIUC

Time: Monday, 5:20 **Room:** Chesapeake C

Section: Algorithms and Machines

Co-authors: Steven Gottlieb, Volodymyr Kindratenko

Abstract:

We present results of the implementation of one MILC lattice QCD application simulation with dynamical clover fermions using the hybrid-molecular dynamics R algorithm on the Cell Broadband Engine processor. Fifty-four individual computational kernels responsible for 98.8% of the overall execution time were ported to the Cells Synergistic Processing Elements (SPEs). The remaining application framework, including MPI-based distributed code execution, was left to the Cells PowerPC processor. We observe that we only infrequently achieve more than 10 GFLOPS with any of the kernels, which is just over 4% of the Cells peak performance. At the same time, many of the kernels are sustaining a bandwidth close to 20 GB/s, which is 78% of the Cells peak. This indicates that the application performance is limited by the bandwidth between the main memory and the SPEs. In spite of this limitation, speedups of 8.7x (for $8 \times 8 \times 16 \times 16$ lattice) and 9.6x (for $16 \times 16 \times 16 \times 16$ lattice) were achieved when comparing a 3.2 GHz Cell processor to a single core of a 2.33 GHz Intel Xeon processor. When comparing the code scaled up to execute on a dual-Cell blade and a quad-core dual-chip Intel Xeon blade, the speedups are 1.5x ($8 \times 8 \times 16 \times 16$ lattice) and 4.1x ($16 \times 16 \times 16 \times 16$ lattice).

219. **A new description of lattice Yang-Mils theory and non-Abelian magnetic monopoles as the quark confiner**

Presenter: Akihiro Shibata — Computing Research Center, KEK

Time: Friday, 4:10 **Room:** Tidewater B

Section: Vacuum Structure and Confinement

Co-authors: Seikou Kato, Kei-Ichi Kondo, Toru Shinohara Tkeharu Murakami and Shoichi Ito

Abstract:

We give a new description of the $SU(N)$ Yang-Mills theory on a lattice, which enables us to define a gauge-invariant magnetic monopole for explaining quark confinement in a gauge independent way based on the dual superconductivity picture. Although numerical simulations on a lattice have given remarkable results supporting this picture such as magnetic monopole dominance and center vortex dominance, they are obtained only in the special gauge choice such as maximal Abelian gauge (MAG) and Laplacian Abelian gauge. In our description, the link variable $U_{x,\mu} \in G = SU(N)$ is decomposed into the product of two elements $U_{x,\mu} = X_{x,\mu}V_{x,\mu}$ in a gauge independent way: $V_{x,\mu} \in \tilde{H}$ (the stability subgroup) and $X_{x,\mu} \in G/\tilde{H}$ (the coset space) where the decomposed link variable $V_{x,\mu}$ can be identified with the "Abelian' part according to a non-Abelian Stokes theorem. For $G = SU(3)$, we have two options: The minimal option $\tilde{H} = U(2) \cong SU(2) \times U(1)$ is a new one (overlooked so far) on which we focus in this talk, while the maximal one $\tilde{H} = U(1) \times U(1)$ corresponds to a gauge independent reformulation of the Abelian projection represented by the conventional MAG as reported in the lattice 2007 conference. In numerical simulations of the minimal one, we demonstrate the color symmetry restoration, the non-Abelian magnetic monopole dominance in the string tension and infrared V dominance for correlation functions.

220. **Chiral and Continuum Extrapolations in HISQ Simulations**

Presenter: Junko Shigemitsu — The Ohio State University

Poster Session: B **Section:** Weak Decays and Matrix Elements

Co-authors: C.Davies, E.Follana, P.Lepage

Abstract:

The Highly Improved Staggered Quark (HISQ) action is currently enabling some of the most precise lattice calculations in light and charm quark systems. Recent results include accurate determinations of pion, kaon, D and D_s meson decay constants with errors small enough to have impact on phenomenology. An important and often determining factor in the final error budget for a lattice calculation is the control one has over chiral and continuum extrapolations. In this poster we describe our methods for carrying out such extrapolations to the physical real world limit in recent HISQ action simulations, and the ways in which we have tested them.

221. **Wilson twisted mass fermions in the epsilon regime**

Presenter: Andrea Shindler — University of Liverpool

Time: Wednesday, 3:10 **Room:** Tidewater A

Section: Chiral Symmetry

Co-authors:

Abstract:

I report on theoretical and numerical results obtained in the ϵ regime with two dynamical Wilson twisted mass quarks. I will focus on two-point correlation functions, cut-off effects, and the extraction of low energy constants.

222. **Strong coupling constant and four-quark condensates from vacuum polarization functions with dynamical overlap fermions**

Presenter: Eigo Shintani — KEK

Time: Friday, 3:10 **Room:** Chesapeake A

Section: Hadron Spectroscopy

Co-authors: S. Aoki, S. Hashimoto, H. Matsufuru, J. Noaki, T. Onogi, N. Yamada

Abstract:

We report on a calculation of strong coupling constant and four-quark condensates from vacuum polarization functions of vector and axial-vector current correlators. We use dynamical overlap configurations with 2 (or possibly 2+1) flavors on a $16^3 \times 32$ ($16^3 \times 48$) lattice at $a^{-1} \sim 1.7$ GeV. Fitting to the function motivated by operator product expansion in the high momentum scale, we obtain $\Lambda^{N_f}_{\overline{MS}}$ and four-quark condensate $\langle O_6 \rangle$. The exact chiral symmetry of overlap fermion helps systematic uncertainties to be under good control.

223. **Confinement and Chiral Symmetry, a Lattice QCD test of AdS/QCD**

Presenter: Donald Sinclair — Argonne National Laboratory

Time: Tuesday, 6:20 **Room:** Chesapeake A

Section: Nonzero Temperature and density

Co-authors:

Abstract:

In proposed holographic duals of QCD (AdS/QCD), the scales of chiral symmetry breaking and confinement can be varied independently. In finite temperature lattice QCD with fundamental quarks the deconfinement and chiral symmetry restoration transitions appear to coincide. AdS/QCD suggests that adding extra 4-fermion interactions can separate the scales and hence the two transitions. Simulations of lattice QCD with extra 4-fermion interactions show that for large enough 4-fermion couplings, the deconfinement temperature is significantly lower than the chiral symmetry restoration temperature.

224. **A perturbative study of the chirally rotated Schroedinger functional**

Presenter: Stefan Sint — Trinity College Dublin

Time: Wednesday, 2:50 **Room:** Chesapeake C

Section: Standard Model Parameters and Renormalization

Co-authors: Bjoern Leder

Abstract:

In order to implement SF schemes with Wilson type quarks which are compatible with automatic $O(a)$ improvement, we implement a variant of chirally rotated SF boundary conditions and study it in perturbation theory. Tuning conditions for the critical mass and the boundary counterterm of dimension 3 are investigated, and automatic bulk $O(a)$ improvement is demonstrated. Corresponding non-perturbative results will be presented in the parallel talk by Bjoern Leder.

225. **Quark Mass Dependence of the QCD Equation of State on $N_t = 8$ Lattices**

Presenter: Wolfgang Soeldner — BNL

Time: Monday, 3:30 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: for the RBC-Bielefeld Collaboration

Abstract:

We currently perform calculations with an improved staggered fermion action (p4fat3). We use a strange quark mass that has been tuned to its physical value and light quarks of mass $m_s/20$ on lattices of size $32^3 \times 8$. This corresponds to an almost physical Goldstone pion mass. We present first results on the low temperature part of the equation of state of QCD. Through comparison with the preliminary hotQCD results on the Nt=8 equation of state, which have been obtained with twice heavier light quark masses, we can quantify the quark mass dependence of the equation of state in the low temperature regime. We also comment on the quark mass dependence of the equation of state at high temperature.

226. **Efficient use of the Generalised Eigenvalue Problem**

Presenter: Rainer Sommer — DESY

Time: Friday, 3:30 **Room:** Chesapeake A

Section: Hadron Spectroscopy

Co-authors: Benoit Blossier, Michele Della Morte, Georg von Hippel, Tereza Mendes

Abstract:

We analyse the systematic errors made when using the generalised eigenvalue problem for extracting energies and matrix elements. Both the case of a theory with a positive transfer matrix and the one of an effective theory such as HQET are discussed. Numerical results are shown for the extraction of ground state and excited B-meson masses and the ground state decay constant at lowest and first order in the HQET 1/m expansion. The correlators were computed using all-to-all propagators.

227. **Lattice Weak Matrix Elements: A diagnostic tool for New Physics in the LHC era**

Presenter: Amarjit Soni — Brookhaven National Lab

Time: Friday, 2:30 **Room:** Tidewater A

Section: Weak Decays and Matrix Elements

Co-authors:

Abstract:

B-factories with important input from the lattice have confirmed that the dominant fraction of the observed CP violation in the B and K systems comes the CKM-paradigm. However, compelling theoretical arguments suggest existence of beyond the Standard Model sources of CP violation. In light of B-factory results these are generally expected as sub-dominant effects requiring greater precision from theory and experiment. The recent significant reduction of error in B_K is a step in the right direction. Using only the matrix elements of ΔF=2 4-quark operators necessary in the context of mixing and oscillation phenomena, in K^0, B_d and B_s mesons, non-trivial test of the SM are now possible. Extension of this strategy into the future suggests how precise lattice calculations in conjunction with the forthcoming pool of experimental data could be used as an effective diagnostic tool for categorizing New Physics.

228. **Infrared exponents and the strong-coupling limit in lattice Landau gauge**

Presenter: Andre Sternbeck — University of Adelaide

Time: Friday, 3:50 **Room:** Tidewater B

Section: Vacuum Structure and Confinement

Co-authors: Lorenz von Smekal

Abstract:

We study the gluon and ghost propagators of lattice Landau gauge in the strong-coupling limit $\beta = 0$ in pure $SU(2)$ lattice gauge theory to find evidence of the conformal infrared behavior of these propagators as predicted by a variety of functional continuum methods for asymptotically small momenta $q^2 \ll \Lambda^2_{\rm QCD}$. In the strong-coupling limit, this same behavior is obtained for the larger values of a^2q^2 (in units of the lattice spacing a), where it is otherwise swamped by the gauge field dynamics. Deviations for $a^2q^2 < 1$ are well parametrized by a transverse gluon mass $\propto 1/a$. Perhaps unexpectedly, these deviations are thus no finite-volume effect but persist in the infinite-volume limit. They furthermore depend on the definition of gauge fields on the lattice, while the asymptotic conformal behavior does not.

229. **Nonperturbative infrared fixed point in sextet QCD**

Presenter: Benjamin Svetitsky — Tel Aviv University

Time: Friday, 2:30 **Room:** Chesapeake C

Section: Applications beyond QCD

Co-authors: Thomas DeGrand and Yigal Shamir

Abstract:

The SU(3) gauge theory with fermions in the sextet representation is one of several theories of interest for technicolor models. We have carried out a Schrodinger functional (SF) calculation for the lattice theory with two flavors of Wilson fermions. We find that the discrete beta function changes sign when the SF renormalized coupling is in the neighborhood of $g^2 = 2.0$, showing a breakdown of the perturbative picture even though the coupling is weak. The most straightforward interpretation is an infrared-stable fixed point.

230. **Nucleon Structure with Domain Wall Fermions at a = 0.086 fm**

Presenter: Sergey Syritsyn — MIT CTP

Time: Friday, 5:40 **Room:** Auditorium

Section: Hadron Structure

Co-authors: J. D. Bratt, R. G. Edwards, M. Engelhardt, Ph. Hagler, H.W. Lin, M. F. Lin, H. Meyer, B. Musch, J. W. Negele, K. Orginos, A. V. Pochinsky, M. Procura, D. G. Richards

Abstract:

Initial calculations of hadronic matrix elements of twist-two operators in the nucleon are presented using domain wall fermions with 2+1 flavors at a lattice spacing a = 0.086 fm for pion masses down to 280 MeV.

231. **The QCD transition with 2+1 dynamical flavors**

Presenter: Kalman Szabo — Wuppertal University

Time: Friday, 3:30 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: Zoltan Fodor, Sandor Katz, Stefan Krieg

Abstract:

We extend previous studies on the QCD $T > 0$ transition by $N_t = 12$ simulations. The analyses are carried out at the physical quark masses with 2+1 flavors of stout improved staggered fermions.

232. **Perturbative analysis of the Neuberger-Dirac operator in the Schroedinger functional**

Presenter: Shinji Takeda — Humboldt University

Time: Wednesday, 2:30 **Room:** Chesapeake C

Section: Standard Model Parameters and Renormalization

Co-authors:

Abstract:

We investigate the spectrum of the free Neuberger-Dirac operator in the Schroedinger functional. We also perform a one-loop calculation of the Schroedinger functional coupling, and then check the universality and investigate lattice artifacts of the step scaling function. It turns out that the lattice artifacts for the Neuberger-Dirac operator are comparable to those of the clover action. Furthermore, we will show a preliminary perturbative results.

233. **Non-perturbative renormalization of $N_f = 2+1$ QCD with Schroedinger functional scheme**

Presenter: Yusuke Taniguchi — University of Tsukuba

Time: Friday, 5:40 **Room:** Chesapeake A

Section: Standard Model Parameters and Renormalization

Co-authors: for PACS-CS collaboration

Abstract:

We report on evaluation of the running couping for $N_f = 2+1$ QCD in the Schroedinger functional scheme using the $O(a)$ improved Wilson quark action and the Iwasaki gauge action. We adopt 7 scales to cover strong coupling region defined by the renormalized coupling $g_R^2 = 3.418$ and weak coupling region $g_R^2 = 1.0006$. Physical scale is introduced through r_0 evaluated at $\beta = 1.83, 1.90, 2.05$. We may also present non-perturbative renormalization of the quark mass in a scheme with inhomogeneous Schroedinger functional boundary condition for gauge field.

234. **Light and heavy-light decay constants from $N_f = 2$ Lattice QCD with twisted mass fermions**

Presenter: Cecilia Tarantino — University Roma Tre and INFN

Time: Friday, 3:50 **Room:** Tidewater A

Section: Weak Decays and Matrix Elements

Co-authors:

Abstract:

I present the results of a lattice QCD calculation of the light (f_K and f_K/f_π) and heavy-light (f_D and f_{D_s}) meson pseudoscalar decay constants, performed by the ETM Collaboration with $N_f = 2$ dynamical fermions. The simulation is carried out with the twisted mass fermionic action at maximal twist, which guarantees automatic O(a)-improvement of the physical quantities and at three values of the lattice spacing thus allowing the extrapolation to the continuum limit. The chiral extrapolation has been performed by investigating different functional forms for the quark mass dependence of the pseudoscalar decay constants.

235. **Melting instantons, domain walls, and large N**

Presenter: H. B. Thacker — Physics Dept., University of Virginia

Time: Thursday, 11:00 **Room:** Chesapeake C

Section: Vacuum Structure and Confinement

Co-authors:

Abstract:

For both $SU(N)$ gauge theory in 4D and the CP^{N-1} model in 2D, there are classical instantons which are expected to disappear from the quantum theory at sufficiently large N. I discuss evidence that the disappearance of instantons as a function of N occurs at a critical value $N = N_c$, which defines a tipping point where the action begins to favor large instantons over small ones. When instantons try to become large in the quantum theory, they are forced by the negativity of the two-point correlator to become hollow, thin-walled bags. The walls are then screened by a layer of opposite topological charge (anti-bag). For $N > N_c$ this process continues, and the Wilson bags become arbitrarily large and interleaved, replacing the instanton liquid by a laminated vacuum consisting of alternating sign layers of codimension 1 topological charge sheets. This agrees with the structure observed in Monte Carlo configurations. A semiclassical estimate of the instanton melting point gives $N_c = 2$ for CP^{N-1}, while Monte Carlo results give a somewhat higher result $N_c \approx 4$. For 4-dimensional QCD, the semiclassical estimate gives $N_c = \frac{12}{11}$. The observed topological structure in $SU(3)$ indicates that $N_C < 3$ for QCD.

236. **Polarizabilities from Lattice QCD**

Presenter: Brian Tiburzi — University of Maryland

Time: Monday, 6:00 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: William Detmold, Andre Walker-Loud

Abstract:

The response of hadrons to electromagnetic probes is highly constrained by chiral dynamics, but, in some cases, predictions are at odds with experimental data. The lattice can be used to test the chiral electromagnetism of hadrons and ultimately confront experiment. We use background field techniques to study the electromagnetic polarizabilities of hadrons. Focusing on simulations in background electric fields, we present results for both charged and neutral particle polarizabilities. The former are extracted using a novel method.

237. **Meson Baryon Scattering in LQCD**

Presenter: Aaron Torok — University of New Hampshire

Time: Thursday, 8:50 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: Silas R. Beane, William Detmold, Thomas C. Luu, Kostas Orginos, Assumpta Parreno, Martin J. Savage, Andre Walker-Loud

Abstract:

Elastic scattering of mesons and baryons is considered in a few isospin channels in mixed-action Lattice QCD. Heavy Baryon Chiral Perturbation Theory is used for chiral extrapolation to the physical point, and several low-energy constants are determined.

238. **Towards a determination of c_{SW} using Numerical Stochastic Perturbation Theory (NSPT)**

Presenter: Christian Torrero — University of Regensburg

Time: Monday, 3:30 **Room:** Tidewater A

Section: Standard Model Parameters and Renormalization

Co-authors: Gunnar S. Bali

Abstract:

We outline a strategy to compute the second loop contribution to the c_{SW} coefficient of the Sheikholeslami-Wohlert-Wilson fermion action by means of NSPT. We also present preliminary results for higher order integrators for the Langevin evolution within NSPT. At fixed numerical accuracy these integrators considerably reduce the required computer-time.

239. **Wilson Chiral Perturbation Theory for twisted mass QCD at NLO**

Presenter: Satoru Ueda — University of Tsukuba

Time: Wednesday, 3:30 **Room:** Tidewater A

Section: Chiral Symmetry

Co-authors: Sinya Aoki

Abstract:

We investigate the quark mass dependence of pion sectors in the twisted mass lattice QCD, using the Wilson Chiral Perturbation Theory(WChPT). In order to consider the small quark mass regime such that $m_q \sim a^2\Lambda^3$, we include $O(a^2, am)$ terms at the leading order(LO), which induce non-trivial phase structure at the tree level. At the next leading order(NLO), due to the presence of the twisted mass, not only pion masses but also a vacuum expectation of the neutral pion have divergences, which must be removed by local terms at NLO. We demonstrate that cancellations of these divergences can be consistently performed. As an interesting application of the NLO calculation, we derive the twisted quark mass dependence of the pion mass at the maximal twist which is defined through the untwisted PCAC quark mass.

240. **2+1 flavor lattice QCD simulation with $O(a)$-improved Wilson quarks**

Presenter: Naoya Ukita — University of Tsukuba

Time: Monday, 6:20 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: PACS-CS Collaboration

Abstract:

We present algorithmic details and physical results in 2+1 flavor lattice QCD using the nonperturbatively $O(a)$-improved Wilson quark action and the Iwasaki gauge action. Simulations are carried out at a lattice spacing of 0.09fm on a $(2.9\text{fm})^3$ box using the PACS-CS computer. Thanks to the DDHMC algorithm combined with several algorithmic improvements we successfully simulate the up-down quark mass as light as the physical value. We compare the light hadron spectrum extrapolated at the physical point with the experimental values. Results for other physical quantities are also presented.

241. **Thermodynamics of SU(3) gauge theory at fixed lattice spacing**

Presenter: Takashi Umeda — University of Tsukuba

Time: Monday, 3:50 **Room:** Chesapeake B

Section: Nonzero Temperature and density

Co-authors: WHOT-QCD Collaboration

Abstract:

We study thermodynamics of SU(3) gauge theory at fixed scales on the lattice, where we vary temperature by varying the temporal lattice size $N_\tau = (Ta_\tau)^{-1}$. The fixed scale approach is able to reduce computational costs for zero temperature subtraction and parameter search to find lines of constant physics, which are demanding in full QCD simulations. As a test of the approach, we study the thermodynamics of the SU(3) gauge theory on isotropic and anisotropic lattices. We calculate the equation of state and the critical temperature.

242. **Scaling and chiral extrapolation of pion mass and decay constant with maximally twisted mass QCD**

Presenter: Carsten Urbach — Humboldt-University Berlin

Time: Tuesday, 5:00 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: for the ETM Collaboration

Abstract:

We present recent results for pion mass and its decay constant as obtained by the ETM collaboration in large scale simulations with maximally twisted mass fermions and two mass degenerate flavours of light quarks. We discuss the continuum, chiral and infinite volume extrapolation of these quantities as well as the extraction of low energy constants, and investigate possible systematic uncertainties in detail.

243. **The $B \to \pi \ell \nu$ form factor and $|V_{ub}|$ from unquenched lattice QCD**

Presenter: Ruth Van de Water — Fermilab

Time: Thursday, 11:20 **Room:** Tidewater A

Section: Weak Decays and Matrix Elements

Co-authors: Fermilab Lattice and MILC Collaborations

Abstract:

We calculate the form factors, f_+ and f_0, for B-meson semileptonic decay using improved staggered light quarks and Fermilab heavy quarks. We simulate at multiple quark masses and three lattice spacings, and extrapolate to the physical quark mass and continuum limit with rooted staggered Chiral Perturbation Theory. We then use constraints on the form factor q^2 shape based on analyticity and unitarity to combine the lattice result with the experimental branching fraction measured by BABAR and determine a model-independent value for the CKM matrix element $|V_{ub}|$.

244. **Entanglement entropy in SU(N) gauge theory**

Presenter: Alexander Velytsky — University of Chicago

Time: Monday, 6:20 **Room:** Tidewater B

Section: Vacuum Structure and Confinement

Co-authors:

Abstract:

We consider the entanglement entropy for a sub-system in SU(N) lattice gauge theory. The 1+1 dimensional gauge theory is treated exactly. Gauge theories in higher dimensions are treated within Migdal-Kadanoff approximation and exhibit a non-analytical change in the entanglement entropy reminiscent of phase transition.

245. **Phase of the Fermion Determinant for QCD at Finite Chemical Potential**

Presenter: Jacobus Verbaarschot — Stony Brook University

Time: Tuesday, 5:20 **Room:** Chesapeake A

Section: Nonzero Temperature and density

Co-authors: Kim Splittorff

Abstract:

We discuss the average phase factor of the fermion determinant in QCD at nonzero chemical potential. Using a chiral Lagrangian the behavior of the phase factor in the approach to the thermodynamic limit is analyzed. At finite volume, we find good agreement with lattice results by Allton et al.. Random matrix results are recovered in the microscopic limit. We also derive analytical expressions for the distribution of the phase of the fermion determinant and compare our results with recent lattice simulations by Ejiri.

246. **K-meson vector decay constant and B-parameter from $N_f = 2$ tmQCD**

Presenter: Anastassios Vladikas — INFN-"Tor Vergata"

Time: Monday, 3:10 **Room:** Tidewater B

Section: Weak Decays and Matrix Elements

Co-authors: ETMC: European Twisted Mass Collaboration

Abstract:

We present work in progress on the determination of the K-meson vector and tensor day constants as well as the B-parameter in Kaon oscillations. Our simulations are performed in a partially quenched framework, with two dynamical (sea) quark flavours. Wilson fermions with a twisted mass term is the regularization of choice for the decay constants, while for the B-parameter a combination of standard tmQCD and Osterweiler-Seiler valence quarks is implemented in order to reduce discretization errors.

247. **D_s physics from fine dynamical lattices**

Presenter: Georg von Hippel — DESY, Zeuthen

Time: Friday, 5:00 **Room:** Chesapeake A

Section: Standard Model Parameters and Renormalization

Co-authors: J. Heitger, S. Schaefer, R. Sommer, N. Tantalo

Abstract:

We present first results for the charm quark mass and decay constant of the D_s meson in $N_f = 2$ QCD with non-perturbative O(a) improvement. The simulations are done with the DD-HMC algorithm as part of the CLS effort, reaching a lattice spacing of $a = 0.04$fm.

248. **Perturbative improvement with HISQ fermions: the gluon action at $O(N_f \alpha_s a^2)$**

Presenter: Georg von Hippel — DESY, Zeuthen

Poster Session: B **Section:** Algorithms and Machines

Co-authors: A. Hart, R.R. Horgan

Abstract:

The Highly Improved Staggered Quark (HISQ) action is the successor to the asqtad action. As it consists of two levels of smearing with reunitarisation in between, perturbative calculations become rather difficult. Here we present an algorithm that allows to derive and evaluate the Feynman rules for a HISQ-style multiply smeared action in an efficient manner. An application to the calculation of the $O(N_f \alpha_s a^2)$ improvement coefficients of the gluonic action in the presence of dynamical HISQ fermions is also shown.

249. **Static-light meson masses from twisted mass lattice QCD**

Presenter: Marc Wagner — Humboldt University Berlin, Department of Physics

Time: Wednesday, 4:10 **Room:** Auditorium

Section: Hadron Spectroscopy

Co-authors: Karl Jansen, Chris Michael, Andrea Shindler

Abstract:

I present a study of the static-light meson spectrum using two-flavor Wilson twisted mass lattice QCD. We have considered five different values for the light quark mass corresponding to $m_\pi = 300$ MeV ... 600 MeV. We have extrapolated our results, to make predictions regarding the spectrum of B mesons.

250. **Tests of Electric Polarizability on the Lattice**

Presenter: Walter Wilcox — RIKEN BNL Research Center

Poster Session: B **Section:** Hadron Structure

Co-authors: Frank X. Lee, Victor Guerrero, Walter Wilcox, and Joe Christensen

Abstract:

Using clover fermions on CP-PACS dynamical configurations, we consider a number of ways of measuring hadronic electric polarizability, an E^2 effect in hadron masses, using lattice techniques. We consider the effects of periodic and fixed spatial boundary conditions, the field linearization postulate as well as various types of quark sources. We also consider two ways of formulating the classical vector potential which describes a uniform electric field in combination with the other possibilities.

251. **Nucleon Wave Function from Lattice QCD**

Presenter: Nikolaus Warkentin — University of Regensburg

Time: Wednesday, 3:30 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: for the QCDSF collaboration

Abstract:

We compute moments of distribution amplitudes using QCDSF/UKQCD/DIK gauge configurations with two flavors of clover fermions and operators which are optimized with respect to their behavior under the lattice symmetries. The knowledge of these quantities helps in understanding the internal structure of hadrons and in the analysis of (semi-)exclusive processes. Unfortunately only rather indirect information about distribution amplitudes can be obtained from experiments, while the sum rule approach suffers from considerable systematic uncertainties. Lattice QCD, on the other hand, offers the possibility to calculate them from first principles. We present results for the nucleon distribution amplitude which suggest that the asymmetries (the deviations from the asymptotic form) are smaller than indicated by sum rule calculations. We also show first results for moments of the distribution amplitude of $N^\star$, the parity partner of the nucleon. Combining our results and the light cone sum rule approach we are able to calculate nucleon form factors in the kinematic range $Q^2 = 1...10 GeV^2$ which is of particular interest in recent experiments, in particular because of new data from JLAB.

252. **Topological susceptibility from twisted mass QCD**

Presenter: Urs Wenger — Institute for Theoretical Physics, University of Bern, Switzerland

Time: Monday, 6:00 **Room:** Tidewater B

Section: Vacuum Structure and Confinement

Co-authors: European Twisted Mass Collaboration (ETMC)

Abstract:

We report on our investigation of the topological susceptibility of QCD with $N_f = 2$ light quarks in the twisted mass formalism. The topological charge density is evaluated using both smearing methods and fermionic methods. We compare the results for the susceptibility with the theoretical expectations in the limit of light quarks and also discuss the link between the flavour-singlet pseudoscalar meson mass and the fluctuations of the topological charge density.

253. **Neutral Kaon Mixing beyond the Standard Model from 2+1 flavour Domain Wall QCD**

Presenter: Jan Wennekers — University of Edinburgh

Time: Monday, 2:30 **Room:** Tidewater B

Section: Weak Decays and Matrix Elements

Co-authors: for the RBC and UKQCD collaborations

Abstract:

We present a study of $\Delta S = 2$ matrix elements originating from physics beyond the Standard Model. Using 2+1 flavour Domain Wall fermions we obtain the non-perturbative renormalisation (mixing) matrix from the Rome-Southampton method. We also discuss the chiral extrapolation of the renormalised matrix elements in a partially quenched set-up.

254. **Deflated and restarted symmetric Lanczos methods for linear equations in lattice QCD problems with multiple right-hand sides**

Presenter: Walter Wilcox — Baylor University

Time: Monday, 6:20 **Room:** Chesapeake C

Section: Algorithms and Machines

Co-authors: Abdou Abdel-Rehim, Ronald B. Morgan, Dywayne Nicely

Abstract:

A deflated restarted Lanczos algorithm to solve real symmetric or complex Hermitian linear systems and at the same time compute eigenvalues and eigenvectors is given. For the first system, eigenvectors with small eigenvalues are computed simultaneously while solving the linear system. To avoid roundoff errors associated with the Lanczos algorithm we apply a selective re-orthogonalization method over the eigenvectors kept at restart during the solution of the first right-hand side. Two versions of the algorithm are given. The first is called Lan-DR and is based on conjugate gradient implementation of the Lanczos algorithm. This version will be optimal for the hermitian positive definite case. The second version will be called MinRes-DR and will be based on the MinRes implementation of Lanczos algorithm. This will be optimal for indefinite hermitian systems where the conjugate gradient algorithm is subject to instabilities. For subsequent right-hand sides, we project over the calculated eigenvectors to speed up convergence. The algorithms used for subsequent right-hand sides will be called D-CG and D-MinRes respectively. The algorithms are tested for the case of Wilson fermions and a considerable speed up in the convergence is observed.

255. **Non-Hermitian Polynomial Hybrid Monte Carlo**

Presenter: Oliver Witzel — Humboldt University

Time: Wednesday, 2:30 **Room:** Chesapeake B

Section: Algorithms and Machines

Co-authors:

Abstract:

We report on a new variant of the hybrid Monte Carlo algorithm employing a polynomial approximation of the inverse, non-Hermitian Dirac-Wilson operator. Our approximation relies on simple and stable recurrence relations of complex Chebyshev polynomials. First performance figures are presented.

256. **Solving some gauge systems at infinite N**

Presenter: Jacek Wosiek — Jagellonian University

Time: Tuesday, 4:10 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors:

Abstract:

After summarizing briefly some numerical results for four-dimensional supersymmetric SU(2) Yang-Mills quantum mechanics, we review a recent study of systems with an infinite number of colours. We study in detail a particular supersymmetric matrix model which exhibits a phase transition, strong-weak duality, and a rich structure of supersymmetric vacua. In the planar and strong coupling limits, this field theoretical system is equivalent to a one-dimensional XXZ Heisenberg chain and, at the same time, to a gas of q-bosons. This not only reveals a hidden supersymmetry in these well-studied models; it also maps the intricate pattern of our supersymmetic vacua into that of the, now-popular, ground states of the XXZ chain.

Generalizations required to attack the problem of spectra of planar field theories will be also discussed.

257. **Inverse Monte-Carlo and Demon Methods for Effective Polyakov Loop Models of SU(N)-YM**

Presenter: Christian Wozar — FSU Jena

Poster Session: A **Section:** Vacuum Structure and Confinement

Co-authors: T. Heinzl, T. Kästner, S. Uhlmann, B. H. Wellegehausen, A. Wipf

Abstract:

We study effective Polyakov Loop models for SU(N)-Yang-Mills theories at finite temperature with a focus on SU(3)-YM. The coupling constants of effective models are computed using inverse Monte-Carlo techniques. The phase structure of SU(3)-YM with an additional adjoint potential term is rendered with effective models. On this model we compare the IMC method of Schwinger-Dyson equations with the demon method. Our results indicate that the demon method works better than the Schwinger-Dyson equations in the vicinity of phase transitions and for the anti-centre phase of our model. Finally details of the demon method are discussed with a focus on the relation between microcanonical and canonical demon method.

258. **Numerical Investigation of the 2-D $N = 2$ Wess-Zumino Model**

Presenter: Christian Wozar — FSU Jena

Time: Monday, 3:50 **Room:** Chesapeake C

Section: Theoretical Developments

Co-authors: G. Bergner, T. Kästner, S. Uhlmann, A. Wipf

Abstract:

We study the N=2 Wess-Zumino model on the lattice. Discretizations without preserved supersymmetry are compared with discretizations preserving one supersymmetry formulated in local Nicolai variables. We observe that the so called "Nicolai improvement' introduces new problems to simulations of the supersymmetric model. Furthermore we compare perturbative mass corrections to one loop order in the weakly coupled regime with continuum extrapolations of our lattice results. In simulation runs with high statistics we checked the degeneracy of bosonic and fermionic masses on the lattice. For intermediate couplings first results of fermionic masses in the continuum are presented. In the strong coupling regime on the lattice we observe deviations from the perturbative result. Finally finite size effects of the effective potential are discussed.

259. **S-parameter and pseudo-Nambu-Goldstone boson mass from overlap lattice QCD**

Presenter: Norikazu Yamada — KEK

Time: Friday, 3:30 **Room:** Tidewater A

Section: Weak Decays and Matrix Elements

Co-authors: S. Aoki, T.W. Chiu, H. Fukaya, S. Hashimoto, T.H. Hsieh, T. Kaneko, H. Matsufuru, J. Noaki, T. Onogi, E. Shintani

Abstract:

We present a lattice calculation of L_{10}, one of the LECs in Chiral Perturbation Theory, and the charged-neutral pion mass splitting, using dynamical overlap fermion. Since we use the fermion formalism with exact chiral symmetry, we can reliably extract these quantities from the difference of the vacuum polarization functions for vector and axial-vector currents. In the context of the technicolor models, these two quantities are read as the S-parameter and the pseudo-Nambu-Goldstone boson mass induced by the electromagnetic interaction, respectively, and play an important role in discriminating the models from others. This calculation can serve as the feasibility study of the lattice techniques for more general technicolor gauge theories.

260. **Nucleon form factors from dynamical N_f=2+1 domain wall fermions**

Presenter: Takeshi Yamazaki — YITP

Time: Monday, 4:10 **Room:** Chesapeake A

Section: Hadron Structure

Co-authors: RBC and UKQCD Collaborations

Abstract:

We present our results of iso-triplet nucleon form factors, vector, induced tensor, axial vector and induced pseudoscalar form factors obtained from matrix elements with the vector and axial vector currents, using $N_f = 2+1$ dynamical domain wall fermions and Iwasaki gauge action at $\beta = 2.13$. The lattice scale is $a^{-1} \approx 1.73$ GeV and the physical volume is as large as about $(L$=2.7 fm$)^3$. We investigated the pion mass dependence of the form factors with four pion masses, $m_\pi \sim 330, 420, 560, 670$ MeV, and also the momentum transfer q^2 dependence with four lowest non-zero momenta. We confirm that the axial charge g_A/g_V has significant finite volume effect at the lightest pion mass that scales in a variable $m_\pi L$. We also found that the axial r.m.s. radius, which is determined from q^2 dependence of the axial vector form factor, has also a similar pion mass dependence as in the axial charge. The results are compared with the previous results for quenched, dynamical and mixed action calculations.

261. **Volume dependence of Fisher's zeros**

Presenter: Liu Yuzhi — University of Iowa

Poster Session: B **Section:** Theoretical Developments

Co-authors: A. Denbleyker, D. Du, Y. Meurice and A. Velytsky

Abstract:

We discuss the limitations of various MC based methods to locate the Fisher's zeros (of the partition function in the complex beta plane) in pure gauge theory on medium size lattices. We propose new methods that are applicable for larger volumes. We compare numerical results with general expectations at zero and finite temperature.

262. **$K \to \pi$ semileptonic form factor and the pion electromagnetic form factor using domain wall fermions and partially twisted boundary conditions**

Presenter: James Zanotti — University of Edinburgh

Poster Session: A **Section:** Weak Decays and Matrix Elements

Co-authors: P. Boyle, J. Flynn, A. Jüttner, Hugo Pedroso de Lima, C. Sachrajda

Abstract:

263. **Isospin symmetry breaking effects in the pion and nucleon masses**

Presenter: Ran Zhou — University of Connecticut

Time: Friday, 2:30 **Room:** Chesapeake A

Section: Hadron Spectroscopy

Co-authors: Thomas Blum, Takumi Doi, Masashi Hayakawa, Taku Izubuchi, Norikazu Yamada

Abstract:

We investigate the mass splittings in the pion and nucleon systems by combining 2+1 flavor domain wall fermion gauge configurations, generated by the RBC and UKQCD collaborati gons, and quenched, non-compact, lattice QED configurations. We study both the effect of the electromagnetic interaction as well as non-degenerate quarks on the mass splittings. We also analyze finite volume effects by using 16^3 and 24^3 lattices.