Future directions in lattice gauge theory - LGT10

Report of Contributions

https://indico.cern.ch/e/64133

Contribution ID: **0** Type: **not specified**

[K–>pipi]_2 decay amplitudes

Monday, 19 July 2010 11:00 (30 minutes)

The RBC-UKQCD calculation of Re[A_2] and Im[A_2] for almost physical kaons and pions will be reviewed, where A_2 is the amplitude for the decay of a kaon into two-pions with isospin 2. The simulations are performed on a 32ˆ3X64, L_s=32 lattice with N_f=2+1 flavours of light quarks, using the DWF-Iwasaki/DSDR action and the mass dependence of the amplitude is studied.
The calculations include (unitary) pions with a mass of 165 MeV and (partially quenched) pions with a mass of 145 MeV. The operators appearing in the weak Hamiltonian are renormalized non-perturbatively and finite-volume corrections are calculated using the Lellouch-Luscher formula. Re[A_2] will be compared to the experimental value and the phenomenological significance of the result for Im[A_2] will be discussed.

Presenter: SACHRAJDA, Chris (Univ. of Southampton)

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

Preliminary results of Delta I=1/2 and 3/2, K–>pipi decay amplitudes from Lattice QCD

Monday, 19 July 2010 11:30 (30 minutes)

We report a direct lattice calculation of the K–>pipi decay matrix elements for both Delta I=1/2 and 3/2 channels on 2+1 flavor, domain wall fermion, 16^3X32 lattices. This first direct calculation of the Delta I=1/2 channel is made possible by collecting very large statistics and studying the decay at pi-pi threshold with 420 MeV pions in a small, 1.8 fm box. All possible contractions are carefully listed and calculated and identities among them are verified. The decay into the isospin zero pi-pi final state, which receives contributions from the disconnected graphs, is very difficult to calculate, but a clear signal in the similar disconnected pi-pi correlator can be seen. We also demonstrate that a large explicit subtraction of the divergent (sbar gamma_5 d) contribution is necessary even for the case of kinematics which are nominally energy conserving.
Preliminary results, some with large errors, will be presented for the various contributions to the renormalized weak matrix elements A_0 and A_2 in the case of M_pi=420MeV. Delta I=1/2 Rule is demonstrated from our calculation.

Presenter: LIU, Qiu (Columbia University)

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

Topological gravity on the lattice

Tuesday, 20 July 2010 11:00 (30 minutes)

I show that a particular twist of N=4 super Yang-Mills in three dimensions with gauge group SU(2) possesses a set of classical vacua corresponding to the space of flat connections of the complexified gauge group SL(2,C). The theory also containsa set of topological observables corresponding to Wilson loops wrapping non-trivial cycles of the base manifold. This moduli space
and set of topological observables is shared with the Chern Simons formulation of three dimensional gravity and we hence conjecture that the Yang-Mills theory gives an equivalent description of the gravitational theory. Unlike the Chern Simons formulation the twisted Yang-Mills theory possesses a supersymmetric and gauge invariant lattice construction which then provides a possible non-perturbative definition of three dimensional gravity.

Presenter: CATTERALL, Simon (Syracuse University)

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

Conformal or Walking? Monte Carlo Renormalization Group studies of technicolor-inspired models

Tuesday, 20 July 2010 11:30 (30 minutes)

Models with many fermions or fermions in higher representations can be candidates for extended technicolor or unparticle theories. The phenomenologically most interesting models show "walking" or develop an infrared fixed point in strong gauge coupling. Lattice methods can be used to explore the phase diagram of these models, and Monte Carlo renormalization group (MCRG) methods are especially effective in identifying an infrared fixed point and measuring anomalous dimensions (critical indexes). In this talk I discuss the MCRG method as applied to SU(3) gauge models with many fermion flavors and discuss some new results in the 8, 12 and 16 flavor models.

Presenter: HASENFRATZ, Anna (Univ. of Colorado, Boulder)

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

Testing universality and automatic O(a) improvement in massless lattice QCD with Wilson quarks

Wednesday, 21 July 2010 11:00 (30 minutes)

The chirally rotated Schroedinger functional provides a test bed for universality and automatic O(a) improvement. In joint work with Bjoern Leder, we have implemented the chirally rotated Schroedinger functional and carried out extensive quenched simulations. We demonstrate that, after proper tuning of a dimension 3 boundary counterterm, the expected chirally rotated boundary conditions are indeed obtained. As a result, automatic O(a) improvement is realised and we demonstrate this with a few examples. Universality of properly renormalized correlation functions is confirmed by comparing to results obtained with the standard set-up of the Schroedinger functional. As a by-product of this study the non-singlet current renormalisation constants Z_A and Z_V are obtained from ratios of 2-point functions.

Presenter: SINT, Stefan (Trinity College, Dublin)

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

Oblique correction from sextet QCD

Wednesday, 21 July 2010 11:30 (30 minutes)

I compute the difference of vector and axial vector current correlators in the weak coupling phase of (lattice-regulated) SU(3) gauge theory with two flavors of symmetric-representation dynamical fermions. For the chosen parameters of the simulation, this model exhibits walking and for all practical purposes it is conformal. Consequences for the phenomenology of beyond Standard Model
physics are discussed.

Presenter: DEGRAND, Thomas (Univ. of Colorado, Boulder)

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

Unitary Fermions on the Lattice

Thursday, 22 July 2010 11:00 (50 minutes)

Understanding the properties of few to many strongly interacting fermions in a finite volume is of interest in many areas of physics, and is computationally challenging. One of the simplest non-trivial systems to look at are "unitary fermions": non- relativistic fermions with short range interactions and infinite scattering length. This is a conformal theory which can be studied experimentally with trapped atoms; it may also serve as a starting point for numerical nuclear physics, given how large are nucleon scattering lengths. In addition the system provides a good testing ground for confronting various computational challenges in finite density simulations. I discuss recent work with Endres, Nicholson and Lee where to date we have simulated up to 20 fermions on a 64^3 x 80 lattice, and 38 fermions on 16^3 x 36.

Presenter: KAPLAN, David (Inst. of Nuclear Theory, Seattle)

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

Renormalization of minimally doubled fermions

Friday, 23 July 2010 11:30 (30 minutes)

Minimally doubled fermions have been proposed as a strictly local discretization of the QCD quark action, which also preserves chiral symmetry at finite cut-off. We study the renormalization and mixing properties of two particular realizations of minimally doubled fermions in lattice perturbation theory at one loop. We also construct conserved axial-vector currents, which have a simple form
involving only nearest-neighbors sites.

Presenter: CAPITANI, Stefano (University of Mainz)

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

The FLAG working group: lattice results for phenomenologists

Friday, 23 July 2010 11:00 (30 minutes)

In the framework of the Flavianet European Network, a group of lattice and ChPT theorists, known as the Flavianet Lattice Averaging Group (FLAG), is making an effort to create a compilation of results on a few physical quantities, which critically summarize the state of the art in Pion and Kaon Physics. The quantities examined so far are quark masses, f_K/f_\pi, the Kaon decay form factor f_+(0), B_K and the ChPT low energy constants. The aim of the talk is to provide the best lattice value for a particular quantity, in a way which is readily accessible to non-experts. Given the limited duration of the talk, we will concentrate on the averaging selection criteria, rather than on the results themselves.

Presenter: VLADIKAS, Anastassios (Univ. of Tor Vergata, Rome)

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

Recent Results in Precision Heavy Quark Physics

Monday, 26 July 2010 11:00 (30 minutes)

I will report on recent results of the on-going efforts by the ALPHA collaboration to determine hadronic quantities in the heavy-flavor sector. In particular, I will highlight a precise calculation of the B*Bpi coupling in which a method to evaluate mesonic three-point correlation functions with small statistical and systematic errors is used. The efficacy of this approach is also compared with standard three-point function construction.

Presenter: BULAVA, John (DESY, Zeuthen)

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

B-physics on current lattices

Monday, 26 July 2010 11:30 (30 minutes)

A method to extract B-physics parameters (b-quark mass and fB, fBs decay constants) from currently available lattice data is presented. The approach is based on the idea of constructing appropriate ratios of heavy-light meson masses and decay constants, respectively, possessing a precisely known static limit, and evaluating them at various pairs of heavy quark masses around the charm. Via a smooth interpolation in the heavy quark mass from the easily accessible are computed with a few percent (statistical + systematic) error, using as a testing ground, recently produced Nf = 2 maximally twisted Wilson fermions data.

Presenter: ROSSI, Giancarlo (Univ. of Tor Vergata, Rome)

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

Using volume reduction to study QCD-like theories at large N_c

Tuesday, 27 July 2010 11:00 (50 minutes)

I describe ongoing work to implement the idea of volume-reduction for various QCD-like lattice gauge theories. If reduction holds, then many physical, infinite-volume, quantities can be obtained, by doing calculations on lattices of any size, including a single site, and taking the large N_c limit. Reduction holds as long as certain conditions are fulfilled, the most stringent of which is that the Z_N^4 center symmetry of the single-site model is not spontaneously broken. Previous work has shown that this symmetry is broken for the pure gauge theory (the Eguchi-Kawai model), and for various variants. Following a suggestion from Kovtun, Unsal and Yaffe, we have been investigating the possibility that reduction holds in the presence of dynamical fermions in the adjoint representation. Results will be presented for one and two Dirac fermions. The former theory is related, by large-N_c equivalences, to QCD with two degenerate Dirac flavors; the latter is the large-N_c version of a theory studied recently as a candidate for walking technicolor.

Presenter: SHARPE, Stephen (Univ. of Washington, Seattle)

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

Phase of the fermion determinant and QCD at nonzero chemical potential

Thursday, 29 July 2010 11:00 (30 minutes)

Because of the phase of the fermion determinant lattice QCD at nonzero chemical potential cannot be simulated by standard stochastic algorithms. However, if the sign problem is not severe, various independent methods give consistent results. We will investigate the severity of the sign problem by means of chiral perturbation theory. The distribution of the average phase factor, the chiral condensate and the baryon number will be derived and the overlap problem will be discussed. We compare various observables evaluated in QCD and in phase quenched QCD and give quantitative estimates for the contribution due to the phase of the fermion determinant. We will ask the question if there is a preferred class of observables with weak correlations with the phase factor which can be evaluated despite a severe sign problem. The relation between the Dirac spectrum and the sign problem will be discussed. We will illustrate these questions by explicit calculations in one dimensional lattice QCD and random matrix theory. Finally, implications for other nonhermitean Dirac operators such as the Wilson Dirac operator at nonzero lattice spacing will be discussed.

Presenter: VERBAARSCHOT, Jacobus (State University of New York, Stony Brook)

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

The meanfield laboratory to study five-dimensional gauge theories

Thursday, 29 July 2010 11:30 (30 minutes)

We present results from a meanfield expansion around a non-trivial background in five-dimensional SU(2) gauge theory. The physics goals are the study of dimensional reduction and spontaneous symmetry breaking. On the torus the meanfield expansion shows a second order phase transition in the non-compact regime, where the anisotropy becomes a relevant parameter. Dimensional reduction and effects of confinement are demonstrated. We show a comparision
to results from Monte Carlo simulations. Finally we describe the case of the orbifold geometry, where spontaneous symmetry breaking can occur.

Presenter: KNECHTLI, Francesco (Bergische Universitaet Wuppertal)

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

Form factor calculations for mesonic and baryonic systems

Monday, 2 August 2010 11:30 (30 minutes)

I report on an on-going project based on simulations with Nf=2 flavours of O(a) improved Wilson fermions. The main focus is on precision determinations of the pion form factor using twisted boundary conditions. I also describe our efforts to control a variety of systematic uncertainty in calculations of nucleon form factors. Finally, I present some lattice results for the hadronic vacuum polarisation contribution to the muon's anomalous magnetic moment.

Presenter: WITTIG, Hartmut (Univ. of Mainz)

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

Ouverture to lattice study of supersymmetric gauge theories

Friday, 30 July 2010 11:30 (30 minutes)

We report our recent results concerning the realization of supersymmetric gauge theory on the lattice. Specifically, we present a clear numerical evidence in a lattice formulation of 2D N=(2,2) supersymmetric Yang-Mills theory that supersymmetry Ward-Takahashi identities, which are broken by the lattice regularization, are restored in the continuum limit without fine tuning. As "physical application" of the formulation, we consider numerical measurement of the vacuum energy of the system which provides an order parameter of the spontaneous supersymmetry breaking.

Presenter: SUZUKI, Hiroshi

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

Aspects of center symmetry in the QCD phase diagram

Monday, 2 August 2010 11:00 (30 minutes)

We explore the role of center symmetry and its explicit and spontaneous breaking in different parts of the QCD phase diagram. In particular the following issues are addressed: 1) In a fugacity expansion the grand canonical fermion determinant can be decomposed into canonical determinants with a fixed quark number. The canonical determinants have simple transformation properties under center transformations and we explore how different center sectors contribute to observables. 2) We study the behavior of local Polyakov loops in pure gluodynamics and full QCD. It is shown that spatial clusters may be identified where the phases of the local Polyakov loops have coherent values near the center elements. The transition to the deconfining phase is signaled by the onset of percolation. 3) An effective theory for the Polyakov loop with center symmetry breaking terms and a chemical potential is studied. The theory can be exactly mapped onto a dimer-monomer system where the sign problem is solved. We simulate the system with a worm algorithm and discuss its phase diagram and the consequences for the QCD phase diagram.

Presenter: GATTRINGER, Christof (Univ. of Graz, Austria)

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

Phases of gauge theories and applications from LHC to cosmology

Friday, 30 July 2010 11:00 (30 minutes)

I will review the state-of-the-art of the phase diagram of chiral and non chiral gauge theories obtained using several distinct analytical methods. I will then show how to use this information to construct models of dynamical electroweak symmetry breaking. Finally I will discuss relevant applications for cosmology.

Presenter: SANNINO, Francesco (CP3-Origins, Odense, Denmark)

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

Loop formulation of supersymmetric models on the lattice

Thursday, 5 August 2010 11:00 (30 minutes)

We review the construction of twisted supersymmetry and Q-exact actions on the lattice in low dimensions and discuss the formulation of such supersymmetric lattice models as an interacting gas of bosonic and fermionic loops. We comment on the relevance of the fermion sign problem for the vanishing of the Witten index and show how this sign problem can be solved by employing the Prokof'ev-Svistunov worm algorithm together with topological boundary conditions.

Presenter: WENGER, Urs (ITP, Bern)

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

Spectra of the Wilson Dirac operator at nonzero lattice spacing

Tuesday, 3 August 2010 11:30 (30 minutes)

This talk discusses the effect of the lattice spacing on the microscopic spectrum of the Wilson Dirac operator. Exact results are obtained from Wilson chiral Perturbation Theory in sectors of fixed topology, where topology is defined as the number of real eigenvalues of the Wilson Dirac operator. We compute the density of these real modes as well as the microscopic spectral density of the hermitian Wilson Dirac operator. Both quenched and unquenched results are presented. We introduce a chiral Random Matrix Theory that reproduces these results. Finally, we discuss how these results may be used to determine the coefficients of Wilson chiral perturbation theory.

Presenter: SPLITTORFF, Kim (Niels Bohr Inst., Copenhagen)

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

Kaon physics from lattice QCD

Wednesday, 28 July 2010 14:00 (1 hour)

Enhanced algorithms and multi-teraflops computer resources are making an increasing range of kaon physics accessible to lattice QCD. After an overview of the RBC/UKQCD chiral fermion simulation program, results will be presented for f_K/f_pi, B_K and the complex amplitude A_2 determining Delta I = 3/2, K -> pi+pi decay. Initial work and prospects for the similar Delta I = 1/2 K -> pi+pi amplitude will also be described.

Presenter: CHRIST, Norman (Columbia University)

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

Technicolor and conformal window on the lattice

Wednesday, 4 August 2010 14:00 (1 hour)

In phenomeologically acceptable technicolor theories the gauge coupling evolves very slowly, "walks", over a specific range of energies. Thus, the beta-function of the theory has a near-zero at a non-zero value of the coupling constant, where the theory becomes almost conformal. Because the almost-fixed point is at relatively strong coupling, non-perturbative lattice simulations are required for reliable investigations of these theories. In recent years these theories have attracted a lot of interest from the lattice community. In this talk I review the progress, problems and prospects in studies of some candidate theories with an fixed point or almost-fixed point, concentrating on the theory with SU(2) gauge fields and two flavours of adjoint representation fermions.

Presenter: RUMMUKAINEN, Kari (University of Helsinki)

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

Excited State Spectroscopy from Lattice QCD

Thursday, 5 August 2010 11:30 (30 minutes)

There has been a resurgence of interest in spectroscopy with a new generation of experiments that are starting worldwide, for example BES III, GSI/Panda, and Jefferson Lab's GlueX project as well as CLAS12.
Spectroscopy reveals fundamental aspects of hadronic physics. However, the excited spectrum of light quark mesons and baryons is not well determined or understood. The GlueX project will search for gluonic excitations of matter which have not unambigously been observed.
Lattice QCD is quite amenable to such non-perturbative studies, but there are many challenges. I will report on some recent progress that has been made in determining the highly excited spectrum of QCD, and point out challenges for future work.

Presenter: EDWARDS, Robert (Jefferson Lab)

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

Lattice Perturbation Theory: is still there space for novelty?

Tuesday, 3 August 2010 11:00 (30 minutes)

The author has been involved for quite a long time in a non-standard approach to Lattice Perturbation Theory (a stochastic method named NSPT).
I will try to have a look at some unconventional approaches to PT computations on which we have been trying to move some steps forward for a while, like non-trivial vacua or the Dirac spectrum.

Presenter: DI RENZO, Francesco (Univ. of Parma and INFN)

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

Physical Point Simulation in 2+1 Flavor Lattice QCD

Friday, 6 August 2010 11:00 (30 minutes)

We present the results of the physical point simulation in 2+1 flavor lattice QCD with the non-perturbatively O(a)-improved Wilson quark action and the Iwasaki gauge action at beta=1.9 on a 32ˆ3x64 lattice. The physical quark masses together with the lattice spacing is determined with m_pi, m_K and m_Omega as physical inputs.
There are two key algorithmic ingredients to make possible the direct simulation at the physical point:
One is the mass-preconditioned domain-decomposed HMC algorithm to reduce the computational cost. The other is the reweighting technique to adjust the hopping parameters exactly to the physical point.
We discuss the latter in detail.
Some physics results are also presented.

Presenter: KURAMASHI, Yoshinobu (University of Tsukuba)

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

Experiences and results in N_f=2+1 lattice QCD at and around the physical mass point

Friday, 6 August 2010 11:30 (30 minutes)

I will present the recent progress made by the Budapest-Marseille-Wuppertal collaboration in simulating N_f=2+1 QCD with pion masses down to around 120 MeV, and will show some of the results obtained on these and earlier sets of configurations.

Presenter: LELLOUCH, Laurent (Centre de Physique Theorique)

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

Extraction of hadron interactions from lattice QCD

Monday, 9 August 2010 11:00 (50 minutes)

A few years ago, we proposed a method to extract potentials from the Nambu-Bethe-Salpeter wave function and indeed obtained the nucleon-nucleon potential in lattice QCD. In this talk, as an extension of this method, we propose a new method to extract information of hadron interactions in lattice QCD above the inelastic threshold. After theoretical considerations of this method, we present results from a toy model to show a main idea of this method as well as from lattice QCD to extract hyperon-hyperon potentials.
We briefly discuss other applications.

Presenter: AOKI, Sinya (Univ. of Tsukuba)

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

Calorons with non-trivial holonomy

Tuesday, 10 August 2010 11:00 (30 minutes)

The progress on calorons (finite temperature instantons) is sketched. In particular there is some interest for confining temperatures, where the holonomy (the asymptotic value of the Polyakov loop) is non-trivial. I also will give more recent results by others.

Presenter: VAN BAAL, Pierre (Institut Lorentz for Theoretical Physics, University of Leiden)

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

Lattice QCD at the Turning Point

Wednesday, 11 August 2010 14:00 (1h 30m)

Lattice QCD is now turning a crucial corner. Progress over the last four decades in physics, algorithms, and supercomputers is finally bringing it to the point where it is possible to carry out calculations in a large enough box and a small enough lattice spacing at the physical masses for light quarks. Soon we shall no longer be simulating but calculating strong interactions as they take place in Nature. We discuss how this progress came about, and what advances it is bringing in for the understanding of the dynamics of strong interactions. We also discuss aspects of lattice QCD research which are somewhat different from those of pure theory. This includes development of high performance computing infrastructure such as R&D of supercomputers and International Lattice Data Grid for global data sharing. Recent status of the National "Kei"(10 Pflops in Japanese counting system) Supercomputer Project in Japan is touched upon in this context.

Presenter: UKAWA, Akira (University of Tsukuba)

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

Momentum space proof of BPH renormalization to all orders in perturbation theory

Thursday, 12 August 2010 11:00 (50 minutes)

A new momentum space formalism is given for the renormalization of quantum field theories to all orders of perturbation theory, in which there are manifestly no overlapping divergences. We prove the BPH theorem in this formalism, and show how the required local subtractions add up to counterterms in the action. Applications include a proof of the renormalization of lattice perturbation theory, the decoupling theorem, Zimmermann oversubtraction, the renormalization of operator insertions, operator product expansion, and (perhaps) a proof of renormalizability of the Schr\"odinger functional.

Presenter: KENNEDY, Anthony (Univ. of Edinburgh)

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

Lattice QCD+QED simulation

Friday, 13 August 2010 11:00 (30 minutes)

Each individual masses of up, down, and strange quarks are extracted using lattice QCD+QED simulation using Nf=2+1 DWF ensemble generated by RBC/UKQCD collaboration. An analysis on isospin breaking in Kaon mass, or proton/neutron mass difference will be also presented.

Presenter: IZUBUCHI, Taku (Brookhaven National Laboratory)

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

2+1 flavor QCD simulations with domain wall fermions and the I-DSDR gauge action

Friday, 13 August 2010 11:30 (30 minutes)

I discuss current RBC and UKQCD collaboration 2+1 flavor QCD simulations using domain wall fermions and the Iwasaki+dislocation-suppressing-determinant-ratio (I-DSDR) gauge action with beta=1.75. Unitary pion masses for these simulations are 180 MeV and 250 MeV.
Partially quenched pion masses go down to the physical pion mass. The size of the lattice is 32ˆ3X64X32, corresponding to a volume of ˜(4.5 fm)ˆ3. Gauge field topology, light pion and kaon physics, and scaling errors are discussed.

Presenter: BLUM, Tom (Univ. of Connecticut)