Impact of the Asqtad Gauge Configurations

In this attachment we show some of the results obtained from the Asqtad gauge configurations and compare them with experiment. We also describe the impact of the Asqtad gauge configurations on the determination of the CKM matrix elements, and discuss the work of other physicists who have used them.

Comparison of Lattice Calculations with Experiment

In order to validate our approach, we and others making use of the Asqtad gauge configurations have calculated a number of quantities whose values can be determined to high accuracy on the lattice, and are well known experimentally [1, 2, 3]. In Table 1 we compare results for $\alpha_S(M_Z)$, the strong coupling constant evaluated at the mass of the Z boson; f_π and f_K, the leptonic decay constants of the π and K mesons; V_{us}, the CKM matrix element for the weak transition of a u to an s quark; M_{Ω^-}, the mass of the Ω^- baryon; and $\Delta E_\psi(1P-1S)$ and $\Delta E_\Upsilon(1P-1S)$, the $1P-1S$ level splittings in the charmonium and bottomonium spectra. Note that this list includes some quantities with only up, down, and/or strange valence quarks, and others with heavier charm or bottom valence quarks. The quantities measured to determine $\alpha_S(M_Z)$ have no valence quarks at all. These and additional validation results are shown in Figure 1 of the progress report.

Quantity	Lattice QCD	Experiment
$\alpha_S(M_Z)$	0.1170 ± 0.0012	0.1185 ± 0.0014
f_π	$128.3^{+2.5}_{-3.5}$ MeV	130.7 ± 0.4 MeV
f_K/f_π	$1.202^{+0.008}_{-0.014}$	1.223 ± 0.012
V_{us}	$0.2246^{+0.0025}_{-0.0013}$	0.2257 ± 0.0021
M_{Ω^-}	1667 ± 52 MeV	1672 MeV
$\Delta E_\psi(1P-1S)$	422 ± 16 MeV	428 MeV
$\Delta E_\Upsilon(1P-1S)$	447 ± 9 MeV	440 MeV

Table 1: Comparison of several quantities calculated on the lattice with their experimental determinations. When no experimental error is given, it is smaller than the last digit shown.

Perhaps the most convincing test of methods is to make successful predictions in advance of experimental measurements. Five such predictions have been tested to date: the mass of the B_c meson [4, 5], the leptonic decay constants of the D^+, D_s and B mesons [5, 6, 7], and the shape and normalization of the $D \to K l \nu$ semileptonic form factor. The original predictions for the first four quantities and the initial experimental results confirming them are shown in Table 2. The predictions and experimental results for the $D \to K l \nu$ form factor are shown in Fig. 1.

Quantity	Lattice QCD	Experiment
f_{D^+}	$201 \pm 3 \pm 17$ MeV	$223 \pm 17 \pm 3$ MeV
f_{D_s}/f_{D^+}	$1.21 \pm 0.01 \pm 0.04$	$1.27 \pm 0.12 \pm 0.03$
M_{Bc}	6304 ± 22 MeV	6286 ± 5 MeV
f_B	216 ± 22 MeV	$229 \pm 36 \pm 34$ MeV

Table 2: Lattice predictions for the leptonic decay constants of the D, D_s and B mesons and the mass of the B_c meson, along with the experimental results that initially confirmed them.

During the past year there have been very interesting new experimental measurements and lattice calculations of f_{D^+} and f_{D_s}. Averaging over results from recent experiments, Rosner and Stone find $f_{D^+} = 205.8 \pm 8.9$ MeV and $f_{D_s}/f_{D^+} = 1.33 \pm 0.07$ [8]. Meanwhile, the HPQCD Collaboration has made a new determination of these quantities on the lattice using the Asqtad gauge configurations and valence quarks

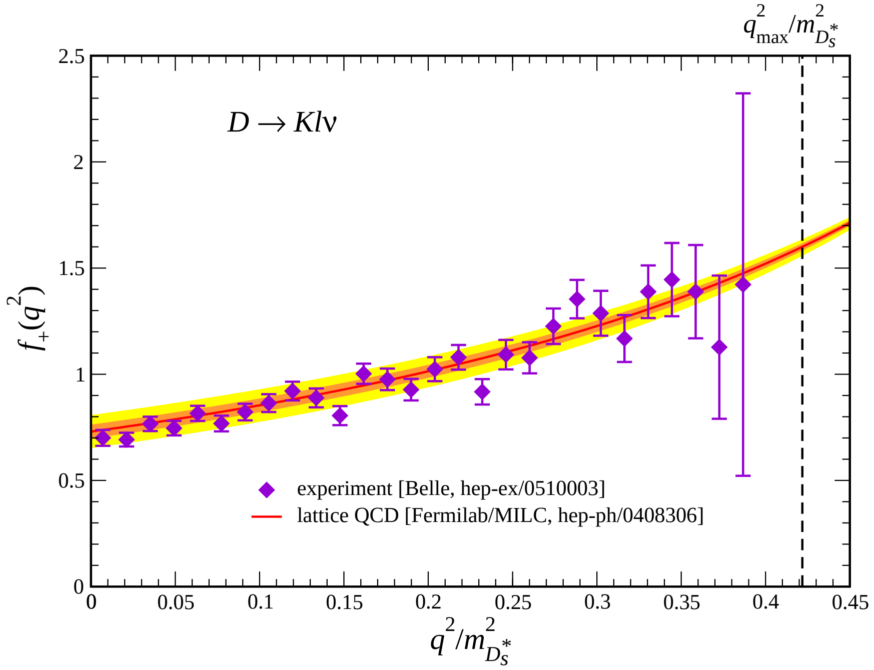

Figure 1: The semileptonic form factor $f_+(q^2)$ for the decay of a D meson into a K meson, a lepton,and a neutrino, as a function of the momentum transfer to the leptons q^2. The orange curve is the lattice prediction, and the blue points are the experimental results of the Belle Collaboration.

from the highly improved staggered quark (HISQ) action, which it recently developed [9]. HPQCD obtained $f_{D+} = 208 \pm 4$ MeV and $f_{D_s}/f_{D+} = 1.162 \pm 0.009$ [10]. Thus, the HPQCD result for f_{D+} is in good agreement with the experiment, but its result for the ratio of decay constants disagrees with the experimental result by 2.4 standard deviations. The most recent Fermilab-MILC calculation of this ratio, which uses the same Asqtad configurations, Asqtad light valence quarks, and the Fermilab formulation of charmed valence quarks, yields $f_{D_s}/f_{D+} = 1.20 \pm 0.025$ [11]. It is clearly very important to improve the accuracy of both lattice calculations, and work is in progress to do so. A disagreement between the lattice calculation and experimental determination of f_{D_s} could signal the presence of physics not included in the Standard Model [12].

Impact on the Determination of CKM Matrix Elements

The level of accuracy we seek in our calculations is determined in large part by our studies of the weak interactions of strongly interacting particles. An international effort is in progress to determine the elements of the Cabibbo-Kobayashi-Maskawa (CKM) matrix, which determines how quarks, the fundamental strongly interacting particles, couple to the weak interactions. In most cases both an accurate experiment and lattice calculation are needed. By determining individual elements of the CKM matrix from different experiments and lattice calculations, one can place powerful constraints on the range of validity of the Standard Model. The U.S. Lattice QCD Executive Committee, which is leading an effort to develop computational infrastructure for our field, has made a detailed analysis of the impact of improved lattice calculations on the determination of CKM matrix elements. It is based in large part on the configurations we have or are planning to generate. Table 3 summarizes the portion of the study relevant to this proposal. The first column indicates the decay process to be studied. For the first row one must perform a lattice calculation of the ratio of the leptonic decay constants of the K and π mesons, and in the remaining rows one must determine the semileptonic form factors of the process indicated. The second column shows the CKM matrix element to be determined, the third column the present errors on the CKM matrix element arising from experimental uncertainties, and the fourth column the present errors arising from uncertainties in the lattice calculations. The fifth and six columns show the expected lattice contributions to the errors by the end of 2009 and 2014, respectively. One notes that in all cases the current lattice errors are larger than the experimental ones. Our goal is to bring the lattice errors down to or below the experimental ones, which will themselves be decreasing over the next few years. The importance of doing so can be seen from the fact that a significant fraction of the $750,000,000 per year that the United States has spent on experimental high energy physics over the last several years has been devoted to the study of the weak decays of strongly interacting particles. It is clear that to fully capitalize on this investment, the lattice calculations must keep pace with the experimental measurements.

Quantity	CKM element	Present expt. error	Present lattice error	2009 lattice error	2014 lattice error	Error from non-lattice method
f_K/f_π	V_{us}	0.3%	0.9%	0.5 %	0.3%	0.9%($K^+ \to \pi^0 e^+ \nu$)
$D \to \pi \ell \nu$	V_{cd}	3%	11%	6%	4%	4.8%(ν scatt.)
$D \to K \ell \nu$	V_{cs}	1%	11%	5%	2%	5% (ν scatt.)
$B \to D^* \ell \nu$	V_{cb}	1.8%	2.4%	1.6%	0.8%	$<$ 2% (Incl. $b \to c$)
$B \to \pi \ell \nu$	V_{ub}	3.2%	14%	10%	4%	10% (Incl. $b \to u$)

Table 3: Present status and future prospects for lattice calculations which directly determine elements of the CKM matrix. All errors are quoted for the CKM elements themselves. Estimates are from the contributions of Juettner, Laiho, Lüth, Shipsey, and van de Water to Ref. [13], and from Ref. [14]. The last column, if present, shows the present error attainable on the CKM element using competing, non-lattice approaches.

Use of the Asqtad Gauge Configurations by Other Physicists

As noted in the proposal, a total of sixty-seven physicists outside our collaboration have used the Asqtad gauge configurations we are generating in their own research. These include colleagues at thirty-three institutions throughout the world. Their research covers a very broad range of topics including determinations of the strong coupling constant, the quark masses, the quarkonium spectrum and decay widths, the mass spectrum of mesons with a heavy quark and a light antiquark, the masses of mesons and baryons, as well as studies of the weak decays of mesons containing heavy quarks, the mixing of neutral K and B mesons with their antiparticles, the quark and gluon structure of hadrons, the scattering lengths of pions and nucleons, the hadronic contributions to the muon anomalous magnetic moment, and meson spectral functions. We believe that the outstanding research they are doing with our configurations is an additional justification for the resources we request.

Some of the physicists using our gauge configurations are collaborating with us, while others are using them for separate projects. Here we list the papers published in refereed journals or conference proceedings by physicists from outside our collaboration that are based on the use of our configurations.

Publications Enabled by the Asqtad Gauge Configurations

Publications In or Submitted to Refereed Journals

1. The Fermilab, HPQCD, MILC and UKQCD Collaborations: C.T.H. Davies, *et al.*, “High-Precision Lattice QCD Confronts Experiment,” Phys. Rev. Lett. **92**, 022001 (2004) [arXiv:hep-lat/0304004].

2. The HPQCD Collaboration: J. Shigemitsu, *et al.*, “Heavy-light meson semileptonic decays with staggered light quarks,” Nucl. Phys. Proc. Suppl. **129 & 130**, 325 (2004) [arXiv:hep-lat/0309039].

3. The HPQCD Collaboration: J. Shigemitsu, *et al.*, “Progress calculating decay constants with NRQCD and Asqtad actions,” Nucl. Phys. Proc. Suppl. **129 & 130**, 331 (2004) [arXiv:hep-lat/0309092].

4. The HPQCD Collaboration: A. Gray, *et al.*, “The B/s and D/s decay constants in 3 flavor lattice QCD,” Phys. Rev. Lett. **92**, 162001 (2004) [arXiv:hep-ph/0311130].

5. The HPQCD, MILC and UKQCD Collaborations, C. Aubin *et al.*, “First determination of the strange and light quark masses from full lattice QCD,” Phys. Rev. D **70**, 031504 (2004) (Rapid Communications) [arXiv:hep-lat/0405022].

6. The Fermilab Lattice and MILC Collaborations: C. Aubin *et al.*, “Semileptonic decays of D mesons in three-flavor lattice QCD,” Phys. Rev. Lett. **94**, 011601 (2005) [arXiv:hep-ph/0408306].

7. The Fermilab Lattice and HPQCD Collaborations: I. Allison *et al.*, “Mass of the B_c meson in three-flavor lattice QCD,” Phys. Rev. Lett. **94**, 172001 (2005) [arXiv:hep-lat0411027].

8. The HPQCD and UKQCD Collaborations: C. Davies *et al.*, “Accurate Determinations of α_s from Realistic Lattice QCD,” Phys. Rev. Lett. **95** 052002 (2005) [arXiv:hep-lat/0503005].

9. The NPLQCD Collaboration: S. Beane, *et al.*, “I=2 pi-pi Scattering from Fully-Dynamical Mixed-Action Lattice QCD,” Phys. Rev. **D73**, 054503 (2006) xi[arXiv:

10. The Fermilab Lattice and MILC Collaborations: C. Aubin *et al.*, “Charmed meson decay constants in three-flavor lattice QCD,” Phys. Rev. Lett. **95**, 122002 (2005) [arXiv:hep-lat/0506030].

11. The HPQCD Collaboration: A. Gray *et al.*, “The Upsilon spectrum and m_b from full lattice QCD,” Phys. Rev. **D72**, 094507 (2005) [arXiv:hep-lat/0507013].

12. The HPQCD Collaboration: A. Gray, *et al.*, “The B Meson Decay Constant from Unquenched Lattice QCD,” Phys. Rev. Lett. **95**, 212001 (2005) [arXiv:hep-lat/0507015].

13. The LHPC Collaboration: R. Edwards, *et al.*, “The nucleon axial charge in full lattice QCD,” Phys. Rev. Lett. **96** 052001 (2006) [arXiv:hep-lat/0510062].

The HPQCD Collaboration: Q. Mason *et al.*, “High-precision determination of the light-quark masses from realistic lattice QCD,” Phys.Rev. D **73**, 114501 (2006) [arXiv:hep-ph/0511160].

14. The HPQCD Collaboration: E. Dalgic, *et al.*, “B Meson Semileptonic Form Factors from Unquenched Lattice QCD,” Phys. Rev. D **73**, 074502 (2006) [Erratum-ibid. D **75**, 119906 (2007)] [arXiv:hep-lat/0601021].

15. The NPLQCD Collaboration: S. R. Beane, P. F. Bedaque, K. Orginos and M. J. Savage, “Nucleon nucleon scattering from fully-dynamical lattice QCD,” Phys. Rev. Lett. **97**, 012001 (2006) [arXiv:hep-lat/0602010].

16. The HPQCD Collaboration: E. Gamiz, *et al.*, “Unquenched determination of the kaon parameter B(K) from improved staggered fermions,” Phys. Rev. D **73**, 114502 (2006) [arXiv:hep-lat/0603023].

17. The NPLQCD Collaboration: S. R. Beane, K. Orginos and M. J. Savage, “The Gell-Mann - Okubo mass relation among baryons from fully-dynamical mixed-action lattice QCD,” Phys. Lett. B **654**, 20 (2007) [arXiv:hep-lat/0604013].

18. The NPLQCD Collaboration: S. R. Beane, K. Orginos and M. J. Savage, “Strong-isospin violation in the neutron proton mass difference from fully-dynamical lattice QCD and PQQCD,” Nucl. Phys. B **768**, 38 (2007) [arXiv:hep-lat/0605014].

19. The NPLQCD Collaboration: S. R. Beane, *et al.*, “f(K)/f(pi) in full QCD with domain wall valence quarks,” Phys. Rev. D **75**, 094501 (2007) [arXiv:hep-lat/0606023].

20. The NPLQCD Collaboration: S. R. Beane, *et al.*, “pi K scattering in full QCD with domain-wall valence quarks,” Phys. Rev. D **74**, 114503 (2006) [arXiv:hep-lat/0607036].

21. C. Alexandrou, T. Leontiou, J. W. Negele and A. Tsapalis, “The axial N to Delta transition form factors from lattice QCD,” Phys. Rev. Lett. **98**, 052003 (2007) [arXiv:hep-lat/0607030].

22. C. Aubin and T. Blum, “Calculating the hadronic vacuum polarization and leading hadronic contribution to the muon anomalous magnetic moment with improved staggered quarks,” Phys. Rev. D **75**, 114502 (2007) [arXiv:hep-lat/0608011].

23. The HPQCD and UKQCD Collaborations: E. Follana *et al.*, “Highly improved staggered quarks on the lattice, with applications to charm physics,” Phys. Rev. D **75**, 054502 (2007) [arXiv:hep-lat/0610092].

24. The HPQCD Collaboration: E. Dalgic *et al.*, “B/s0 - anti-B/s0 mixing parameters from unquenched lattice QCD,” Phys. Rev. D **76**, 011501 (2007) [arXiv:hep-lat/0610104].

25. The NPLQCD Collaboration: S. R. Beane, *et al.*, “Hyperon nucleon scattering from fully-dynamical lattice QCD,” Nucl. Phys. A **794**, 62 (2007) [arXiv:hep-lat/0612026].

26. C. Alexandrou, G. Koutsou, T. Leontiou, J. W. Negele and A. Tsapalis, “Axial Nucleon And Nucleon To Delta Form Factors And The Goldberger-Treiman Relations From Lattice QCD,” Phys. Rev. D **76**, 094511 (2007) [arXiv:0706.3011 [hep-lat]].

27. K. Orginos and A. Walker-Loud, “Mixed meson masses with domain-wall valence and staggered sea fermions,” Phys. Rev. D **77**, 094505 (2008) [arXiv:0705.0572 [hep-lat]].

28. The HLPC Collaboration: Ph. Hagler *et al.*, “Nucleon Generalized Parton Distributions from Full Lattice QCD,” arXiv:0705.4295 [hep-lat].

29. The HPQCD and UKQCD Collaborations: E. Follana, *et al.*, “High Precision determination of the pi, K, D and D_s decay constants from lattice QCD,” Phys. Rev. Lett. **100**, 062002 (2008) [arXiv:0706.1726 [hep-lat]].

30. The NPLQCD Collaboration: S. R. Beane, *et al.*, “Precise Determination of the I=2 pi-pi Scattering Length from Mixed-Action Lattice QCD,” Phys. Rev. D **77**, 014505 (2008) [arXiv:0706.3026 [hep-lat]].

31. NPLQCD Collaboration: S. R. Beane, *et al.*, “The K+K+ Scattering Length from Lattice QCD,” arXiv:0709.1169 [hep-lat].

32. The NPLQCD Collaboration: S. R. Beane, *et al.*, “Multi-Pion Systems in Lattice QCD and the Three-Pion Interaction,” Phys. Rev. Lett. **100**, 082004 (2008) [arXiv:0710.1827 [hep-lat]].

33. C. Alexandrou, G. Koutsou, H. Neff, J. W. Negele, W. Schroers and A. Tsapalis, “The nucleon to Delta electromagnetic transition form factors in lattice QCD,” Phys. Rev. D **77**, 085012 (2008) [arXiv:0710.4621 [hep-lat]].

34. H. W. Lin and K. Orginos, “First Calculation of Hyperon Axial Couplings from Lattice QCD,” arXiv:0712.1214 [hep-lat].

35. K. Orginos, “Lattice QCD And Nuclear Physics: Computations Of Hadron Hadron Scattering,” Eur. Phys. J. A **31**, 799 (2007).

36. C. Aubin, J. Laiho and R. S. Van de Water, “Discretization effects and the scalar meson correlator in mixed-action lattice simulations,” arXiv:0803.0129 [hep-lat].

37. The NPLQCD Collaboration: W. Detmold, *et al.*, “Multi-Pion States in Lattice QCD and the Charged-Pion Condensate,” arXiv:0803.2728 [hep-lat].

38. E. Gamiz, J. Shigemitsu and H. Trottier, “Four Fermion Operator Matching with NRQCD Heavy and Asqtad Light Quarks,” arXiv:0804.1557 [hep-lat].

39. The HPQCD Collaboration: I. Allison *et al.*, “High-Precision Charm-Quark Mass from Current-Current Correlators in Lattice and Continuum QCD,” arXiv:0805.2999 [hep-lat].

40. The NPLQCD Collaboration: S. Beane, *et al.* “Hadronic Interactions from Lattice QCD,” arXiv:0805.4629 [hep-lat], to be published in International Journal of Modern Physics C.

41. A. Walker-Loud, *et al.*, “Light hadron spectroscopy using domain wall valence quarks on an Asqtad sea,” arXiv:0806.4549 [hep-lat].

Publications in Conference Proceedings

1. The HPQCD Collaboration: A. Gray *et al.*, “The Upsilon spectrum from lattice QCD with 2+1 flavors of dynamical Nucl. Phys. Proc. Suppl. **119**, 592 (2003) [arXiv:hep-lat/0209022].

2. The HPQCD Collaboration: J. Hein, *et al.*, “On the strange quark mass with improved staggered quarks,” Nucl. Phys. Proc. Suppl. **119**, 317 (2003) [arXiv:hep-lat/0209077].

3. The HPQCD Collaboration: M. Wingate, *et al.*, “B/s mesons using staggered light quarks,” Nucl. Phys. Proc. Suppl. **119**, 604 (2003) [arXiv:hep-lat/0209096].

4. The HPQCD and UKQCD Collaborations: C. Davies *et al.*, “The determination of α_s from lattice QCD with 2+1 flavors of dynamical quarks,” Nucl. Phys. B (Proc. Suppl.) **119** (2003) 595 [arXiv:hep-lat/0209122].

5. The LHPC Collaboration: W. Schroers *et al.*, “Moments of nucleon spin-dependent generalized parton distributions,” Nucl. Phys. Proc. Suppl. **129 & 130**, 907 (2004) [arXiv:hep-lat/0309065].

6. The Fermilab and MILC Collaborations: M. Okamoto *et al.*, “Semileptonic decays of D mesons in unquenched lattice QCD,” Nucl. Phys. Proc. Suppl. **129 & 130**, 334 (2004) [arXiv:hep-lat/0309107].

7. The Fermilab Lattice Collaboration: M. di Pierro *et al.*, “Properties of charmonium in lattice QCD with 2+1 flavors of improved staggered sea quarks,” Nucl. Phys. Proc. Suppl. **129 & 130**, 340 (2004) [arXiv:hep-lat/0310042].

8. The Fermilab Lattice Collaboration: M. di Pierro *et al.*, “D_s spectrum and leptonic decays with Fermilab heavy quarks and improved staggered light quarks,” Nucl. Phys. Proc. Suppl. **129 & 130**, 328 (2004) [arXiv:hep-lat/0310045].

9. T. Blum, “Lattice calculation of the lowest order hadronic contribution to the muon anomalous magnetic moment: An update with Kogut-Susskind fermions,” Nucl. Phys. Proc. Suppl. **129 & 130**, 904 (2004) [arXiv:hep-lat/0310064].

10. The LHPC Collaboration: F. D. R. Bonnet, *et al.*, “Mesonic form factors,” Nucl. Phys. Proc. Suppl. **128**, 59 (2004) [arXiv:hep-lat/0312008].

11. The LHPC Collaboration: J. W. Negele *et al.*, “Insight into nucleon structure from lattice calculations of moments of parton and generalized parton distributions,” Nucl. Phys. Proc. Suppl. **128**, 170 (2004) [arXiv:hep-lat/0404005].

12. P. Petreczky and T. Blum, “Cut-off effects in meson correlators and spectral functions,” Nucl. Phys. Proc. Suppl. **140**, 553 (2005) [arXiv:hep-lat/0408045].

13. The HPQCD Collaboration: Alan Gray, *et al.*, “B Leptonic Decays and $B-\overline{B}$ Mixing with $2+1$ Flavors of Dynamical Quarks”, Nuc. Phys. (Proc. Suppl.) **140**, 446 (2005) [arXiv:hep-lat/0409040].

14. The HPQCD and UKQCD Collaborations: E. Gamiz, *et al.*, “B_K from improved staggered quarks” Nucl. Phys. B (Proc. Suppl.) **140**, 353 (2005) [arXiv:hep-lat/0409049].

15. The LHPC Collaboration: G. Fleming, *et al.*, “Pion form factor using domain wall valence and asqtad sea quarks,” Nucl. Phys. (Proc. Suppl.) **140**, 302 (2005) [arXiv:hep-lat/0409081].

16. I. Allison, C.T.H. Davies, A. GRAY, A. Kronfeld, P. Mackenzie and J. Simone, Nucl. Phys. (Proc. Suppl.) **140**, 440 (2005) [arXiv:hep-lat0409090].

17. The LHPC Collaboration: Dru B. Renner, *et al.*, “Hadronic physics with domain-wall valence and improved staggered sea quarks,” Nucl. Phys. Proc. Suppl. **140**, 255 (2005) [arXiv:hep-lat/0409130].

18. R. Edwards [LHPC Collaboration], “Electromagnetic Hadronic Form-Factors,” Nucl. Phys. Proc. Suppl. **140**, 290 (2005) [arXiv:hep-lat/0409119].

19. Tom Blum, “Lattice calculation of the hadronic contributions to the muon anomalous magnetic moment,” Nucl. Phys. Proc. Suppl. **140**, 311 (2005) [arXiv:hep-lat/0411002].

20. Konstantin Petrov, “On quark mass and lattice spacing dependence of the the singlet free energies with improved fermions,” Nucl. Phys. Proc. Suppl. **140**, 556 (2005).

21. M. Nobes and H. Trottier, “Heavy quark masses from Fermilab Fermions,” PoS **LATTICE 2005**, 209 (2005) [arXiv:hep-lat/0509128].

22. The LHPC Collaboration: C. Alexandru, *et al.*, “ A study of the N to Delta transition form factors in full QCD,” PoS **LATTICE 2005**, 091 (2005) [arXiv:hep-lat/0509140].

23. The Fermilab Lattice, HPQCD and MILC Collaborations: A. Kronfeld, *et al.*, “Predictions from Lattice QCD,” Int. J. Mod. Phys. **A21**, 713 (2006) [arXiv:hep-lat/0509169].

24. The LHPC Collaboration: R. Edwards *et al.*, “Hadron structure with light dynamical quarks,” PoS **LATTICE 2005**, 056 (2005) [arXiv:hep-lat/0509185].

25. The HPQCD and UKQCD Collaborations: E. Gamiz, *et al.*, “Dynamical determination of B_K from improved staggered quarks,” PoS **LATTICE 2005**, 347 (2005) [arXiv:hep-lat/0509188].

26. I. Allison, C.T.H. Davies and A. Gray, “NRQCD results on the MILC extra coarse ensemble,” PoS **LATTICE 2005**, 217 (2005) [arXiv:hep-lat/0510001].

27. The HPQCD Collaboration: E. Gulez, *et al.*, “B “Semileptonic Decays with $Nf = 2+1$ Dynamical Quarks,” PoS **LATTICE 2005**, 220 (2005) [arXiv:hep-lat/0510002].

28. S. Gottlieb, *et al.* [Fermilab Lattice and MILC Collaborations], “Onium Masses with Three Flavors of Dynamical Quarks,” PoS **LATTICE 2005** 203 (2005) [arXiv:hep-lat/0510072].

29. P. B. Mackenzie, “CKM physics from lattice QCD,” *In the Proceedings of 4th Flavor Physics and CP Violation Conference (FPCP 2006)*, Vancouver, British Columbia, Canada, 9-12 Apr 2006, pp 022 [arXiv:hep-ph/0606034].

30. The LHPC Collaboration: D. B. Renner *et al.*, “Calculation of the nucleon axial charge in lattice QCD,” J. Phys. Conf. Ser. **46**, 152 (2006) [arXiv:hep-lat/0607008].

31. C. Ehmann, T. Burch and A. Schafer, “Investigation of the overlap of excited bottomonium states with hybrid operators,” PoS **Lattice 2006** 106 (2006) [arXiv:hep-lat/0609028].

32. The LHPC Collaboration: R. G. Edwards *et al.*, “Nucleon structure in the chiral regime with domain wall fermions on an improved staggered sea,” PoS **LATTICE 2006**, 121 (2006) [arXiv:hep-lat/0610007].

33. The LHPC Collaboration: C. Alexandrou, *et al.*, “The N to Δ axial transition form factors in quenched and unquenched QCD,” PoS **LATTICE 2006**, 115 (2006) [arXiv:hep-lat/0610107].

34. The Fermilab Lattice and MILC Collaborations: E. D. Freeland, *et al.*, “$\overline{\Lambda}$, λ_1, and m_b in three-flavor (lattice) QCD,” PoS **LATTICE 2006**, 083 (2006) [arXiv:hep-lat/0610108].

35. The HPQCD Collaboration: C. T. H. Davies *et al.*, “Charm physics with highly improved staggered quarks,” PoS **LATTICE 2006**, 082 (2006) [arXiv:hep-lat/0610110].

36. C. T. H. Davies, G. P. Lepage, Kit Yan Wong [HPQCD Collaboration], “B meson decays from moving-NRQCD on fine MILC lattices,” PoS **Lattice 2006** 099 (2006), [arXiv:hep-lat/0611009].

37. The LHPC Collaboration: R. G. Edwards *et al.* “Hadron spectrum with domain-wall valence quarks on an improved staggered sea,” PoS **LATTICE 2006**, 195 (2006).

38. R. S. Van de Water and P. B. Mackenzie [Fermilab Lattice and MILC Collaborations], “Unitarity and the heavy quark expansion in the determination of semileptonic form factors,” PoS **LATTICE 2006**, 097 (2006).

39. S. A. Gottlieb, L. Levkova, M. Di Pierro, A. X. El-Khadra, A. S. Kronfeld, P. B. Mackenzie and J. N. Simone [Fermilab Lattice and MILC Collaborations], “Update on onium masses with three flavors of dynamical quarks,” PoS **LATTICE 2006**, 175 (2006).

40. J. Laiho [Fermilab Lattice and MILC Collaborations], “The B → D* l nu form factor from lattice QCD,” PoS **LATTICE 2006**, 087 (2006).

41. The HPQCD Collaboration: J. Shigemitsu *et al.*, “B/s mixing parameters in N(f)=2+1 full QCD,” PoS **LATTICE 2006**, 093 (2006).

42. The Fermilab Lattice, HPQCD and MILC Collaborations: C. Bernard *et al.* “The decay constants f(B+) and f(D+) from three-flavor lattice QCD,” PoS **LATTICE 2006**, 094 (2006).

43. C. Aubin and T. Blum, “Hadronic Contributions To The Muon G-2 From The Lattice,” Nucl. Phys. Proc. Suppl. **162**, 251 (2006).

44. The HPQCD and UKQCD Collaborations: E. Gamiz, *et al.*, “Dynamical Study Of B(K) With Improved Staggered Quarks,” Nucl. Phys. Proc. Suppl. **153**, 114 (2006).

45. T. Burch and C. Ehmann, “Couplings of hybrid operators to ground and excited states of bottomonia,” Nucl. Phys. A **797**, 33 (2007) [arXiv:hep-lat/0701001].

46. T. Bae *et al.*, “Improvement of the pion spectrum with HYP-smeared staggered fermions,” PoS **LAT-**

TICE 2007, 089 (2007) [arXiv:0710.0017 [hep-lat]].

47. The HPQCD Collaboration: E. Gamiz, C. T. H. Davies, G. P. Lepage, J. Shigemitsu and M. Wingate, "B_s and B_d mixing in full lattice QCD using NRQCD b quarks," PoS **LATTICE 2007**, 349 (2007) [arXiv:0710.0646 [hep-lat]].

48. The HPQCD Collaboration: C. T. H. Davies, *et al.*, "B Semileptonic Decays at High Recoil Momentum," PoS **LATTICE 2007**, 378 (2007) [arXiv:0710.0741 [hep-lat]].

49. C. Aubin, J. Laiho and R. S. Van de Water, "Taste violations in the scalar correlator in mixed action simulations," PoS **LATTICE 2007**, 088 (2006) [arXiv:0710.0804 [hep-lat]].

50. J. Laiho [Fermilab Lattice and MILC Collaborations], "B -¿ D* l nu with 2+1 flavors," PoS **LATTICE 2007**, 358 (2006) [arXiv:0710.1111 [hep-lat]].

51. C. Aubin, J. Laiho and R. S. Van de Water, "The kaon B^{-} parameter from unquenched mixed action lattice QCD," PoS **LATTICE 2007**, 375 (2006) [arXiv:0710.1121 [hep-lat]].

52. The LHPC Collaboration: D. B. Renner *et al.*, "Generalized parton distributions from domain wall valence quarks and staggered sea quarks," PoS **LATTICE 2007**, 160 (2006) [arXiv:0710.1373 [hep-lat]].

53. The LHPC Collaboration: C. Alexandrou, *et al.* "Nucleon and Nucleon to Delta Axial form factors from Lattice QCD," PoS **LATTICE 2007**, 162 (2007) [arXiv:0710.2173 [hep-lat]].

54. The Fermilab Lattice Collaboration: E. D. Freeland, *et al.*, "Heavy-Quark Masses from the Fermilab Method in Three-Flavor Lattice QCD," PoS **LATTICE 2007**, 243 (2006) [arXiv:0710.4339 [hep-lat]].

55. The LHPC Collaboration: B. U. Musch, *et al.*, "Transverse momentum distributions of quarks from the lattice using extended PoS **LATTICE 2007**, 155 (2007) [arXiv:0710.4423 [hep-lat]].

56. D. Richards, "Nucleon Structure from Lattice QCD," arXiv:0711.2048 [nucl-th].

57. The HPQCD Collaboration: E. Follana *et al.*, "High Precision Determination of the D and D_s Decay Constants and Masses from Lattice QCD," PoS **LATTICE 2007**, 353 (2007).

58. The Fermilab Lattice and MILC Collaborations: P. Mackenzie *et al.*, "B and D meson semileptonic decays in three-flavor lattice QCD," PoS **Lattice2007**, 207 (2007).

59. The Fermilab Lattice and MILC Collaborations: C. Bernard *et al.*, "The decay constants f_B and f_{D+} from three-flavor lattice QCD," PoS **Lattice2007**, 370 (2007)

60. R. S. Van de Water [USQCD Collaboration], "Testing The Standard Model Of Particle Physics Using Lattice QCD," J. Phys. Conf. Ser. **78**, 012079 (2007).

References

[1] The Fermilab, HPQCD, MILC and UKQCD Collaborations: C.T.H. Davies, *et al.*, Phys. Rev. Lett. **92**, 022001 (2004) [arXiv:hep-lat/0304004].

[2] The MILC Collaboration: C. Aubin *et al.*, Phys. Rev. D **70**, 114501 (2004) [arXiv:hep-lat/0407028]; Nucl. Phys. B (Proc. Suppl.) **140**, 231 (2005) [arXiv:hep-lat/0409041]; Proceedings of Science (Lattice 2005) 025 (2005) [arXiv:hep-lat/0509137]; Proceedings of Science (Lattice 2006) 163 (2006) [arXiv:hep-lat/0609053]; Proceedings of Science (Lattice 2007) 090 (2007) [arXiv:0710.1118[hep-lat]].

[3] The HPQCD and UKQCD Collaborations: C. Davies *et al.*, Phys. Rev. Lett. **95** 052002 (2005) [arXiv:hep-lat/0503005].

[4] I. Allison, C.T.H. Davies, A. GRAY, A. Kronfeld, P. Mackenzie and J. Simone, Nucl. Phys. (Proc. Suppl.) **140**, 440 (2005).

[5] The Fermilab Lattice, HPQCD and MILC Collaborations: A. Kronfeld, *et al.*, Int. J. Mod. Phys. **A21**, 713 (2006). Phys. Rev. Lett. **94**, 172001 (2005).

[6] The Fermilab Lattice and MILC Collaborations: C. Aubin *et al.*, Phys. Rev. Lett. **95**, 122002 (2005).

[7] The HPQCD Collaboration: A. Gray, *et al.*, Phys. Rev. Lett. **92**, 162001 (2004); Phys. Rev. Lett. **95**, 212001 (2005);

[8] J. Rosner and S. Stone, arXiv:0802.1043 [hep-exp].

[9] The HPQCD and UKQCD Collaborations: E. Follana, *et al.*, Phys. Rev. D **75**, 054502 (2007) [arXiv:hep-lat/0610092].

[10] The HPQCD and UKQCD Collaborations: E. Follana, C. T. H. Davies, G. P. Lepage and J. Shigemitsu, Phys. Rev. Lett. **100**, 062002 (2008) [arXiv:0706.1726 [hep-lat]].

[11] The Fermilab Lattice and MILC Collaborations, C. Bernard *et al.*. manuscript in preparation.

[12] B. Dobrescu and A. Kronfeld, arXiv:0803.0512 [hep-lat].

[13] USQCD workshop “Lattice QCD meets Experiment 2007”, Fermilab, Dec. 2007, http://usqcd.fnal.gov/lattice-experiment2007/schedule.html

[14] USQCD white paper “Fundamental Parameters from Future Lattice Calculations”, Jan. 2007, http://www.usqcd.org/documents/fundamental.pdf