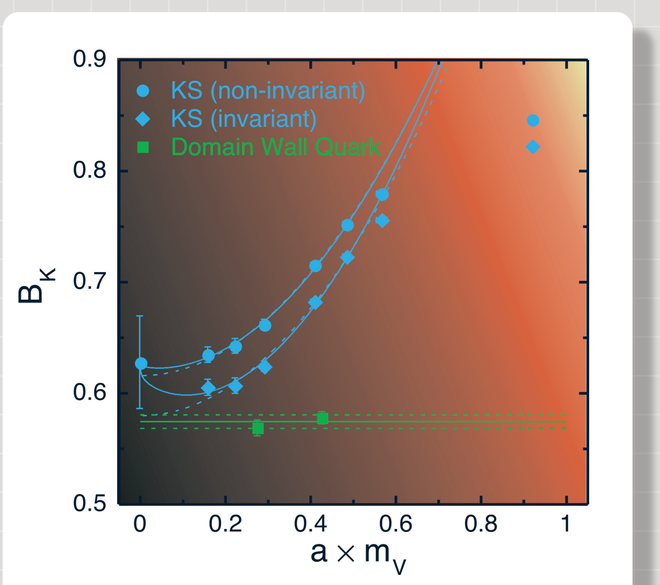
Center for Computational Sciences, University of Tsukuba
http://www.ccs.tsukuba.ac.jp/

Research in Particle Physics (2)

CP violation of weak interactions



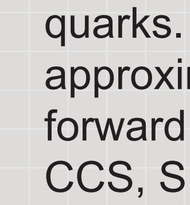
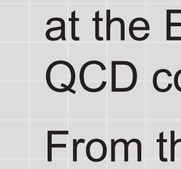
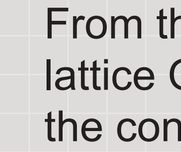
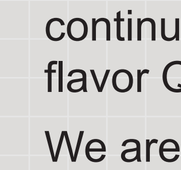
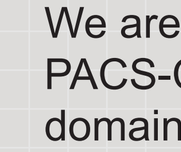
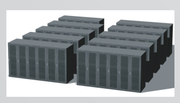
The asymmetry between matter and anti-matter in the universe is believed to have its origin in the CP violation of weak interactions. On CP-PACS we have investigated several quantities relevant for CP violating weak interactions. This figure shows the B-parameter in the K meson mixing. The CP-PACS result obtained with domain-wall lattice quarks show a much weaker lattice-spacing dependence than the previous results using KS lattice quarks by JLQCD Collab., and hence are expected to give a more precise prediction in the continuum limit.

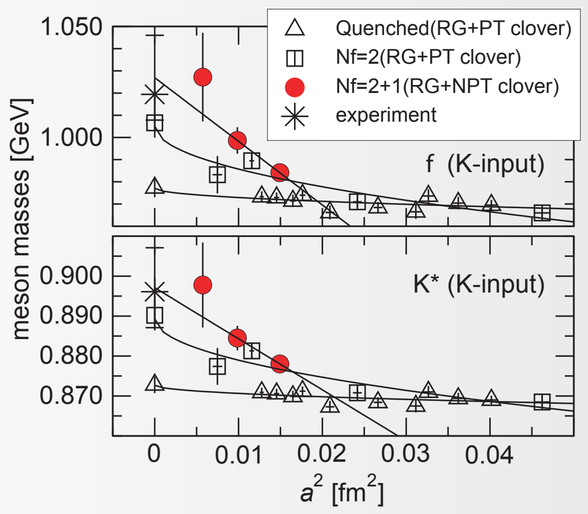
Towards a fully realistic simulation of QCD

The large scale simulations of QCD by the CP-PACS have shown the importance of dynamical quarks. In the two flavor simulations, the third quark "s" is still treated in the quenched approximation. As the last step toward a fully realistic simulation of QCD, we are pushing forward 2+1 flavor full QCD simulations, concentrating the computer power of CP-PACS at CCS, SR-8000 at CCS and KEK, VPP-5000 at ACCC, Univ. Tsukuba, and the Earth-Simulator at the ES center. Total fraction of the peak performance for QCD is about 2.5 TFLOPS. Our QCD code has achieved the efficiency of 20-44% in the actual production runs.

From the simulations at two lattice spacings $a \sim 0.01$ and 0.122 fm using a highly improved lattice QCD action, we found that the experimental meson masses are correctly reproduced in the continuum limit. Our preliminary results at $a \sim 0.076$ fm are consistent with these continuum extrapolations. This suggests that the deviation of meson masses is absent in 2+1 flavor QCD in the continuum limit.

We are planning to extend the study at quark masses much closer to the real values, using the PACS-CS computer to be constructed in 2006, and adopting a new simulation algorithm, domain-decomposed HMC algorithm, to accelerate simulations at small quark masses.

	Machines	Peak GFLOPS	Fraction for LQCD	Performance of our code
	CP-PACS (CCS)	614	614	20%
	SR-8000/G1 (CCS)	173	173	44%
	SR-8000/F1 (KEK)	1200	768	35%
	VPP-5000 (ACCC)	768	230	44%
	EarthSimulator (ES Center)	40960	640	31%
	PACS-CS (CCS) to be installed in June 2006	14300		30% (target)



Continuum extrapolation of ϕ and K* meson masses, using K meson mass as the input for physical s quark mass. The experimental values shown by stars are correctly reproduced by the 2+1 simulation (red circles).

CP-PACS and JLQCD Collaborations (2005)