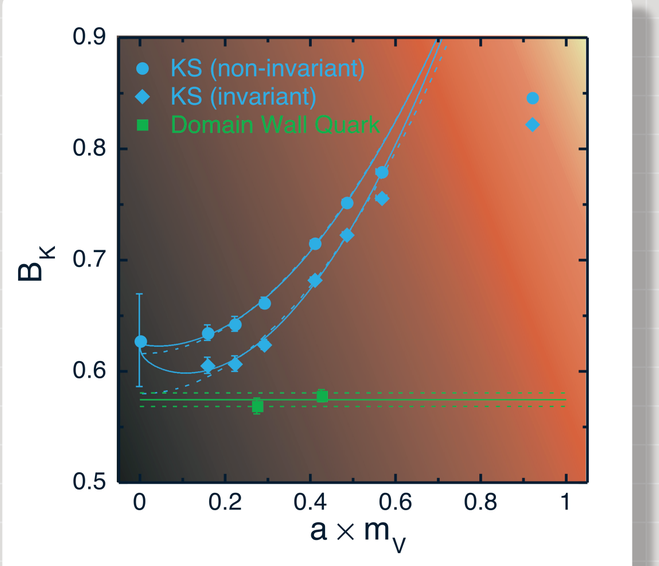
Center for Computational Physics University of Tsukuba

Research in Particle Physics (2)

CP violation of weak interactions

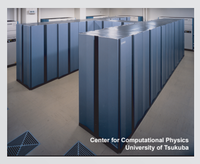
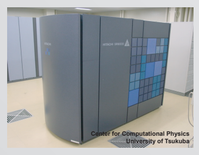


The asymmetry between matter and anti-matter in the universe is believed to have its origin in the CP violation of weak interactions. On CP-PACS we have investigated several quantities relevant for CP violating weak interactions. This figure shows the B-parameter in the K meson mixing. The CP-PACS result 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

Large scale simulations of QCD by the CP-PACS show the importance of dynamical quarks. In the two-flavor full QCD simulations, the third quark "s" is still treated in the quenched approximation. As the last step towards a fully realistic simulation of QCD, we have started a grand challenge project of three-flavor full QCD simulations, concentrating all big computers accessible to us. Those include the CP-PACS and SR-8000/G1 at the Center for Computational Physics, SR-8000/F1 at KEK, VPP-5000 at S.I.P.C. of Univ. Tsukuba, and the Earth-Simulator at the ES center. Total fraction of the peak performance for lattice QCD is about 2.5 TFLOPS.

To avoid introducing uncontrolled systematic errors, we have developed simulation codes adopting an exact algorithm called the Polynomial Hybrid Monte Carlo algorithm, in contrast to approximate algorithms used in previous studies. Through optimizations for each computer, we have achieved the efficiency of 20-44% in the actual production runs, as listed in the table below.

	Machines (Location)	Peak GFLOPS	Fraction for LQCD	Performance of our code
	CP-PACS (CCP)	614	614	20%
	SR-8000/G1 (CCP)	173	173	44%
	SR-8000/F1 (KEK)	1200	768	35%
	VPP-5000 (SIPC)	768	230	44%
	EarthSimulator (ES Center)	40960	640	31%