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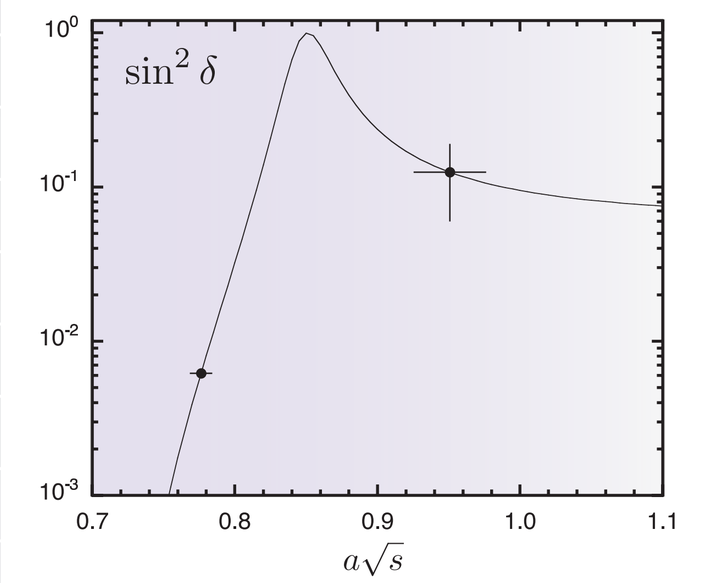
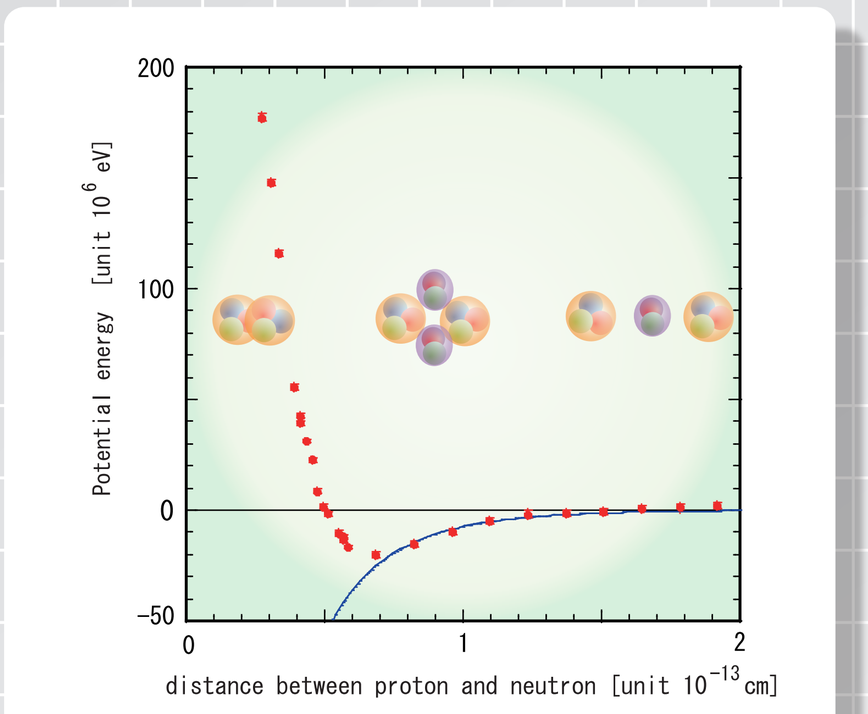
Research in Particle Physics (2)

ρ meson decay width

A study of the ρ meson decay is a significant step for understanding the dynamical aspect of hadron reactions with lattice QCD. We have calculated the scattering phase shift for the I = 1 two π meson system and estimated the ρ meson decay width from it. This fiugre shows our results of the scattering phase shift $\sin^2\delta$. The ρ meson decay width was estimated from the scattering phase shift with some assumptions for the quark mass dependece for the phase shift. We obtaine $\Gamma = 162 \pm 35$ MeV, which is consistent with experiment, $\Gamma = 150$ MeV.



Nuclear force from lattice QCD



In 1935, Hideki Yukawa introduced the π meson to account for the nuclear force among protons and neutrons in the nuclei. Later, it was found that the proton, the neutron and the π meson are all composed of more fundamental quarks. However, due to high complexities of the dynamics governing the quarks, the quantum Chromodynamics (QCD), it has been difficult to reproduce the nuclear force from quarks.
Employing the lattice QCD, we have succeeded, for the first time, in unraveling the nature of the nuclear force directly from the dynamics of quarks. The left figure shows the potential for the nuclear force from lattice QCD. We find that not only the Yukawa's meson theory (solid line) at long distances but also the strong repulsive core at short distances are reproduced. The repulsive core was speculated from an analysis of the nucleon-nucleon scattering data and is considered to be indispensable for the stability of nuclei and neutron stars.

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. We have investigated several quantities relevant for CP violating weak interactions. The right figure shows the results for the B-parameter in the K meson mixing. The CP-PACS result obtained with domain-wall lattice quarks and non-perturbative renormalization factor (red circles) shows a much weaker lattice-spacing dependence than the previous results using Kogut-Suskind lattice quarks by the JLQCD Collaboration, and hence are expected to give a more precise prediction in the continuum limit.