

Electromagnetic mass difference on the lattice

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Numerical simulations based on lattice QCD allow us to calculate physical quantities in high accuracy. However, electromagnetic and isospin-violating effects are usually ignored. Taking into account these effects is important for more realistic predictions. In practice, for light quark masses systematic errors from electromagnetic effects can be comparable with statistical one.

In this work, we studied electromagnetic mass splittings of mesons in the quenched theory [1]. The RG-improved gauge action and the non-compact Abelian gauge action were employed to generate configurations. Our simulation parameters are summarized in Table. 1. Quark propagators in the range of $m_{PS}/m_V = 0.76 - 0.51$ were calculated on the background of gluon and photon fields, using the meanfield-improved clover quark action. Pseudoscalar and vector meson masses were computed from these quark propagators. After chiral and continuum extrapolations, we obtained

$$\begin{aligned} m_\pi^+ - m_\pi^0 &= 4.7(1.4), \\ m_\rho^+ - m_\rho^0 &= 0.9(1.9). \end{aligned}$$

These values agreed with experimental ones, $m_\pi^+ - m_\pi^0(exp) = 4.5936(5)$ and $m_\rho^+ - m_\rho^0(exp) = -0.7(7)$.

Quark masses can be extracted by meson spectrum. Our results are shown in Fig. 1. In pure QCD case, only averaged value of up and down quark masses is calculable. But, by including electromagnetic effects, we can extract up and down quark masses separately. We also found that QED correction to strange quark mass is small, 1%.

An important future work is to include dynamical quark effects. Simulations using generated full QCD data are ongoing.

β	2.187	2.334	2.575
Size	$12^3 \times 24$	$16^3 \times 32$	$24^3 \times 48$
N_{conf}	800	400	100

Table 1: Simulation parameters

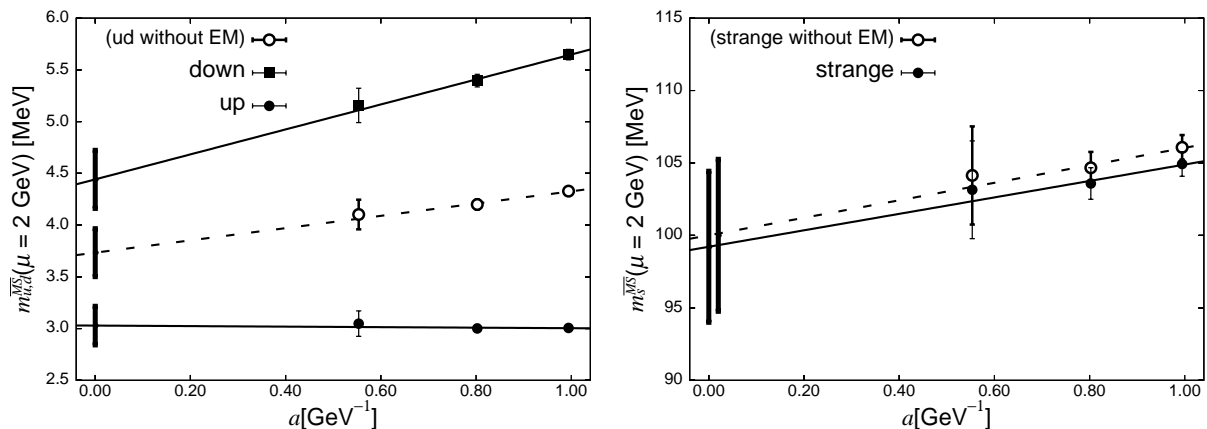


Figure 1: Continuum extrapolations of up, down(left panel) and strange(right panel) quark masses with and without electromagnetic(EM) corrections.

References

- [1] Y. Namekawa and Y. Kikukawa, PoS LAT2005:090,(2005)[arXiv:hep-lat/0509120].