Negative-Parity Baryons in Quenched Anisotropic Lattice QCD

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Excited states of baryons are still less known than the ground states of them both theoretically and experimentally. From theoretical point of view, the quark model reproduces the low-lying excited states of baryons fairly well. However, it has still not been solved how the quark model is derived from the first principle of the strong interaction, QCD. To get deeper insight into the connection between QCD and the quark model, it is meaningful to compute spectra of excited baryons from lattice QCD, and compare them with the results of the quark model.
We investigate the low-lying negative-parity baryons in the $SU(3)$ flavor octet, decuplet and singlet with the standard Wilson gauge action and the $O(a)$ improved Wilson quark actions. For accurate measurements of the masses of the negative-parity baryons, we have adopted quenched anisotropic SU(3) lattice QCD, where the temporal lattice spacing is finer than the spatial one [1].
Particular attention is paid to $\Lambda(1405)$, which is considered to be the flavor singlet baryon (qqq state) in the naive quark model, or the exotic state of the five-quarks ($\bar{q}q$-qqq). We show the results of the various baryon masses in the physical unit in Figure 1. It is notable that the $\Lambda(1405)$ seems much lighter than the lattice result on the corresponding three-quark state, while the other negative-parity baryons seem to be reproduced on lattice. This indicates that the $\Lambda(1405)$ cannot be identify as a three-quark state, which may support the possibility of the picture of the exotic-state of $\Lambda(1405)$.

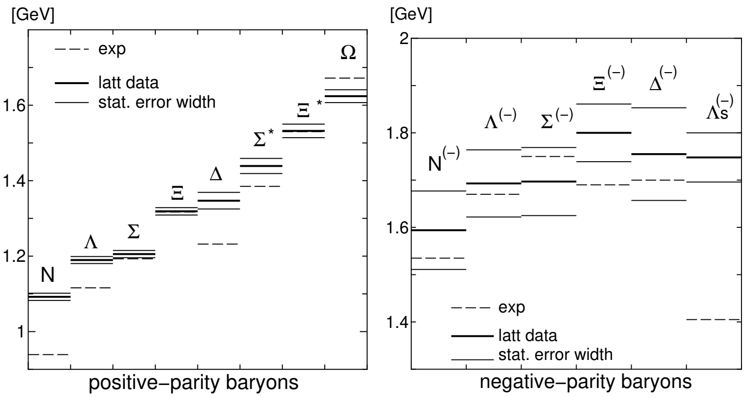

Figure 1: Various baryon masses from the $a_s^{-1} = 2$ GeV lattice.

References

[1] N. Nakajima, H. Matsufuru, Y. Nemoto and H. Suganuma, proceedings of International Symposium on Hadron and Nuclei, Yonsei Univ., Seoul, Korea, Feb. 2001 (hep-lat/0204014); Y. Nemoto, N. Nakajima, H. Matsufuru, and H. Suganuma, in preparation.