Spectroscopy and structure of excited heavy baryons

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Spectroscopy of excited mesons and baryons with heavy quark(s) is one of the major subjects in the hadron physics. Several experimental facilities, such as J-PARC and GSI, have plans to explore charmed baryon spectroscopy. It is very important to give predictions and physics guidelines in advance from theory. Lattice QCD is very successful for the ground states, but it has some difficulty in predicting excited states. Therefore it is necessary to construct a reliable model for the spectroscopy for the heavy baryons.

In our study, we use the Gaussian-Expansion-Method(GEM)[1] to obtain precise energies and wave functions of baryons. GEM has been successful in few body physics providing good precision of the energies and wave function. We construct a constituent quark model which is well tuned in the strangeness sector and analyze the excited states of charmed and bottomed baryons. We focus our study on the excited states and perform a precise calculation. We analyze two characteristic excitation modes, the λ-mode and the ρ-mode. From the analysis, we get information on the structure of heavy baryons, which characterizes the production and decay mechanisms and patterns. Such information should be very useful for experimental identification of these excited states.

In this talk, we show heavy baryon spectrum, the wave functions of excited states and their quark mass dependence. We find that in heavy quark sector, mixing of the ρ and λ modes strongly are suppressed and only one mode survives. For instance, in the $\Lambda_Q(1/2^-)$ the λ mode becomes dominant as m_Q increases(See Fig.1). This indicates that $\Lambda_c(1/2^-)$ or $\Lambda_b(1/2^-)$ decay dominantly to a light baryon and a heavy meson, as the decay to a heavy baryon and a light meson is suppressed.

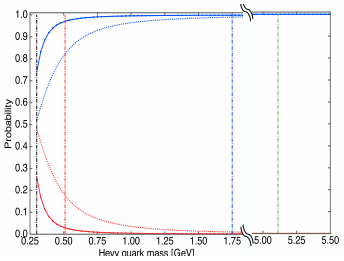

Figure 1: The prbability of λ mode (blue line) and ρ mode (red line) of $\frac{1}{2}^-$ for Σ_Q (dotted line), Λ_Q (Solid line).

References

[1] E. Hiyama, Y. Kino, and M. Kamimura, Prog. Part. Nucl. Phys. 51, 223 (2003).