The F/D ratio and Meson-Baryon couplings from QCD sum rules

Takumi Doi[a], Hunchong Kim[b], Yoshihiko Kondo[c] and Makoto Oka[a]

[a] *Department of Physics, Tokyo Institute of Technology, Meguro, Tokyo 152-8551, Japan*
[b] *Institute of Physics and Applied Physics, Yonsei University, Seoul 120-749, Korea*
[c] *Kokugakuin University, Higashi, Shibuya, Tokyo 150-8440, Japan*

Meson-baryon couplings are important phenomenological parameters in hadron physics and the determination of these quantities from QCD is an interesting topic. With this motivation, the diagonal meson-baryon couplings, πNN, ηNN, $\pi\Xi\Xi$, $\eta\Xi\Xi$, $\pi\Sigma\Sigma$, and $\eta\Sigma\Sigma$ are evaluated from the QCD sum rules for the two-point(baryon-baryon) correlation function with an external meson field. We first point out that it is not enough to consider the correlation functions in the soft-pion limit, but the contribution due to the finite meson momentum is essential. Then several terms associated with different Dirac matrices arise and the results depend on the choice of the Dirac structure. In order to study the difference between three distinct Dirac structures, $i\gamma_5$, $i\gamma_5 \not{p}$,$\gamma_5\sigma_{\mu\nu}q^\mu p^\nu$, we use general baryon current with mixing parameter t

$$J_B(x;t) = 2\epsilon_{abc}[\ (q_a^T(x)Cq_b(x))\gamma_5 q_c(x) + t\ (q_a^T(x)C\gamma_5 q_b(x))q_c(x)\ ]\ ,$$

and study how the results depend on the currents. Taking into account that physical observables are ideally independent of the chosen current, it has been found that the $\gamma_5\sigma_{\mu\nu}q^\mu p^\nu$ gives the most reliable predictions[1-3].

Further more, using the pertinent Dirac structure, $\gamma_5\sigma_{\mu\nu}q^\mu p^\nu$, the SU(3) symmetric limit is analyzed and has been found that the OPE structures match the SU(3) relation for the couplings. Thus, we identify the OPE terms responsible for the F/D ratio. Performing numerical analysis, we conclude $F/D \sim 0.6 - 0.7$. This is the first reliable evaluation of the F/D ratio directly from QCD. The range includes the value from SU(6) quark model($F/D = 2/3$) and close to the empirical value ($F/D \sim 0.57$) from semi-leptonic decay[4]. The low sensitivity of the F/D ratio(Figure) to the choice of the currents confirms the reliability of the result[3].

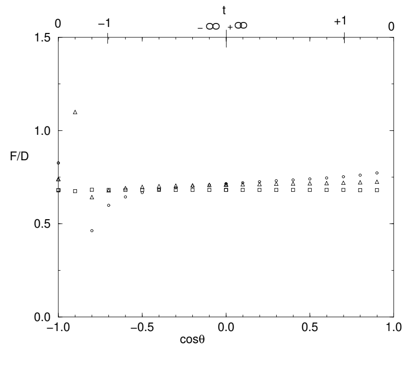

Figure: The F/D ratio vs. the choice of the current (parametrized by t or $\cos\theta$)

Besides the SU(3) symmetric limit analysis, the SU(3) breaking effect is interesting to investigate. Recently, new "projected correlation function formalism" is proposed by one of the authors[5]. In this method, we can treat the difference of the baryon masses of concern. Expanding our QCD sum rule when the strangeness is concerned beyond SU(3), we discuss the application to the off-diagonal couplings, especially, to the $\pi\Lambda\Sigma$ coupling constant.

References

[1] H. Kim, T. Doi, M. Oka and S. H. Lee, Nucl.Phys.A**662** (2000) 371.
[2] H. Kim, T. Doi, M. Oka and S. H. Lee, Nucl.Phys.A**678** (2000) 295.
[3] T. Doi, H. Kim and M. Oka, Phys.Rev.C**62** (2000) 055202.
[4] P. G. Ratcliffe, Phys.Lett.B**365** (1996) 383.
[5] Y. Kondo and O. Morimatsu, nucl-th/0102028.