The constraint on the spin dependent structure function g_1 at low Q^2 through the sum rule corresponding to the moment at $n = 0$

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The sum rule for the spin dependent structure function g_1^{ab} in the equal time formalism corresponding to the moment at $n = 0$ has been known to be peculiar, where a, b denotes the flavor dependence of the currents (for a detail see the textbook *Current Algebras* by Adler and Dashen (Benjamin,1968) p.325.). This point has been cured by the sum rule based on the null-plane formalism (Dicus,Jackiw and Teplitz, Phys.Rev.D4,1733,(1971)). In this formalism, we get an additional contribution from the connected matrix element of the bilocal currents which remove the peculiarity.

Now, since the integral of the matrix element of the bilocal current is Q^2 independent, we can equate sum rules at different Q^2. For this purpose, we can take one sum rule at $Q^2 = 0$ and the other one at very small Q^2. This is motivated by the recent experimental discovery of the sign change near $Q^2 \sim 0.3\text{GeV}^2$(CLAS Collaboration, Phys.Rev.Letts.91,222002(2003)) in the first moment of the g_1^p. This sign change validates the sign difference between the Ellis-Jaffe sum rule in the deep inelastic reaction and Drell Hern Gerasimov sum rule in the photoproduction. However, the reason why this sign change occurs in such a small Q^2 was not well understood theoretically.

We first derive the sum rule which relates the g_1^{ab} and the photoproduction in the isovector reaction in case of the current commutation relation by using the same method as in the Cabibbo-Radicati sum rule, and show that there is a deep connection among the elastic, the resonance, and the non-resonant contributions.[1]. Then, in case of the connected matrix element of the current anticommutation relation between the stable hadron obtained with use of the Deser-Gilbert-Sudarshan representation, we derive the sum rule which relates the cross section of the phtoproduction with g_1^p at low Q^2.

Phenomenologically, by using this sum rule, we can investigate the reason why the sign change occurs at such a very small Q^2. The sum rule shows that there must be a deep connection among the elastic, the resonance, and the non-resonant contributions to satisfy it. While,the elastic contribution in the low Q^2 region changes very rapidly. Since the main contribution at low Q^2 is resonant and elastic contribution, the rapid change of the elastic contribution is compensated by the rapid change of the resonant contribution. Then, this change of the resonant contribution affects largely on the estimate of the inelastic part of the moment $n = 0$ and $n = 1$. [2]

References

[1] S.Koretune, Phys.Rev.C73,058201(2006), hep-ph/0604073.

[2] S.Koretune, Phys.Rev.C72,045205(2005), hep-ph/0510155.