ON Q^2-DEPENDENCE OF THE SUM RULES FOR $g_1(x, Q^2)$

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I wish to make a remark about Q^2-dependence of the function $G_1^p(x, Q^2) = (m^2/\nu) \cdot g_1^p(x, Q^2)$ in the region of intermediate Q^2. At intermediate $Q^2 \approx$ 1-3 GeV^2, the integral $\int (d\nu/\nu)\ G_1^p(\nu, Q^2)$ is dominated by the isobar $\Delta(1232)$ contribution. Let us consider the Q^2-dependence of isobar electroproduction. As can be shown from the chiral invariance[1,2] at large Q^2, the isobar electroproduction cross section is dominated by $\sigma_{1/2}(\sigma_{1/2} \gg \sigma_{3/2}$ where $\sigma_{1/2}$ and $\sigma_{3/2}$ are the cross sections corresponding to projections 1/2 and 3/2 of the total photon-nucleon spin upon the photon momentum direction in the virtual photon-proton c.m.s.). Therefore the asymmetry $A_1^p = (\sigma_{1/2} - \sigma_{3/2})/2\sigma_T$ is positive and $G_1^p > 0$. However of the values of Q^2 which are presently accessible to experiment ($Q^2 < 3$ GeV^2), the situation is reversed, $\sigma_{1/2} \ll \sigma_{3/2}$ and $A_1^p < 0$, $G_1^p < 0$ (magnetic dipole transition is dominating). This fact may explain, at least partly, why we expect the change of sign in the sum rule $\int (d\nu/\nu)\ G_1^p(\nu, Q^2)$, when we go from large Q^2 to $Q^2 = 0$.[1,2,3] It is necessary to remark that according to isospin invariance, the isobar contributions cancel in the difference $G_1^p - G_1^n$. This may be the reason why Bjorken sum rule permits a smooth extrapolation from large Q^2 to $Q^2 = 0$.

References

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