Fundamental and non-fundamental sum rules in polarised lepton-nucleon scattering

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Abstract

In this presentation we make a distinction between fundamental and non-fundamental sum rules which appear in polarised and unpolarised lepton-nucleon scattering. The fundamental sum rules can be expressed into expectation values of (partially) conserved (axial-) vector currents sandwiched between the nucleon state. These expectation values yield the quantum numbers of the corresponding nucleon which are determined by the underlying flavour group $SU(n)_F$. This property does not apply to the non-fundamental sum rules. In this case it is either impossible to express them into expectation values of the (axial-) vector currents mentioned above or these currents are not conserved at all so that they need an infinite renormalisation. The fundamental sum rules can be subdivided into two classes. The first one, represented by the Adler sum rule and its polarised analogue $\int_0^1 \frac{d\ x}{x} \left(g_4^{\mathrm{W^-N}}(x,q^2) - g_4^{\mathrm{W^+N}}(x,q^2)\right)$, are derived from equal time current algebra and do not receive any QCD corrections or power contributions of the type $\mathcal{O}(m^2/q^2)$ (higher twist). The second class, repesented for instance by the unpolarised Bjorken sum rule and its polarised analogue $\int_0^1 d\ x \left(g_5^{\mathrm{W^-N}}(x,q^2) - g_5^{\mathrm{W^+N}}(x,q^2)\right)$, follows from light cone current algebra. Since the latter algebra is equivalent with the contribution of leading twist operators these type of sum rules receive power contributions (higher twist) and QCD corrections. Non-fundamental sum rules have no foundation in quantum field theory. They can be derived from the parton model or from dispersion relations. Examples of the latter are $\int_0^1 dx\ g_2(x,q^2,m^2) = 0$ (Burkhardt-Cottingham) and $\int_0^1 dx\ \left(g_4(x,q^2,m^2) - g_3(x,q^2,m^2)\right) = 0$.

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