Veneziano-Type Representations of the Pion Form Factor and Couplings of Photons to Heavy Vector Mesons.

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Summary. — Consequences of Veneziano-type representations for the pion form factor are considered. It is found that a simultaneous fit to the asymptotic behaviour and to the couplings of photons to vector mesons is not possible without adding satellite terms. The smallness of the derived couplings of higher vector mesons is shown to be related to the small observed deviation from φ universality.

1. - Introduction.

Recently, a new approach to the study of electromagnetic form factors (1) has been directly inspired by the Veneziano model for π−π scattering (2–4). In particular, Frampton (5) has shown that the function

\[
\frac{\Gamma(11/4)}{\sqrt{\pi}} \frac{\Gamma(1 - \alpha(t))}{\Gamma(13/4 - \alpha(t))},
\]

where \(\alpha(t)\) is the \(\phi\) Regge trajectory, gives a better fit to the magnetic nucleon form factor \(G_M(t)\) than does the dipole formula. In this paper we study

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(1) For a review on form factors see: R. Rodenberg: Electromagnetic and weak form factors and nucleon structure, forthcoming monograph.
whether such "Veneziano-like" form factors also give reasonable estimates for the couplings of heavy vector mesons to the photon for which upper limits have been given by recent experiments\(^{(6)}\). To this end we have considered representations of the type

\[
\frac{\Gamma\left((n-1)/2\right)}{\sqrt{\pi}} \frac{\Gamma(1-\alpha(t))}{\Gamma(n/2-\alpha(t))}
\]

for the pion form factor. We came to the conclusion that for \(n > 5\) one gets a reasonable fit in the spacelike region, whereas the couplings to vector mesons do not come out correctly. For \(n < 5\) the reverse happens, namely, very bad asymptotic behaviour but good couplings arise. In particular, for \(n = 3\) we get back the KSFR relation\(^{(7,8)}\), but not \(\rho\)-meson universality, i.e.

\[
g_{\rho\pi\pi} \neq g_{\rho}.
\]

For \(n\) about 5, we are between both extremes; this is probably the reason why this case has been studied so extensively in recent literature\(^{(9-11)}\). For \(n = 5\) we get the asymptotic behaviour

\[
F_{\pi}(t) \sim t^{-3},
\]

which is not inconsistent with the experimental data on the pion form factor. However, such a behaviour gives very bad fits to the nucleon form factor.

For \(n = 17/4\) we get

\[
g_{\rho\pi\pi}^2 = 1.15 \frac{g_{\rho}^2}{4\pi},
\]

which agrees very well with the experimental data\(^{(12)}\). In this case, the asymptotic behaviour comes out as

\[
F_{\pi}(t) \sim t^{-\frac{5}{4}},
\]

which is close to the simple \(\rho\)-pole fit. For this special value of \(n\) we get very small couplings of the photon to higher vector mesons. The small deviation

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