ELECTRIC QUADRUPOLE AND MAGNETIC DIPOLE MOMENTS OF THE ρ-MESON

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The electromagnetic form factors $F_1(q^2)$, $F_2(q^2)$ and $F_3(q^2)$ (refs.[1,2]) of the ρ-meson are studied in a model in which the electromagnetic current is described by a simple triangular diagram with a pion loop. Thus the interaction of the ρ-meson with the electromagnetic field is dominated by the pion form factor in the $\gamma\pi\pi$ vertex. The other two vertices are taken to be functions of the pion square momenta normalized in such a way that they are equal to the ρ-meson decay constant for pions on the mass shell. It is shown that the presence of these functions and of the pion form factor in the vertices does not spoil the gauge invariance of the diagram.

Without further assumptions (an analytic expression for the pion form factor, for example) complete calculations cannot be carried out. Nevertheless, some analytic properties of the form factors can be studied.

It is clear that in the space-like region a singularity exists due to the anomalous threshold[3]. Cutting the diagram across two pion lines, the contribution of this singularity can be calculated explicitly, but its contribution is negligible as long as we are interested in the region $q^2 \sim 0$.

In the limit $q^2 \to 0$, the form factors are related to the static moments of the particle[1]: charge, magnetic dipole and electric quadrupole. It is shown that $F_2(0) = 0$ and that the following relation between the quadrupole moment Q and the magnetic moment μ holds:

$$Q = \frac{1}{m_\rho}(1 - 2\mu m_\rho) .$$

This is consistent with the minimal electromagnetic interaction assumption[4].

References

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