Electromagnetic isoscalar $\rho\pi\gamma$ exchange current and the anomalous action

E. Truhlík and J. Smejkal
NPI Řež n. Prague, Czechia
and
F. C. Khanna
Theoretical Physics Institute, Department of Physics, University of Alberta, Edmonton, AB, Canada, and TRIUMF, 4004 Wesbrook Mall, Vancouver, BC, Canada

We have studied [1] the electromagnetic processes in the $\pi\rho a_1\omega$ system, characterized by the change of the natural parity of the participating particles, by using the anomalous chiral Lagrangian [2],[3]. This Lagrangian contains 4 constants $\tilde{c}_7$–$\tilde{c}_{10}$, which were first extracted from the data in [2]. Using new data [4] on the radiative decays of the ρ–, ω– and f_1 mesons and on the decay $f_1 \to \rho\pi\pi$ and the constant $\tilde{c}_7$ from [5], we have determined the constants $\tilde{c}_8$, $\tilde{c}_9$ and $\tilde{c}_{10}$. The new constants differ considerably from the old ones. These constants enter the decay rates in the combinations $\tilde{c}_7 + \tilde{c}_9$ and $\tilde{c}_8 + \tilde{c}_{10}$, which can be obtained only up to the sign. We considered both possibilities and we extracted two sets of constants. Disregarding the sign problem, these constants are now known within a 10–15% accuracy. The main source of the uncertainty is due to an inconsistency in the data for the radiative decays of the charged and neutral ρ mesons and of the ω meson. However, the effective couplings $\mathrm{g}_{\rho\pi\gamma}$ and $\mathrm{g}_{\omega\pi\gamma}$ suffer from this inconsistency by an uncertainty only of about 4%.

We have subsequently constructed the electromagnetic form factor $K_{\rho\pi\gamma}(q^2)$ that contains, besides the well known term, an additional piece which can be large, if the corresponding choice of the constant $\tilde{c}_9$ is made. The presence of the $\rho a_1\omega$ vertex in the Lagrangian gives rise to the new $\rho a_1\gamma$ vertex, which contains two form factors $K_1(q^2)$ and $K_2(q^2)$. The isoscalar exchange currents, associated with these vertices, are constructed as well. In addition to the known $\rho\pi\gamma$ current, we have also $\rho a_1\gamma$ current with well defined parameters extracted from the data. This is in contrast to $\omega\epsilon\gamma$ [6] or $\omega\sigma\gamma$ [7] currents based on less firm ground.

References

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