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Isospin breaking in Ke4 decays

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Isospin breaking in the $K_{\ell 4}$ form factors induced by the difference between charged and
neutral pion masses is discussed within a framework built on suitably subtracted dispersion representations.
The $K_{\ell 4}$ form factors are constructed in an iterative way up to two loops in the low-energy expansion by implementing analyticity, crossing, and unitarity due to two-meson intermediate states. Analytical expressions
for the phases of the two-loop form factors of the $K^{\pm} \to \pi^+ \pi^- e^{\pm} \nu_e$ channel are presented, allowing one to
connect the difference of form-factor phase shifts measured experimentally (out of the isospin limit) and the
difference of S- and P-wave $\pi\pi$ phase shifts studied theoretically (in the isospin limit). The dependence with
respect to the two S-wave scattering lengths a_0^0 and a_0^2 in the isospin limit is worked out in a general way,
in contrast to previous analyses based on one-loop chiral perturbation theory. The results on the phases of
the $K^{\pm} \to \pi^+ \pi^- e^{\pm} \nu_e$ form factors obtained by the NA48/2 collaboration at the CERN SPS are reanalysed
including isospin-breaking correction to extract values for the scattering lengths a_0^0 and a_0^2.

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