the ρ^0 dip around $t=-0.7$ $(\mathrm{GeV}/c)^2$ with increasing s, while the narrow ω^0 dip at $t\approx-0.25$ $(\mathrm{GeV}/c)^2$ remains. Note that the present interpretation, unlike that of Ref. 5, does not absolutely require the existence of the ρ^0 dip.

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Fermion Loops and the $K_2^0\to\mu^+\mu^-$ Puzzle

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We show that the fermion-loop model for $K_2^0\to\gamma\gamma$ recently proposed by Rockmore and Wong makes the puzzle of the missing $K_2^0\to\mu^+\mu^-$ rate some four times worse, and that the difficulty cannot be removed by the usual CP-violation hypothesis.

In a recent letter, Rockmore and Wong[1] have shown that the fermion-loop model can be used to provide a quantitative explanation of the $K_2^0\to\gamma\gamma$ rate. It is the purpose of this comment to point out that their explanation only makes the $K_2^0\to\mu^+\mu^-$ puzzle worse.

The branching ratio

$$R=\frac{\Gamma(K_2^0\to\mu^+\mu^-)}{\Gamma(K_2^0\to\gamma\gamma)}$$

is measured to be less than 0.31×10^{-5} with 90% confidence.[2] If one assumes CP invariance and standard electrodynamics, one can bound this ratio by $R\geq1.17\times10^{-5}$ by using unitarity and only the imaginary part of $K_2^0\to\mu^+\mu^-$.[3] The experiment is outside this bound. It has been suggested by Christ and Lee[4] that a CP violation could produce destructive interference and vitiate the use of the unitarity bound. However, given a model for the $K_2^0\to\gamma\gamma$ process such as Rockmore and Wong's, one need not just bound the $K_2^0\to\mu^+\mu^-$ amplitude, but rather one can calculate the whole thing. Assuming CP conservation, one can now calculate the real part as well as the imaginary part. If the $K_2^0 \to \gamma\gamma$ vertex is taken as a point, the real part diverges, but the fermion loop provides a cutoff.[3] In a recent paper Pratap and Smith[5] have shown that the fermion-loop model of η decay gives a ratio

$$\frac{\Gamma(\eta \to \mu^+\mu^-)}{\Gamma(\eta \to \gamma\gamma)} = 3.6 \times 10^{-5}.$$

This is nearly four times the unitarity bound but in good agreement with experiment. Pratap and Smith also point out that the kinematics of K decay and η decay are essentially identical. Hence a fermion-loop model of K decay would also give some four times the unitarity bound for R.

Unlike the unitarity bound this result cannot be easily fixed by violations of CP. The usual model for CP violations in the weak decay would make the $K_2^0 \to \gamma\gamma$ amplitude complex, but of fixed phase. This phase can mix real and imaginary parts, but it cannot change the over-all magnitude of the amplitude and therefore cannot affect the $K_2^0 \to \mu^+\mu^-$ rate or the branching ratio, R. Hence, unless the CP-violating phase depends on the virtual mass in the intermediate state or unless standard electrodynamics fails (neither of which assumption can be directly accommodated in the Rockmore-Wong calculation), the explicit model of Rockmore and Wong for the $K_2^0 \to \gamma\gamma$ process makes the $K_2^0 \to \mu^+\mu^-$ puzzle some four times worse. Similarly, any other model of $K_2^0 \to \mu^+\mu^-$, CP-violating or not, must not only deal with the unitarity bound but must also find a way to suppress the contributions from virtual photons. Models based on fermion loops make the cutoff of the $K_2^0 \to \gamma\gamma$ vertex too large to do this.

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