$$\mathscr{L}^{LL}_{eff} = - \frac{G_F}{\sqrt{2}} \frac{\alpha}{16\pi} \left(\frac{m_{p'}}{M_W}\right)^2 \frac{\sin^2\theta_c \cos^2\theta_c}{\sin^2\theta_W} \bar{\lambda}_i \gamma_\mu (1+\gamma_5) n_i \bar{\lambda}_j \gamma_\mu (1+\gamma_5) n_j + h.c.$$

where θ_c is the Cabibbo angle, θ_W the Weinberg angle, G_F the Fermi coupling constant, and where the indices i and j run over the three colors.

For the left-right case of Fig. 1b we find by similar methods

$$\mathscr{L}^{L-R}_{eff} = + \frac{G_F}{\sqrt{2}} \frac{\alpha}{16\pi} \left(\frac{m_{p'}}{M_W}\right)^2 2(\ln \frac{M_W}{m_{p'}} - 1) \frac{\cos^2\theta_c}{\sin^2\theta_W} \Big\{ 4 \bar{\lambda}_i (1-\gamma_5) n_i \; \bar{\lambda}_j (1-\gamma_5) n_j$$

$$+ \bar{\lambda}_i \sigma_{\mu\nu} (1-\gamma_5) n_i \; \bar{\lambda}_j \sigma^{\mu\nu} (1-\gamma_5) n_j \Big\} + h.c.$$

In order to compute the short-distance contribution to the K_L-K_S mass difference one requires the matrix element of the four-quark operators that appear in $\mathscr{L}_{eff}$. No exact methods are available. However, for the left-left case considered by them, Gaillard and Lee[5] have argued that a reasonable estimate can be obtained by inserting the vacuum state between two currents, in all possible ways, so that one encounters (suppressing color indices)

$$\langle \bar{K} | \bar{\lambda} \gamma_\mu \gamma_5 n | 0 \rangle \langle 0 | \bar{\lambda} \gamma_\mu \gamma_5 n | K \rangle = f_K^2 m_K^2 \quad .$$

On this basis they then find an upper limit of about 1.5 GeV on the mass $m_{p'}$.

Proceeding in the same vacuum insertion approximation for the operator in $\mathscr{L}^{L-R}_{eff}$, we encounter