Translating Meson Decay Bounds to our System

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The existing flavor-dependent bounds on secret ineractions from particle decay widths are [Peres] $\sum_\alpha |g_{e\alpha}|^2 \leq 5.5 \times 10^{-6}$,$\sum_\alpha |g_{\mu\alpha}|^2 \leq 4.5 \times 10^{-5}$ and $\sum_\alpha |g_{\tau\alpha}|^2 \leq 5.5 \times 10^{-2}$. Under our model the couplings are directly to neutrino mass states, and so:

$$g_{\beta\alpha} = \sum_i U^*_{\alpha i} U_{\beta i} g_i \tag{1}$$

with $g = m_i/\nu_h$. The weakest bounds apply when the lightest neutrino is massless, such that, in NO, $g_2 = \sqrt{\Delta m^2_{12}}/\nu_h$ and $g_3 = \sqrt{\Delta m^2_{23} + \Delta m^2_{12}}/\nu_h$. The coupling we have been considering in this work is $g = g_3$, and in these terms we can identify all the other g's, $g_1 = 0$; $g_2 = \sqrt{\Delta m^2_{12}/(\Delta m^2_{23} + \Delta m^2_{12})} g$; $g_3 = g$. To obtain the flavor-dependent couplings in [Peres] we must account for flavor mixing:

$$g_{\beta\alpha} = \left[U^*_{\beta 2} U_{\alpha 2} \sqrt{\frac{\Delta m^2_{12}}{\Delta m^2_{23} + \Delta m^2_{12}}} + U^*_{\beta 3} U_{\alpha 3} \right] g \tag{2}$$

Finally the limits are expressed as sum over index α:

$$\sum_\alpha |g_{\beta\alpha}|^2 = \sum_\alpha \left| U^*_{\beta 2} U_{\alpha 2} \sqrt{\frac{\Delta m^2_{12}}{\Delta m^2_{23} + \Delta m^2_{12}}} + U^*_{\beta 3} U_{\alpha 3} \right|^2 g^2 = \mathcal{K}^{NO}_\beta g^2 \tag{3}$$

In the IO, we have a slightly different arrangement of masses. In this case $g_3 = 0$; $g_1 = \sqrt{\frac{\Delta m^2_{23} - \Delta m^2_{12}}{\Delta m^2_{23}}}$g; $g_2 = g$and Namely:

$$\sum_\alpha |g_{\beta\alpha}|^2 = \sum_\alpha \left| U^*_{\beta 1} U_{\alpha 1} \sqrt{\frac{\Delta m^2_{23} - \Delta m^2_{12}}{\Delta m^2_{23}}} + U^*_{\beta 2} U_{\alpha 2} \right|^2 g^2 = \mathcal{K}^{IO}_\beta g^2 \tag{4}$$

We now evaluate the various $\mathcal{K}'s$:

	NO	IO
$\mathcal{K}_e$	0.031	0.93
$\mathcal{K}_\mu$	0.40	0.60
$\mathcal{K}_\tau$	0.60	0.38

And so the limits on our g from each mode are:

	NO	IO
e	0.013	0.0024
μ	0.011	0.0086
τ	0.28	0.36