APPENDIX II

It may appear at first sight that various two-body operators can contribute to nonleptonic decay. Let us list all two-body operators with canonical dimension ≤ 6 here:

$$\theta_1 = \bar{n}\lambda, \qquad \theta_2 = \bar{n}\not{D}\lambda, \qquad \theta_3 = \bar{n}D_\mu D^\mu\lambda$$

$$\theta_4 = \bar{n}D_\mu\not{D}D^\mu\lambda, \qquad \theta_5 = g\bar{n}\gamma_\mu D_\nu\lambda F^{\mu\nu},$$

$$\theta_6 = \epsilon_{\mu\nu\rho\sigma}\bar{n}\gamma^\mu D^\nu D^\rho D^\sigma\lambda.$$

Here D_μ represents the covariant derivative. It is well-known that θ_1 and θ_2 may be transformed away. The Wilson coefficient of θ_3 in the relevant operator-product expansion is of order g^2 and hence suppressed in an asymptotically free theory. By using the equation of motion θ_3 is also related to the operator $g\bar{n}\sigma_{\mu\nu}\lambda F^{\mu\nu}$. θ_4 is related to $g\bar{n}\gamma_\mu D_\nu\lambda F^{\mu\nu}$ and has a Wilson coefficient of order g^0 but is suppressed by the GIM mechanism. The Wilson coefficient of θ_5 is of order g^2. The operator θ_6 is related to θ_5. There are other operators which we have not listed, e.g., $\epsilon^{\mu\nu\rho\sigma}\bar{n}\gamma_\mu\gamma_\nu D_\rho D_\sigma\lambda$. However, by using the equation of motion, one can easily reduce these operators to the ones listed. Finally the operator $\bar{\psi}D^2\psi$ does not mix with the four-fermion operators to lowest order.

We also remark that in the nonleptonic decay of charmed particles the GIM mechanism may not be available to suppress the charmed analogue of θ_4. For example, in model D of the text the nonleptonic decay of charmed hadrons will receive a contribution from the SU(3) triplet[34] operator $\bar{c}D_\mu\not{D}D^\mu p$.