Problem 4

Consider an electron-like (charge – e) spin 0 particle in EM field $A^\mu(x)$. Identify the interaction potential V(x) appearing in $T_{fi} = -i\int d^4x \Phi_f^*(x)V(x)\Phi_i(x)$**. Show that** $T_{fi} = -i\int d^4x \; j_\mu^{fi}(x) \; A^\mu(x)$ **where** $j_\mu^{fi}(x) = -eN_iN_f(p_i + p_f)_\mu \; e^{i(p_f - p_i).x}$

Hint. See § 4.1 of the book, Quarks and Leptons by Halzen and Martin, John Wiley & Sons © 1984.

Comments:

(i) The transition amplitude T_{fi} for electron (spin ½) or electron-like spin 0 particle in the presence of EM field $A^\mu(x)$ is of the form, $T_{fi} = -i\int d^4x \; j_\mu^{fi}(x) \; A^\mu(x)$ where for spin 0 particle $j_\mu \propto -e(p_i + p_f)_\mu$ while for spin ½ particle $j_\mu \propto -e \; \bar{u}_f \gamma_\mu u_i$.

(ii) The spin 0 particle has EM interaction due to electric charge only while the spin ½ particle has EM interaction due to charge as well as due to magnetic moment. In fact the term $-e\bar{u}_f\gamma_\mu u_i$ can be decomposed into two parts, one of which contains a factor $-e \; \bar{u}_f(p_i + p_f)_\mu u_i$ representing interaction due to electric charge. The other term represents interaction due to magnetic moment. (See Gordon decomposition).