Phy 523
PARTICLE PHYSICS- Problem sheet 2

19th January 2009

Due 27th January 2009

6. Calculate the decay rate of $A \to B + C$ in the frame in which A has momentum $\vec{P}_A$, using the expression

$$\Gamma_{A(\vec{P}_A)\to B+C} = \int\int \frac{d^3P_B d^3P_C}{(2\pi)^2} \frac{\delta^4(P_A - P_B - P_C)}{2P_A^0 2P_B^0 2P_C^0} |M(P_A, P_B, P_C)|^2$$

and show that the result is related to the decay rate in the rest frame by

$$\Gamma_{A(\vec{P}_A)\to B+C} = \frac{m_A}{E_A} \Gamma_{A(rest)\to B+C}$$

7. Show that

$$(a) \quad \gamma^\mu \not{p} \gamma_\mu = -2 \not{p} \tag{1}$$

$$(b) \quad \gamma^\mu \not{p} \not{q} \gamma_\mu = 4p.q \tag{2}$$

$$(c) \quad \gamma^\mu \not{a} \not{b} \not{c} \gamma_\mu = -2 \not{c} \not{b} \not{a} \tag{3}$$

8. Show that

$$(a) \quad Tr(\not{a} \not{b}) = 4a.b \tag{4}$$

$$(b) \quad Tr(\not{a}) = Tr(\not{a}_1 \not{a}_2 ... \not{a}_{2n+1}) = 0 \quad n = 0, 1, ... \tag{5}$$

$$(c) \quad Tr(\gamma_5) = Tr(\gamma_5 \gamma^\mu) = Tr(\gamma_5 \gamma^\mu \gamma^\nu) = Tr(\gamma_5 \gamma^\mu \gamma^\nu \gamma^\rho) = 0 \tag{6}$$

$$(d) \quad Tr(\gamma_5 \gamma^\mu \gamma^\nu \gamma \rho \gamma \sigma) = -4i\epsilon^{\mu\nu\rho\sigma} \tag{7}$$

where $\gamma_5 = i\gamma^0\gamma^1\gamma^2\gamma^3$ and $\epsilon^{0123} = 1$ and it is antisymmetric in all its indices.

9. Show that

$$\sum_{s=1}^{2} u(p,s)\bar{u}(p,s) = \not{p} + m; \quad \sum_{s=1}^{2} v(p,s)\bar{v}(p,s) = \not{p} - m \tag{8}$$

wher $u(p,s), v(p,s)$ represents the positive enregy solution and negative energy solution respectively and $p, s$ repesent their momentum and spin.

10. Evaluate $\sum_{s=1}^{2}\sum_{s'=1}^{2} |\bar{u}(p,s') \not{a} u(q,s)|^2$ in terms of $p, q$ and $a$.