Phy 523
PARTICLE PHYSICS
Problem sheet V

10th February 2009

17th February 2009

21. Consider the state $|\vec{P}=0;\vec{n}>$ for a spin one particle with spin along a unit three vector $\vec{n}$, i.e. $\vec{S}.\vec{n}|\vec{P}=0;\vec{n}>=|\vec{P}=0;\vec{n}>$. ($\vec{S}$ is the spin operator) If the wave function for the particle is represented by the four vector $X_\mu(x)$ find the components of the vector field (Palne wave solution in the frame in which $\vec{P}=0$). If P is the parity operator what is $P|\vec{P}=0;\vec{n}>$ if the particle is (a) $J^P=1^-$ and (b)$J^P=1^+$?

22. Consider the decay of $\Lambda^0(J^P=1/2^+)\rightarrow p+\pi^-$ whose matrix element is given by

$$< p,\vec{P}_p;\pi,\vec{P}_\pi|M|\Lambda^0,\vec{P}_\Lambda >$$
$$=\bar{u}(P_p)(A+B\gamma_5)u(P_\Lambda)$$

. where A and B are functions of masses of the three particles.

Show that a term like $\bar{u}(P_p)(C\gamma_\nu P^\nu{}_\pi)u(P_\Lambda)$ and$\bar{u}(P_p)(D\gamma_5\gamma_\nu P^\nu_\pi)u(P_\Lambda)$ can be converted to terms of the form A and B.

$u(P_\Lambda)$ obeys $(\gamma_\nu P^\nu_\Lambda - m_\Lambda)u(P_\Lambda)=0$ and a similar equation for the proton spinor.

23. Calulate the decay rate for $\Lambda^0\rightarrow p+\pi^-$ where we sum over the final spins of the proton and average over the initial spin of Λ^0. (Use the expression given in Problem 22.)

24. Is parity conserved in this reaction (Problem 23)? If so why? If not why?

25. From the momentum dependence (in terms of $\vec{P}_\pi$) of decay rate calculated in problem 23, what can conclude about the angular momentum of the outgoing particles?