PHYS 560: Assignment 1

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Abstract

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1 Question 1: Isospin

In addition to the nucleons, pions and nucleon resonances we have talked about in class there are other strongly interacting particles. There are hadrons that contain one or more quarks that are not up or down. The Σ^*, Σ and Λ are hadrons that carry the strangeness quantum number. Both the Σ^* and Σ have isospin $I = 1$, while the Λ has $I = 0$.

1. Find the tensor S_{ab} that contains the Σ fields using the techniques presented in class.

2. Assuming exact isospin symmetry, find the relations between the decay rates for $\Sigma^{+*} \to \Sigma^0 \pi^+$ and $\Sigma^{-*} \to \Sigma^- \pi^0$. Check your result by using both methods outlined in class.

3. Can these rates be related to that for $\Sigma^* \to \Lambda\pi$ by isospin? If so what are the relations?

2 Question 2: Kinematics

2.1 Resonance Production

A beam of π^+'s is incident upon a hydrogen target at rest in the laboratory. Find the minimum beam energy required to produce a Δ resonance. Use $m_\pi = 140$ MeV, $M_p = 940$ MeV and $M_\Delta = 1230$ MeV.

2.2 Pair Production

A proton beam is incident upon a hydrogen target at rest in the laboratory. Find the minimum beam energy required to produce an anti-proton, $\overline{p}$ (which has the same mass as the proton by CPT).