The $\Sigma^0$-hyperon decays electromagnetically in the mode $\Sigma^0 \rightarrow \Lambda + \gamma$. Show how the relative parity of $\Sigma^0$ and $\Lambda$ determines the multipolarity of the $\gamma$-ray emitted. From the polarization vector $\epsilon$ of the photon, and the propagation vector $k$ and spin $\sigma$ of the $\Lambda$, deduce the simplest forms for the matrix element for even or odd relative parity. The experimental determination of the $\Sigma$-$\Lambda$ parity has been based on the analysis of the Dalitz decay $\Sigma \rightarrow \Lambda e^+ e^-$. Which of the parity assignments has the steeper distribution in the invariant mass of the $e^+ e^-$ pair?

Sketch the favored orientations of the photon polarization $\epsilon$ supposing the $\Lambda$ spin $\sigma$ is $\perp$ to the momentum vector $k$ (in $\Sigma^0$ rest frame, of course).

The intrinsic parity of the hyperon $\Xi^-$, of strangeness $-2$, can in principle be determined from observations on capture in hydrogen from an $S$-orbit:

$$\Xi^- + p \rightarrow \Lambda + \Lambda.$$  

The polarization of the $\Lambda$-hyperons can be determined from the asymmetry in the weak decay $\Lambda \rightarrow p + \pi^-$ (see Section 7.7). State what is the polarization (if any) of the $\Lambda$s produced in the above reaction and how the relative polarizations are determined by the $\Xi$-parity.

a) Find a relation between the total cross-sections (at a given energy) for the reactions

$$\pi^- p \rightarrow K^0 \Sigma^0,$$

$$\pi^- p \rightarrow K^+ \Sigma^-,$$

$$\pi^+ p \rightarrow K^+ \Sigma^+.$$

b) Deduce through which isospin channels the following reactions may proceed: (a) $K^+ + p \rightarrow \Sigma^0 + \pi^0$, (b) $K^- + p \rightarrow \Sigma^+ + \pi^-$. Find the ratio of cross-sections for (a) and (b), assuming that one or other channel dominates.