CHAPTER VIII

Determination of the Spin of the Second Excited State in \( ^7\text{Li} \).
In ref. (1) Ramachandran has suggested to use linearly polarized photons parallel and perpendicular to the production plane for the photoproduction of \( \pi^0 \) meson on \(^7\)Li in the elastic as well as in the inelastic channels to determine the form factors \( F_{1e}, F_{2e} \) and \( F_{2p} \).

However, we note that the spin-parity of the second excited state in \(^7\)Li is rather ambiguous being \( \leq 7/2 \) and to determine the form factor terms empirically it would be necessary to ascertain the spin of the second excited state in \(^7\)Li. In this chapter we have suggested a method to ascertain the spin of the second excited state in \(^7\)Li, by making measurements of the differential cross-sections for \( \pi^0 \) meson photoproduction on \(^7\)Li leading to this second excited state using linearly polarized photons parallel to or perpendicular to the production plane and comparing these measurements with the experimental results obtained in the case of \( \pi^0 \) photoproduction on nucleons.

We note from eqns. (1.18) to (1.21)

\[
(8.1) \left( \frac{d\sigma}{d\omega} \right)^{L_z}_{\pm} = \frac{9}{2} \left[ 6 \left( \frac{17}{45} F_{2p} \right)^2 L L_L^2 + \frac{4}{3} \left( \frac{37}{45} F_{2p} \right)^2 \left( R^2 \right) \right]
\]
(3.2) \( \left( \frac{d\sigma}{d\alpha} \right)_{L^1}^{L^1} = \frac{9}{2} \left[ 36 \left( \frac{37}{45} F_p \right)^2 L L^* + \frac{2}{21} \left( \frac{37}{45} F_p \right)^2 (k^2 k^*)_L \right] \). 

As in eqn. (6.3)

\[
(k \cdot k^*)_L = \frac{2}{21} \left( \frac{d\sigma}{d\alpha} \right)_L - \sum \frac{LL^*}{7}
\]

and using eqns. (6.4) to (6.6) we have

(3.3) \( (k \cdot k^*)_L = \left[ \frac{2}{21} \left( \frac{d\sigma}{d\alpha} \right)_L - \sum \frac{LL^*}{7} \right] (90^\circ) (1 + \Sigma (90^\circ) - \frac{1}{4} \left\{ \sqrt{\frac{d\sigma}{d\alpha} (0^\circ)} + \sqrt{\frac{d\sigma}{d\alpha} (180^\circ)} \right\}^2 \sin^2 \theta \)

while

(3.4) \( (LL^*)_L = \sum \frac{LL^*}{7} \)

Therefore

(3.5) \( \left( \frac{d\sigma}{d\alpha} \right)_{L^1}^{L^1} = \frac{80}{21} \left( \frac{37}{45} F_p \right)^2 \left\{ \left( \frac{d\sigma}{d\alpha} \right) (90^\circ) (1 + \Sigma (90^\circ) - \frac{1}{4} \left\{ \sqrt{\frac{d\sigma}{d\alpha} (0^\circ)} + \sqrt{\frac{d\sigma}{d\alpha} (180^\circ)} \right\}^2 \sin^2 \theta + \frac{46}{21} \left( \frac{37}{45} F_p \right)^2 \left( \frac{d\sigma}{d\alpha} \right)_L \right) \right] \)
In eqns. (3.5) and (3.6) the first terms differ considerably whereas the second terms are nearly the same. Therefore from eqns. (3.5) and (3.6) it would be possible to determine the spin of the second excited state in $^7\text{Li}$ by making measurements of differential cross-sections for inelastic $\gamma\gamma$ photoproduction on $^7\text{Li}$ leading to the second excited state with linearly polarized photons parallel or perpendicular to the production plane.